



Effectiveness of Inquiry-Based Learning and Virtual Laboratory Experiments in Traditional and Virtual Classroom Settings

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Introduction

- Are inquiry-based learning and virtual laboratory experiments more effective than rote memorization and testing in both traditional and virtual classrooms?
- Inquiry-based learning and virtual laboratory experiments improve the overall understanding of topics in the classroom (1).
- Next Generation Science Standards (NGSS) promote the use of inquiry-based teaching and technology in the classroom (3).
- Memorization alone is not effective in inquiry-based classrooms because students are continuously building off of information that they already have (4).
- Hybrid learning models are when inquiry-based learning is used to include both technology and traditional teaching methods in the same classroom.

Methods

- Two databases and Google Scholar were searched from October 2020 to January 2021. The search strategy was based on the following criteria:
 - All studies included data on virtual laboratory experiments and/or inquiry-based learning implementation in the classroom.
 - No publication dates earlier than 2014 were selected
 - Published in a peer-reviewed journal
 - Studies include students of all ages and location
- Between January 2021 and February 2021, observations were made in a blended high school chemistry classroom.
 - Students worked with virtual experiments and traditional teaching methods in the classroom
 - Work was done as individual students understood the material and moved onto the next portion of the course

October 2020 to January 2021

Database Research and Article Review

January 2021 to February 2021

Observation in a blended High School Chemistry Classroom

Results

- Hybrid teaching, teaching of both traditional and virtual methods in the classroom, of inquiry-based learning and virtual lab experiments showed the most improvements between all of the sources reviewed
- Students showed improved understanding and comprehension with different methods in each source
 - Each source included a form of inquiry-based learning, virtual laboratory experiments, or a combination of both
 - Sources included a variety of methods, such as pre- and post-tests, standardized testing scores, general classroom assessment scores, and formative assessment results
- Research showed that students taught with visual representations and physical models to assist with conceptual learning achieved higher levels of understanding and comprehension of material
- Conceptualizing the sub-microscopic levels of certain aspects of chemical sciences has been shown to be most difficult for students of all ages
 - This level of detail is difficult to envision due to the lack of experience students have with it in everyday life
 - Students interact with the macroscopic and symbolic levels throughout K-12 education, however the sub-microscopic levels are shown less often before more advanced continuing education courses, such as in colleges or universities
- Statistically significant pre- to post-test improvements showed that students demonstrated improved problem solving and inquiry abilities through the use of virtual laboratory experiments and activities
 - A total of 1473 high school students showed an overall statistically significant increase in pre- to post-test scores with the use of virtual activities and experiments

Discussion/Conclusion

- Results showed that majority of references found improvements in both content understanding and comprehension with both inquiry-based learning and virtual laboratory experiments
 - Shown through pre- to post-test score improvements, and other testing score improvements
- Inquiry-based learning alone showed improved understanding and comprehension
- Within the blended high school chemistry course that has been observed, students have benefited most from inquiry-based activities that are based on their virtual experiences
 - This is beneficial for teachers looking to determine the best teaching method in their classroom
- Data collected throughout this experiment concerned the teaching of science courses, specifically at the secondary level, and only with virtual laboratory experiments
 - Additional research in both hybrid and blended classrooms is essential to determining the full capabilities that these methods have to improve understanding and comprehension
 - Data collection with virtual activities other than laboratory experiments would be beneficial

References

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Acknowledgements

- Mr. Darr and the 2021 High School Chemistry Class at Rudyard Jr./Sr. High School
- Thank you to Dr. David Myton, Dr. Barbara Light, Dr. Cathy White, and Dr. Derek Wright for feedback throughout this process