roadsafetyanalysis

Virtual reality measures potential in education of adolescents

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Contents

Introduction

This report provides the results of a pilot which aimed to evaluate the impact of virtual reality resources on the knowledge and attitudes of adolescents. It is based on data from a knowledge test and survey conducted in January 2018 in a secondary school in Kent among pupils from Year 9, completed before and after educational sessions on climate change that were delivered with the use of a virtual reality video and game - “Cleanopolis” and a comparison lesson. The stimuli addressed the issues of global warming, its prevention, contributing human activities and habits. Four classes were involved in the experiment with two classes assigned to use a virtual reality video and game - “Cleanopolis” (treatment group). In order to assess the strength and validity of the potential impact of a VR game and video on learning outcomes, a session on the same subject was delivered to the other two classes (control group), using more traditional methods, such as a classroom-based presentation and a card game. The same knowledge test and survey, under the same distribution scheme, was applied to both groups. The classroom lesson was adapted to ensure that all elements tested in the virtual reality game were included, so that all participants would be learning the same things. This involved systematically working through the topics in the virtual reality game and adding or removing content to the classroom lesson presentation and card game to ensure that the two approaches included identical information.

The test and survey were conducted with the use of paper questionnaires, completed by the respondents. The sample size of the treatment group was 49 participants in the pre-phase and 48 participants in the post-phase and 58 and 59 participants in the control group respectively.

The purpose of the experiment was to determine if using new technologies (specifically a VR game) can be more effective than traditional approaches in terms of knowledge acquisition and shift in attitudes. The results could influence decisions whether investment is made into new technologies to use novel ways to increase road safety knowledge and attitudes amongst this age group.

Sessions

All the participants were from Year 9 and from different class sets. Of the six sets in total in Year 9, four of these were included in the experiment.

Initially, two classes for the control group were run at the same time in two different rooms. Each class was taught by a different facilitator, utilising the same material as each other and over the same period of time as stated in the design. Both facilitators had teaching qualifications.

The VR experimental groups were run with one taking place after the other, with all facilitators present. However, technical difficulties with the first group meant that the total exposure time was shorter than for the second group. Managing 30 separate devices meant that they kept turning to standby making preparation redundant. This was corrected by the time the second group took part.

After approximately 30 minutes of use with the VR headsets, there were a number of students from the second experimental group who began removing them to take a break from exposure. As being inside a VR headset is an isolating experience and students could not see that others were removing headsets, it is interesting to note that students chose a very similar time to remove them for a break, perhaps suggesting that it is the limit for exposure to this type of environment.

The results should therefore be interpreted with the following observations in mind:

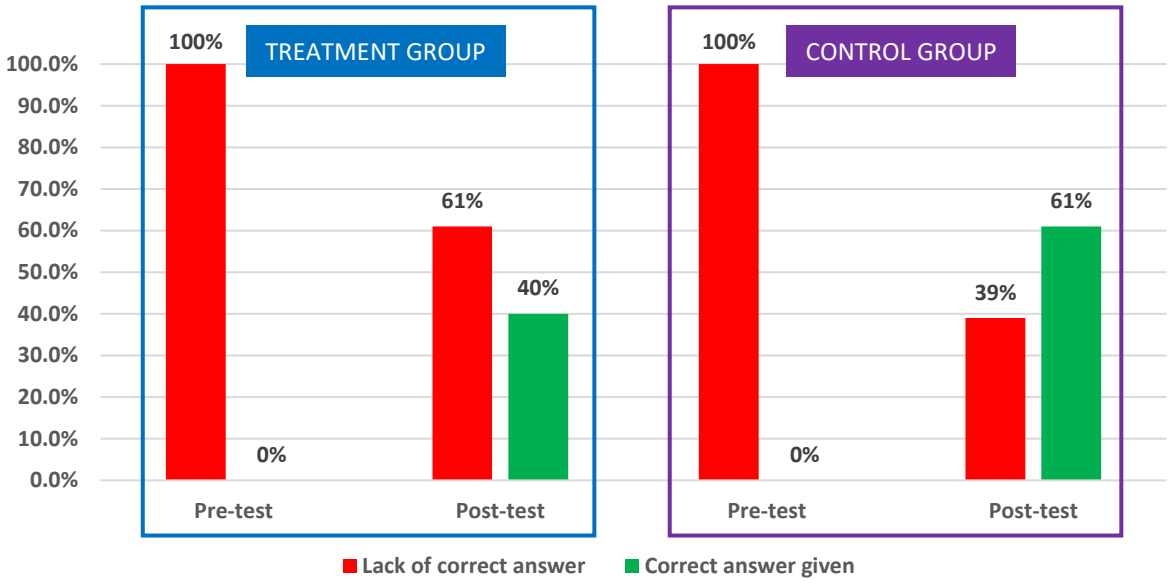
- The control group lessons were not delivered in exactly the same manner as one of the instructors was a former science teacher and this would have influenced the quality of delivery, which may affect control group results.
- There were technical difficulties with setting up the VR experimental group, reducing the time they were exposed to the intervention, which may affect experimental group results.
- Several of the students in the 2nd experimental group independently removed their headsets after about 30 minutes. This seems like a natural time limit for exposure, so VR interventions should be designed to be completed in less than 30 minutes.
- Materials or activities should be prepared in advance to give to students who remove their headsets before 30 minutes or who are unable to take part in the experience for medical reasons.

Study Results

Change in Knowledge

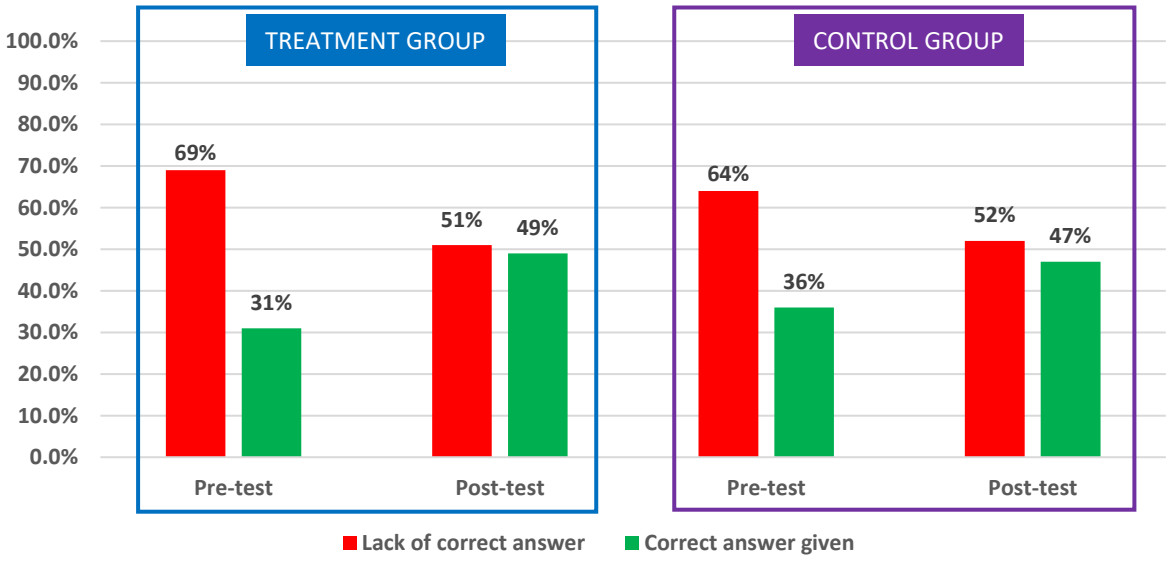
Before exposure to the educational materials, none of the respondents were able to provide correct answers to the question on the length of the global warming's period. After the intervention, 40% of the treatment group provided the correct answer, compared to 61% of the control group (Figure 1). Therefore, for this particular question, the knowledge acquisition was higher amongst the classroom group.

Figure 1. Results of the knowledge test on length of the temperature's increase period.



In the case of knowledge gain on the factors related to the increasing amount of greenhouse gases in the atmosphere there was only a little difference between the two groups. For the treatment group, there was an improvement of 18 percentage points (ppt) compared to 11 ppt for the control group (Figure 2).

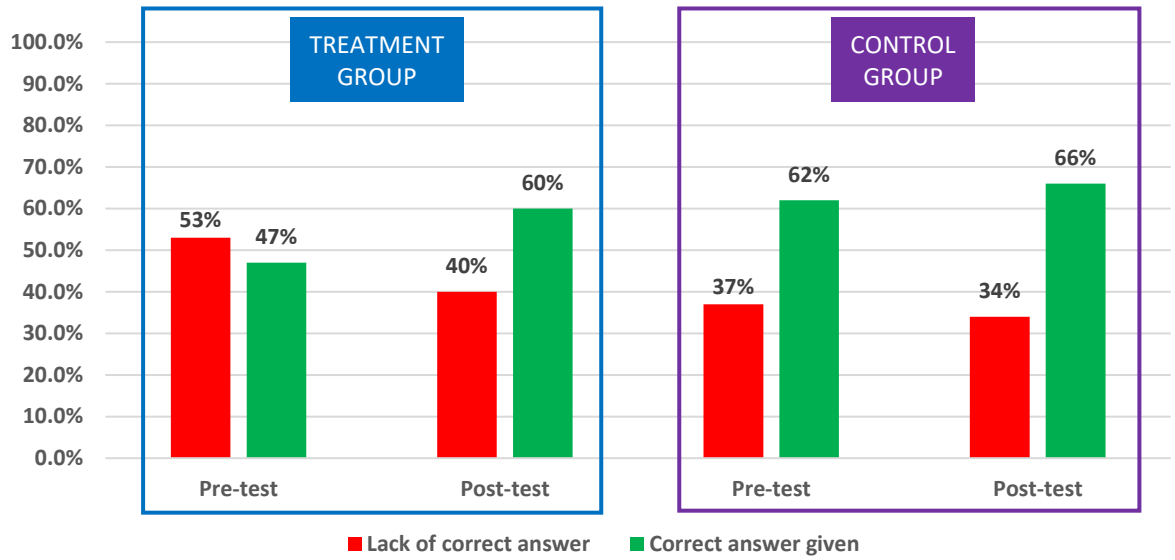
Figure 2. Results of the knowledge test on factors increasing amount of greenhouse gases in the atmosphere.



The progress rate in the knowledge on types of car fuels producing greenhouse gases in the atmosphere was higher among the adolescents who experienced the virtual reality method (13 ppt)

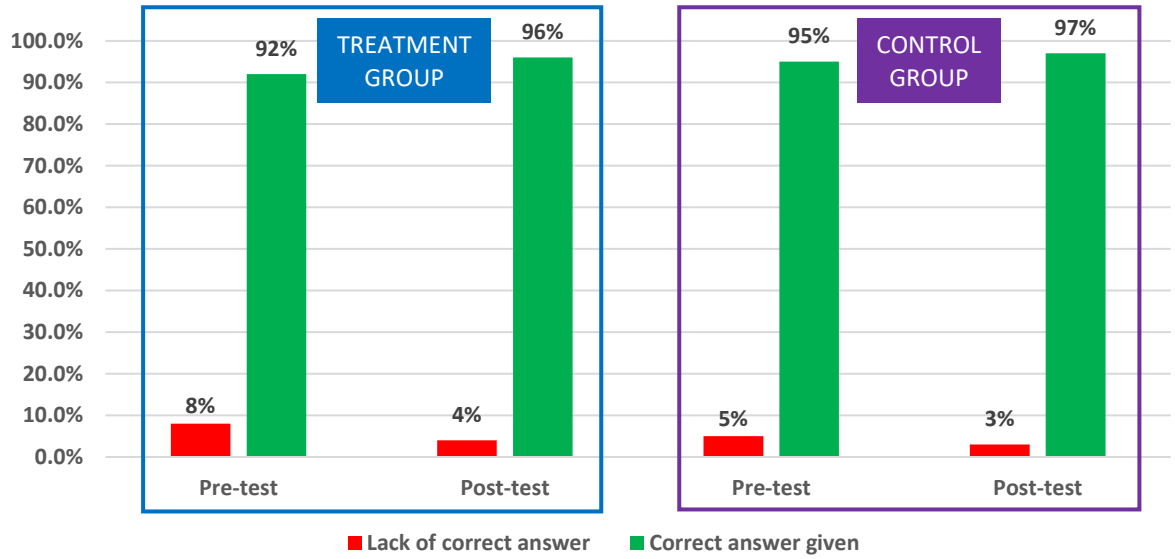
than those exposed to the traditional methods (4 ppt) (Figure 3). However, it should be noted that a higher percentage of the treatment group were incorrect at the pre-test stage.

Figure 3. Results of the knowledge test on types of car fuels producing greenhouse gases.



Before the classes, 92% of participants from the treatment group indicated the correct answer on the environmentally friendly way of travelling to school and after its delivery it was 96% (Figure 4). In the control group these rates amounted respectively to 95% and 97%. This again indicates little difference between the two groups.

Figure 4. Results of the knowledge test on environmentally friendly way of travelling to school.



There was no progress in the knowledge on environmentally friendly cars in either of the groups (Figure 5). Nevertheless, it has to be considered that the initial awareness of this issue was relatively high, unlike the knowledge of low energy bulbs. In the latter case, considerable progress was noticeable in the control group only, indicating that the classroom lesson improved knowledge the most about this topic (Figure 6).

Figure 5. Results of the knowledge test on environmentally friendly cars.

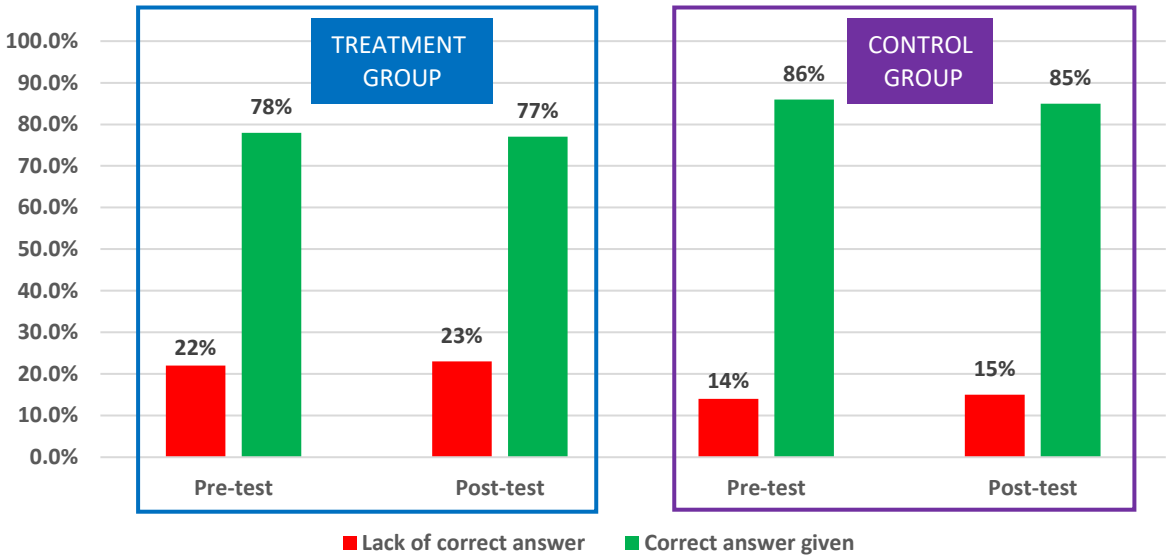
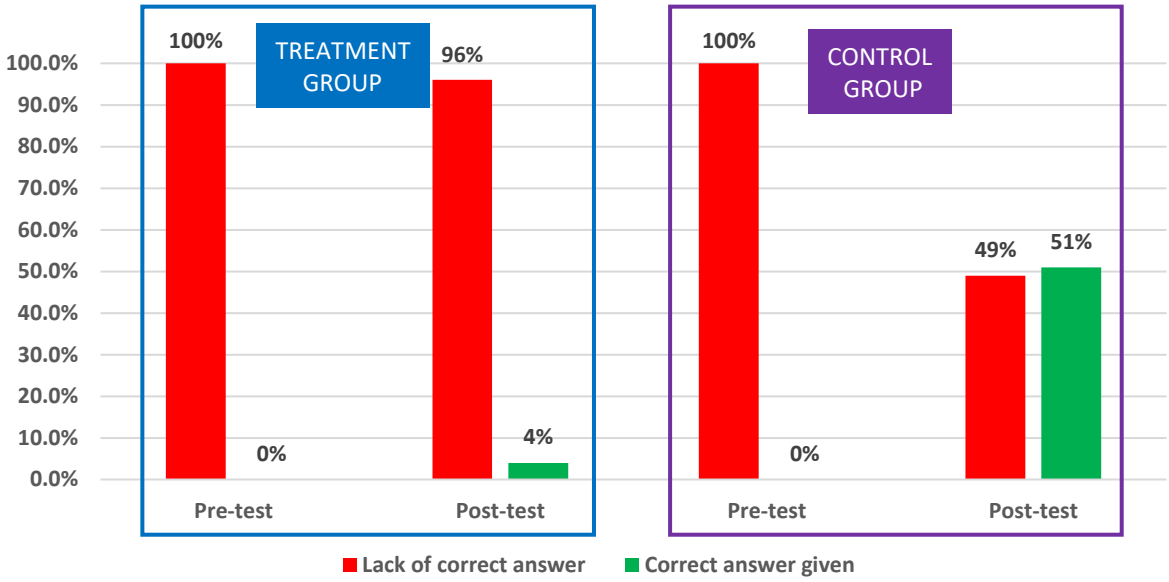


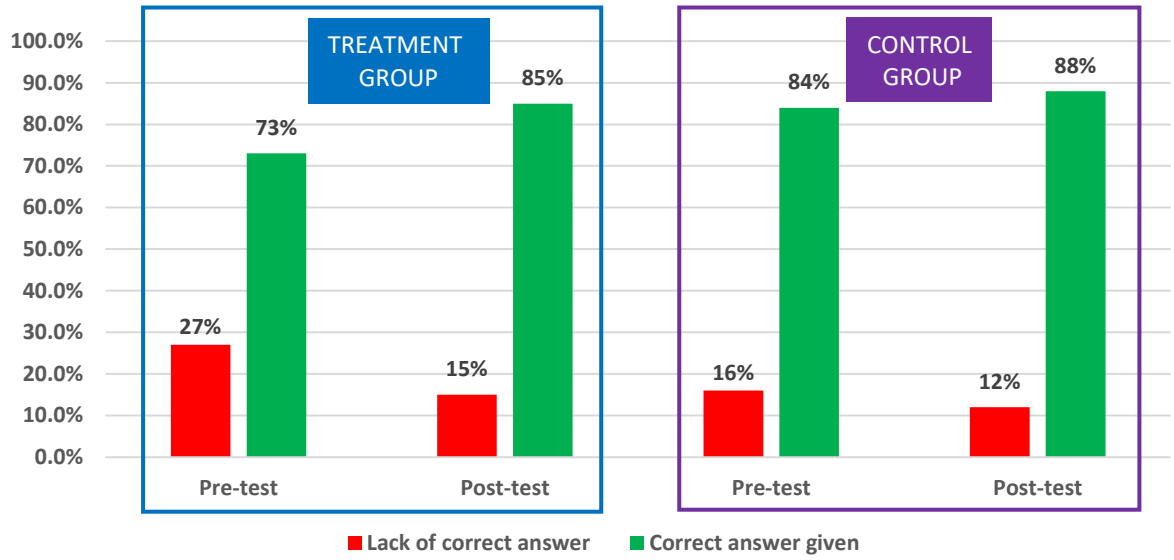
Figure 6. Results of the knowledge test on low energy bulbs



The knowledge on measures to save energy increased to a higher extent in the treatment group than in the control group (After the interventions, there was an improvement of 12 ppt amongst the treatment group on the question on using lights, which was higher than for the control group (Figure 7). However, it should be noted that knowledge was higher at the pre-test stage amongst the control group.

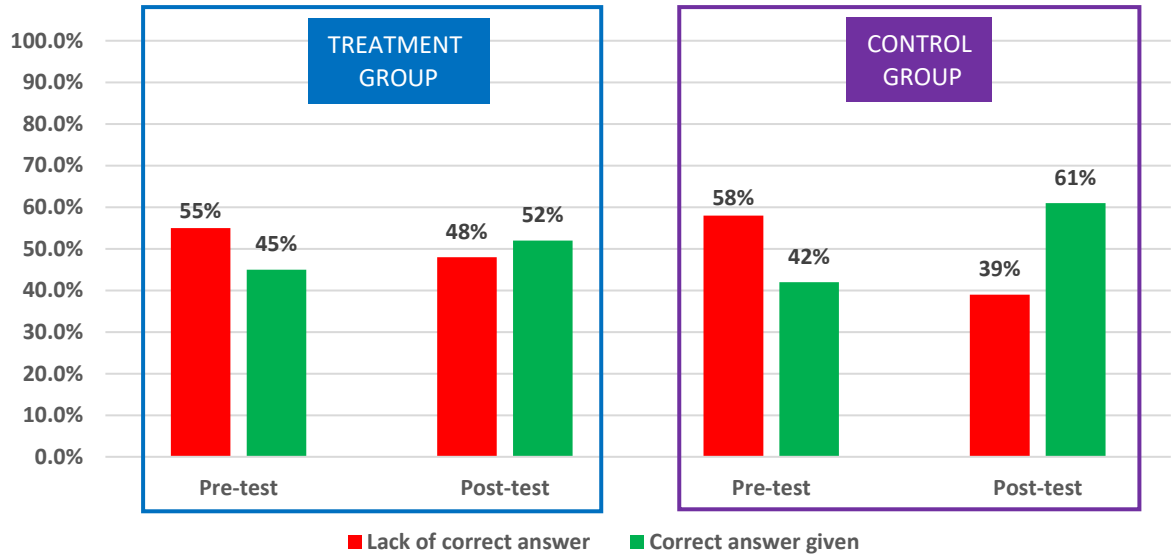
Figure 7). After the interventions, there was an improvement of 12 ppt amongst the treatment group on the question on using lights, which was higher than for the control group (Figure 7). However, it should be noted that knowledge was higher at the pre-test stage amongst the control group.

Figure 7. Results of the knowledge test on proper ways of using light.



After the intervention delivery, there were 7 ppt more participants in the group of students from the treatment group who were able to provide correct answer on thickness of the ice layer that doubles freezers' energy usage. In the group of students who were experiencing the traditional methods, this rate amounted to 19 ppt (Figure 8). There was a higher percentage of the treatment group who provided the correct answer at the pre-stage.

Figure 8. Results of the knowledge test on ice layer and freezers' energy usage.

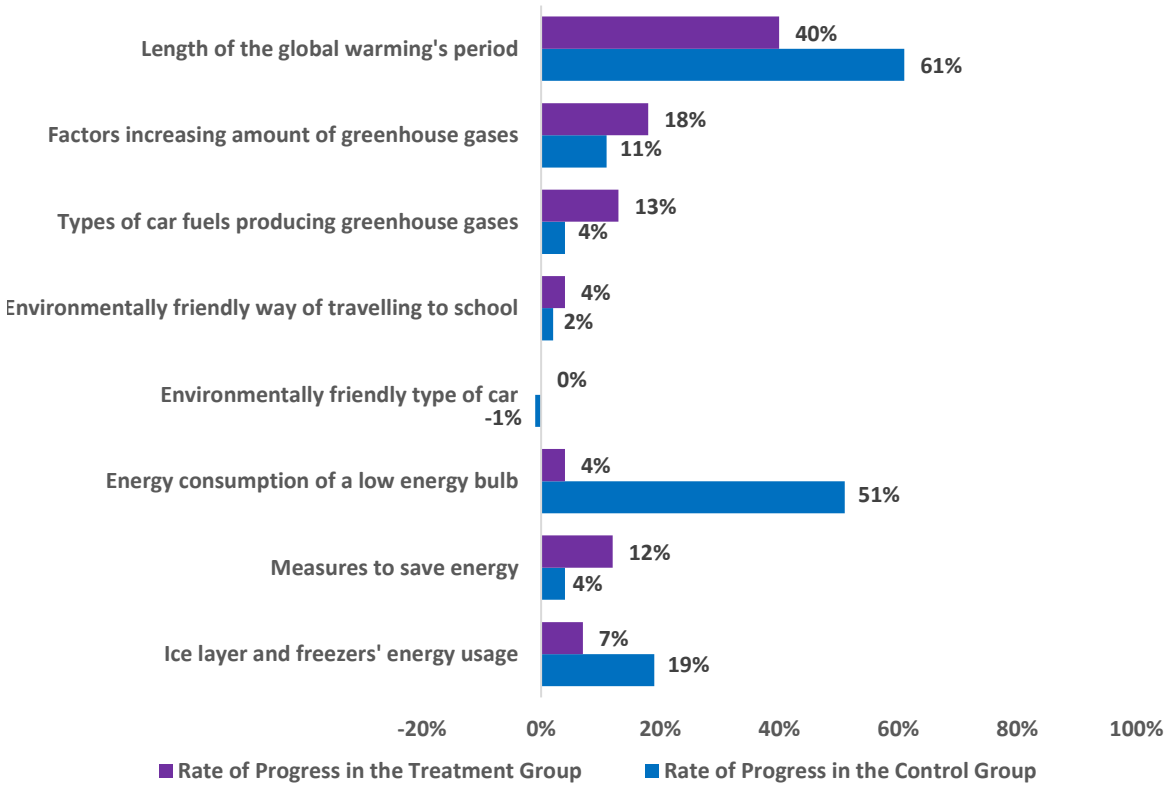


Participants were also asked about the actions to take when not watching TV. However, the way of answering the question by them in the pre- and post-tests does not give a clear indication of what these particular actions would be.

In total, the rate of progress of participants exposed to the virtual reality intervention was higher for 4 out of the 8 analysed topics (Figure 9). Conversely, the classroom group improved to a greater extent on 3 out of the 8 topics. It suggests that the knowledge acquisition varied between the two approaches and that in some cases, the virtual reality game was better whilst at other times, the traditional classroom approach improved knowledge more. It should be remembered that in many cases, the starting knowledge was not the same between the two groups.

It should be noted that overall, the size of the improvement was larger for the control group, as can be seen in Figure 9.

Figure 9. Comparison of progress rates of participants from the treatment group and from the control group.



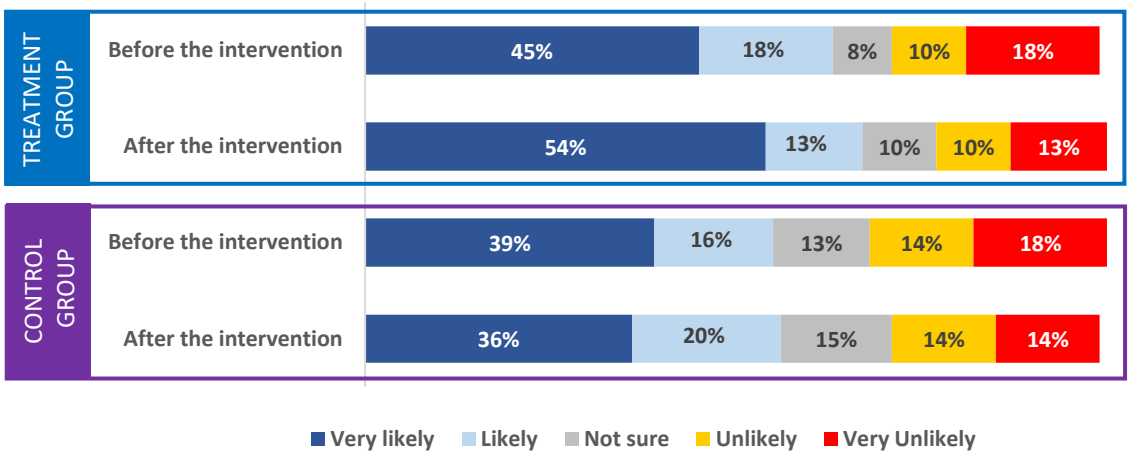
Shift in Attitudes

The questionnaires also asked the participants about their attitudes towards environmentally-friendly behaviours.

There were no considerable improvements in the attitudes of participants from the control and the treatment groups towards their likelihood to walk or cycle to school after the interventions (

Figure 10). More participants from the treatment group reported being 'very likely' or 'likely' to walk or cycle to schools at both stages of the experiment, and there was a switch to a higher percentage of this group reporting that they would be 'very likely' to walk or cycle after the intervention.

Figure 10. Participants' likelihood to walk or cycle to school most days.



However, in terms of general pro-environmental attitude there were other more noticeable increases in the treatment group. After the intervention there were more participants from the treatment group who personally were willing to be environmentally friendly (Figure 11), as well as those willing to talk with parents about climate change (Figure 12) and share with them knowledge on environmentally friendly behaviours (Figure 13). It should be noted that none of the control group students reported being 'very likely' to talk to their parents about climate change at either stage.

Figure 11. Participants' likelihood to be environmentally friendly.

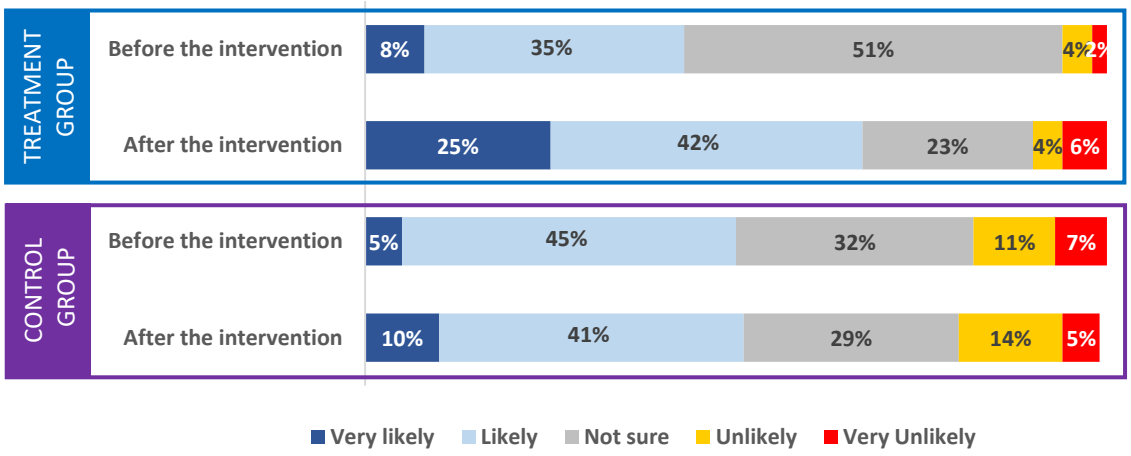


Figure 12. Participants' likelihood to talk with parents about the climate change.

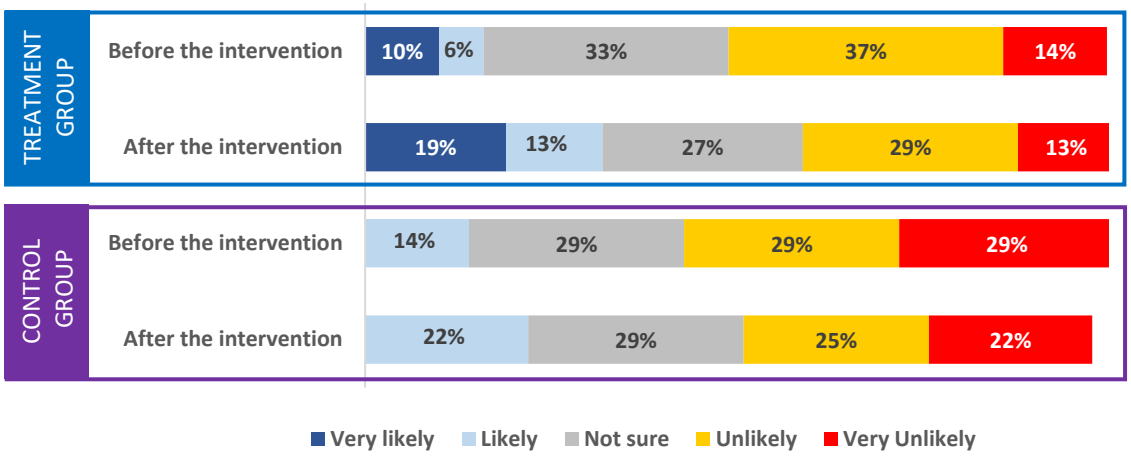
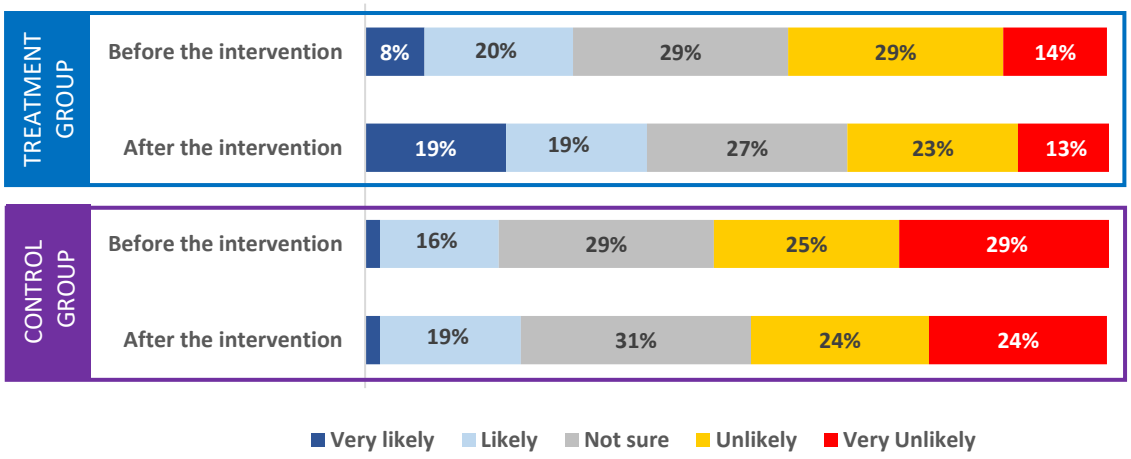


Figure 13. Participants' likelihood to share knowledge on the environmentally friendly behaviours with parents.



Summary

There appears to be little difference in the knowledge gained by the two groups of participants. The group of participants exposed to the virtual reality intervention enjoyed a higher increase in knowledge for 4 out of 8 issues. The baseline knowledge differed between the two groups for some topics. The average increase in the knowledge measures was 7 percentage points higher in the group of participants experiencing the traditional methods than among those exposed to the virtual reality method. It should be remembered that half of the control group received a lesson from a former science teacher and that half of the experimental group encountered technical difficulties with their intervention. It is not possible to say what would have happened if these two influences had not occurred but it is possible that they affected results.

Virtual reality does seem to be more effective in terms of influencing the attitudes of participants and this is worthy of more research. It is interesting to note that the only attitude measure where there wasn't an improvement amongst the virtual reality group was regarding their likelihood to walk or cycle to school. This might be because it is not a decision they are able to make, due to accessibility or parents' wishes. However, where they did have some personal influence, when it came to talking to their parents about environmental issues, sharing knowledge on how to be environmentally friendly and their own likelihood to act in an environmentally friendly manner, the attitudes of the virtual group improved more than the traditional methods group. Over the four attitudinal measures, there was an average 12% increase in attitudes for the virtual reality group to 'very likely' compare to no improvement to 'very likely' amongst the traditional methods group.

Conclusions

Virtual reality technology, as a highly involving and emotional-heightening environment, shows potential in raising interest in a particular issue and in altering respective attitudes. Whilst the experiment did not show that it was a vastly superior method for raising knowledge compared to traditional methods, it does show potential.

A previous review of evidence about using virtual reality technology in education found the following:

> There is limited research on the current iteration of virtual reality technology in use with children. The relevant studies have all been conducted since 1999, however with faster development in graphics technology, these studies will have had a varying degree of realism, however the principles and comparative context to other media available at the time when they were conducted means that they are still relevant.
>
> Presence usually comes up as one of the key measures in a lot of studies. Strong links have been indicated between emotion and the level of presence. High levels of presence indicate that the technology is working at its best to mimic reality. This was one of the focal points for the evaluation that we did for Humberside. There are strong links between positive emotion and heightened presence. There is no evidence to contradict this when considering a younger age group.
>
> When considering design criteria for a virtual reality tool, motivation may be something worth looking in to. One of the studies mentions the key ingredients which have an influence over children's motivation specifically related to VR, stating that challenge, variance and competition were important ingredients.
>
> There are countless other studies citing play as an appropriate method of delivering learning or training for children, as it allows them to each learn at their own pace and is an essential element in a child's development. Also referred to as 'edutainment'.
>
> A study specifically looking in to comparing Virtual Reality and other types of media as an educational tool, determined that the interactivity and control over the environment afforded

by virtual reality meant that the children were more engaged with the educational content and could learn more than in other comparative media delivery methods.

A neurological study into brain activity effects on children and adults while in a highly immersive virtual reality environment showed differences in the adult brain, which increases and decreases activity in certain pre-frontal cortex areas and shows no change in children. This is an area of the brain that has not yet fully developed in children and may explain the differences in experiencing presence in virtual reality at a younger age.

The examples of studies that have been conducted on children in relation to road safety education for the most part demonstrate improvement; however, this has moreso been done as an evaluation of the VR intervention itself. While the results have been mostly positive in achieving their objectives, they haven't directly compared the methods of delivery to see whether there is any benefit to delivery via VR, over any other method of delivery.

Virtual reality, and gamification in particular, does have the potential to be an effective tool in road safety education for this age group. The interactivity provided by the technology, and the ability for learning to take place at the pupil's own pace are clear advantages. However, it is felt that more research is required to conclusively determine efficacy.

In this experiment, attitudes improved through the technology. It is interesting to note that attitudes to environmentally friendly behaviours improved for the virtual reality group when there was almost no improvement in attitudes for those who received the traditional classroom lesson. It could be that the level of presence in the virtual reality game and the links presence have to emotions were what positively affected attitudes. It could also be that the interactivity and control that the virtual reality participants had made them feel like they have control over their behaviour towards the environment in the real world.

If VR was to be pursued as a pedestrian training aid, there are key elements which should be considered as part of the development of such a tool:

- That the game/VR environment is framed appropriately so that the sense of presence does not lead to the arousal of negative emotions
- That the ingredients of challenge, variation and competition are included if there is a game element
- That key learning points from the game/VR are reinforced as part of a more traditional approach (placing the technology as part of a lesson would allow key points to be revisited and would limit the time that the pupils are exposed to the technology, thereby limiting any negative physiological effects). Furthermore, there is a risk that a purely virtual reality approach could allow for key messages to be missed due to the participant being too busy immersing themselves into the experience. Reinforcement of the key messages through a normal lesson would mitigate this.
- That a maximum time of 30 minutes of immersion is designed into the game/VR.

The observed benefits of improvements in attitudes, alongside a similar level of knowledge acquisition as the traditional approach provide opportunities for virtual reality to be potentially effective with this target audience. On the other side, the use of virtual reality brings increased costs, a requirement for more time to set up and implement the equipment, and thus requires more effort. Additionally, there are the potential health and safety issues which should always be considered with virtual reality and given the other marginal benefits and observed disadvantages, it is felt that more research should be considered before this intervention is pursued.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