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Investigating the influence of Virtual Chemistry Laboratories on learners' attitudes towards Chemistry in rural schools

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Abstract: This study investigates the influence of Virtual Chemistry Laboratories (VCLs) on Grade 12 learners' attitudes towards Chemistry in rural secondary schools in the Sekhukhune East District, Limpopo Province, South Africa. Employing a quasi-experimental pre-post non-equivalent control group design, 115 learners were assigned to an experimental group (EG) utilising VCLs and a control group (CG) receiving conventional teacher-centred instruction. The Attitudes Towards Chemistry Scale (ATCS), comprising 24 items, was validated by two senior education specialists in Chemistry. Reliability analysis indicated a Cronbach's alpha of 0.82, demonstrating good internal consistency. To compare pre–post ATCS results, data were analysed using ANCOVA at $\alpha = 0.05$. The covariate (pre-ATCS scores) significantly predicted post-test scores, $F(1,112) = 8.56$, $p = 0.004$, $\eta^2 = 0.07$. After controlling for pre-test scores, the instructional method had a significant effect, $F(1,112) = 20.62$, $p < 0.001$, $\eta^2 = 0.16$, with the experimental group outperforming the control group. The results suggest that VCLs significantly improved learners' attitudes towards Chemistry, highlighting their influence as learner-centred instructional tools. The study recommends integrating VCLs into the Physical Sciences curriculum and providing professional development for educators to effectively implement VCL-based instruction.

Keywords: Learners' attitudes, chemistry, rural schools, virtual laboratories, secondary schools.

1. Introduction

The central aim of integrating classroom-based technology into science education is to deepen understanding of concepts and improve attitudes towards learning. In the 21st century, developing positive attitudes towards natural science disciplines such as biology, physics, and chemistry has become a priority. Over the years, researchers have shown a growing interest in how learners' attitudes could be improved, with studies focusing on the pedagogy of teaching specific topics in science and fostering positive attitudes as essential for better learning outcomes (Wicaksono & Korom, 2023). The feelings, beliefs, or mental predispositions that learners display can influence their engagement with science-related activities and attitudes towards science (Wicaksono & Korom, 2023). Attitudes towards science, particularly chemistry, are shaped by factors such as curriculum content and pedagogical strategies (Musengimana et al., 2021). Namayanja (2024) similarly posits that learners' attitudes towards chemistry are influenced by factors such as the complexity of content taught and the effectiveness of instructional methods, highlighting the importance of integrating methodologies that improve attitudes towards chemistry.

Despite the importance of positive attitudes in science education, global trends indicate a decline in learners' interest in natural science disciplines, particularly chemistry (Zhan et al., 2022). Contributing factors include teachers' subject knowledge, limited use of effective teaching methods (Christian et al., 2021), inadequate laboratory infrastructure in rural schools, ineffective classroom pedagogy (Ajayi, 2017), and the abstract nature of chemistry concepts alongside classroom environment factors (Musengimana et al., 2021). Integrating cost-free, flexible, and technologically

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enhanced experimental activities is seen as a preferred method to improve understanding of abstract concepts and enhance attitudes towards learning (Sari & Yilmaz, 2015). However, negative attitudes persist across educational levels as learners continue to face unresolved challenges linked to the abstract nature of chemistry.

In the post-COVID-19 era, with the emergence of modern classroom-based technology and the CAPS Curriculum (DBE, 2011), teachers are encouraged to adopt learner-centred tools such as Virtual Chemistry Laboratories (VCLs), in line with the National Chemistry Curriculum, to improve attitudes towards science subjects, including chemistry (Ali, 2020). Exploring factors that contribute to improved attitudes towards chemistry is therefore valuable for teachers, curriculum developers, and policymakers. This paper focuses on investigating the influence of VCLs in enhancing attitudes towards abstract concepts, specifically acid-base concepts, in Grade 12 chemistry learning in two rural secondary schools in Limpopo Province, South Africa.

2. Literature Review

The term 'attitude' is widely utilised across academic and social contexts, often encompassing varying interpretations dependent on personal perspectives. Its lack of a universally clear definition has incited debates among researchers who regard it as a multidimensional construct (Letzel et al., 2023). In the realm of science education, the assessment of learners’ attitudes towards STEM subjects, such as Chemistry, has long been a priority, given that attitudes significantly influence learning outcomes and the efficacy of teaching strategies (Ramzan et al., 2023). Within this study, the enhancement of learners’ attitudes towards Chemistry is a central focus, particularly concerning acid–base concepts, where attitudes are understood as learners’ positive or negative perceptions of the subject.

Research indicates that negative attitudes towards Chemistry often contribute to poor academic achievement, while positive attitudes enhance engagement and outcomes. Kaur and Zhao (2017) argue that positive attitudes not only increase interest in Chemistry but also elevate the likelihood of learners pursuing it further. Additionally, studies conducted during the COVID-19 era underscore that learners with positive attitudes towards Chemistry are more receptive to new ideas, a quality that benefits their overall learning. Positive attitudes have consistently been correlated with higher engagement, participation, critical thinking, and interest in Chemistry, as well as improved academic performance and an increased likelihood of pursuing Chemistry-related careers. Liou (2021) further corroborates that learners with positive attitudes towards Chemistry generally achieve greater success, reinforcing the strong association between attitudes and academic achievement.

Learners’ attitudes are shaped by multiple factors, including gender, instructional strategies, grade level, interest, learning environment, curriculum design, teacher behaviour, and perceived subject difficulty (Musengimana et al., 2021). Among these factors, instructional method is particularly significant in examining the influence of educational tools such as Virtual Chemistry Laboratories (VCLs). Gambari et al. (2016), in a study involving 90 Nigerian secondary school learners, found that the utilisation of VCLs improved attitudes towards Chemistry. Similarly, Keter et al. (2016) reported notable improvements in attitudes among 230 Kenyan learners following exposure to VCLs. Such evidence highlights the potential of VCLs as effective learner-centred tools for enhancing perceptions and attitudes towards Chemistry.

3. Methodology

The study employed a quantitative quasi-experimental approach, using a pre-post non-equivalent control group design to compare the attitudes of the Experimental Group (EG), which was exposed to Virtual Chemistry Laboratories (VCLs), with the Control Group (CG), which utilised the VCL Conventional Teaching Approach to learn Acid-Base concepts in Chemistry. Table 1 shows the structure of the quasi-experimental design, with O1 = Pre-test, O2 = Post-test; O3 = Pre-test; O4 = Post-test; X1 = Integration of VCLs; X2 = CTA.

Table 1: Quasi-experimental design structure

Group	Pre-Test	Treatment	Post-Test
Experimental Group	O1	X1	O2
Control Group	O3	X2	O4

In this study, the EG was exposed to VCLs using ChemCollective, Labster, and VRLab Academy simulation software. These platforms allowed learners to manipulate experimental variables, observe real-time outcomes, and record results, providing a practical and immersive learning experience despite the absence of a fully equipped physical laboratory.

3.1 Population, sample and sampling technique

The target population for this quantitative study included all no-fee public secondary schools in the Sekhukhune East District, Limpopo Province, South Africa. The overall study consisted of 115 Grade 12 Physical Sciences learners who participated in the pre-post Likert Scale attitude test. Two co-educational, quintile one secondary schools were purposively selected from the population of underperforming schools. Moreover, the targeted schools were drawn from different educational circuits within the district. This sample is justified for the following reasons: with a smaller sample size, the researcher can conduct a more in-depth analysis of each school, gathering rich data through the pre-post Attitudes Towards Chemistry Scale (ATCS). Given the resources and time constraints, studying two targeted schools enhances the data collection process. Furthermore, although the sample size is small, the two targeted schools can be representative of the larger population of underperforming schools in the Sekhukhune East District, allowing for the generalisability of findings. The selection was based on specific criteria: schools had to be quintile one institutions consistently performing below the Limpopo Department of Education's 70% National Senior Certificate (NSC) pass rate benchmark over the past five years. Additionally, the focus was placed on schools with large learner enrolments (exceeding 1,000). These selected schools had registered candidates for the Physical Sciences NSC examinations in the 2025 academic year.

3.2 Development of the pre-post attitudes towards chemistry scale

Attitudes of learners towards Chemistry were measured using the Attitudes Towards Chemistry Scale (ATCS), developed through a systematic process involving item generation, adaptation, piloting, and factor analysis. Initially, Grade 12 learners with both high and low interest in Chemistry participated in brainstorming sessions to generate positive and negative attitude items, which were later supplemented by adapting an existing validated scale. To reduce response bias, some items were phrased negatively; these were reverse-scored during data entry in SPSS to ensure that higher scores consistently reflected more positive attitudes. Responses were collected using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), with negatively worded items coded in the opposite direction.

After piloting an initial 35-item version, skewed or poorly performing items were eliminated through descriptive statistics and exploratory factor analysis. Before factor analysis, items were screened using descriptive statistics to ensure a normal response distribution. Skewness was divided by its standard error to generate a z-score, with $|z| > 1.96$ indicating significant skew (Field, 2003). Eleven items were eliminated, and after a Varimax rotation, 24 items with strong loadings were retained for the final ATCS, which was administered unchanged in both pre- and post-tests. A Varimax rotation was conducted, and 24 items with strong factor loadings were retained to form the final ATCS, which was administered unchanged in both pre- and post-tests.

3.3 Instrument validity and reliability

To establish validity, the scale underwent expert evaluation. Two senior educational specialists in Chemistry reviewed the instrument for both face validity, ensuring that the items were clear, relevant, and appropriate for measuring learners' attitudes, and content validity, confirming that the items adequately represented the construct of attitude towards Chemistry. Their feedback was utilised to refine and enhance the wording and coverage of the items. A pilot study was subsequently conducted in a school that was not part of the main research sample. This trial application aimed to test the instrument's reliability and identify any potential ambiguities or weaknesses within the questionnaire. Based on the pilot results, the instrument demonstrated strong internal consistency, yielding a Cronbach's alpha coefficient of 0.82, which is regarded as highly acceptable in educational research. This reliability index confirmed that the ATCS items consistently measured the intended construct and were suitable for use in the main study.

3.4 Data collection and analysis

Following approval from the Durban University of Technology Institutional Research Ethics Committee (DUT-IREC-043/25), as well as formal permission from the Limpopo Department of Education Head of Department, Sekhukhune East District, and the principals of the targeted schools, the researcher commenced the data collection process. The researcher visited the selected schools to familiarise himself with the setting, introduce the study, outline its purpose, and obtain informed consent from participants. Data were collected using a pre-post ATCS on a 5-point Likert scale. Both the experimental group, exposed to VCLs, and the control group, taught using the CTA, completed the pre-test ATCS to establish baseline attitudes. The post-test ATCS was administered after the intervention to determine changes in attitudes towards Chemistry for both groups. Data analysis for Research Question 1 involved descriptive statistics (mean and standard deviation) to characterise the learners' attitudes towards Chemistry before and after the treatment. To test the study hypotheses and account for potential differences in baseline attitudes, analysis of covariance (ANCOVA) was employed. The pre-test ATCS scores were used as the covariate to control for initial group differences, while the post-test scores served as the dependent variable. This approach allowed the researcher to examine the effect of the intervention (VCLs) on post-test attitudes while adjusting for learners' prior attitudes.

3.5 Intervention description

The intervention lasted one week and involved the experimental group (EG) completing five virtual laboratory lessons on Acid-Base concepts using ChemCollective, Labster, and VRLab Academy simulations on tablets. The experiments included: (i) reactions of strong/weak acids and bases, (ii) titration of a strong acid with a weak base, (iii) titration of a weak acid with a strong base, (iv) pH indicator experiments, and (v) preparation of a standard solution of oxalic acid. The virtual laboratory activities were aligned with the Grade 12 Curriculum and Assessment Policy Statement (CAPS) for the Physical Sciences curriculum and were implemented over a one-week period during scheduled class sessions. The five laboratory sessions were structured to complement conventional classroom instruction, foster active participation, and enhance learners' attitudes towards abstract Chemistry concepts, particularly acids and bases. The first and last days were used for administering the pre-ATCS and post-ATCS, respectively, each lasting one hour, while the five days in between were devoted to the intervention.

3.6 Ethical considerations

All ethical protocols were strictly followed in this study. Approval was obtained from the Durban University of Technology Institutional Research Ethics Committee (DUT-IREC 043/25), as well as formal permission from the Limpopo Department of Education and the principals of the participating schools. Informed consent was secured from all participants after they were fully briefed on the objectives, benefits, and voluntary nature of the study. Information sheets and consent forms were provided, and participants were assured of their right to withdraw at any stage without penalty. To ensure confidentiality and anonymity, pseudonyms were used instead of real names. The researcher emphasised that participation carried no risks and that responses would not have any personal consequences.

3.7 Limitations

This study, with its innovative focus on the role of Virtual Chemistry Laboratories (VCLs) in improving attitudes towards Chemistry in rural schools in Limpopo Province, offers valuable insights into how learners' perceptions of Acid-Base concepts, a key component of Physical Sciences, can be enhanced. Nonetheless, several limitations were identified.

Firstly, the study population consisted of Grade 12 Physical Sciences learners from the Sekhukhune East District, all drawn from rural schools. This limited sampling frame restricts the generalisability of the findings. Including participants from urban schools, both public and independent, could have provided richer and more representative data. Additionally, the study was confined to one Chemistry topic, Acids and Bases, whereas exploring more complex areas such as Chemical Equilibrium, or extending the scope to Grade 10 and 11 learners, might have yielded broader insights. Secondly, as the research was conducted in a predominantly rural context in Limpopo Province, the results may not accurately reflect the wider learner population. Factors such as location, socio-economic background, and educational resources may have influenced learners' attitudes. Sampling also posed a limitation: the study relied on a relatively small group of 115 learners (65 females and 50 males), with females slightly overrepresented at 57%, compared to 43% males, which may have skewed the results. Finally, the scope of the study was restricted to examining VCLs' influence on Chemistry attitudes within rural secondary schools. A broader investigation incorporating urban schools, other science disciplines such as Life Sciences and Physics, as well as primary schools in both rural and urban contexts, could provide a more comprehensive understanding of the impact of VCLs across diverse educational environments.

4. Presentation of Results

This section presents the results of the study based on the data collected and analysed to address the stated research questions. It provides both descriptive and inferential statistics to compare learners' attitudes towards Chemistry before and after the intervention.

4.1 Mean Attitude Towards Chemistry Scores of Grade 12 Learners

This theme explores the comparative mean attitude scores of Grade 12 learners towards Chemistry when taught using different instructional approaches: Virtual Chemistry Laboratories (VCLs) and the Conventional Teaching Approach (CTA). The analysis aims to determine how the two methods influenced learners' attitudes before and after the intervention, providing insights into the effectiveness of technology-enhanced learning environments in fostering positive dispositions towards Chemistry.

Research Question 1: *What is the mean attitude towards Chemistry scores of Grade 12 learners taught Chemistry using VCLs compared to those taught using CTA?*

Table 2: *Group statistics of the Experimental Group and the Control Group before and after the intervention*

Pre-MAPS					Post-MAPS			
Groups	N	Mean	SD	SEM	Mean	SD	SEM	Mean Gain
CG(CTA)	60	67.44	9.42	1.24	75.12	13.91	1.83	7.68
EG(VCL)	55	67.70	11.03	1.49	83.52	14.68	1.98	15.82

Where; CTA = Conventional Teaching Approach; MAPS = Mean Attitude Percentage Score, MAG = Mean Attitude Gain; N = Number of participants; SEM = Standard Error Mean; SD = Standard Deviation and VCL = Virtual Chemistry Laboratory

The result in Table 2 shows the pre-Attitudes Towards Chemistry (pre-ATC) and post-Attitudes Towards Chemistry mean and standard deviation scores of learners taught Chemistry using VCL (experimental group) and CTA (control group). Results suggest that the pre-ATC and post-ATC mean scores for the experimental group (EG) were 67.70 and 83.52, respectively, with corresponding standard deviations of 11.03 and 14.68. For learners taught using the Conventional Teaching Approach (CTA), the pre-ATC and post-ATC mean scores were 67.44 and 75.12, respectively, with corresponding standard deviations of 9.42 and 13.91. The pre-intervention means for the control group (CG) (67.44, SD= 9.42) and EG (M= 67.70, SD= 11.03) were similar, suggesting that the groups were comparable in attitude towards Chemistry before the intervention. In the post-intervention, the means for the CG and EG were (M= 75.12, SD= 13.91) and (M= 83.52, SD= 14.68), respectively. The post-ATC standard deviations for both groups were slightly higher than their respective pre-ATC scores, suggesting a small increase in score variability after instruction. In both groups, the post-ATC means were higher than the pre-ATC means, indicating that both VCL and CTA improved learners' attitudes towards Chemistry concepts taught. However, the post-ATC mean for the EG (83.52) was notably higher than that of the CG (75.12), suggesting that learners taught using VCL achieved better results than those taught with CTA. The mean gain score for the EG was 15.82, compared to 7.68 for the CG, representing a mean difference of 8.14 in favour of VCL. This implies that the Virtual Chemistry Laboratory was more effective in enhancing learners' attitudes towards Chemistry than the Conventional Teaching Approach.

Both groups showed improvement from pre-test to post-test, as indicated by the positive mean gain scores. The variability of post-test scores was higher than pre-test scores for both groups, suggesting differences in how learners responded to each learning strategy. The mean gain of the VCL group (15.82) was more than twice that of the CTA group (7.68), demonstrating that the VCL strategy had a greater impact on student achievement. The data indicates that VCLs are a more effective strategy than the Conventional CTA for enhancing learners' achievement in Chemistry, as evidenced by higher post-test means and larger mean gains.

4.2 Analysis of pre-post mean Attitudes Towards Chemistry scores using ANCOVA

This theme investigates whether the differences in learners' attitudes towards Chemistry, resulting from the use of Virtual Chemistry Laboratories (VCLs) and the Conventional Teaching Approach (CTA), are statistically significant after controlling for pre-test scores. The analysis employs Analysis of Covariance (ANCOVA) to adjust for initial attitude differences and determine the true effect of the instructional methods. Accordingly, the following null hypothesis was tested:

Null Hypothesis (H_0): There is no statistically significant difference in post-test attitudes towards Chemistry between Grade 12 learners taught using VCLs and those taught using CTA, after controlling for pre-test ATCS scores.

Table 3: *ANCOVA of post-test attitude scores for control and experimental groups*

Source	**SS**	**df**	**MS**	**F**	**p**	**Partial η^2**
Pre-ATCS (Covariate)	12.41	1	12.41	8.56	0.004	0.07
Group (VCL vs CTA)	29.87	1	29.87	20.62	<0.001	0.16
Error	154.23	112	1.38	—	—	—
Total	196.51	114	—	—	—	—

Table 3 presents the ANCOVA results conducted to examine the effect of teaching method—Virtual Chemistry Laboratories (VCLs) versus Conventional Teaching Approach (CTA)—on Grade 12 learners' attitudes towards Chemistry, while controlling for pre-test scores (pre-ATCS). The dependent variable was the post-test ATCS scores, with the pre-test ATCS scores serving as the covariate to adjust for baseline differences between groups.

The ANCOVA results indicate that the covariate (pre-ATCS scores) significantly predicted post-test ATCS scores, $F(1, 112) = 8.56$, $p = 0.004$, with a small-to-moderate effect size (partial $\eta^2 = 0.07$). This suggests that learners' initial attitudes towards Chemistry had some influence on their post-intervention attitudes, as expected. After controlling for the pre-test scores, the type of instructional method (group) had a significant effect on post-test ATCS scores, $F(1, 112) = 20.62$, $p < 0.001$, with a moderate effect size (partial $\eta^2 = 0.16$). Since $p < 0.001$ for the group effect, the null hypothesis is rejected. This finding confirms that learners exposed to VCLs (experimental group) achieved significantly higher attitudes towards Chemistry compared to those taught via CTA (control group).

In practical terms, this indicates that VCLs were more effective than CTA in improving learners' attitudes towards Chemistry. Mean post-test ATCS scores suggest that learners in the experimental group showed noticeable gains relative to their control group peers, highlighting the impact of VCLs on promoting positive learning dispositions towards Chemistry.

Additionally, the effect of the covariate was modest (partial $\eta^2 = 0.07$), suggesting that while baseline attitudes contributed to post-test scores, the intervention itself (VCLs) played a major role in enhancing attitudes. The null hypothesis that there is no difference between the groups was therefore rejected, demonstrating the effectiveness of VCLs as a learner-centred educational tool.

5. Discussion of Findings

The findings from both the group statistics and ANCOVA reveal that learners exposed to VCLs demonstrated significantly higher post-test attitudes towards Chemistry compared to their counterparts taught through the CTA. While both strategies yielded positive gains, the magnitude of improvement was greater for the VCL group, suggesting that the virtual environment offered unique affordances that shaped learners' attitudes. VCLs, as interactive and learner-centred tools, not only actively engage learners but also facilitate understanding of abstract concepts, enhancing motivation and promoting positive perceptions towards Chemistry. These findings align with contemporary studies emphasising the role of technology-enhanced learning environments in fostering positive attitudes, engagement, and improved academic outcomes (Bazie, 2024; Viitaharju, 2023; Ross et al., 2020).

One possible explanation lies in the visual and interactive nature of VCLs. Chemistry, particularly topics such as acids and bases, involves abstract concepts that learners often struggle to visualise in traditional classroom settings. The simulations in ChemCollective, Labster, and VRLab Academy enabled learners to observe chemical reactions in real time, manipulate variables such as pH and concentration, and receive immediate feedback. This dynamic interaction likely made the concepts more concrete, reducing cognitive load and enhancing conceptual clarity, which in turn fostered more positive attitudes.

A second factor relates to the element of gamification and engagement. Unlike passive instruction, VCLs presented tasks in problem-solving formats where learners could "experiment" in safe and repeatable environments. This sense of autonomy and control has been shown to increase motivation and curiosity, which are strongly linked to more favourable attitudes towards science learning. Learners may have perceived the virtual labs as less intimidating and more enjoyable than conventional teacher-led demonstrations, thus contributing to the stronger post-test scores observed.

Furthermore, VCLs offer a risk-free environment where learners can make mistakes without fear of material loss or safety hazards. This reduces anxiety often associated with laboratory work and encourages experimentation. Such safe exploration may explain why the variability in post-test scores increased, as different learners engaged with the simulations at their own pace and level, leading to a wider range of experiences and reflections, but overall stronger mean gains. And finally, the alignment of VCL activities with the CAPS curriculum ensured that learners were not merely playing with simulations but were engaging meaningfully with content relevant to assessment objectives. The structured nature of the intervention, combined with interactivity, likely produced a deeper cognitive engagement that conventional lectures and textbook examples could not match.

In summary, the superior outcomes of the VCL group can be attributed to the integration of visualisation, interactivity, gamification, learner autonomy, and reduced anxiety, all of which supported deeper learning and more positive dispositions towards Chemistry. These mechanisms collectively explain why learners in the VCL condition developed stronger post-intervention attitudes compared to those in the CTA group.

6. Conclusions and Recommendations

This study examined the influence of VCLs on Grade 12 learners' attitudes towards Chemistry in two rural schools in Limpopo Province. The findings revealed that learners exposed to VCLs demonstrated significantly more positive attitudes than their peers taught through the CTA. The interactive and visual features of VCLs helped learners grasp abstract Acid-Base concepts and motivated them to engage more meaningfully with Chemistry. These results suggest that VCLs can serve as a valuable pedagogical supplement, particularly in resource-constrained contexts where access to physical laboratories is limited.

While the results are promising, they should be interpreted within the scope of this study. The research was conducted with a small sample from two schools and focused only on one Chemistry topic, which limits the extent to which the findings can be generalised to all schools or subject areas. Broader adoption of VCLs requires further research across different provinces, topics, and larger learner populations before systemic recommendations can be made. Nevertheless, this study provides evidence that VCLs hold considerable potential for enhancing attitudes towards Chemistry and lays a foundation for further investigation into scalable, technology-enhanced teaching approaches in South African classrooms.

Based on the findings, the following recommendations are made, considering the study's limited scope: (i) Chemistry teachers, particularly in resource-constrained schools, should be encouraged to experiment with VCLs as supplementary tools to support learner engagement and attitudes towards abstract concepts, such as acids and bases; (ii) the Department of Basic Education, through senior education specialists, could organise targeted workshops and professional development programmes to familiarise teachers with VCL platforms and their classroom integration; (iii) rather than immediate large-scale adoption, the Department of Basic Education may consider pilot projects in selected districts to assess the feasibility, cost-effectiveness, and scalability of VCLs before developing broader implementation guidelines; and (iv) further studies should investigate the long-term influence of VCLs across multiple Chemistry topics, involve larger and more diverse samples (urban and rural), and explore other digital tools, such as simulation-based learning and virtual reality, in STEM education.

7. Declarations

Author Contributions: Conceptualisation (R.H., M.T. & M.D.); Literature review (R.H.); methodology (R.H., M.T.); software (N/A); validation (M.D.); formal analysis (R.H., M.T. & M.D.); investigation (R.H., M.T. & M.D.); data curation (R.H., M.T. & M.D.); drafting and preparation (R.H., M.T. & M.D.); review and editing (M.T. & M.D.); supervision (N/A); project administration (N/A); funding acquisition (N/A). All authors have read and approved the published version of the article.

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Data Availability Statement: The data are not publicly available due to confidentiality agreements with participants and ethical restrictions imposed by the Institutional Review Board. However, de-identified data can be made available from the corresponding author upon reasonable request, subject to approval by the ethics committee.

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