

WEST VISAYAS STATE UNIVERSITY
COLLEGE OF EDUCATION
GRADUATE SCHOOL
Iloilo City

TEACHERS' AND STUDENTS' BIOLOGY LABORATORY SKILLS: BASIS FOR THE
DEVELOPMENT OF LABORATORY GUIDE

A Dissertation Presented to the
Faculty of the Graduate School
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La Paz, Iloilo City

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of the Requirements for the Degree
Doctor of Philosophy in Science Education
(Biology)

by

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Abstract

This Design-based research was conducted to determine the extent of acquisition of Biology laboratory skills of STEM students, to determine the extent to which Biology teachers integrate laboratory in their classes to better equip these students with the needed skills, and to assess the present conditions of Biology laboratory of the Senior High Schools offering STEM in Guimaras. Using these as basis, the ADDIE model was utilized to create a Biology laboratory guide to enhance the laboratory skills among STEM students in the Senior High School, in preparation for college. The researcher used a researcher-made questionnaire for students' laboratory skills acquisition, teachers' integration of Biology laboratory, and present conditions of laboratory among schools. One-on-one interviews with the teacher-participants were conducted in order to enrich the data gathered. For the Analysis phase, the responses were analyzed, and found those Biology laboratory skills acquired to a low extent, as well as those without laboratory activities conducted by the teachers were identified as 'gaps'. These became the basis for the Design of the Biology 1 Laboratory Guide for Senior High School. During the Development phase, 5Es (engage, explore, explain, evaluate and extend) was used in the content of the laboratory guide. The different laboratory procedures were carried out in the Implementation phase, of which the teacher-implementers,

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teacher-observers and students have given their observations and comments on the delivered guide. The Evaluation phase then followed, where the developed laboratory guide was evaluated by a set of experts. Students have generally acquired Biology Laboratory Skills to a high extent, except for certain laboratory procedures. These certain laboratory skills were not developed because of the lack of activities to enhance their skills; laboratories among schools lack the appropriate Biology laboratory facilities and equipment. Laboratory work in Biology must be viewed as essential to every Biology class. Finally, the use of the developed Biology I Laboratory Guide for Senior High School is recommended. Improvements in facilities must therefore be taken into consideration and teachers include laboratory activities in Biology classes.

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REFERENCES

References

- Aydede, M., & Robbins, P. (Eds.). (2009). *The Cambridge handbook of situated cognition*. New York, NY: Cambridge University Press.
- AAAS (American Association for the Advancement of Science) (1993). *Benchmarks for scientific literacy: A Project 2061 report*. New York: Oxford University Press.
- Banchi, H., & Bell, R. (2008). The many levels of inquiry. *Science and Children*, 46(2), 26–29. Retrieved from <http://www.eric.ed.gov/>
- Basey, J. M., Mendelow, T. N. & Ramos, C. N. (2000). Current trends of community college lab curricula in biology: An analysis of inquiry, technology, and content. *Journal of Biological Education*, 34(2), 80 -86.
- Bekalo, S. A.; Welford, A. G. *Secondary Pre-Service Teacher Education in Ethiopia: Its Impact on Teachers' Competence and Confidence To Teach Practical Work in Science*. *International Journal of Science Education*, v21 n12 p1293-1310 Dec 1999
- Bevevino, M.M., Dengel, J., & Adams, K. (1999) *Constructivist Theory in the Classroom Internalizing: Concepts through Inquiry Learning*. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 72:5, 275-278, DOI: 10.1080/00098659909599406
- Biehle, J. T, Motz, L. L., & West, S. S.. (1999). *NSTA guide to school science facilities*. Arlington, VA: NSTA Press. Retrieved December 3 2018 from <http://www.nsta.org/about/positions/laboratory.aspx>

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher*, 18(1), 32-42.

Chabalengula, V.M., Mumba, F., Hunter, W. & Wilson, E. (2009) A MODEL FOR ASSESSING STUDENTS' SCIENCE PROCESS SKILLS DURING SCIENCE LAB WORK. *Problems of Education in the 21st Century*, 11. P.28-36.

<http://oaji.net/articles/2014/457-1392408154.pdf>

Collins, A., Brown, J. S., & Newman, S. E. (1988). Cognitive apprenticeship. *Thinking: The Journal of Philosophy for Children*, 8(1), 2-10.

Clough, M.P. 2002. National Science Teachers Association. Using the Laboratory to Enhance Student Learning. *Learning Science and the Science of Learning*, ed. R.W. Bybee, 85–96. Arlington, VA: NSTA Press.

Dahar, R. & Faize, F. (2011). Effect of the Availability and the Use of Instructional Material on Academic Performance of Students in Punjab (Pakistan). *European Journal of Social Sciences – Volume 19, Number 1*.

Ebert*, J. D. (2019) National Science Education. Retrieved January 10, 2019 from <https://www.nap.edu/read/4962/chapter/5#30>

Ergul, R., Simsekli, Y., Calis, S., Ozdilek, Z., Gocmencelebi, S., & Sanli, M. (2011) The Effect of Inquiry-Based Science Teaching on Elementary School Students' Science Process Skills and Science Attitudes. *Bulgarian Journal of Science and Education Policy* 5(1). 2011, pp. 48-68(21). Retrieved from <http://bjsep.org/getfile.php?id=88>.

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- Germann, P.J., Haskins, S., & Auls, S. (1996). Analysis of nine high school biology laboratory manuals: Promoting scientific inquiry. *Journal of research in Science teaching*. 33(5). p. 475-499. [https://doi.org/10.1002/\(SICI\)1098-2736\(199605\)33:5<475::AID-TEA2>3.0.CO;2-O](https://doi.org/10.1002/(SICI)1098-2736(199605)33:5<475::AID-TEA2>3.0.CO;2-O)
- Gobaw, G.F. & Atagana, H.I.(2014). *Biology Laboratory Practical Assessment Methods used by Ethiopian Universities*. Proceedings of international conference of ISTE, October 19-24/2014, South Africa
- Hofstein, A. & Lunetta, V.N. (1982). The Role of the Laboratory in Science Teaching: Neglected Aspects of Research. *Review of Educational Research*. Vol. 52, No. 2 (Summer, 1982), pp. 201-217
- Hofstein, A., & Lunetta, V.N. (2003). The laboratory in science education: Foundations for the twenty-first century. *Science Education*, 88(1), 28–54.
- Hofstein, A., & Mamlok-Naaman, R. (2007). The laboratory in science education: the state of the art. *Chemistry Education Research and Practice*, 8(2), 105-107.
- Hunt, L., Koender, A. & Ynnild, V. (2012). Assessing practical laboratory skills in undergraduate molecular biology courses. *Assessment & Evaluation in Higher Education*, 37(7), 861–874.
- Jack, G.U. (2013). The Influence of Identified Student and School Variables on Students' Science Process Skills Acquisition. *Journal of Education and Practice*, 4(5), 16-22

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Lunetta ,V. & Lunetta, N. (2003).The Laboratory in Science Education: Foundations for the Twenty-First Century. AVI HOFSTEIN Department of Science Teaching, TheWeizmann Institute of Science. Retrieved January 4, 2018 from <http://gpquae.iqm.unicamp.br/gtexperimentacao.pdf>

National Research Council (NRC). (2006). America's lab report: Investigations in highschool science.

National Science Teachers Association (NSTA). 2004. Investigating safely; A guide for high school teachers. Arlington, VA: NSTA Press. Retrieved December 3 2018 from <http://www.nsta.org/about/positions/laboratory.aspx>

Nuri Balta University of International Business . (2016).The Effect of 7E Learning Cycle on Learning in Science Teaching: A metaAnalysis. European Educational Research Journal · April 2016. DOI: 10.12973/eu-jer.5.2.61 <https://www.researchgate.net/publication/301774388>

Okoli, J.N. (2006). Effects of investigative laboratory approach and expository method on acquisition of science process status by biology students of different levels of scientific literacy. *Journal of STAN*, 41 (1&2), 79-85.

Padilla, M. J. (1990) *The science Process skills*. Retrieved from <https://www.narst.org/publications/research/skill.cfm>

Psillos, D., & Niedderer, H. (2002). *Teaching and Learning in the Physics Laboratory*. Physics and Technology Education Library, Dordrecht: Kluwer Academic Publishers

Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29(4), 4–15.
doi:10.3102/0013189X029001004

Sabri, K.S. & Emuas, A.H.M. (1999) The relationship between school laboratory experiments and academic achievement of Palestinian students in introductory university science courses, *Research in Post-Compulsory Education*, 4:1, 87-96, DOI: 10.1080/13596749900200047

Saha, G.S. (2001). *Implementing the Science Assessment Standards: Developing and validating a Set of Laboratory Assessment Tasks in High School Biology*. A doctoral dissertation submitted to the Faculty of the Graduate School of State University of New York at Buffalo. Available from Bell and Howell information and learning database. (UMI number: 9997996)

The Manila Times. (2014, May 28). *Science Education Realities*. Retrieved from <http://www.manilatimes.net/science-education-realities/100096/>

Tamir, P. & Lunetta, V.N. (1978). An Analysis of Laboratory Inquiries in the BSCS Yellow Version. *The American Biology Teacher*, 353-357.

Tessier, J. (2010). *An Inquiry-Based Biology Laboratory Improves Pre-service Elementary Teachers' Attitudes about Science*. *Journal of College Science Teaching*, 84-90.

Wambugu, P. W. & Changeiywo, J. M. Effects of Mastery Learning Approach on Secondary School Students' Physics Achievement. *EURASIA Journal of Mathematics, Science & Technology Education*, v4 n3 p293-302 2008

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Wang, Chin-Kuo. (2016). Expectation of attaching importance to instructional design.

Taiwan Educational Review Monthly, 5(2), 71-75.

West, S.S., Westerlund, J.F., Nelson, N.C. & Stephenson, A.L. (2001). Conditions that affect safety in the science classroom: Results from a statewide safety survey.

Austin, TX: Texas Association of Curriculum Development. Washington, DC:

National Academy Press. Retrieved December 4, 2018 from

<http://www.nsta.org/about/positions/laboratory.aspx>