The opinions and attitudes of students – future IT teachers – on the use of VR and AR in teaching

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Abstract - **Recent technological advances in the field of Virtual Reality (VR) have resulted in market release of multiple head mounted displays such as Oculus Rift, Sony Gear VR and HTC Vive. This new technology brings great possibilities in education in terms of new methods of learning, and its applications in teaching have already been studied in several studies worldwide. Augmented Reality (AR), as an emerging technology, is predicted to have even more potential usages than VR, both in education and other areas. The advantages of AR are increased freedom, lack of simulator sickness, and broader application range. The aim of this paper was to investigate the opinions and attitudes of students who will, presumably after their graduation, teach ICT in primary education schools. The research showed that even though a majority of students have positive opinions and expectations of these technologies, such as immersive learning and pupils' motivation, only a few of them feel competent enough to use them in classroom. They also have some concerns regarding health issues of using AR/VR technologies, as well as students losing their concentration in class.**

Keywords - education, teaching, ICT, virtual reality, augmented reality

I. INTRODUCTION

While the virtual and augmented reality (VR/AR) are research topics which have been studied for decades now, recent introduction of novel devices affordable to a large section of customer market has again inspired significant research efforts in these areas. There are multiple definitions of what VR and AR are and what their relationship is. One of the commonly used states in which virtual reality places a user is a completely computer-generated environment, while AR aims to present computer-generated information that is directly registered to the physical environment. While in VR the user's whole field of view (FOV) is occupied by computer-generated content, this is not the case with AR – and according to [1], it needs to have the following characteristics: combination of real and virtual, interactivity in real time, and be registered in 3D. Currently, there are many Head Mounted Display (HMD) devices enabling VR on the market (e.g., Oculus Rift, HTC Vive, PlayStation VR, etc.) while there are only few AR HMD devices (e.g., Microsoft Hololens, Magic Leap). In general, the technology enabling high grade consumer applications in the AR segment is still on a lower level of development in comparison with VR. On the other hand, looking at future use, AR has a significant application advantage: the lack of Simulator Sickness (SS) which originates from elements of visual display and visuo-vestibular interaction and has symptoms similar to those of motion-induced sickness, but tends to be less severe [2]. Nevertheless, both VR and AR have significant possible applications in many areas, especially education.

There are many studies that showed advantages in using VR/AR in education. For instance, [3] in their review showed advantages of using AR in education such as: learning gains, motivation, and students' engagement in class. When it comes to VR, many studies showed improvements in students' academic performance [4][5], motivation [6][7], collaboration [8], and psychomotor and cognitive skills [9][10][11]. VR has been particularly praised as a great tool for students suffering from autistic specter disorder (ASD) [12] [13] [14] and AR has been used for rehabilitation of cognitively disabled children [15]. In [16] it is stated that virtual technologies encourage students to be active learners, because VR/AR promote decision-making when interacting with virtual environments, permitting autonomous exploration, understanding complex concepts, creating new experiences, and learning by doing.

During the past decades, teacher motivation has been studied in relation to student motivation and learning incomes [17] [18] [19]. Some researchers claim that teacher motivation is fundamental to the teaching and learning process [20]; thus, it is very important to investigate the opinions, attitudes and motivation of future ICT teachers when it comes to using new technologies in the classroom – that is the aim of this paper.

II. VR/AR IMPLICATIONS IN EDUCATION

The main motivation for using VR in education is that it gives students the opportunity to experience and experiment in situations that "cannot be physically accessed". In [21], some of the possible situations are as follows:

- Problems with time: travelling in time allows students to experiment with different historical periods; students can travel in time and VR technology allows them to experience different periods in history;
- Physical inaccessibility: e.g. students can explore the solar system by freely moving around planets and galaxies;

• Limitations due to dangerous situations: for example, students who are training to become firefighters can experience the situations in which the physical and psychological stresses are analogous to live firefighting situations.

Other benefits of using VR in education are described in [22] and [23]. VR provides new methods of visualization, and alternate methods for the presentation of learning materials. For example, VR can more precisely illustrate some features and processes by allowing extreme close-up examinations of objects, or observations from a great distance, or observations of areas and events that are not available by other means. For instance, students can study a molecule in great detail, go inside of it, walk around, and become familiar with its parts. As another example, students can explore VR models of their area which will give them a different perspective on the interconnections between buildings, streets, and open areas. Basically, VR allows students to learn by doing, a so-called constructivist approach. VR also grabs the attention of students and it genuinely motivates them. It encourages active participation of students and students find it exciting and challenging. They enjoy walking and interacting within 3D surroundings, as well as creating their own 3D environments. Some types of VR are collaborative and that encourages students to collaborate with each other, which creates a positive social atmosphere in the classroom. VR also allows students to experience new things in their own place and time, not a fixed time in class, and it is very beneficial for special needs students who cannot attend regular classes.

When it comes to AR and its implications in education, it is much more researched than VR. Systematic literature review was done in [24] and it described many benefits such as:

Constructivist learning – AR can be used in a way that encourages students to engage with subjects on a deeper level; that way students can make deeper and more lasting connections within their knowledge base.

Situated learning – AR can enable authentic and contextualized learning by implanting educational experiences through bringing the real-world situations into the classroom.

Games-based learning – AR can be used to enable immersive games-based learning by creating a digital narrative, placing students in certain roles, providing authentic resources and embedding contextually relevant information.

Enquiry-based learning – VR offers means to electronically gather data for future analysis and provides virtual, easily manipulated models located within a real-world context .

In conclusion, [16] elaborates on four main aspects regarding the advantages of using VR/AR technologies in education:

1. Using VR/AR in education can increase student motivation and engagement. Students have immersive experiences while studying 3D models that enhance their learning experience.
2. VR/AR allows for a constructivist approach to learning. Students can freely interact with virtual objects and other students as well. Consequently, students can examine, research, and obtain feedback, resulting in an experience that expands their learning.
3. VR/AR are becoming more affordable and accessible to masses. Recent technological advances have facilitated access to VR/AR with smartphones, tablets, and videogame devices. There is no more need for complex devices, and students can get an easy access to shared VR contents through common online platforms such as YouTube. Additionally, special needs students have easier access to virtual environments and are able to interact with virtual objects and other students.
4. VR/AR allow for more interaction than conventional learning materials. By using VR/AR, students feel more immersed when interacting with different learning concepts by using headsets, tactile gloves, and motion sensors. This special engagement permits students to experience situations with realistic objects that could not be accessed otherwise.

Several disadvantages of using VR/AR in education have been documented in [23] and they are primarily related to the cost and time necessary for learning how to use those new technologies. In [25] it was described that VR could be seen only as a game, something that is fun to play with, but there is a possibility it would not be taken as a serious tool in education and learning. Also, it has been reported that older teachers are sometimes reluctant to use new forms of education in classroom [25], while another research shows that older teachers actually have a positive attitude to new technologies [26] and there is no significant difference in teacher age when it comes to their attitudes towards using new technology [27] [28].

The question of possible health and safety effects are arising, especially with the usage of VR. The occurrence of SS is still not explained in full. In some segments of the population it may never occur while using VR, whereas others get the symptoms really fast. Movement patterns in virtual environment play a significant role in triggering SS symptoms in VR, and previous research showed that users prefer discrete movement methods (i.e., “teleporting” in virtual environment [29]. Also, many developers have opted, in creating applications, with very limited or no movement to limit the effects of SS. There are other safety concerns such as tripping, hitting objects and other people, which limits a broad range of usage cases for VR. Therefore, VR needs to be performed in a specialized and secured space. On the other hand, AR does not have such restrictions because users are at all times completely aware of their real environment. Therefore, AR has higher potential for use

in education in everyday activities as opposed to VR. Pupils can use an AR HMD, which would, for example, display details of DNA structure, while at the same time paying attention to their teachers, all without the presence of any health risks for themselves or their surroundings.

Like with all new technologies, all the issues mentioned could fade away as time goes by and VR/AR could become more commonly used in many areas inside and outside of education. It is very important to ensure that VR/AR technologies do not become a technological problem and it is imperative to encourage teachers to incorporate new technology in classroom.

III. METHODOLOGY

The aim of this paper was to investigate the opinions and attitudes of students about the use of VR/AR in teaching. The students who participated in the research are studying to become primary education teachers as well as ICT teachers in primary education schools.

An online questionnaire was distributed between 83 ICT module students (1st-5th year of study program) at the Faculty of Teacher Education, University of Zagreb. It consisted of 16 statements regarding the participant's opinions, attitudes and motivation on the use of VR/AR in education. Participants specified their level of agreement with each statement on a five-level Likert scale: 1 – Strongly disagree; 2 – Disagree; 3 – Neither agree nor disagree, 4 – Agree, and 5 – Strongly agree. The questionnaire also had 2 open questions where participants could freely express their thoughts on the use of VR/AR in education.

IV. RESULTS

The research showed that 65.1% of the students agree and strongly agree to being computer-literate but only 27.7% of them agree or strongly agree that they follow new technological developments in the field of ICT. Even though the majority of the students agree and strongly agree that it is important to use new technologies in classroom (Chart 1) and consequently the majority of them plan to use new technologies in classroom (Chart 2), only 21.7% of students agree and strongly agree that they are familiar with VR/AR applications for education (Chart 3). It is interesting to note that even students who consider themselves well IT-educated do not feel capable

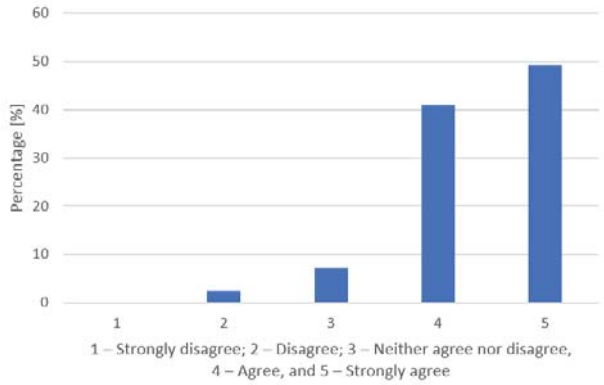

Chart 1 – The importance of using new technologies

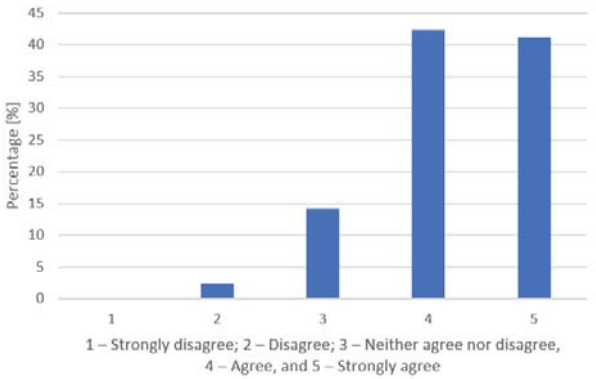

Chart 2 – Planning to use new technologies

of using VR/AR, indicating that these technologies can still be considered emerging. This is shown in Chart 4,where the scale of the bubbles indicates the number of occurrences of particular response). Regarding their motivation towards using AR/VR in classroom, 49.4% of students neither agree nor disagree that they will use this technology in their future teaching.

The students also feel that the use of AR/VR in teaching would allow pupils to visualize teaching materials more easily (69.9% agree and strongly agree) and that the use of AR and VR in teaching would make pupils learn better (66.3 % agree and strongly agree). They also agree and strongly agree (65.1%) that the use of AR and VR would facilitate a more active participation in class. However, they are also unsure about the possible negative aspects of using AR and VR in teaching. 38.9% of the students neither agree or disagree that the use of VR/AR would disrupt pupils' concentration, and 28.9% students agree or strongly agree that it would disrupt pupils' concentration. They also neither agree nor disagree (33.7%) that the use of VR/AR in class would prevent pupils' from paying attention to the teacher. The answers to negative perceptions for VR/AR are displayed in Chart 5, indicating that all have very similar distribution.

In the open question section of the questionnaire, the students had to list the school subjects they think would particularly benefit from the use of VR/AR in teaching and explain why. A lot of students mentioned that studying history would have many benefits; "traveling in time and seeing some things first-hand", "the pupils could easily experience historical battles first-hand",

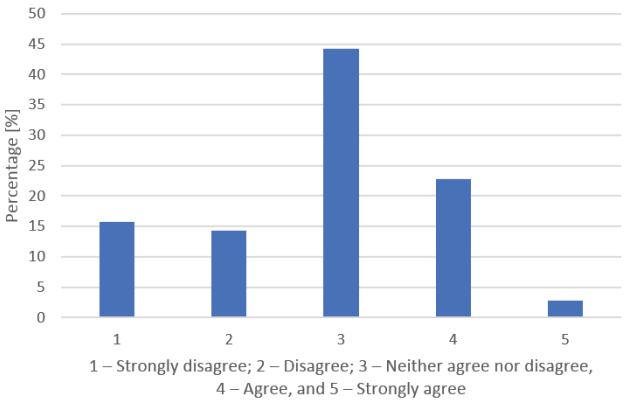

Chart 3 – Familiarity with VR/AR education applications

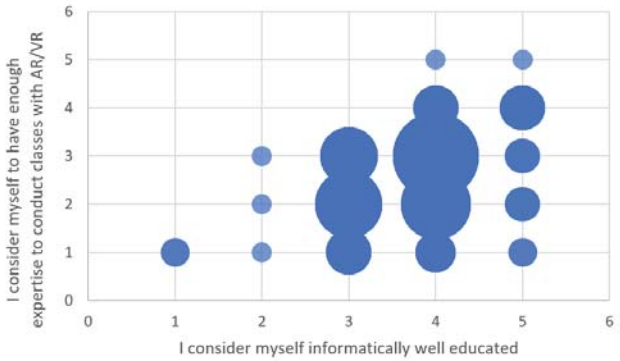

Chart 4 – Confidence of using VR/AR with regard to perception of IT-education

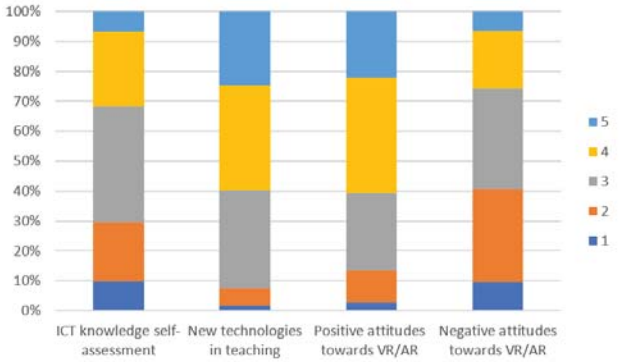

Chart 6 – Summary of responses per question group

"a lot of historical facts could be easily visualized instead of just learning them by heart", "pupils could see what the lost cities looked like, which would be interesting", "walking through the streets of ancient Egypt or Rome". The students also mentioned great potential in using VR/AR in teaching when it comes to natural sciences like biology and geography: "easier visualization of natural phenomena", "close representation of the human body", "experiencing different places and animals", "traveling around the world", "orientation in different places".

Other mentions include chemistry, physics and mathematics, since the students feel these subjects are abstract. VR/AR could bring pupils closer to the understanding of these subjects due to better visualization of learning materials. They also see the benefits of AR/VR in art studies, as well as language learning. Overall, they feel that VR/AR could bring school subjects closer to students and make the learning process more interesting and visually stimulating.

Another open question was regarding potential advantages and disadvantages of using VR/AR in education. Only a few students answered that they do not feel AR/VR should be used in teaching and that pupils should experience learning material "in the flesh" and not through the use of technology. Other students list benefits such as: "something new and exciting for both teachers and pupils", "it would make learning more interesting and interactive", "if used well, it could bring multi-directional communication in classroom", "immersive learning", "modern style of teaching for new generations", "easier memorization", and "more motivation". Overall, they feel that AR/VR technologies could bring many exciting things to classroom.

When it comes to disadvantages, students listed such things as: "it is not good for health, it is too artificial", "there is too much radiation while using VR/AR", "pupils could lose concentration", "children spend too much time looking at screens", "it is expensive and our schools are reluctant to use such new technologies", "teachers could matter less and less", "too different from old style teaching methods", "pupils could lose interest in paper books", "it could be bad for pupils' eyesight", "it would alienate pupils", "pupils could use it more for fun than learning". Many students stated their fears of children being too exposed to screens and new technologies, as well as fears of new technologies alienating pupils. Only a few of the students saw the benefits when it comes to collaboration in classroom. Some of the students wrote that they do not know how to answer the open questions because they were not familiar with VR/AR technologies and their applications in learning.

Finally, we have grouped all questions into four categories related to: *New technologies in teaching*, *ICT knowledge self-assessment*, *Negative attitudes towards VR/AR*, and *Positive attitudes towards VR/AR*. The final results per score in each category are displayed in Chart 6. The chart displays that, in general, the students agree more with positive attitudes towards VR/AR and lean towards using new technologies in teaching. In much lesser extent, the students agree with negative attitudes towards VR/AR, which is very promising for the evolution of teaching in Croatia in regards to the use of new immersive technologies.

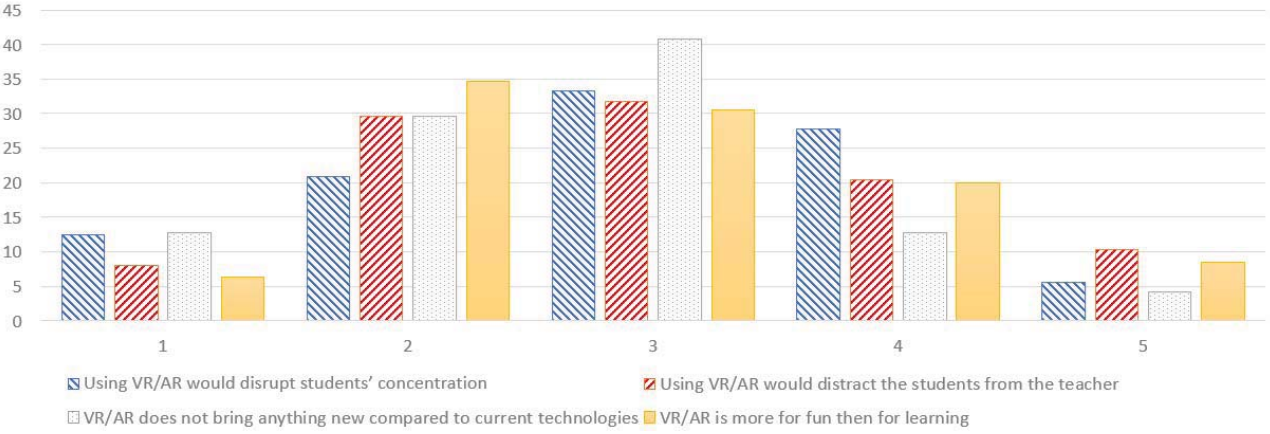

Chart 5 – Distribution of negative responses towards VR/AR

V. DISCUSSION

The research showed that students overall have positive attitudes towards VR/AR in teaching. They believe that using VR/AR in education will help pupils to better visualize teaching materials and that it will help them to learn better. This result is in line with the findings reported in [16][22][23]. In the open question section of the questionnaire, they listed benefits like immersion, better memorization, motivation and feeling like they are in the "real world" as it was described in [24] and time traveling as it was shown in [21]. To sum up: the students recognized many benefits of using VR/AR; these benefits are described in literature, which means that they are familiar with the general benefits of VR/AR for teaching, although the technologies are quite new, and majority of students do not follow new technological developments in ICT-sector?

It is important to state that even though students mentioned many benefits of using VR/AR in teaching, when it comes to disadvantages, they listed a significant number of them. Most of their concerns were about VR/AR being generally used for playing games, not for learning. This problem was also described in [25]. Such concerns could be alleviated by including new technologies in the education process of young teachers and showcasing educational non-gaming usage scenarios. They also fear that VR/AR would disrupt pupils' concentration, and that they would not pay attention to the teacher. It also seems that the students feel the traditional form of teaching methods is still prevalent in primary education schools in Croatia; therefore, they believe that using new technologies could be too different. While this attitude of young teachers is not surprising because of the limited use of technologies in teaching process in Croatian schools, we believe that this issue will be resolved in time, especially with a large project named "e-Schools: Establishment of the system for the development of digitally mature schools" [1] working to bring new technologies into Croatian education system.

Even though research showed that VR/AR have great benefits in work with special needs children [12][13][14][15], none of the students mentioned that fact. They also did not seem to understand that VR/AR could be collaborative technologies [23] and they felt that this would alienate pupils. All of this could be due to the fact that only 27.7% of the students follow new technological developments in ICT, so it is understandable that only 21.7% of them have knowledge about VR/AR technologies and only 14.4% of them feel adequate to teach with VR/AR. Even though the majority of students think it is important to use new technologies in teaching, as was shown in Charts 1 and 2, and although they plan to use them, it seems that they are reluctant to do so when it comes to using VR/AR technologies. They also mentioned many health issues arising from the use of VR/AR, but many of the issues they mentioned could not be found in current literature and belong in the category of widely spread misconceptions regarding technology in general. Therefore, we emphasize again the importance of introducing these new technologies in the process of education of teachers themselves. This process would solve the issue of many misconceptions the students currently have towards VR/AR technologies. In conclusion, as shown in Chart 6, the students agree more with positive attitudes towards VR/AR and lean towards using new technologies in classroom, which is very promising for the evolution of teaching in Croatia in regard to using new immersive technologies.

[1] https://www.e-skole.hr/

VI. CONCLUSION

In this paper, a survey was presented comprising attitudes and opinions of future ICT teachers, students of the Faculty of Teacher Education, University of Zagreb, towards AR/VR technologies as tools in the education process. The results show that while the majority of the students have positive expectations of these new technologies, there is still a significant number of misconceptions present amongst them, especially towards health effects of AR/VR. This is probably due to the fact that only a fraction of students are familiar with VR/AR technologies and how to use them in classroom. We believe it is important to educate future teachers about new technologies and how to use them without fear and restraint, because they can be powerful tools in the teaching process. In our future work we aim to identify the factors which impact the positive attitudes towards AR/VR, so they could be used to increase motivation for using new technologies among future ICT teachers.

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