The Use of Virtual Reality to Drive Innovations. VRE-IP Experiment

Yulia Skrupskaya[1](✉), Valeriia Skibina[2], Victor Taratukhin[3], and Elvira Kozlova[1]

[1] National Research University Higher School of Economics, Moscow 101000, Russia
yubskrupskaya@edu.hse.ru
[2] Lomonosov Moscow State University, Moscow 119991, Russia
[3] University of Muenster, 48149 Muenster, Germany

Abstract. In the context of widespread digitalization of businesses and academia due to COVID-19, the new effective tool has become necessary to drive innovations. This paper observes the international scientific experiment VRE-IP that tested the hypothesis of the advantages of using virtual reality for teamwork, creativity, and innovation. VRE-IP experiment was based on design thinking methodology and supported SAP innovation process. The analysis of the trends of using virtual reality for educational and business development goals, and VRE-IP experiment revealed that employing virtual reality technology to organize workshops, distant meetings, plenary reports, and other tasks is exceptionally efficient, improves the engagement rate and creativity and contributes to the process of innovative ideas stimulation. The experiment also demonstrated the need for building a hybrid model for teamwork. The combination of traditional teamwork instruments and virtual technologies is proposed as the most sustainable and systematic model for online collaboration at the current stage of technological development.

Keywords: Virtual reality · Digital transformation · Design thinking

1 Introduction

The COVID-19 pandemic 2020 had a strong impact on different spheres of life especially on education since universities were forced to adjust to new reality with remote education. In most cases, the learning process was based on the use of platforms for virtual meetings, such as Zoom and Microsoft Teams (Navleen 2020). These platforms were originally created for video conferencing and work calls, and therefore they were not specialized for teaching and gaining knowledge. Interaction between students and teachers has become a routine process consisting only of presentations, questions and answers. The necessity to adapt to new learning conditions lead to the search for innovative solutions that would contribute to the improvement of the student productivity. Distance learning opens the new opportunities for educational processes. However, now there are no methodologies and studies demonstrating new options for obtaining and submitting educational material and their feasibility of implementation. The scientific novelty and practical significance

V. Taratukhin et al. (Eds.): ICID 2021, CCIS 1539, pp. 336–345, 2022.
https://doi.org/10.1007/978-3-030-95494-9_28

of the work is the hypothesis that the use of virtual reality in the process of remote learning will positively affect the speed and quality of learning and increase motivation to learn.

1.1 Application of Virtual Reality Technologies in Education

The development of virtual reality has led to various experiments of its practical application, including integration into the educational process. There are a few reasons for the research on the impact of virtual reality technologies on education. Firstly, the experience of practical application in other industries shows positive dynamics and optimization of processes. Virtual reality is used in the oil and gas industry, metallurgy, telecommunications, and advertising, gradually moving away from being used only in the gaming industry (Krayushkin 2021). Secondly, over the past few years, the average cost of technical equipment has decreased (The Economist 2020). Increasing availability of virtual reality devices has a positive effect on the growth of the audience interested in the technology.

1.2 VR Programs

There are many programs on the virtual reality market that are suitable for educational purposes (Smith 2021). Most of them have the same minimal functionality: the presentation demonstration, whiteboards, conference halls. However, there are also specialized programs for training in narrow professional or subject areas. At the first step of the experiment, we analyzed the most popular communication virtual reality applications for the further use during the experiment.

Spatial: a virtual reality program created for video conferences (Spatial 2021). Spatial allows users create realistic avatars by transferring their appearance to a virtual environment. It provides an opportunity to receive and exchange information (images, pdf files) inside a virtual environment. The application monitors the position of the hands using a controller during immersion in a virtual environment, users can see the gestures during a dialogue. The conference limit of participants equals 40 individuals. The tools include a whiteboard for writing and drawing using controller, speech notes, and a virtual keyboard.

Meetinvr: a platform that provides a virtual space for meetings and conferences, allowing users to work together on presentations, notes and mind map diagrams (Meetinvr 2021). Maximum 32 users can be present in the presentation hall at the same time. The advantages of Meetinvr: the ability to provide access to pre-uploaded files, visualize PowerPoint files, whereas in most virtual conference applications only PDF format is available. The Meetinvr application is not free but it has a trial version for a month of free use with some restrictions on functionality. VR headsets that could be used with Meetinvr are limited to: Oculus Quest, Oculus Quest 2, Pico Neo 2 and Pico Neo 2 Eye.

Rumii: the most accessible and free program for various types of VR headsets (Rumii 2021). In every meeting hall there is a large multifunctional central screen on one of the walls of the three-dimensional room. The user can activate the screen: a whiteboard, access to the Internet or a demonstration of a PDF file or images. The user's avatar is more animated compared to other applications and is created manually by the user. The

maximum capacity of the virtual hall in the application Rumii is 20 active users, which is suitable for group work.

All the three programs are the examples of widely applicable applications in the learning process. The essential characteristics for us were the capability to interact with 10 users at the same time, make smaller rooms, make and then later present projects inside virtual reality, record the interaction process, compatibility with the Oculus Go virtual reality headset. Thus, the application Rumii was chosen for the further experiment.

1.3 Methodology of Design Thinking

The first paragraphs that follows a table, figure, equation etc. does not have an indent, either. All the three programs are the examples of widely applicable applications in the learning process. The essential characteristics for us were that the Design thinking is based on a creative approach to solving tasks, it differs a lot from analytical techniques that include critical analysis (Leifer 2016). One of the main parts of this methodology is teamwork. That why is why there could be an assumption that design thinking in team projects would have a positive impact on the results of students (Taratukhin et al. 2020). The methodology of design thinking in the approach to problem solving that includes five stages (Leifer 2016).

1. Empathize. This stage includes observation, engagement, and immersion. The team studies the intended users of the final solution, meets, and communicates with them, learns what kind of experience users get and what problems they go through.
2. Define. At the second stage of design thinking, it is necessary to focus on and define a specific problem. This can be done by achieving two goals: understanding the target audience and the user of the final product and determining the POV (point- of-view) and further tasks based on the understanding of the user.
3. Ideate. This stage usually begins with brainstorming – a way to find a large number of ideas through teamwork and collective reflection on the task in a short time. Then the ideas can be selected by voting, thereby narrowing the range of solutions for further prototyping.
4. Prototype. Prototyping is a part of implementation process. The selected ideas are implemented in the real world using improvised means. Anything can become a prototype, for example, a wall in paper stickers or a rough version of the application interface. Design thinking does not limit the freedom of actions and manifestations of imagination at all stages.
5. Test. The testing stage is aimed at improving solutions to the problem. Testing is usually carried out repeatedly, interactively and in real conditions. Testing usually involves demonstration of prototypes and getting feedback from users.

Design thinking is applied in various fields and has no limitations (Leifer et al. 2019). According to our hypothesis, the application of design thinking methodology in distance learning processes can have a positive impact on the interaction of students in a team.

2 Description of the Experiment

The experiment was based on the hypothesis that the introduction of virtual reality technologies into the learning processes will help to increase the productivity of students and reduce the routine of processes, which, in turn, will lead to more successful and high results compared to traditional distance learning processes (Dzardanova et al. 2021). VRE-IP experiment was organized jointly with the University of Muenster (ERCIS - University of Muenster) and SAP University Alliances. Students from different cities and universities such as Lomonosov Moscow State University, National Research University Higher School of Economics (HSE), Wilhelm University of Westphalia (University of Muenster), Norilsk State Industrial Institute, Arctic and Antarctic Research Institute, Stanford Janus Project (Stanford Project Janus) participated in the project. The students were divided into 4 groups of 2 people. Three groups used virtual reality technologies – glasses and the Oculus Go controller, Rumii program. The remaining group was a focus group and used the traditional methods of remote interaction – Zoom, Telegram and Google Slides. Group division was necessary for the further comparison and analysis of the results at the end of the experiment to find a connection between the results of the participants and the use of virtual reality technology. Surveys were conducted among students before and after the experiment.

The experiment was an accelerated version of the hackathon – the event when the teams solve a task with a time limit (Taratukhin et al. 2021).

The duration of the experiment was limited to 2 days. On the first day there was the introductory lecture and task announcement. On the second day the teams demonstrated their work. Intra-team interaction was carried out throughout the experiment. The introductory lecture was held in Zoom. The interaction of the participants within the three teams was carried out using virtual reality technologies. This allows us to assess the presence of the impact of VR implementation on student productivity and improving the quality of team interaction at a distance.

The final team presentations at the end of the experiment were shown in the environment in which they interacted during the experiment. The completion of the hackathon and the announcement of the results of the participants' speeches took place in Zoom.

2.1 Preparation for the Experiment

During the preparation of the experiment, instructions were developed for quick and easy cooperation. The instructions described the sequence of actions required during the installation and use of the program Rumii. The survey was also created for the participants of the experiment to obtain information about their expectations from virtual reality technologies, as well as their experience in distance education. The main task for the participants during the experiment was to offer solutions to the environmental problems: recycling plastic waste and reducing CO2 emissions. A lecture on the methodology of design thinking was prepared and presented before the hackathon to all participants of the experiment. It contained all the necessary information about the approach of design

Fig. 1. Participants of the experiment wearing Oculus Go Headsets.

thinking in solving problems and described the stages of design thinking on which it was necessary to rely during the solution of the problem.

In the Rumii application, three separate halls for each team were created. The team members could stay in this hall for an unlimited amount of time during the experiment. The participants were not limited in the possibility of using any programs and communication methods convenient for interaction.

Participants were offered a survey after the first day of using the technology in order to form an idea of the first impression of virtual reality technology, another survey at the end of the experiment contained questions aimed at obtaining detailed feedback from the use of the new technology.

2.2 Experiment

The initial purpose of the experiment was to receive feedback on remote interaction through the use of virtual reality technologies, and to compare it with conventional distance education processes by involving a focus group in the experiment. Given that the Oculus Go virtual reality headsets have a limited operating time without connecting to batteries. Teamwork according to the experiment schedule was limited to 1–2 h. It was followed by a break for charging/recharging devices. Thus, the participants totally spent an average of 4.5 h in virtual reality. The rest of the team interaction took place in Telegram messenger and Zoom application.

After the beginning of the practical part of the experiment, some participants had a problem connecting to Rumii, they had black screen when trying to enter previously

created conference halls and returning to the main screen of the program. The occurrence of this problem might have been due to both the instability of the Internet connection and the technical characteristics of the selected devices - Oculus Go has weaker characteristics compared to other Oculus devices. Due to the technical characteristics of virtual reality headset, there is also a problem of overheating after an hour and a half of the use. The problem was observed in 100% of the participants of the experiment.

During the experiment, after the initial setup of virtual reality devices and gaining access to the halls for team interaction, there were no massively encountered problems. During the preparation of presentations of their projects to solve the problem of ecology, most of the participants used a hybrid format of interaction, using virtual reality technologies and other methods of remote interaction. For example, the program Rumii does not allow you to create and edit presentations, so participants used Google Slides to create presentations. The participants preferred virtual reality to be used at such stages of design thinking as empathy, focusing, generating ideas, and choosing the best one. In other words, all the teams preferred team interaction with the help of the virtual reality program Rumii and used it during the need for intensive interaction and dialogue. Also, Rumii allows to draw inside a virtual environment, so the participants used this function on a white board inside the virtual hall to mark the main points of discussion and ideas. At the prototyping stage, the participants used programs for design and prototyping: Figma, Miro, Wireframepro.

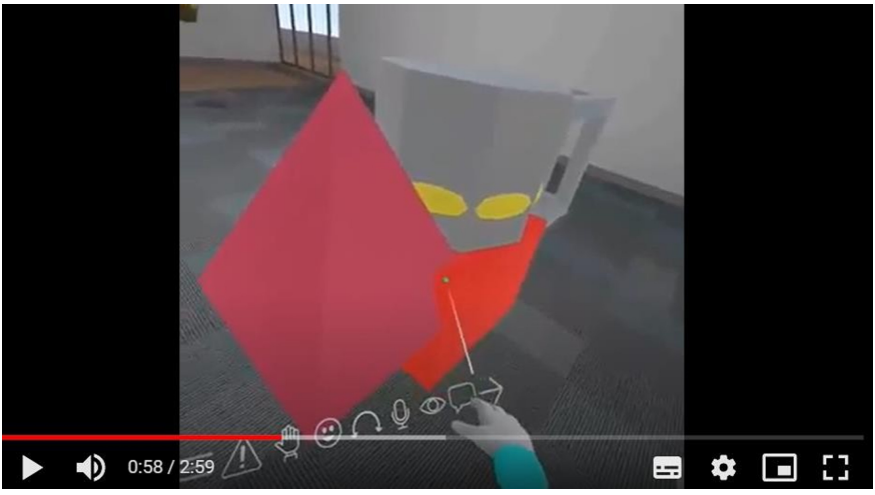

Fig. 2. Modeling in VR.

Increase in concentration was found among the participants when virtual reality technologies were introduced into the interaction process. For example, according to the results of the survey the pronounced change in the distribution of self-concentration is noticeable. For the lecture, which was held at Zoom, half of the participants chose a score below or equal to 5 out of 10, and the average concentration score among all participants was 8.25 out of 10. If we talk about the evaluation of team interaction, then all scores

exceed or equal to 6, and the average score among all participants takes the value of 8.25. In connection with the results obtained, it is possible to confirm the assumption of increased concentration and attention when using virtual reality technology in distance learning processes. One of the reasons explaining such a result is the impossibility of losing attention due to surrounding distractions: a smartphone or a book. Being in virtual reality, the user is completely detached from the real world around him, unable to pick up a smartphone or simultaneously engage in third-party business. Virtual reality requires the user to be completely immersed in the process, thereby reducing the impact of third-party stimuli. The second reason is the novelty of the participants' feelings from immersion in a virtual environment. The participants had not previously used virtual reality technology. The use of virtual reality during the experiment reduced the routine of interaction processes, thereby increased the interest of participants in what was happening.

Moreover, it is worth noting that the participants spoke positively about team interaction. According to the participants' feedback on the comfort of interacting with each other, the average score of the participants takes the value of 9, which is a good indicator, close to the maximum possible value 10. From this it can be assumed that most of the participants received positive impressions from the use of virtual reality technology in order to solve the task as a team.

Fig. 3. Three-dimensional representation of virtual reality in the program Rumii.

At the end of the experiment, 66% of participants rated the virtual reality technology as promising and are looking forward to unlocking the potential in the field of distance education.

The results of the experiment demonstrate the success of integrating virtual reality technologies into the process of remote team interaction, the ultimate goal of which is to obtain a solution to the task. The participants of the experiment speak positively about the technology used and note an increase in motivation due to the new sensations of immersion in a virtual environment.

The practical use of virtual reality technology in the educational process confirms the hypothesis of improving the built remote process. There is a clear connection between an increase in interest in receiving and working with information, as well as an increase in direct motivation motives among the participants of the experiment, and the integration of virtual reality technology.

Some of the disadvantages were also revealed such as poor Wi-Fi connection which delayed some steps of the design thinking, overheating, inability to arrange and take surveys inside virtual reality, the participants also noted that it was quite difficult to draw using the remote control on the board, the absence of the eraser. The last major disadvantage was fatigue. Even though VR glasses were quickly discharged, during this short period of time, the participants became very tired.

The experiment demonstrated the feasibility of building a hybrid model of distance learning using virtual reality technologies. The participants of the experiment were not ready to use virtual reality throughout all stages of the experiment, and, in addition to the virtual environment, they used other technologies previously used in distance learning.

2.3 Recommendations for Integrating Reality into Learning Processes

It was revealed that the optimal solution for improving distance education processes is the integration of a hybrid learning model. The list of recommendations might be useful for teachers or employees of educational institutions interested in integrating virtual reality technology into distance learning processes.

- During the initial integration of virtual reality technologies into the process of distance learning, a virtual environment should be used as a substitute for some types of receiving and presenting information in training. In other words, to create a hybrid model of the distance learning process, affecting both virtual reality technologies and other applications and programs for remote interaction.
- Virtual conference programs implemented in virtual reality are recommended for use during the explanation and repetition of new material - lectures, as well as during interaction in teams at the initial stages of solving a problem or seminars that require discussions and close interaction (McShaneh 2021).
- The requirements of the means for the virtual reality technology - headset and controller, include the limited time of use until the moment of complete shutdown due to the rarefaction of the battery. In this regard, when building distance learning using virtual reality technology, it is necessary to consider the operating time of the headset and controller used and provide additional time for charging.
- When integrating virtual reality technology, it is recommended to use the methodology of design thinking during the learning process. This methodology is closely related to the quality of team interaction and implies carrying out most of the work on the task using communication and discussion in teams. Due to the isolation that led to the mandatory use of distance education, students began to interact less with each other. Coupled with the use of design thinking, virtual reality will make it possible to fill in the gaps in communication and interaction among students.
- For the successful initial use of virtual reality programs, it is recommended to develop and provide detailed instructions for the teacher and students. These instructions

should help you install the program and use all the functions necessary for the learning process. It is also recommended to instruct the teacher inside the virtual environment for a more detailed and clear explanation of the principles of interaction with the environment and the use of functionality.

The use of the recommendations presented above will help to optimize the implementation process and will also help to avoid possible failures during the initial use of programs.

3 Conclusion

Virtual reality technologies represent a promising direction for development in new areas, including distance learning. The results of the experiment demonstrated an increase in the concentration of participants when using virtual reality technology, as well as a positive assessment of team interaction. Moreover, the development of virtual reality technologies leads to wider use and implementation of new programs, including those created for educational purposes. Hybrid type of interaction is the most practical way to study since it leaves some tasks to be performed using traditional means of remote interaction, which will improve and diversify the learning process, thereby improving the quality of education. The outcomes of this work can be useful for educational purposes in academic institutions and businesses.

References

Dzardanova, E., Kasapakis, V., Gavalas, D., et al.: Virtual reality as a communication medium: a comparative study of forced compliance in virtual reality versus physical world. Virtual Reality (2021)

Krayushkin, N.: Virtual reality in education, Competence Development Center in Business Informatics of the Higher School of Business (2021), https://hsbi.hse.ru/articles/virtualnaya-realnost-v-obrazovanii/. Accessed 15 Oct 2021

Leifer, L., Dym, C., Agogino, A., Eris, O., Frey, D., Engineering design thinking, teaching, and learning, J. Eng. Educ. **94**(1), 103–120 (2016)

Leifer, L., Sonalkar, N., Mabogunje, A., Miller, M.R., Bailenson, J.N.: Augmenting learning of design teamwork using immersive virtual reality. In: Meinel, C., Leifer, L. (eds.) Design Thinking Research. UI, pp. 67–76. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-28960-7_5

McShaneh, M.: Classical Education Meets Virtual Reality, Forbes (2021). https://www.forbes.com/sites/mikemcshane/2021/10/19/classical-education-meets-virtual-reality/?sh=89a40494eb53. Accessed 15 Dec 2021

Meetinvr, the program for holding virtual conferences (2021). https://www.meetinvr.com/. Accessed 15 Oct 2021

Navleen, K., Supriya, S.: Fighting COVID-19 with technologyand innovation, evolving and advancing with technological possibilities. Int. J. Adv. Res. Eng. Technol. **11**, 395–405 (2020)

Rumii, the program for virtual conferences (2021). https://www.oculus.com/experiences/go/1312559188845495/?locale=ru_RU. Accessed 15 Oct 2021

Smith, S.: Virtual Reality or Education in 2021, AR VR EDTECH (2021). https://arvredtech.com/blogs/news/virtual-reality-for-education-in-2021-how-to-utilize-the-benefits-of-vr-in-education. Accessed 15 Dec 2021

Spatial, the program for virtual conferences (2021). https://spatial.io/about. Accessed 15 Oct 2021

Taratukhin, V., Pulyavina, N., Becker, J.: The Future of Design Thinking for Management Education. Project-based and Game-oriented methods are critical ingredients of success, Issue Vol. 47: Developments in business simulation and experiential learning. Volume: Innovations and Future Directions in Education (2020)

Taratukhin, V., Skrupskaya, Y., Kozlova, E., Pulyavina, N., Yudina, V.: Bringing together engineering and management students for a project-based global idea-thon: towards next-gen design thinking methodology. In: 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference (2021)

The Economist, Headsettechnology is cheaper and better than ever (2020). https://www.economist.com/technology-quarterly/2020/10/01/headset-technology-ischeaper-and-better-than-ever. Accessed 15 Oct 2021