Virtual Biomedical and STEM/STEAM Education

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Evaluation Framework for VR Platforms

Summary of Interviews Conducted with Representatives of Companies Using Virtual and\or Augmented Reality

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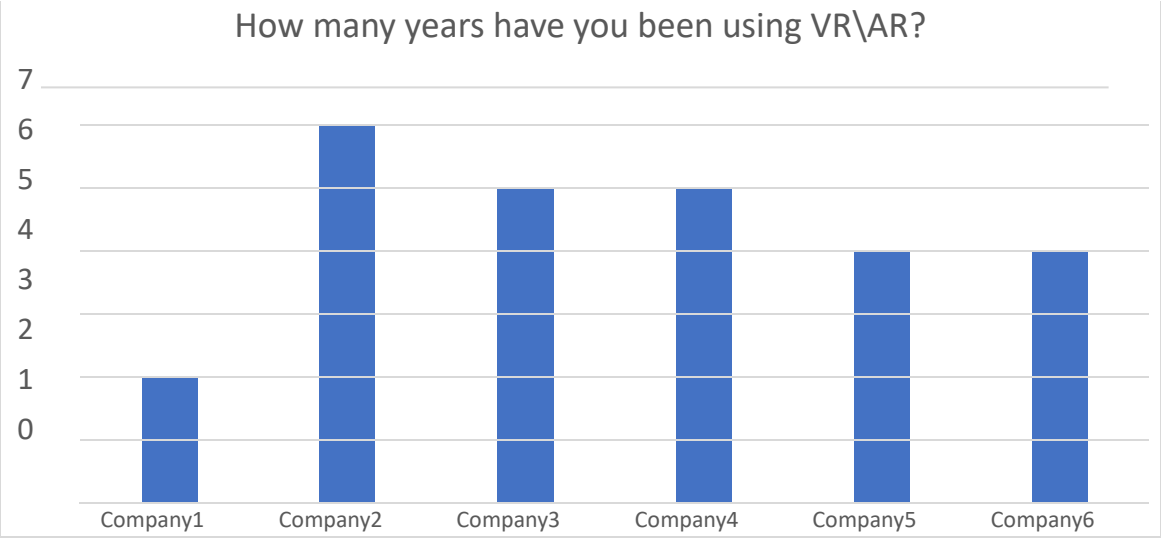
Introduction

To explore multiple topics regarding the use of virtual reality (VR) and augmented reality (AR), we conducted interviews with representatives of six companies from different European countries. The inclusion of these companies was decided based on our previously knowledge regrading the scope and technology used by the companies. With the interviews, one of our main goals was to get information on best practices and to investigate different related issues such as potential differences between female and male users of VR\AR or differences between people with better or poorer digital competences. In this summary, we included the nine most important interview questions and a summary and interpretation of the answers given by the six companies.

Question #1

Approximately how long have you been using VR/AR tools and/or software?

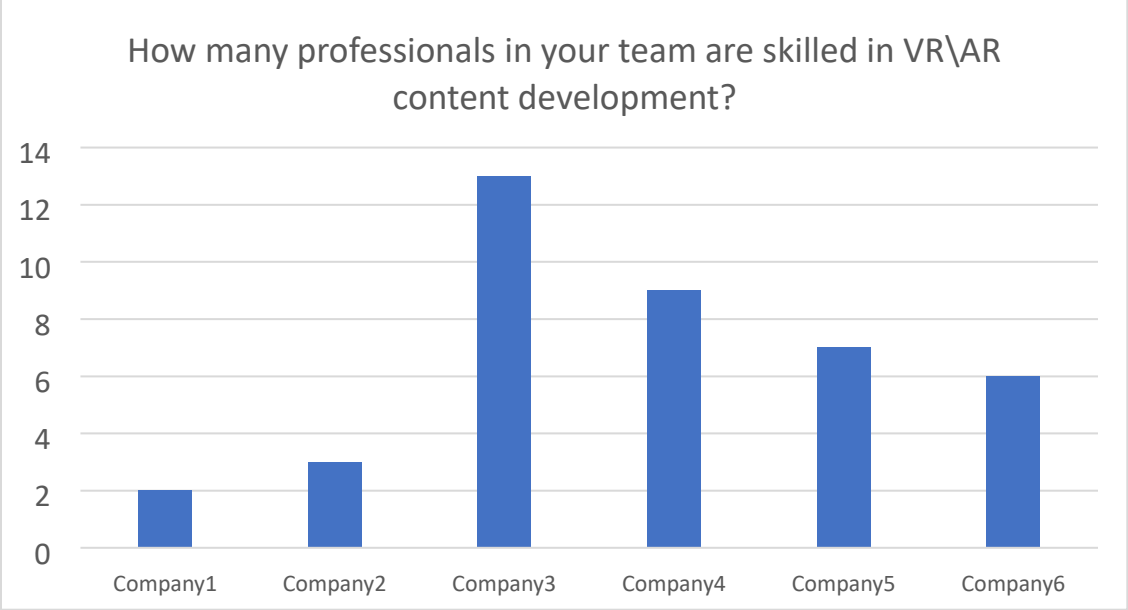
On average the companies have been using VR and\or AR for 4.33 years. The distribution of years of experience is presented in the following figure:



Question #2

How many professionals on your team are skilled in VR/AR content development? What is the typical professional background and education of these professionals?

The distribution of the number of professionals who for the companies involved in the interviewing process is presented in the following figure:



The VR\AR specialists working for the companies show a very high level of variability in terms of their educational and professional background. Most of the professionals are programmers, software developers or engineers (mechanical or computer engineers with MSC) or other IT specialists. Company 4 reported to have an especially colourful team: "*In our team, there is 1 neuroscientist, 3 developers, 1 game designer with expertise in sound effects, 1 responsible for imaging, 1 quality controller, and 2 co-founders with business expertise*."

Another interesting answer was received from Company 5: "…*software developers, two VFX artists, 3D modellers and graphic designers*".

To sum up, the companies work in teams that include professionals with variable backgrounds and most of the companies include less than ten professionals in their VR or AR team.

Question #3

What VR/AR hardware tools do they use? Which ones do they consider good/bad and why?

The hardware tools used by the companies are summarized in the following table:

Hardware	Count	Proportion of companies using it
Hololense 1	1	16.6%
Hololense 2	2	33.3%
Oculus	3	50%
Meta	3	50%
HTC	3	50%
HP	2	33.3%
PICO	1	16.6%
VALVE	1	16.6%
Real	1	16.6%

Company 1 said that they consider Hololense 2 the best hardware tool because "*it is used in an industrial environment, can be used by professionals to detect defects and has proven to be a good solution for accident prevention*".

On the other hand, Company 2 found Hololense 2 has some serious drawbacks in terms of hardware but they also mentioned some advantages (e.g. easy handling). They also emphasized that they always make a decision on which hardware to use depending on the task at hand. For example, for demonstrations (e.g, for the public), they use Oculus rift, while for other tasks they use other tools. They mentioned that HP VR glasses has a great price for its value and they also highlighted its easy use.

Company 3 found Meta Quest to be the best and they use it most of the time.

Company 6 said that "*For VR, we are using Oculus Quest 2, which is the mid-way regarding pricing and quality. We are happy to stick with this solution and so are our clients as this product provides what they need for a reasonable price."*

Question #4

What VR/AR software tools do they use? Which ones do they consider good/bad and why?

The software tools used by the companies are summarized in the following table:

Software	Count	Proportion of companies using it
Unity	4	66.6%
Unreal engine	1	16.6%
Guides (Microsoft)	1	16.6%
Invelon Arena	1	16.6%
Visual studio	1	16.6%
Blender	1	16.6%
Sidequest	1	16.6%
Self-developed software	1	16.6%
ARcore	1	16.6%
ARkit	1	16.6%

For this question, we received more variable answers. Only Unity is being used by more than one companies.

Company 5 developed their own software but also developed extra platforms to help the deploying of their solutions. They also develop tools such as a dashboard, which is a web-based platform that allows the access of organizations to the state of the user's game and allows them to follow their evolution in the game. They also have an "app" that works as a remote controller, which allows an authorized person to guide and change settings in the app/game, helping the user. This was thought and developed to avoid barriers and facilitate the use of people with low digital literacy (focusing on kids and older adults).

The interviewees did not elaborate much on the advantages and disadvantages of software tools. Company 2, however, gave us an explanation:

"Unity: The reason we use it the most is because we can do almost everything in it. "The right tool for the right job". Absolutely right, of course there is no tool without bugs. But it's easy to program and collaborate with, it's quicker to set up a framework. It is also true that it requires continuous professional work in terms of programming.

Unreal Engine: Another one we know, but it is rarely used for more than one or two tasks."

Question #5

In general, are there any aspects of VR/AR use that are challenging for the company and/or its users?

List of the most important challenges mentioned by the companies is as follows:

1. *Hardware Limitations:*

Developers face challenges with hardware limitations, particularly in AR. Devices like Hololens have small form factors, and the chip processing all data (gestures, inputs) must fit within these constraints. This compromises technological requirements and fidelity for userfriendliness.

2. *User Adoption and Learning Curve:*

Users, especially older individuals, may find it challenging to adopt VR/AR technologies. There is a learning curve associated with using these tools, and older users might experience difficulties adapting to the new technology. Younger individuals tend to adapt more quickly, but there's variability.

3. *VR Sickness:*

Some users, regardless of age, may experience "VR sickness," including dizziness and, rarely, nausea or vomiting. This can be attributed to the body's struggle to adjust to the virtual reality, and there is a need to better understand the prevalence of these symptoms.

4. *Resistance to Change:*

Companies express challenges in convincing their employees to adopt VR/AR tools. Some managers need to use strong measures to encourage initial usage, but once adopted, users often find the technology beneficial.

5. *Purpose and Implementation Understanding:*

For companies, understanding the need to implement VR/AR is a challenge. There is a fear of change and hesitancy toward new technologies that bring about organizational changes. It's crucial for companies to see the purpose and benefits of these technologies for successful implementation.

6. *Optimization:*

One company identifies optimization as the most challenging aspect, without specifying further details.

7. *Digital Literacy and Comfort:*

Users, especially the older population, may have low digital literacy, making it challenging for them to use VR/AR. Uncomfortable headsets and potential issues like motion sickness or falls are also mentioned, requiring careful design considerations.

8. *Target Audience and Purpose Clarity:*

Defining the target audience and purpose of implementing VR/AR is emphasized. Bringing these technologies closer to users, ensuring they are easily understandable, and addressing digital literacy are essential for successful integration.

In summary, the challenges range from technical constraints and user adaptation to organizational resistance, understanding the purpose, and ensuring user comfort and safety.

Question #6

Based on your experience so far, what benefits have you gained from using VR/AR?

The following key points were mentioned by the interviewees:

1. *Efficiency and Training:*
    - VR/AR contribute to faster and more efficient task completion.
    - Reduces training time and barriers, enhancing individual skills and competencies.
    - Boosts confidence among workers in the field.

2. *Education and Training Innovation:*
    - Particularly valuable in education and training, creating a safe environment for learning and experimentation.
    - Enables the simulation of extraordinary situations, facilitating preparedness and testing reactions without real-world consequences.
    - Enhances the ideation and design phase of development projects, especially in health education.

3. *Engagement and Motivation:*
    - Users tend to learn more in VR, driven by higher motivation and engagement.
    - The controlled environment in VR ensures the quality of information and data acquired by users.

4. *Accessibility and Peer-reviewed Models:*
    - Offers accessibility advantages, requiring fewer physical devices for students.
    - Incorporates peer-reviewed models, ensuring professional accuracy and quality in educational content.

Overall, VR/AR technologies are proving to be transformative, not only in enhancing task performance and education but also in creating immersive and effective learning environments.

In addition, Company 5 was kind enough to share some statistics with us:

"Based on user experience, 1800 user reviews: 65% said they had a better understanding of how pedestrians, cyclists, motorcyclists or scooters behave in traffic; 88% said that the overall usefulness of the anet360 VR experience for their work was good or the best compared to what they had experienced. Our customers have reported a reduction in the number of accidents (we do not have an exact figure)."

Question #7

How do you see VR/AR being used in education? Have you used it for educational purposes and if so, what were your experiences?

In general, companies have found various applications for VR and AR in education:

1. *Efficiency Enhancement:*
    - VR is utilized to streamline operations and design, aiming to increase overall efficiency.
    - Tutorials and procedures are developed to address specific challenges and shorten learning curves.

2. *Specialized Training:*
    - VR is employed in specialized training scenarios, such as astronaut training for navigation in hazardous areas.
    - Medical training programs include detailed virtual anatomy models, offering advantages over physical models.

3. *Collaboration in Research:*
    - Collaborative research projects with educational institutions involve simple VR testing tasks for students.
    - VR is integrated into real operation simulations, allowing students to practice and receive feedback on performance.

4. *Motivational Tools:*

   Points systems and leader boards are introduced as motivational tools to encourage student engagement and competition.

5. *Emotional Engagement:*

   - VR is used to create emotional engagement, such as presenting virtual experiences of traffic accidents for realistic survival scenarios.

6. *Accessibility and Creativity:*

   - Companies emphasized the accessibility of VR/AR tools in distance learning environments.
   - The main added value is seen in the creativity facilitated by high technological expertise in VR and AR.

7. *Tailoring Solutions to Digital Literacy:*

   - Consideration is given to the level of digital literacy among users in specific sectors, with a recognition that some industries may have more traditional and conservative practices.
   - Solutions are designed to be user-friendly, matching the digital skills and preferences of the target audience.

Question #8

How can VR/AR be made user-friendly? Have there been concrete attempts to do so?

The companies provided very valuable information on how to make VR and AR more userfriendly. The following points were mentioned by the representatives of the companies:

2. *Inclusive Development Process:*

   - Involving both development experts and end-users in the development process.
   - Continuous validation with external users to identify unforeseen issues and ensure usability.
   - Customer requirements are considered, but developers may express disagreements to prioritize usability.

3. *Change Management and User Acceptance:*
    - Acknowledging the psychological barriers users may face, such as feeling clumsy.

      Implementing change management strategies to make users comfortable and show them that using VR/AR is not disadvantageous.
    - Building user confidence through experience, where brave users demonstrate without harm to encourage others.
4. *Preventing Motion Sickness:*
    - Implementing measures to prevent motion sickness, such as ensuring the body moves with the user in VR.
    - Providing tutorials before entering VR for an extended period to address challenges like using controllers.
5. *User Testing and Adaptation:*
    - Conducting testing with individuals less experienced in VR/AR to understand user adaptability.
    - Noting that children adapt more easily to controls, while adults may initially face shyness and dizziness.
6. *Hardware and Software Development:*
    - Anticipating that as hardware advances and prices decrease, interaction will become easier, making platforms more accessible.
    - Emphasizing the importance of creating better software solutions and engaging in co-creation activities with individuals with low digital literacy to address difficulties and enhance satisfaction.
7. *User-Centric Development and Simplicity:*
    - Focusing on end-users in the development process and prioritizing simplicity.
    - Considering user-specific needs, such as providing masks for makeup protection.
    - Aligning content with users' digital literacy levels and avoiding overly complex experiences for those new to VR/AR.

Overall, user-friendly VR/AR development involves an inclusive, user-centric approach, addressing psychological barriers, preventing discomfort, and adapting solutions to various user profiles and needs.

Question #9

Do you have any experiences on whether learning to use/use VR/AR is more challenging for people with low digital literacy? Are there gender differences in learning to use VR/AR?

When we asked our interviewees about the potential challenges of people with low digital literacy, the answers implied the following factors and challenges:

1. *Age and Familiarity with Technology:*
    - Generally, younger individuals who are more familiar with newer technologies find it easier to adapt to VR/AR.
    - Older people may feel less comfortable or more averse to using these technologies.
2. *Adjustment to AR and VR:*
    - Adjusting to AR technologies is perceived as less challenging since people are accustomed to mobile phones and tablets.
    - Using VR headsets may be more challenging for end users without prior "training" or practice.
    - Tutorials are created for those new to VR technology, and breaks are recommended during usage.
    - The age at which people find it challenging to learn VR technology is not clearly defined, but it can be overwhelming for children.
3. *Learning Curve and Shyness:*
    - Children are considered to learn best, while adults may face challenges related to shyness.
    - Overcoming shyness is key, and even those with low digital literacy can learn basic VR controls.
4. *Complex Issue with Training Solutions:*
    - The issue of learning VR/AR is seen as complex, and developers may not necessarily meet end users.
    - Trainers play a crucial role in providing the right information and teaching users how to use VR/AR.
    - Companies are preparing dedicated services, mentoring, and customer support activities to help users overcome challenges and get familiar with the programs.

In summary, the consensus is that age, familiarity with technology, and the learning curve for VR/AR can vary. While younger individuals and children might adapt more easily, challenges exist for those with low digital literacy, and efforts are made to provide support and training to overcome these challenges.

Regarding gender, the answers varied more. While some companies reported no gender differences, others said that either women or men seem to have more success with AR and VR. For example, Company 2 said that:

"In terms of gender, women sometimes feel self-conscious, find it harder to adjust the glasses on their head because of different hairstyles. In general, however, women get used to using them more quickly. This was surprising to us, as the majority of interested parties are male users in the IT sector. But many of them said that it was not comfortable, etc. Women have a greater desire to explore and/or are simply more open and have no expectations."

On the other hand, Company 4 reported that they studied their database and concluded that males have better results in games than females, namely in the first session.