The main domain of both the research papers has to do with task completion and efficiency of both augmented and virtual reality. In the research paper from 1999 titled: *Virtual Reality and Augmented Reality as a Training Tool for Assembly Task,* researchers are examining whether using virtual and augmented reality over conventional instructions minimizes the assembly time of a building task. While the newer research paper titled: *Augmented Reality versus Virtual Reality for 3D object manipulation* takes what is learned from the 1999 article to go beyond to see which of the two is the most optimal.

In the older research paper, the main goal of the experiment was to see if virtual reality (VR) and augmented reality (AR) would be useful in the future training of manual skill jobs. During the time in which the research was conducted virtual and augmented reality were not as mainstream and widely available as they are today. With the goal set, the researches gathered 5 groups of 5 students, with engineering backgrounds, from their own university (The University of Birmingham) to test the completion time of assembling a water pipe given different sets of instructions. With 5 different groups of students there were 5 instruction sets to assemble the water pipe, the first being a conventional 2D schematic, the second a desktop VR with a 2D mouse, next, a desktop VR with 3D glasses and 2D mouse, immersive VR and 3D mouse, and lastly AR. For the conventional 2D drawings users were given 10 minutes to study while the VR users were given 2 minutes to study the drawing and 8 minutes to work with the virtual environment. AR users were given special headsets allowing to view a projected view of the water pipe on a special screen with a total of 8 minutes. After the experiments were conducted the results showed that the conventional way of studying a diagram and schematics took much longer than every other method in the experiment. The conventional method of studying a diagram and instruction manual group took an average of 4 minutes when it was time to build the water pipe while the other four groups averaged less than 1 minute each. The researchers concluded that both AR and VR were extremely useful in improving the performance of studying and assembling an item. The domain of the older paper explores the idea of one day being able to integrated VR and AR in everyday life. The current researcher paper feeds off of this idea but now researchers are interested in which of the two realities is optimal:

augmented or virtual?

In the current research paper, it is understood that through the right usage, VR and AR can be highly effective and efficient. From the older research paper, it is proven that when given the opportunity to interact with something virtually beforehand it can help in assembling the item in real life, as proven by their research. Now, researchers want to determine which of the two is the fastest and most efficient for object manipulation. The main hypothesis of the article was that with AR, due to the fact that images are being virtually displayed in real time in a real special setting, that task completion would be further optimized than with VR. In order to test their theory, they conducted a study which tasked users with manipulating a 3D object (selection, transformation…) which included using their own 3D input device and a regular mouse with four conditions: using the regular mouse in an AR setting, using a 3D input device in an AR setting and using both the regular mouse and 3D input device in VR setting. The room in which all four conditions were held stayed standard throughout. On average the AR setting both with a regular mouse and 3D input device took less time to complete the given tasks by around 15 seconds. Researchers conclude that while AR showed speed improvements there still was not enough information to fully decide that AR was greater than VR mainly due to the fact that they were fully aware variables could skew results.

The similarities between the two research papers is shown in both experiments wanting to determine if using AR and VR is the most time efficient. Both experiments use a combination of different AR and VR settings to fully examine the scope of the usefulness of both tools. While the older paper seeks to implement VR and AR into society. The current paper goes beyond the assumption that both are efficient in completing physical tasks by trying to determine which of the two is most optimal.

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