# Open Educational Resources and Virtual Reality: An inventory

Sergej Görzen [1], Birte Heinemann [1], Marlene Heim, Ulrik Schroeder [1]

**Abstract:** Virtual reality (VR) in education is a current field of research, e.g. because it provides an immersive and safe learning environment for dangerous or expensive training. But developing VR learning applications is time-consuming and costly. The development of open educational resources (OER) can facilitate educators' access to VR and help integrate technology into everyday education. This paper presents the current state of open educational resources in virtual reality and discusses the possibilities and challenges of combining VR and OER.

**Keywords:** Virtual Reality, Extended Reality, Open Educational Resources

## 1 Motivation: Open Education Resources and Virtual Reality

Open Educational Resources (OER) are materials for research, learning, and teaching in any medium under an open license that allows reuse and re-purpose, adaption, and redistribution with no costs, according to the UNESCO Forum [Un02]. OER can be single materials, like textbooks, videos, tests, software, or entire courses. The creation of educational material is complex, dealing with learning goals, methods, and teaching and learning preferences. In line with this, is the creation of learning applications for VR a difficult task because of the diverse requirements of an educational VR application. Moreover, according to [Ra20], although there is an increasing interest in using VR technologies for educational purposes, the exchange of experiences to integrate this technology into the educational context is low. This fact indicates the need for shareable and open resources for educational VR applications, which connects the two main topics of this paper VR in education and OER.

For the related technology Augmented Reality (AR) [Mi94] the first steps are already taken in adapting AR resources as OER. For example, [OE20] shows one possibility to use OER assets for AR. However, downloading OER content into an application is not the only possibility to connect OER and VR/AR. There were also experiments in combining OER and VR by creating scenarios with 360° OER materials [Be19], [St20], and [To18]. Another compelling use case could be considered interactive educational 3D VR scenarios as OER. Although there are several educational XR (eXtended reality, in other words, AR or VR) applications that are open source, most of them cannot be found as explicit "*Open*

[1] RWTH Aachen, Informatik 9, Ahornstr. 55, 52074 Aachen, {goerzen, heinemann, schroeder}@cs.rwth-aachen.de, https://orcid.org/{0000-0003-3853-2435, 0000-0002-7568-0704, 0000-0002-5178-8497}

doi: 10.18420/delfi2022-ws-73

*Educational Resources".* Using OER portals (like oercommons.org) combined with the keyword *Virtual Reality* ends up with specific components like 3D models, articles, or PowerPoint slides instead of ready-to-use applications. There is no OER portal for XR content. Further, the creation of VR OER content merges the challenges of both. Here, some guidelines and tools may give some support. However, the community still lacks concrete guidelines for creating VR for educational purposes [Fo15]. Combining XR and OER could make this task easier because the software and several VR components are designed for openness and reusability. There is a holistic conceptual framework for creating open XR content in [Ab21] by covering pedagogical, technical, and administrative perspectives. But the previously mentioned problem of finding explicitly VR OER is still unsolved. To target this issue, it is necessary to get an overview of current existing open educational XR applications by questioning: *What is the status of XR in education without focusing on the individual components like 3D models of XR applications?* To answer this, we searched and then classified the results.

## 2 Challenges

The combination of OER and VR challenges the developers and users of educational VR scenarios. Creating educational material, especially VR apps, is both time-consuming and expensive. Although immersive VR technologies for educational purposes have overall promising results, in most domains, VR is still experimental, and its usage is not systematic or based on best practices. Learning theories were often disconnected, and evaluation focused mainly on usability. Better evaluation procedures are claimed, and a recommendation is that future VR development for higher education needs to be built on existing experiments [Ra20]. Here it would also help to reuse existing evaluated resources.

In open projects, developers can assume they can use material resources freely. But in some cases, there is no explicit license information about its' assets. As a VR application is software itself, it should mainly follow the concept of FOSS (free/open source software), which follows four types of freedom: freedom to (1) run the program for any purpose, (2) study how the program works and adapt it to your needs, (3) redistribute copies so you can help your neighbor and (4) improve the program, and release your improvements to the public so that the whole community benefits [Gnu05]. The software referred by FOSS can be adapted by assets and code. However, clearly defined legal software resources are essential and valuable. Combining the need for clear licensing structures and technical demands, Creative Commons (CC) [2] come into play.

Creative Commons standardizes the public permissions to creative work (science, film, literature, music, photography, etc.) in six different license types (and the public dedication tool CC0). Only four of them fit the principles of OER: *CC BY, CC BY-SA, CC BY-NC, CC BY-NC-SA* (and *CC0),* where the elements *BY* (Credit must be given to the creator)*, SA* (adaption must be shared under the same terms) and *NC* (only noncommercial uses) define the usage rules of the resources. But in software projects, some resources may

[2] https://creativecommons.org/about/cclicenses/, accessed: 21/06/2022

be restricted and could break license chains, as FOSS is provided on an "AS IS" basis without any warranty [Li06]. Further, considering CC of OERs (excluding CC0), they all need to give credit to the creator (BY). Thus, these materials are only allowed to be used in licenses where the copyright shall be provided, like in GPL (General Public License) and LGPL (Lesser GPL) licensed software [Li06]. Licenses with more freedom (e.g., BSD license or MIT) are only compatible with CC0. Based on this fact, bringing VR and OER together challenges the creator with the question: *How should VR learning scenarios be licensed?* On the one hand, the learning interactions are written as software and can be licensed under FOSS. On the other hand, it may make sense to reuse existing evaluated Open Educational Resources in learning scenarios, potentially breaking the chosen FOSS license. Also considering [Hy06], one challenge is the quality assurance of VR OER content. The quality can be ensured by doing e.g. peer review. But the quality of resources is fundamental and too depth to be dealt with quickly. Instead, [Hy06] proposed four quality management processes for OER initiatives: quality management can variate to be open, closed, centralized, or decentralized and be led by peer review, user comments and ratings, internal quality procedures, and the word-of-mouth method. For example, the most used method in academic communities is peer review. In VR OER content, how the quality was proved should be transparent. This fits with the claim of [Ra20] of reusing evaluated material. In addition, resources being evaluated based on previous research with solid connections to learning theories may increase the sustainability of the created OER.

Another problem is that some (and not only) OER projects have strong institutional backing with expiring funds. This fact makes long-term initiatives difficult, and the sustainability of OER suffers. Developing a solid user community seems effective because it bundles connections on the community website and enables rapid sharing. Users return to the repository, and institutions can learn from the community (user comments and ratings). [Hy06] While many domains are experimental [Ra20] and using VR for educational purposes is not broadly used, for example, like presenters, VR learning interventions might remain challenging to find. These indicate the need for a centralized repository for educational VR applications with a strong community.

## 3 Related approaches

For such a repository, like the one described in the section before, it is necessary to get an initial overview of educational XR (VR and AR) applications. Two related approaches are shown in this section, which summarizes educational XR applications and discusses their problems and limitations shortly. After that, we explain how we started to create a first overview of our list of applications.

One approach to creating an overview of VR (and AR) in education from 2020 is the COPLAR guide (german: *COPLAR-Leitfaden*). [GFH21] collected different 49 learning


Fig. 1: The Land of Immersion [GFH21]

scenarios within a project and cooperated with the COPLAR community. They used the collection to classify the projects concerning their learning goals and the help of 17 variables, which created three groups: technic, setting, and didactics. OER is none of the categories chosen by the team. They end up in the XR application categories: *science, authoring, objects and environments, motor skills, dummies, ethics, situations, safety, competence, social,* and *assistance*. Finally, they placed all applications on a colored land map and published them in a filterable online table[3]. As a result, the presented *Land of Immersion* (see Fig. 1) looks colorful and impressive. However, we see limitations in this approach: [GFH21] argue that a map must be updated each time new work appears, which is very time-consuming. The categorization is problematic, too. Some applications could be two of the categories at the same time. For example, the *VR Classroom* [Wi19] is placed on the *social* area. Despite that this application is enhancing teachers' competencies. Thus, the application could also be located in the *competence* area.

Another approach was made by the Virtual Human Interaction Lab at Stanford University. They asked 311 households what VR applications their children use and got a list of 169 VR applications. Based on their study [Ma22], they created a web-based interactive overview[4] (see Fig. 2) and called it *Educational VR Applications Database*. It is grouped into six categories: languages, physical education, social science, STEM, visual and performing arts, and multiple categories. Each application is represented by a colored box. The size and color strength depends on the number of households that used the application. Interactively, a mouse hover can be used to also see the application name and number of households. It's possible to download the list of applications from a Google Docs table. The bottom of the webpage displays a table with the application name and description. By clicking on a button next to the application name, the user can see the assigned categories of each application. This approach delivers a bunch of categorized applications, but the

[3] https://mediencommunity.de/coplar-leitfaden, accessed: 04/09/2022
[4] https://www.stanfordvr.com/edvrapps/, accessed: 04/09/2022

main issue with this approach is that this collection contains VR applications that are not educational (e.g., *Beat Saber*). Therefore, they do only have an „educational value“, which strongly depends on how you define an educational value.

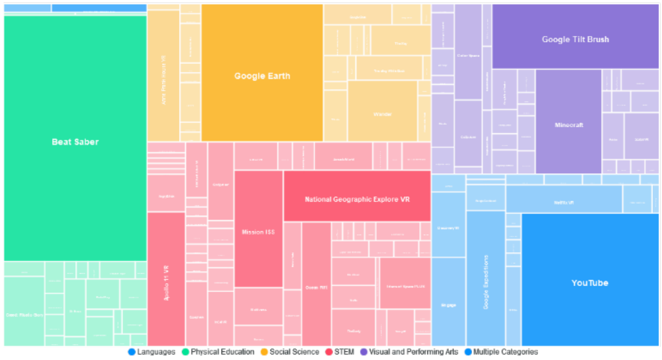


Fig. 2: Screenshot of the interactive Educational VR Applications Database [Ma22]

## 4 Own approach

To gain a clear insight into the current state of open educational XR applications, we conducted small pilot research in the scope of a seminar project in the German winter semester of 2021/2022. After trying to find projects with the keywords *Open Educational Resources*, *OER*, and *Virtual Reality*, we have not seen the desired results. Therefore we shrink the search for VR applications that aim to be used for educational purposes. Thus we have left licensing out of the search query for the time being and instead searched on OER platforms. Finally, we used the keywords *virtual reality, VR,* and *360* at the portals *edutags.de*, *bildungsserver.de/elixier,* and *Google.* Furthermore, we added some known open VR projects. We ended up on a list of 63 educational VR applications. We identified 11 categories*: tutoring, computer science, geography, chemistry, physics, biology, medicine, art and culture, history, storytelling,* and *space (astronomy)*. In scope of the seminar a visualization was created to bundle the results. It is inspired by *The periodic table of IOS Apps for AR and VR* [5]. Every panel displayed its’ logo, developer, source, categories, educational levels and their application types (software features), see Fig. 3.

The pure application itself can be used with CC licenses, while FOSS are used for the code and software. Both regulate the degree of public permissions and the copyright of creative work. *RePiX VR* uses both licenses [HGS22]. The *VR classroom* [Wi19] is published using a *GNU Affero General Public License*. However, as the research was a student project, the scope and time were limited. Moreover, the complete visualization [Goe22] lucks visual issues: the location order was arbitrary, and the possibilities for extension were limited to

[5] https://ictevangelist.com/the-new-periodic-table-of-ios-apps-for-ar-and-vr/, accessed: 04/09/2022

the field of view of the image (similar to the Land of Immersion [GFH21]). Therefore, we created a website [6] with an interactive table where the criterias mentioned can filter the application list.

Another limitation our approach is that there are still projects that could not be found by various concatenations of words such as *Education, Learning, Virtual Reality, OER,* or *Open educational resources*. For expansion, the applications used in [GFH21] could be asked to publish their licenses, which are not communicated by all. To find a comprehensive picture of the currently available applications, one can still search for specific reviews, such as [Pi20], to add these applications onto our list.

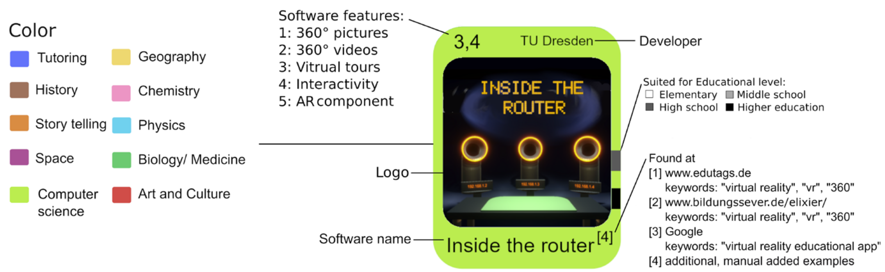


Fig. 3: Initial concept how to visualize the educational VR applications. Referenze for the example: Inside the router [Ba22]

## 5 Conclusion

Creating educational material (especially in XR) is complex. One solution to reduce this complexity is to use OER inside of VR and use VR resources as OER. This paper discussed roughly some challenges of this combination and highlighted the need for a repository for open educational VR resources (and applications). Although some first contact points exist for XR and OER, XR applications are still rare in OER communities. To contribute towards this, this paper discussed two existing educational XR application collections and presented an initial approach where 63 educational VR applications were classified. Besides broader systematic research of more applications, further research will tackle to bring VR and OER together. This combination could regulate the openness and license of VR resources and support the reusability and sustainability of VR learning outcomes and resources. This could reduce the complexity of VR content creation, because new work can be based on existing work.

[6] https://xr-oer.elearn.rwth-aachen.de/, accessed: 09/09/2022

## Bibliography

[Ab21] Abeywardena, I.: Open Extended Reality for Education Framework (OXREF): Mainstreaming XR through Institutional Collaboration. 2021.

[Ba22] Baberowski, D.; Keerl, N. M.; Lilienthal, L.; Rieske, M. E. J.; Leonhardt, T.: Inside the Router. eleed 14/2, 2022, issn: 1860-7470.

[Be19] Berti, M.: Italian Open Education: Virtual Reality Immersions for the Language Classroom. In. S. 37–47, Juli 2019, isbn: 978-2-490-05751-1.

[FO15] Freina, L.; Ott, M.: A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives. In: Proceedings of eLSE ’15. Bucharest, Romania, 2015.

[Fo15] Fowler, C.: Virtual Reality and Learning: Where Is the Pedagogy?: Learning Activities in 3-D Virtual Worlds. British Journal of Educational Technology 46/2, S. 412–422, März 2015, issn: 00071013.

[GFH21] Goertz, D. L.; Fehling, C. D.; Hagenhofer, T.: COPLAR-Leitfaden - Didaktische Konzepte identifizieren Community of Practice zum Lernen mit AR und VR. SVL 2020/, März 2021.

[Gnu05] What is Free Software?, GNU Project – Free Software, 2005 https://www.gnu.org/philosophy/free-sw.html.en, accessed: 01/09/2022.

[Goe22] Görzen, S.; Heinemann, B.; Heim, M.; Schroeder, U.: Overview of Open Educational VR applications for the paper 'Open Educational Resources and Virtual Reality: An inventory', 2022, https://publications.rwth-aachen.de/record/853347, accessed 08.09.2022

[HGS22] Heinemann, B.; Görzen, S.; Schroeder, U.: RePiX VR - Learning Environment for the Rendering Pipeline in Virtual Reality. In (Bourdin, J.- J.; Paquette, E., Hrsg.): Eurographics 2022 - Education Papers. Reims, France, 2022.

[Hy06] Hylen, J.: Open Educational Resources: Opportunities and Challenges. Proceedings of Open Education/, S. 49–63, Jan. 2006.

[Li06] Lin, Y.- H.; Ko, T. - M.; Chuang, T. -R.; Lin, K.-J.: Open Source Licenses and the Creative Commons Framework: License Selection and Comparison./, S. 17, 2006.

[Ma22] Mado, M.; Fauville, G.; Jun, H.; Most, E.; Strang, C.; Bailenson, J. N.: Accessibility of Educational Virtual Reality for Children during the COVID-19 Pandemic. Technology, Mind, and Behavior 3/1, 15. März 2022, issn: 2689-0208.

[Mi94] Milgram, P.; Takemura, H.; Utsumi, A.; Kishino, F.: Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum. Telemanipulator and Telepresence Technologies 2351/, Jan. 1994.

[OE20] OERinfo, OER for Augmented Reality (AR) Education, 2020, https://open-educational-resources.de/oer-for-augmented-reality-ar-education/, accessed: 24/07/2022.

[Pi20] Pirker, J.; Dengel, A.; Holly, M.; Safikhani, S.: Virtual Reality in Computer Science Education: A Systematic Review. In: 26th ACM Symposium on Virtual Reality Software and Technology. ACM, Virtual Event Canada, S. 1–8, Nov. 2020, isbn: 978-1-4503-7619-8.

[Ra20] Radianti, J.; Majchrzak, T. A.; Fromm, J.; Wohlgenannt, I.: A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda. Computers & Education 147/, S. 103778, Apr. 2020, issn: 0360-1315.

[St20] Stepanov, D.; Towey, D.; Chen, T. Y.; Zhou, Z. Q.: A Virtual Reality OER Platform to Deliver Phobia-Motivated Experiences. In: 2020 IEEE 44th Annual Computers, Software, and Applications Conference (COMPSAC). IEEE, Madrid, Spain, S. 1528–1533, Juli 2020, isbn: 978-1-72817-303-0.

[To18] Towey, D.; Walker, J.; Austin, C.; Kwong, C.-F.; Wei, S.: Developing Virtual Reality Open Educational Resources in a Sino-Foreign Higher Education Institution: Challenges and Strategies. In: 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE). S. 416–422, Dez. 2018.

[Un02] UNESCO, Open Educational Resources, 2002, https://www.unesco.org/en/communication-information/open-solutions/open-educational-resources, accessed: 24/07/2022.

[Wi19] Wiepke, A.; Richter, E.; Zender, R.; Richter, D.: Einsatz von Virtual Reality zum Aufbau von Klassenmanagement-Kompetenzen im Lehramtsstudium. In: DELFI 2019. Gesellschaft für Informatik e.V., 2019, isbn: 978-3-88579-691-6.