Influence of Lesson Study Using Inquiry-Based 7e Model to Elementary Pre-Service Teachers' Interest and Achievement in Science

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Abstract

Even today, the pursuit of effective approaches in science teaching takes precedence in science education research, with the sole goal of allowing learners to comprehend and construct the basic systems of the world and beyond. This stage of learning is even more significant in a learner's formative years, where teachers play a significant role in the process. This study investigated interest in science and test scores for 19 pre-service elementary general education teachers at Initao College, Philippines, for two consecutive semesters of the school year 2021-2022 in a science teaching course using lesson study as an intervention. The lesson study utilized an inquiry-based 7E approach for all developed lessons covered in the elementary science K–12 curricula. Although results of the paired T-test revealed that the difference in the level of interest in the subject of the participants before (M = 3.802, SD = 0.515) and after (M = 3.811, SD = 0.480) the school year of the elementary science lesson study is not large enough to be statistically significant, t (18) = 0.060, p = 0.956, d = 0.013, all highly agree that the things they learn in science should be valued. Additionally, test scores for assessing mastery of content were interpreted as high in all disciplines involved. Hence, this study supports a number of research claims on the significant effect of lesson studies on strengthening the content knowledge of science teachers—a very important tool to bridge the gap between concept and understanding.

Keywords: 7E pedagogical approach, inquiry based learning, elementary science lesson study

1. INTRODUCTION

In the Philippines, the K-12 Basic Education Program was implemented in 2012 with the goal of decluttering and improving the basic education curriculum for students to grasp various learning competencies (Seameo Innotech, 2012). One of the features of this curriculum is the spiral progression approach where lessons in subjects like Science are structured as the academic year goes on, from easy to difficult (de Ramos-Samala, 2018). As a consequence, it is very important that teacher preparation programs must be attentive to preservice teachers' competencies on science content knowledge, pedagogical methods, and teaching skills, including the emphasis on the development of attitudes and self-efficacy towards the subject matter which will be taught (Senler, 2016; Kartal and Dilek, 2021).

There is little empirical data on how, when, and where teachers' interests in content develop. Studies on teaching elementary science have shown that when teachers lack confidence in the material, the topic is poorly taught. (Jarrett and Bulunuz, 2009). According to research findings, aspiring elementary teachers frequently despise science since they are unconfident in the field. This would likely lead to poor teaching or avoiding the subject itself which eventually takes a toll on the general take of the young learners in learning science (Palmer, 2002).

Famous education researchers including John Dewey described effective teachers as individuals interested in their subject and demonstrating enthusiasm for teaching the course content. He emphasized that curiosity is innate in children and that becoming interested in a paticular subject often begins in childhood. Moreover, childhood interests have an impact on adulthood interest as people grow older. In the context of the theory of interest however, as cited by Bulunuz and Jarett (2012), natural desire of children to inquire gradually diminishes as they pass through schooling brought by the prevalence of teacher-centered instruction.

Another form of interest is termed situational interest. It is defined as short-term interest that is linked to environmental factors in a particular situation. According to studies, numerous science teaching strategies are efficient at inspiring students' situational interest (Palmer et al., 2016). Bulunuz et al. (2012) further claimed that hands-on science activities demonstrated greater depths of investigation and were regarded as more enjoyable and fascinating.

Students' affective attitudes not only influence achievement but a significant educational goal (Young-Sun and Chan-Jong, 2006). All these settles down to teachers' preparation for the teaching and learning procedure.

In Japan and other countries, lesson studies have been one of the main methods of professional development for both aspiring teachers and currently employed teachers (Lomibao, 2016). In the systematic review conducted by Hervas in 2021, lesson study (LS) is a method of professional growth that has largely been used by elementary, secondary, and in-service teachers. Also, the management of the learning environment, quality of students' engagement with significant content, quality of assessments, and creation of student data were all found to have dramatically improved with lesson studies. (Marble, 2007; Lewis et al., 2011; Aykan and Dursun, 2020).

Furthermore, it has been common knowledge for educators that the student-centered approach has a key factor in improving students' academic performance and has shown early success in refining science attainment (Narad and Abdullah, 2016; Johnson et al., 2016). Additionally, it is affected primarily by an interest in the subject, motivation, and engagement in co-curricular activities. This resulted in momentous evolution in the quality of teachers including the skills and achievement of students (Sokardiyono et al., 2019; Idin and Donmez, 2017). The curriculum and the teacher are the two most crucial factors determining students' science accomplishment, and teaching topics in a way that stimulates students' curiosity the greatest is a predictor of science achievement (Erdal et al., 2016). Science achievement is significantly influenced by the relationship between the value of science and scientific confidence (Liu and Wang, 2019). Moreover, students' attitudes, involvement, and motivation play a significant role in predicting science accomplishment (Areepattamannil and Kaur, 2013).

One of the student-centered approaches is the 7E. The 7E model is summarized as the learning cycle which emphasizes the assessment of the learner's past knowledge for what they wish to know first before learning the new topic (Adesoji and Idika in 2018; Akerson et al., 2009). Through the activities that follow, this cycle contributes to a successful learning process:

- Elicit: The teacher extracts or calls attention to prior understandings and information. Existing knowledge is the foundation for new knowledge. This promotes knowledge sharing.
- Engage: This stage concentrates student thinking on material and provides opportunities for conversation for all students, not just a select few.
- Explore: While the teacher checks for understanding, student record data, isolate variables, plan experiments, generate graphs, interpret results, and arrange findings.
- Explain: While discussing facts and explaining concepts related to the student's exploration, the teacher takes on a more central position. Lessons during this phase introduce students to scientific terminology that helps them to express their experiences and allow students to connect their experiences to the scientific principles being investigated.
- Elaborate: This stage of the learning cycle allows students to apply their knowledge to new areas, which may include posing new questions and hypotheses to investigate. Students may be given similar numerical tasks to solve during this period.
- Evaluate: Formative, summative, formal, or informal evaluations are all possible. The teacher evaluates the extent to which established objectives have been met.
- Extend: This step is actually included to elaborate on the goal of directly reminding teachers of the significance of pupils practicing learning transfer. Teachers must ensure that knowledge is utilized in a new environment and not just in elaboration.

Along with the previously mentioned approach is inquiry-based science instruction. Inquiry-based learning (IBL) is a key goal of the reform in science education (Forbes, 2011). Students instructed by inquiry-based learning performs better in science than other traditional approaches (Ali, 2014). In IBL, students overcome problems by formulating questions, exploring the challenge, observing and applying the findings to understand the general problem (Ketpichainarong et al., 2010). The claim was further justified by Gyampo et al. in (2020), with integrating the 7E learning cycle model with inquiry based learning. In the 7E learning-centered model, phases of activities are arranged to allow the students achieve learning objectives through active learning activities. With both approaches combined, students' ability to critically think, demonstrate and synthesize the concepts learned and process skills acquired are fostered and developed with scientific curiosity (Selahattin et al., 2006; Warner and Myers, 2008; Gyampo, et al., 2020). Researches in education and science teaching have proven IBL &7E is effective. On this note however, the teaching and learning process can be undoubtedly more effective if the teachers develop high interest and mastery of content in the subject they teach. This way, pedagogy and content are secured firsthand.

This research study aimed to evaluate the influence of lesson study with an inquiry-based 7E learning approach on the interest and test scores of pre-service elementary teacher participants. Specifically, this study aimed to (1) evaluate the

difference between the participants' interest in science before and after two semesters of lesson study, (2) assess the level of achievement in terms of test scores in four elementary science disciplines, and (3) evaluate the difference of the level of achievement in terms of test scores in four elementary science disciplines - Chemistry, Biology, Physics, and Earth and Space.

2. MATERIALS AND METHODS

The study conducted in the first and second semesters of the school year 2021–2022 involved 19 pre-service teachers with an age range of 20 to 41 years old from the bachelor of elementary education program at Initao College as participants. The research utilized two consecutive major courses in the curriculum, with the course title "Teaching Science in Elementary Grades" as the venue for the lesson study. These two courses were selected as they cover the understanding of spiraling basic science concepts and applications of scientific inquiry in Chemistry, Biology, Physics, and Earth and Space, strategies in teaching elementary science, the development of instructional materials, and assessment.

Research participants have undergone a series of discussions on lesson development using an inquiry-based 7E approach before the lesson study proper. The basic education K12 science curriculum guide was also used as the primary reference material for both the course and the lesson study. Competencies for elementary science content were identified, studied, and assigned to participants for each science discipline involved. The lesson study process has been conducted virtually and follows the process as depicted in figure 1 below.

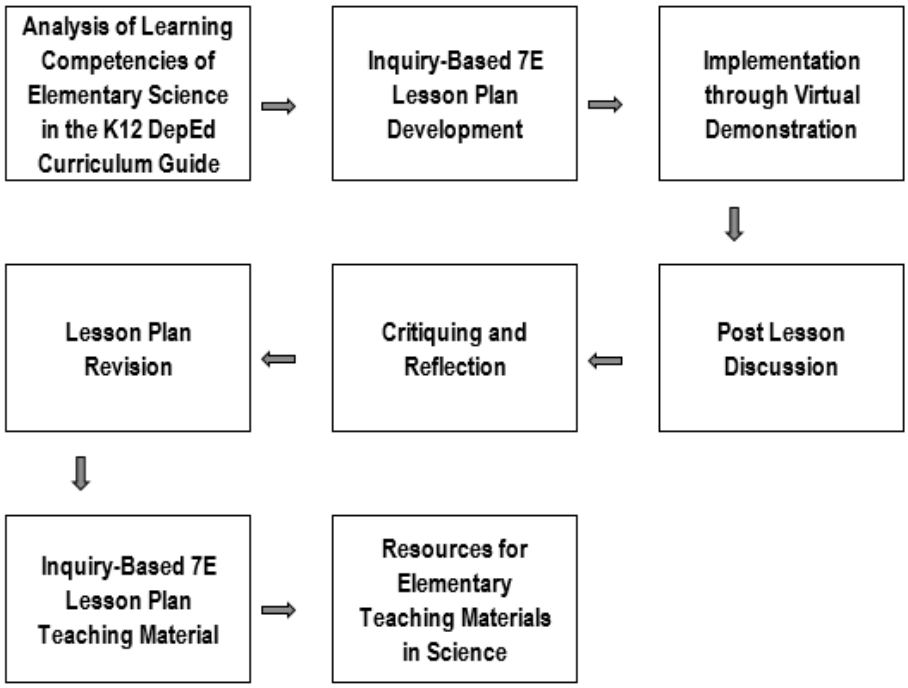

Figure 1. Linear Approach to Pre-service Science Teaching Lesson Study

Beneficial outcomes of LS in the design of the lessons, the participants' pedagogical knowledge, and the participants' approach to teaching. Lesson study also leads to instructional development because teachers become more aware of how students learn and think, as well as how instruction affects student thinking, according to research studies. LS is a process in which teachers engage with other teachers to study and critique one another's teaching techniques as they attempt to improve their own (Isoda et al., 2007, Dudley, 2015). It is a collaborative activity for instructors that takes place at school and is defined by a continuous cycle of rigorous planning, prudent and mindful demonstration, and perceptive lesson improvement. The on-site professional development approach, which involves a small group of teachers, has a broad reach. The teachers have varying degrees of ability but are interested in working together, with specified lesson planning objectives, to carry out the planned and studied lesson (Fong, 2015). The interest of the participants was evaluated before and after their exposure to a school year of lesson study. Interest in science was measured using a 30-item questionnaire with excellent internal consistency of Cronbach alpha 0.92.

Summative tests with acceptable KR20 indexes were also administered every after quarter of each discipline covered. Each test observes the distribution of the basic science process skills on observation, classification, communication, measurement, inference, and prediction, as reflected in the table of specifications.

3. RESULTS AND DISCUSSIONS

One of the biggest issues affecting the fraction of Philippine education today is the poor accomplishment levels of Filipino pupils (Canalita et al., 2019). When the structure of knowledge and learning processes in education and science is analyzed, it is clear that current teaching and learning models are inadequate and must be changed, or alternative models are required (San Miguel, 2021). Hence, curriculum materials are important resources with which teachers make pedagogical decisions about the design of science learning environments. To become well-started beginning elementary teachers capable of engaging students in inquiry-based science, pre-service elementary teachers' science curriculum materials effectively, as one of the five essential features of inquiry-based teaching and learning are curriculum materials. Learning these, lesson study is one good venue for classroom-based professional learning groups (Baricaua, 2016), which may serve as a critical point of leverage for teacher education experience and curriculum development to assist primary teachers' science teaching and practice (Jarrett and Bulunuz, 2009).

The responses of the participants on their interest in science were analyzed and found to be somewhat interested, second highest on the 5-point Likert scale used. This means that in all general areas of interest, respondents have a high interest in science, as shown in table 1 below. In specific items, responses have shown that participants highly enjoy learning new knowledge in science, acknowledge the importance to become knowledgeable in science, and value things learned from science. Furthermore, it was found that lesson study in science has no significant effect on the interest of the participants in science in general. Although paired T-test revealed that the difference in the level of interest in science of the participants before ($M = 3.802$, $SD = 0.515$) and after ($M = 3.811$, $SD = 0.480$) the school year of the elementary science lesson study is not large enough to be statistically significant, $t(18) = 0.060$, $p=0.956$, $d=0.013$, all participants highly agree that the things they learn in science should be valued.

Table 1. Summary Response on Interest in Science

Area of Interest	Number of items	Mean	SD	Description
Interest in scientific topics and conversations	6	3.94	1.02	Somewhat
Advantage in the value of science content learning	7	4.14	1.07	Somewhat
Enjoyment in working with the application of science	3	3.96	0.82	Somewhat
Bringing science beyond the classroom setting	7	3.42	1.18	Somewhat
Preference for scientific knowledge compared with other disciplines	5	3.67	1.12	Somewhat
Influence of science in career choice	3	3.91	0.91	Somewhat

Moreover, the pre-service teacher participants achieved "high" scores in all science disciplines covered in the elementary science curriculum used in the lesson study. In average, participants achieved the highest in Chemistry and least in Earth and Space as shown in table 2 below. The raw scores expressed in percent were interpreted in reference to Nurul and Suziyani (2018).

Table 2. Mean Scores of Pre-Service Teacher Participants

Subject	Mean Scores in %	SD	Interpretation
Biology	86.23	1.79	High
Chemistry	87.98	1.79	High
Earth and Space	76.68	2.60	High
Physics	85.09	2.61	High

4. CONCLUSIONS AND RECOMMENDATION

The extant problem in science learning among young learners as depicted by the Programme for International Student Assessment (PISA) results in the recent years, should be addressed from micro to macro level basis. As one of the major components of an effective teaching and learning process, competent teachers in content and application of science needs to be in the workforce. On this note, training on the mastery of content and efficiency of delivery should start in the pre-service teaching experience. Accordingly, teachers should be highly competent and interested in the subject they teach in order to also increase students' learning motivation and performance.

The research results found that although lesson study has no significant effect on the general interest of pre-service teacher participants in science, the procedure has maintained high results in terms of assessment scores in all science disciplines involved. Unarguably, the utilization of the 7E learning cycle in conjunction with inductive skills can boost students' problem-solving thinking and creativity (Setiawan, 2015), and can improve the high-level thinking skills of elementary students (Aripin et al., 2018). Thus, lesson studies will prepare teachers for their effective teaching engagements. The lesson study conducted has produced an electronic drive with outputs which has undergone lesson study procedures, which may serve as curriculum materials for both pre-service and in-service elementary science teachers.

Future studies may also include the effects of science-teaching lesson studies on self-efficacy, subject self-efficacy, and science teaching expectancy outcome, and involve a larger number of participants, even with secondary science major preservice teachers.

References

Adesoji, F.A. and Idika, M.I. (2015). Effects of 7e learning cycle model and case-based learning strategy on secondary school students' learning outcomes in chemistry. JISTE, 19(1), 7-17

Akerson, V. L., Townsend, S., Donnelly, L. A., Hanson D. L., Tıra, P., & Whıte, O. (2009). Scientific Modelling for Inquiring Teachers

Network (SMIT'N): The Influence on Elementary Teachers' Views of Nature of Science, Inquiry, and Modelling, Journal of Science Teacher Education, 20, 21-40 DOI 10.1007/s10972-008-9116-5.

Ali, A. (2014). The Effect of Inquiry-Based Learning Method on Students' Academic Achievement in Science Course. Universal Journal of Educational Research, v2 n1 p37-41

Areepattamannil, S., Kaur, B. (2013). Factors predicting science achievement of immigrant and non-immigrant students: a multilevel analysis. Int J of Sci and Math Educ 11, 1183–1207 https://doi.org/10.1007/s10763-012-9369-5

Aripin F Y, Cahyana U and Suseno M (2018). Differences in students' higher order thinking skills (HOTS) using the learning cycle 7e and learning cycle 5E methods in science learning Proceedings of the National Seminar and Discussion on Basic Education UNJ pp 6-11

Baricaua Gutierez, S. (2016). Building a classroom-based professional learning community through lesson study: Insights from elementary school science teachers. Professional Development in Education, 42(5), 801–817.

Bulunuz, M., Jarrett, O.S. and Martin-Hansen, L. (2012), Level of Inquiry as Motivator in an Inquiry Methods Course for Preservice Elementary Teachers. School Science and Mathematics, 112: 330-339. https://doi.org/10.1111/j.1949-8594.2012.00153.x

Canalita, E. E., Buan, A.T., Amboayan, N. B. and Mindalano, J. I. (2019). Journal of Physics: Conf. Series 1340 (2019) 012056. doi:10.1088/1742-6596/1340/1/012056

De Ramos-Samala, H. (2018). Spiral progression approach in teaching science: A case study. KnE Social Sciences, 3(6), 555-567. https://doi.org/10.18502/kss.v3i6.2404

Dudley, P. (2015). How lesson study works and why it creates excellent learning and teaching. Routledge.

Erdal, Tatar & Tuysuz, Cengiz & Tosun, Cemal & Ilhan, Nail. (2016). Investigation of Factors Affecting Students' Science Achievement According to Student Science Teachers. International Journal of Instruction. 9. 10.12973/iji.2016.9211a.

Fong M W 2015 Effects of Lesson Study incorporating phase-based instruction on grade seventh students' geometry achievement In: 7th ICMI-East Asia regional conference on mathematics education Cebu City, Philippines

Forbes, Cory. (2011). Preservice Elementary Teachers' Adaptation of Science Curriculum Materials for Inquiry-Based Elementary Science. Science Education. 95. 927 - 955. 10.1002/sce.20444

Gyampo, A.O., Aidoo, B., Nyagblormase, G.A., Kofi, M. & Amwako, S.K. (2020). Investigating the Effect of 7e Learning Cycle Model of InquiryBased Instruction on Students' Achievement in Science. IOSR Journal of Research & Method in Education. Volume 10, Issue 5 PP 39-44

Hervas, G. (2021). Lesson Study as a faculty development initiative in higher education: A systematic review. AERA Open, 7, 233285842098256. https://doi.org/10.1177/2332858420982564

Idin, S., & Dönmez, I. (2017). The Views of Turkish Science Teachers about Gender Equity within Science Education. Science Education International, 28(2), 119-127. https://doi.org/10.33828/sei.v28.i2.4

Isoda M, Stephens M, Ohara Y and Miyakawa T 2007 Japanese Lesson Study in mathematics: its impact, diversity and potential for educational improvement World Scientific Publishing, Singapore

Jarrett, O.S. & Bulunuz, M. (2009). Developing an interest in science: background experiences of preservice elementary teachers. International Journal of Environmental & Science Education Vol. 5, No. 1, January 2010, 65-84

Johnson, C. C., Bolshakova, V. L. J., & Waldron, T. (2016). When Good Intentions and Reality Meet: LargeScale Reform of Science Teaching in Urban Schools with Predominantly Latino ELL Students. Urban Education, 51(5), 476-513. https://doi.org/10.1177/0042085914543114

Kartal, T. & Dilek, I. (2021). Developing pre-service elementary science teachers‟ science teaching efficacy beliefs through microteaching by promoting efficacy sources. International Journal on Social and Education Sciences (IJonSES), 3(4), 710-731. https://doi.org/10.46328/ijonses.124

Ketpichainarong, W., Panijpan, B., & Ruenwongsa, P. (2010). Enhanced learning of biotechnology students by an inquiry-based cellulase laboratory. International Journal of Environmental and Science Education, 5(2), 169-187

Lewis, C., Perry, R., Foster, D., Hurd, J., & Fisher, L. (2011). Lesson study: Beyond coaching. Educational Leadership, 69(2), 64–68.

Liu, C-C & Wang, T-Y (2019). a study of factors affecting science achievements of junior high school female students. Journal of Baltic Science Education. 18(1) 39-50.

Lomibao, L.S. Enhancing mathematics teachers' quality through Lesson Study. SpringerPlus 5, 1590 (2016). https://doi.org/10.1186/s40064-016-3215-0

Marble, S. Inquiring into Teaching: Lesson Study in Elementary Science Methods. J Sci Teacher Educ 18, 935–953 (2007). https://doi.org/10.1007/s10972-007-9071-6

Narad, A., & Abdullah, B. (2016). Academic performance of senior secondary school students: Influence of parental encouragement and school environment. Rupkatha Journal on Interdisciplinary Studies in Humanities, 8(2), 12-19.

Nurul F. D. & Suziyani, M. (2018). Special Needs Education Teachers in implementing a teaching for Learning disabilities. Jurnal Ortopedagodia, 4(1).

Palmer, D.H. (2002), Factors contributing to attitude exchange amongst preservice elementary teachers. Sci. Ed., 86: 122-138. https://doi.org/10.1002/sce.10007

Palmer, D.H., Dixon, J. And Archer, J. (2016), Identifying Underlying Causes of Situational Interest in a Science Course for Preservice Elementary Teachers. Sci. Ed., 100: 1039-1061. https://doi.org/10.1002/sce.21244

Selahattin, G., Kocakaya, S., & Inan, C. (2006). The Effect of the Computer Assisted Teaching and 7e Model of the Constructivist Learning Methods on the Achievements and Attitudes of High School Students. Turkish Online Journal of Educational Technology, 5(4).

Senler, B. (2016). Pre-service science teachers‟ self-efficacy: The role of attitude, anxiety and locus of control. Australian Journal of Education, 60(1), 26-41

Setiawan A 2015 Experimentation of the 7E Learning Cycle Model with Problem Possing on the Material of Constructing Flat Sided Space in terms of Creativity in Mathematics Learning for Class VIII Junior High School Students in Mesuji Regency, Lampung, Electronic Journal of Mathematics Learning 3 pp 1-11

Southeast Asian Ministers of Education Organization and Regional Center for Educational Innovationand Technology - SEAMEO INNOTECH (2012). http://www.seameo-innotech.org/wp-content/uploads/2020/05/k-12-toolkit.pdf

Sukardiyono, Rosana, D., & Dwandaru, W. S. B. (2019). Measuring Junior High School Students' Science Learning and Science Process Skills through an Integrated Science Instructional Assessment. Journal of Turkish Science Education, 16(4), 467-477. https://doi.org/10.36681/tused.2020.1

Warner, A. J., & Myers, B. E. (2008). What is inquiry-based instruction. Florida, USA: University of Florida

Young-Sun, K. & Chan-Jong, K. (2006). Investigation of Elementary and Secondary Students' Interest in Science. Volume 27 Issue 3 Pages.260-268