ABSTRACT

The existing literature on the pedagogical uses of virtual reality technology reveals inconclusive findings. This study synthesised the findings of primary research that investigated the effect of pedagogically integrating virtual reality technology in physical science education. Previously, research in this area was constrained by the high cost of accessing the technology and consequently, there is a paucity of empirical studies conducted on this subject. With the current advancement in digital technology, virtual reality is increasingly becoming affordable, accessible, and having much better representational fidelity. It appears that much of the research that is accumulating on the integration of virtual reality technology in education is driven by perceived technological affordances as opposed to the interplay between pedagogical affordances and the technological affordances.

The current study was guided by pragmatism and used a meta-analytic approach to investigate the pedagogical effectiveness of integrating virtual reality technology in physical science education. The initial literature search conducted on the University of the Witwatersrand's library electronic databases yielded 517 publications with potential for inclusion as identified by the study's keywords. A deduplication process to remove repeating articles and an exhaustive screening process to identify articles that met the study's inclusion criteria were conducted. Ultimately eight articles were identified as meeting the set inclusion criteria. Two more articles that were cited in some of the included studies were deemed appropriate for inclusion in the present study. Thus, a total of 10 articles was accepted for the current meta-analysis.

Viechtbauer's (2010) metafor package, Balduzzi, Rücker and Schwarzer's (2019) meta package and Harrer, Cuijpers, Furukawa and Ebert's (2019) dmetar package, which are all freely available in R for running meta-analyses, were used for data analysis. A pooled effect size estimate of $g = 0.7260$ in the range of *[95% CI: 0.2633, 1.1887]* and a p-value of $p = 0.0043$ were obtained from the analysis, albeit, with a substantial heterogeneity of $Q(df = 16)$

= 355.19, p < 0.0001 and $I^2 = 95\%$. Upon attending to the causes of this variability in the results and eliminating studies contributing to this heterogeneity, the results remained significant with a pooled effect size estimate of *g = 0.5879* standard deviation units in the range of *[95% CI: 0.2938, 0.8820]* and a p-value of *p = 0.0011*. Nonetheless, heterogeneity persisted (*Q (df = 11) = 69.27, p < 0.0001* and $I^2 = 84.1\%$), suggesting that about 84% of the variation in the results was possibly a result of between-study variation.

These results suggest that the pedagogical integration of virtual reality technology in physical science is significant and effective. Thus, the current study's conclusion is that the pedagogical integration of virtual reality technology in physical science presents promising results.

Keywords

Virtual reality; physical science; pedagogical affordance; technological affordance; meta-analysis; conceptual study; conceptual change