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A study on the impact of reliable analysis-support learning on thermal physics education with the examination of the achievement in the physics classroom.

Dr. Flavian Brian Fernandez,
Woodgrove Higher Secondary School,
3 Woodlands Ave 6, Singapore, 738990, Singapore

ABSTRACT

Although students in Singapore receive formal science instruction in Primary 3 or 4 (age 9 or 10) and secondary school (age 13 to 16), they are exposed to thermal physics phenomena from an early age. Subsequently, understudies frequently structure elective or deficient logical originations connected with warm physical science a long time before they start learning it in the science homeroom. Because it does not take into account students' preexisting beliefs about thermal physics, the group of educators who participated in this study believed that traditional instruction would be largely ineffective. An action research process was used to see if students' thinking could be made more explicit through discussions and other social interactions using a more interactive and engaging pedagogical approach like authentic, inquiry-based learning. The following are the three intact classes of Secondary-3 students: an experimental group using Authentic Inquiry-Based Instruction (AIBI) and a high-performing control group using Traditional Physics Instruction (TPI).Although the high-performing control group continued to outperform the experimental group, students in the experimental group demonstrated significant gains in conceptual understanding and student self-efficacy. A deeper look at the data showed that students' conceptual understanding of the material taught in the AIBI classroom was correlated with their performance on standardized tests. Because they do little to cultivate students' self-efficacy and interest in the subject, traditional methods of instruction are ineffective. Instead of standardized tests at the end of each unit, authentic and formative assessment tasks should be incorporated into the curriculum more often.

Key word: Classroom, students' self-efficacy, pedagogical approach, score higher than students.

INTRODUCTION

"Action research" means a formal, structured process in which teachers collaborate to use research methods to solve problems. In most cases, teachers who are involved in action research go through multiple cycles of planning, executing, observing, and reflecting on their actions. Each cycle informs the next and ultimately leads to improved classroom teaching and learning outcomes. There are two main reasons why action research is such an effective and appealing tool for educators. To begin, it provides teachers with a methodical approach to developing new curriculum or enhancing existing curriculum to better meet the requirements of their particular student population. Second, it improves teachers' competence and capacity to implement this new or improved curriculum in the classroom, which is beneficial for teacher professional development. This specific review was a result of an aggregate conviction among a group of physical science educators that customary types of guidance were not powerful in accomplishing instructing and learning results in warm physical science. They started an action research process to see if, through discussions and other social interactions, a more engaging and interactive pedagogical approach like authentic, inquiry-based learning or instruction could make students' thinking more explicit. The subsequent phase of teaching and learning would then be informed by the insights gleaned from students' existing conceptions, making the entire process more effective and efficient.

Even though authentic, inquiry-based learning is explicitly supported at the systemic level in Singapore, users at the school level still do not readily accept it. There are two possible explanations for the current situation. Right off the bat, presenting credible, request based learning in the study hall, in its most genuine sense, possibly becomes conceivable assuming educators themselves are gifted in working with the request cycle. This is a test in light of the enormous speed of progress in Singapore's school system throughout recent many years; Even young teachers who want to use this method face the challenge of creating learning environments in the classroom that are very different from the ones they had as students. Second, a culture of performance permeates Singapore's educational system, which will be elaborated on in a subsequent section of this paper. The outcomes of students on high-stakes standardized tests are inextricably linked to financial advantages after graduation. The Singapore education system appears to be based on "education for earning, not learning," as Lee (1999) puts it well. Therefore, tensions can be expected when attempting to incorporate new initiatives into such a system. When there is no assurance that similar student outcomes will be achieved, teachers and students who have "learnt to succeed" in the existing system may resist adopting such educational reforms.

A social constructivist theoretical framework supports this study. The idea that learning is centered on the "lived experience" is central to social constructivism in education. Knowledge is a human construct that is created by social actors interacting in a particular setting. As a result, a learning environment in which students and teachers can engage in generative dialogue about scientific phenomena is created when AIBL is used as an instructional strategy. They gain a deeper conceptual understanding of the subject matter as they "converse, question, explain, and negotiate meaning" from their observations. Furthermore, various examinations propose that attitudinal factors assume a significant part in accomplishing reasonable change. Conceptual models that are consistent with the larger scientific community are more likely to be developed by learners who have high levels of self-efficacy for science learning.

In terms of conceptual understanding, student achievement, and student self-efficacy, the current research aims to provide empirical evidence of the impact of authentic, inquiry-based learning over traditional instruction on the learning of thermal physics concepts. Additionally, it aims to investigate the connection between students' performance on standardized achievement tests and their conceptual understanding. The goal of the study is to show whether the connections between pedagogy and learning outcomes in Singapore are consistent with previous research. The Biological Sciences Curriculum Study (BSCS) developed the BSCS 5E Instructional Model toward the end of the 1980s to guide classroom inquiry learning design. The five phases of the model are as follows: exploration, engagement, explanation, and evaluation. Students and teachers participate in activities throughout each of these phases to help them develop a deeper comprehension of scientific knowledge, attitudes, and abilities. In this study, this instructional model was used to create lesson plans for real-world, inquiry-based learning. Beyond thermal physics, it is hoped that this study's findings will spur additional research in the field of science education in Singapore and Southeast Asia.

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RESULTS

The purpose of this study was to investigate the relationship between AIBL and conventional physics instruction in terms of student outcomes and learning.

CONCEPTUAL UNDERSTANDING

Each of the three classes received a pre- and post-concept evaluation test to see how the teaching pedagogy affected students' conceptual understanding. The learning gains of individual students were calculated in addition to a comparison of absolute test scores between classes.N2 students' mean post-test score (M = 8.46, SD = 2.88) was significantly higher than their mean pre-test score (M = 6.86, SD = 2.16), as shown by a comparison of the raw TCE scores from the pre- and post-tests (t(27) = 4.69, p.05.However, there was no statistically significant difference between the pre- and post-test scores of N1 and N3 students. A comparison of learning gains revealed that N2 students had a significantly higher mean normalized learning gain (M = 0.09, SD = 0.10) than N3 students did (M = 0.08, SD = 0.18), F(2, 86) = 3.84, p.05.However, the results of a comparable comparison of the gain scores of N1 and N2 students were not statistically significant.

SCORES ON STUDENT ACHIEVEMENT

The achievement test was given to all classes at the end of the entire teaching unit. The questions were taken from the N Level national exams that were given in previous years. According to the test results, the mean achievement score of N1 students was significantly higher than the mean achievement score of N2 students (M = 16.32, SD = 4.36), F(2, 86) = 6.27, p =.007, and the mean achievement score of N3 students (M = 16.80, SD = 4.32), F(2, 86) = 6.27, p .05.The mean achievement scores of N2 and N3 students were not significantly different.

PHYSICS SELF-EFFICACY OF STUDENTS

A comparison of the two groups revealed that the post-intervention MRI on the overall self-efficacy scale for N2 students was significantly higher than the pre-intervention MRI (M = 3.29, SD = 0.48, t(27) = 3.58, p.01) in terms of affective student outcomes. However, there was no statistically significant difference between the N1 and N3 students' pre- and post-intervention

MRIs. Table 1 provides a summary of the findings from a subsequent analysis of the four self-efficacy subscales for N2 students. Again, it's important to note that the difference between N1 and N3 students' pre- and post-intervention MRIs was not statistically significant for any of the four subscales.

Students' achievement scores on the standardized test and their scores on the post-intervention conceptual evaluation instrument were compared using a Pearson's correlation coefficient to see if there was any connection between the two. There was no correlation between students' achievement scores and scores on the post-intervention conceptual evaluation instrument in classes where TPI was used. However, there was a positive correlation between the achievement scores of students on the standardized test and their scores on the post-intervention conceptual evaluation instrument in the class where AIBL was used: r = 0.382, n = 28, p.05.

ANALYSIS OF THE RESEARCH

This study would have liked to enlighten the connections among teaching method and understudy results in the Singapore setting and examine the relationship, if any, between understudies' applied comprehension of warm material science and their accomplishment scores in the subject. The outcomes are encouraging and absolutely call for a more in-depth discussion. The experimental group's gains in their post-intervention concept evaluation suggest that the utilization of AIBL significantly contributes to the promotion of a deeper conceptual comprehension of thermal physics concepts. According to the existing body of research, TPI is ineffective and may even be detrimental to learning thermal physics because there were no comparable results in the comparison group.

However, at the conclusion of the unit of instruction, achievement scores in the high ability control group (N1 students) were significantly higher than those in the experimental group. However, there was no significant difference in achievement scores between the experimental group and the lower ability control group (N3 students).

Even though the intervention in this study only lasted three weeks, the pre- and post-questionnaire results on student self-efficacy were somewhat in line with previous research. Students in the experimental group reported having a significantly higher sense of self-efficacy at

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the end of the unit of instruction. Three out of the four sources of self-efficacy were found to have contributed to this rise after further data analysis; PS, ME, and SPP particularly, SP showed a significant rise in scores. The subscale for VL did not appear to have seen a significant increase.

The experimental group's positive correlation between achievement scores and post-intervention conceptual evaluation scores was yet another intriguing finding. Students in the experimental group were more likely to score well on the achievement test if they had performed well on the conceptual evaluation following instruction, and the reverse was also true. The absence of this correlation in classes with TPI suggests that, in these classes, the scores on the two tests administered at the conclusion of the unit of instruction were somewhat independent of one another.

DISCUSSION

Cobern et al.'s findings could be used to interpret the mixed effect on student achievement scores (2010), which stated that as long as lesson units are well-designed and good instruction is provided in both modes, direct instruction is as effective for traditional outcomes as inquiry-based instruction. There are numerous additional possibilities that could have influenced this outcome.

In the current system, the high-achieving students had "learned how to succeed."To put it another way, they had improved their test-taking and preparation skills in comparison to their N2 and N3 classmates. Their higher score may not entirely be attributed to a deeper conceptual understanding because this includes revision strategies and time and stress management abilities during the test. This is additionally upheld by the absence of relationship between's their accomplishment test scores and their post mediation idea assessment scores, which will be talked about later on in the paper.

The test things in the accomplishment test couldn't give as complete a trial of calculated understanding in warm physical science as the idea assessment test. While the concept evaluation test's items were well-researched and carefully chosen to test students' overall understanding of thermal physics, the achievement test's items were directly lifted from national examination papers from previous years, so they may have been biased toward testing specific thermal physics concepts. High-ability students would have learned how to answer questions like those in the textbook at the end of each chapter and in the workbook with enough practice, but they wouldn't necessarily have a deep understanding of the concept.

The critical learning gains made by the N2 understudies might not have been adequate to connect the prior hole in understanding between the N2 and N1 understudies. The pre-intercession idea assessment showed that the N1 understudies had a fundamentally higher score than the N2 understudies. Even though the conceptual understanding of the N2 students improved significantly, this improvement could not translate into higher scores. This and other possible explanations for this finding could be investigated in additional research using possible qualitative methods. However, the disparity in achievement scores most likely stems from a combination of these factors rather than any one.

Regarding students' physics self-efficacy, the experimental group's assigned tasks may have been one factor in the significant rise in the ME, SP, and PS subscales. The majority of AIBL lessons involved students working together. They were put into groups of four or five and given tasks (such as produce a poster or design a product that would stop an ice cream from melting) that required them to interact with their teacher. Since their teachers and peers had numerous opportunities to praise the work they were doing, this could account for the significant rise in SP scores. In addition, at the conclusion of each lesson, they were required to present their products to the class and "defend" their designs against criticism from peers and teachers. This might have added to the expansion in ME and PS scores. Be that as it may, because of how the example was sequenced, all understudies in the class worked simultaneously and there was little an open door for them to notice each other at work. During the student presentations at the end of the lesson, they were able to see the finished product that their classmates had designed, but they were unable to observe their classmates as they were designing. They were also not shown any teacher demonstrations or given suggestions for how to finish the task. Because of these and the fact that they were already participating in their own activities throughout the lesson, there was very little opportunity for vicarious learning. As a result, by the end of the unit of instruction, the VL scores had not shown any significant improvement. Naturally, these assertions are speculative and necessitate further investigation and investigation. What is more sure from this review, in any event, is that conventional guidance in warm material science has little effect, if any whatsoever, on understudies' convictions in their own capacity to perform logical undertakings connected with warm physical science.

The correlation study seems to indicate that achievement scores are more likely to accurately predict students' conceptual understanding when AIBL is used as an instructional strategy. On the other hand, the fact that there was no correlation between students' conceptual understanding and achievement in the TPI classrooms suggests that when traditional instruction is used, achievement test scores may not be accurate predictors of students' understanding of the material. This, in turn, has serious repercussions, especially in a system where achievement scores are frequently used to make important school decisions like student ranking, course admission, and streaming.

CONCLUSION

If we want to keep improving our students' learning experiences, we need to look at how teachers try to get better at what they do. A viable and methodical approach to making such advancements is provided by action research. Engaging in action research would undoubtedly add to the already overwhelming list of duties teachers already have to fulfill. However, it's important to keep in mind that teachers are in a unique position of controlling curriculum. The influence that teachers have on the learning experiences that students have in the classroom cannot be overstated, from design to implementation. As a result, we need to make an effort to make participation in action research no longer a recommended or optional activity but rather an essential part of the work that teachers do in schools. Science education in the classroom will undoubtedly advance if teaching practice is guided by research that is relevant to the context. The success of such a shift is crucially dependent on the assistance that is provided by MOE and the leadership of the school in terms of (1) developing a school-wide culture of using action research to improve practice among teaching staff and (2) deliberately structuring the time and space for action research to take place in schools.

Additionally, it is necessary to reevaluate our data use and assessment procedures. The purpose of assessment is to support the teaching and learning process; ideally, it should give teachers and students accurate feedback about how well they understand the material being taught.

This, in turn, provides guidance for the subsequent stage of the education process. It is essential that assessment data accurately reflect learner comprehension in a system based on meritocracy and heavily reliant on it for ability grouping from an early age. This is especially important when the decisions made after analyzing such assessment data frequently have significant long-term effects on students in terms of the courses they can take and their job prospects after they leave the system.

It is not too far-fetched to assert that traditional methods of instruction continue to be utilized quite extensively in schools, despite the fact that educators in Singapore have made significant progress in embracing alternative pedagogies and investigating new methods of teaching and learning. Therefore, when empirical studies like this one demonstrate that there is no correlation between student achievement and conceptual understanding of the subject, it is troubling. In our push towards accomplishing scholarly greatness, would we say we are accidentally creating 'great test-takers', as opposed to 'great students'? Is it accurate to assume that the two are always synonymous? It's strange that our assessment landscape hasn't changed much in three decades for a system that has gone through so much change. We must be prepared to reevaluate our current assessment procedures if we are willing to reframe our understanding of how learning occurs. Instead of periodic, standardized tests, which are typically administered at the conclusion of a unit of instruction, authentic and formative assessment that is embedded within the curriculum ought to receive a greater amount of weight. Ideally, however, if we focus on learning for understanding rather than grading, we might see a shift in the type of learner our system produces, and we might need to rely less on assessment data.

REFERENCES

1. Au, K. H. (1998). Social constructivism and the school literacy learning of students of diverse backgrounds. Journal of Literacy Research, 30(2), 297–319.
2. Ball, S. J. (2003). The teacher's soul and the terrors of performativity. Journal of Education Policy, 18(2), 215–228.
3. Bandura, A. (1997). In S. F. Brennan & C. Hastings (Eds.), Self-efficacy: The exercise of control. New York, NY: W.H. Freeman and Company.
4. Baser, M. (2006). Fostering conceptual change by cognitive conflict based instruction on students' understanding of heat and temperature concepts.Eurasia. Journal of Mathematics, Science and Technology Education, 2(2), 96–114.

5. Bouillion, L. M., & Gomez, L. M. (2001). Connecting school and community with science learning: Real-world problems and school-community partnerships as contextual scaffolds. Journal of Research in Science Teaching, 38, 878–898.
6. Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. Colorado Springs: BSCS, 5, 88-98.
7. Capps, D. K., & Crawford, B. A. (2013). Inquiry-based instruction and teaching about nature of science: Are they happening? Journal of Science Teacher Education, 24(3), 497–526.
8. Carey, S. (2000). Science education as conceptual change. Journal of Applied Developmental Psychology, 21(1), 13–19.
9. Cavallo, A. M., Potter, W. H., & Rozman, M. (2004). Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong college physics course for life science majors. School Science and Mathematics, 104(6), 288–300.
10. Cheung, D. (2015). The combined effects of classroom teaching and learning strategy use on students' chemistry self-efficacy. Research in Science Education, 45(1), 101–116.
11. Cobern, W. W., Schuster, D., Adams, B., Applegate, B., Skjold, B., Undreiu, A., et al. (2010). Experimental comparison of inquiry and direct instruction in science. Research in Science & Technological Education, 28(1), 81–96.
12. Cuevas, P., Lee, O., Hart, J., & Deaktor, R. (2005). Improving science inquiry with elementary students of diverse backgrounds. Journal of Research in Science Teaching, 42(3), 337–357.
13. Eccles, J., Adler, T. & Meece, J. (1984). Sex differences in achievement: A test of alternate theories. Journal of Personality and Social Psychology, 46, 26–43.
14. Fencl, H., & Scheel, K. (2005). Engaging students: And examination of the effects of teaching strategies on self-efficacy and course climate in a nonmajors physics course. Journal of College Science Teaching, 35(1), 20–24.
15. Fortus, D., Dershimer, R. C., Krajcik, J., Marx, R. W., & Mamlok-Naaman, R. (2004). Design-based science and student learning. Journal of Research in Science Teaching, 41(10), 1081–1110.
16. Glanz, J. (2014). Action research: An educational leader's guide to school improvement. Rowman & Littlefield.
17. Gormally, C., Brickman, P., Hallar, B., & Armstrong, N. (2009). Effects of inquiry-based learning on students' science literacy skills and confidence. International journal for the scholarship of teaching and learning, 3(2), 16.
18. Gungor, A. A., Eryilmaz, A., & Fakioglu, T. (2007). The relationship of freshmen's physics achievement and their related affective characteristics. Journal of Research in Science Teaching, 44(8), 1036–1056.

19. Hallinger, P. (2010). Making education reform happen: Is there an 'Asian'way? School Leadership and Management, 30(5), 401–418.
20. Hmelo, C. E., Holton, D. L., & Kolodner, J. L. (2000). Designing to learn about complex systems. The Journal of the Learning Sciences, 9(3), 247–298.
21. Hodson, D. (1992). In search of a meaningful relationship: An exploration of some issues relating to integration in science and science education. International Journal of Science Education, 14(5), 541–562.
22. Ketelhut, D. J. (2007). The impact of student self-efficacy on scientific inquiry skills: An exploratory investigation in River City, a multi-user virtual environment. Journal of Science Education and Technology, 16(1), 99–111.
23. Lee, W. O. (1999). Social change and education problems in Japan, Singapore and Hong Kong. London: Macmillan.
24. Liew, W. M. (2012). Perform or else: The performative enhancement of teacher professionalism. Asia Pacific Journal of Education, 32(3), 285–303.
25. McNiff, J. (2013). Action research: Principles and practice. Routledge.
26. Murphy, P., Lunn, S., & Jones, H. (2006). The impact of authentic learning on students' engagement with physics. The Curriculum Journal, 17(3), 229–246.
27. Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. Review of Educational Research, 63(2), 167–199.
28. Salleh, H. (revised for resubmission). Action research in Singapore: Where are we now? Asia-Pacific Science Education.
29. Vygotsky, L. S. (1978). Mind in society: The development of higher mental processes. Cambridge: Harvard University Press.
30. Wigfield, A., & Eccles, J. (1992). The development of achievement task values: A theoretical analysis. Developmental Review, 12, 265–310.
31. Yeo, S., & Zadnik, M. (2001). Introductory thermal concept evaluation: Assessing students' understanding. The Physics Teacher, 39(8), 496–504