

Integrating Social Justice Issues in Teaching Probability and Statistics to Improve Students' Mathematics Achievement

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Abstract The study explored the effects of integrating social justice issues in teaching probability and statistics to the improvement of mathematics achievement and social justice-related attitudes and behaviors of the Grade-11 HUMSS students of Molugan National High School during the school year 2022-2023. It used a pretest-posttest quasi-experimental control group design, using a 21-item teacher made questionnaire to assess the students' mathematics achievement with a reliability index of 0.73. Two sections of HUMSS were involved, one for the control group and the other for the experimental group. The control group received a 5Es instructional model without the integration of social justice issues in their lesson while the experimental group received a 5Es instructional model with the integration of social justice issues in their lessons. The mean, standard deviation, and One-way analysis of covariance (ANCOVA) were used to analyze the data collected. Results of the analysis revealed that the integration of Social Justice Issues through 5Es Instructional Model is effective to improve students' mathematical achievement. Based on the findings of the study, the researchers conclude that the integration of social justice issues through the 5Es instructional model has proven to be a highly effective approach in enhancing students' mathematical achievement. The structured framework of Engage, Explore, Explain, Elaborate, and Evaluate not only provides a comprehensive learning experience but also promotes a deeper understanding of mathematical concepts within the context of social justice. Through this method, students are not only acquiring mathematical skills but also developing a critical understanding of societal issues, promoting a more holistic and meaningful educational experience. As we continue to prioritize innovative and inclusive teaching methodologies, the integration of social justice issues within the 5Es Instructional model emerges as a powerful tool for equipping students with both mathematical proficiency and a socially conscious mindset.

Keywords: 5Es instructional model, social justice issues, mathematics achievement

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1. Introduction

Teaching and learning mathematics are at the heart of education. Finding connections between mathematical concepts and ideas and real-world situations requires learning to solve problems, analyze, represent, and convey mathematical ideas [1].

Learning mathematics entails more than just thinking and reasoning; it also depends on the learners' attitudes about learning and mathematics [2]. Perhaps one of today's main learning objectives is the development of a positive attitude toward the subject being studied. Teachers and parents believed that a student's attitude toward a subject can impact their performance [3]. In this sense, positive attitude toward mathematics is beneficial since they can influence students' motivation to learn as well as the benefits that mathematics instruction can provide.

According to the study of Skovsmose et.al, a critical mathematics education should integrate reflection "through," "with," and "on" mathematics [4]. Learners should reflect "through" mathematics by posing their own questions and making their own judgments while interacting and talking with others. They should think 'with' mathematics by applying it to a variety of social, cultural, economic, and political challenges. They should evaluate mathematics' nature and privileged position, as well as how it might be used to make and defend decisions that influence their lives.

Mathematics is seen as relevant and meaningful by students who believe in its usefulness in their current and future lives. Students may learn mathematics more personally and meaningfully by tackling real-world issues. Examples from everyday life demonstrate how the information and abilities of mathematics that are taught in the classroom may be applied in practical ways to the lives of the students and to society at large. Examples from the actual world highlight the

complexity and unpredictability of current events and can therefore stimulate critical thinking.

Perhaps the question, "but why are we learning this?" has come up for every math teacher at some point or another. Students' real-world experiences should be used to illustrate how valuable mathematics is, but it's also important to emphasize that these activities should help students expand their understanding of the subject [5]. It is essential for students to have the skills necessary to critically analyze and create mathematical texts as well as to pose and answer their own issues if they are to be empowered in and through mathematics [6].

With the "transforming the world" aim of mathematics education, perhaps a different approach of teaching may be essential. There could be a method to integrate mathematics in students' lives in a way that includes the social as well as the physical and economic worlds [5]. Perhaps teaching mathematics in a meaningful context through integration of social justice issue could be the solution. Being aware of this, this present study introduced social context as a way of Mathematics learning to improve mathematics achievement. Specifically, it aims to determine the effect of the integration of social justice issues through the 5Es Instructional Model on the students' mathematics achievement.

2. Literature Review

2.1. Integrating Social Justice Issues in Mathematics Education

Mathematics is essential for everyone. No matter their sex, culture, socioeconomic class, religion, or educational background, everyone has at some point had to use mathematical knowledge to perform daily tasks [7]. It offers us "means of knowing", "ways of thinking", and "ways of comprehending" that go beyond a collection of discrete facts and notions [8]. In addition, it plays a role in "formatting" the world by applying it to a variety of social, cultural, economic, and political challenges [4,9]. However, discourse of these social justice topics is raised rarely in mathematics education.

In the study of Boaler (1993), students' learning will have greater significance for them if their social and cultural values are supported and promoted in the mathematics classroom utilizing contexts or by acknowledging personal approaches and orientation [10]. This was supported by Rogers' Humanist Theory which indicates that students should be motivated and aware that the task they have been given is useful, realistic, and relevant [11].

According to de Freitas (2008), addressing social justice issues should be a primary goal of all education – including mathematics education [12]. Its inclusion of social justice issues into the mathematics curriculum enhances student understanding since sensitivity to social justice concerns often reflects lived experiences [13] which are parallel to Kolb's experiential learning theory where knowledge results from the combination of grasping and transforming an experience.

Mathematics also serve as a powerful means for developing students' understanding of issues of social

justice, and that students are likely to develop an understanding of both social justice issues and mathematical concepts when there is a meaningful link between the two. It showed how student groups can be developed by adopting collaborative, problem-solving approaches to teaching, and encouraging students to choose which issues to explore and which mathematical procedures to apply. Developing and presenting their own arguments enables students to gain an appreciation of how mathematics can be used to better understand a situation and to argue for a change [14]. This was resonated to the study of Butters where students became more knowledgeable of social injustices using mathematics and were able to use mathematics in a way which was different from traditional methods to explore those injustices [15].

Mathematics education provides students with mathematics instruction that includes the mathematics deemed necessary for success in the current system while simultaneously providing students an opportunity to use mathematics to expose and confront obstacles to their success [16]. Teachers may work with students to examine social justice issues and support learning mathematics for social justice so that students use mathematics to examine injustices. Teachers are involved in supporting the development and use of social justice issues in their lessons. This is exhibited in the study of Stinson, et.al. where using narrative and textual data illustrates how a graduate-level' critical theory and teaching mathematics for social justice course assisted in providing not only a new language but also a legitimization in teachers becoming critical mathematics pedagogues [17]. However, teacher education programs are not oriented to prepare them for social justice context [13]. Thus, a need to provide a research agenda that emphasizes enabling the practice of teachers and that draws more heavily on design-based and action re-search, thereby redefining what the practice of mathematics means along the way [16]. This was done by Stinson, et.al. (2012), and Fernando, et.al. (2022) which aimed to engage the educators in a critical and interactive discussion on the integration of social justice in mathematics in general [17,18].

Considering the availability in the literature especially in the Philippines, only few Qualitative studies are present on the integration of social justice issues in Mathematics while the Quantitative studies on the integration of social justice issues are not substantially explored most especially on the effect of integrating social justice issues on students' mathematics achievement.

2.2. 5Es Instructional Model

There are numerous instructional models used by teachers. One of them is 5Es Instructional Model by Bybee, et.al. (2006) which is grounded in sound educational theory and has a growing base of research to support its effectiveness and has had a significant impact on science education [19]. This also holds in the study of Ranjan & Padmanahablan (2018), where their findings revealed that teaching through the 5E approach of constructivism is effective in enhancing achievement in mathematics of upper primary level as compared to traditional method [20]. In addition, the study of Omotayo

& Adeleke (2017) reveals that there is significant effect of treatment on student's mathematics achievement after applying 5Es instructional model. The study also encouraged teachers to adopt constructivist instructional approaches that discourage rote memorization and guide learners to develop their own understanding [21].

The 5Es instructional model provides opportunities for students to learn new knowledge so that it is embedded in students as a concept. This was shown in the study of Tezer & Cumhur (2017) revealed that using 5Es Instructional model increased mathematical achievement, problem-solving skills for the "Geometric Objects" unit. In addition, emphasizing the 5Es instructional model enables students to find and associate new knowledge with the knowledge that they already have. Positive relationship between the application of 5Es instructional model with student activity, availability of opportunity to optimize learning and develop reasoning ability in students, availability of opportunity to build concepts to solve problems, creative and independent thinking skills, increasing in academic achievement, and creating a fun learning atmosphere causes the application of instructional model were able to improve students' ability to solve problems [22].

Runisah, Herman, & Dahlan (2017) used 5Es instructional model with Metacognitive Technique to Enhance Students' Mathematical Critical Thinking Skills. The result of the study reveals that in terms of overall, mathematical critical thinking skills enhancement and achievement of students who received the 5Es Instructional model with Metacognitive technique is better than students who received the 5Es Instructional model and conventional learning. Mathematical critical thinking skills of students who received the 5Es Instructional model is better than students who received conventional learning [23]. This also appeared in the study of Cahyarini, et.al. (2016) which revealed that there were significant differences on students' critical thinking between students taught using conventional method and students taught either using 5Es Instructional Model with Socioscientific Issues and 5Es Instructional Model without Socioscientific Issues. However, there was no significant differences on students' critical thinking skills between students taught using 5Es Instructional Model with Socioscientific Issues and 5Es Instructional Model without Socioscientific Issues model [24].

2.3. Synthesis

Social justice issues may contribute to the growth of a strong mathematics identity that may inspire students to believe they have the capacity to learn mathematics, comprehend the value of mathematical understanding, identify the opportunities and challenges presented by such understanding, and become motivated and persistent in their pursuit of such knowledge [25]. On the other hand, the application of 5Es instructional Model is already proven its effectiveness of improving students' overall mathematics performance. Incorporating integration of social justice issues and the 5Es instructional model may greatly increase not only students' mathematics achievement, but also students' level of social justice-related attitudes and behaviors.

3. Methods

This study utilized the pretest-posttest quasi-experimental control group design to assess the effect of integration of SJI in mathematics learning of the Grade – 11 students of Molugan National High School, Division of El Salvador City school year 2022 – 2023. Quasi-experimental research design was employed to determine the effect of integration of Social Justice Issues through 5E instructional model on the student's mathematics achievement. An experiment is necessary to gather data to answer the problem posed in chapter 1.

This study was conducted at Molugan National High School, Division of El Salvador City. The school postal address is National Highway Molugan, El Salvador City, 9017 Misamis Oriental, Philippines. The participants of this study were the Grade-11 HUMSS students of Molugan National High School in Division of El Salvador City. The two sections are under the teaching load of the researcher. These two sections are pre-assigned to the researcher this school year 2022-2023. This class has a face-to-face session, a transition phenomenon that needs a careful process to bridge the gap of modular atmosphere to a class with interaction and participation.

There are 84 participants in the study: 43 students for the control group and 41 students for the experimental group, which are intact classes. The number of participants is the actual number of students enrolled in their section. This number of students per section is in line with the appropriate class size as advised by the DepEd. The assignment of the experimental group with integration of SJI through 5Es Instructional Model and the control group without integration of SJI through 5Es Instructional Model will be randomly assigned using lottery method.

The instrument used to assess the mathematics achievement is the Quarter 3 assessment test made by the researcher and will serve as pretest and posttest questionnaires. In the achievement test, the question is done by preparing a table of specifications and composed of multiple-choice items which includes topics in the Statistics and Probability Learner's Material of the Grade-11 students of the entire third grading period. Students were required to choose the correct answer from multiple-choice with four (4) options to assess their mastery of the concept and each question corresponds to a score of one (1). The instrument was then validated by the the research adviser and all the Secondary Mathematics Master Teachers of Division of El Salvador City. Upon validation, it was then administered to the students. The questions were checked, items analyzed, and the test was validated by a split-half method with a reliability index value of 0.73 which suggests a moderate level of internal consistency and indicates that there is a reasonably good degree of reliability.

To determine the effect of the integration of social justice issues through the 5Es Instructional Model on the students' mathematics achievement, one-way ANCOVA is used to interpret the data.

4. Results and Findings

The results of this study were presented in the following tables:

Table 1 shows the mean and standard deviation of the pretest and posttest results of the achievement scores for both the control and experimental groups. The overall pretest mean scores for control and experimental group were 4.488 and 4.780 respectively. In particular, the experimental groups outscored the control group by at most 0.292. However, data revealed that both groups were still at the developing level of proficiency. This further suggests that the levels of students' abilities in mathematics from both groups were relatively close and therefore comparable prior to the conduct of this study. This might be since their prior learning experience of modular instruction in mathematics was similar. Moreover, the standard deviation of experimental group was higher compared to the controlled group. This indicates a wider dispersion in the scores of the students in the experimental group compared to the controlled group which were closer to the mean. In particular, the standard deviation of experimental group signifies that some students got high and low scores in the pretest while the control group had almost similar scores.

On the posttest, it can be observed that the control group who received the 5E instructional method without the integration of social justice issues improved and obtained an approaching level of proficiency. This indicates that they were starting to cope up and develop knowledge and their fundamental skills were strengthened and fully acquired to aid their understanding of the concepts. However, the experimental group who received the 5E instructional method with the integration of social justice issues shows more improvement and obtained a proficient level of development. This suggests that students have the skill, knowledge, and understanding of the concepts.

The standard deviation of the posttest scores for both groups indicates that their responses were varied. Specifically, the standard deviation of the scores of the students in the experimental group is lower compared to the controlled group. The lower value of the experimental group shows that their scores were closer to the mean

compared to the controlled group. It further suggests that the students have heterogenous abilities after the lesson.

Meanwhile, a one-way ANCOVA was conducted to compare the achievement scores of the controlled and experimental group. Despite the data not meeting some of the assumptions (e.g. normality; homogeneity) of ANCOVA, the analysis was still conducted because ANCOVA is a robust statistical method that can produce valid results even when some of its assumptions are not met. The results of the analysis of covariance were presented and discussed below.

Table 2 presents the comparison of the students' achievement scores for the experimental group with integration of SJI through 5Es Instructional Model and the control group without integration of SJI through 5Es Instructional Model. The analysis of covariance yielded an F-ratio of 8.55 and a probability value of 0.004479 which led to the rejection of the null hypothesis at a 0.05 level of significance. This implies that there was a significant difference in students' achievement when exposed in the integration of SJI through 5Es Instructional Model. Moreover, the adjusted mean square of 49.32 indicates that the integration of SJI through 5Es Instructional Model had a large effect on students' achievement. This suggests that the students learned through the integration of SJI had a better performance than those students learned through without the integration of SJI. Furthermore, the effect size of 0.62 indicates that the integration of social justice issues on the lessons has a moderate to large effect on students' mathematics achievement.

The results have shown the strengths of integrating SJI in mathematics lessons in improving students' mathematics achievement. Particularly, the integration of SJI provided a relevant and meaningful usage of mathematics by tackling real-world issues such as social justice. The present study will concur Gutstein (2006) that mathematics can and should be taught in a way that supports students in using mathematics to challenge the injustices of the status quo as they learn to read and rewrite their world.

Table 1. Mean and Standard Deviation of Students' Achievement Scores

Group	N	Pretest			Posttest		
		Mean	SD	Descriptive Level	Mean	SD	Descriptive Level
Control	43	4.488	1.653	Developing	11.952	2.776	Approaching Proficiency
Experimental	41	4.780	2.403	Developing	13.489	2.110	Proficient
Perfect Score: 21							
Mean Level				Descriptive Level			
16.80-21.00				Advanced			
12.60-16.79				Proficient			
8.40-12.59				Approaching Proficiency			
4.20-8.39				Developing			
0.00-4.19				Beginning			

Table 2. One-way ANCOVA Summary of Students' Achievement Scores

Source	Df	Adj SS	Adj MS	F-value	p-value	Effect Size
Treatment Within	1	49.32	49.32	8.55	0.004479*	0.62
Error	81	466.97	5.77			
Total	82	516.28				

*significant at $p < 0.05$ alpha level

5. Conclusions

Based on the findings of the study, the researchers conclude that the integration of social justice issues through the 5Es instructional model has proven to be a highly effective approach in enhancing students' mathematical achievement. The structured framework of Engage, Explore, Explain, Elaborate, and Evaluate not only provides a comprehensive learning experience but also promotes a deeper understanding of mathematical concepts within the context of social justice. Through this method, students are not only acquiring mathematical skills but also developing a critical understanding of societal issues, promoting a more holistic and meaningful educational experience. As we continue to prioritize innovative and inclusive teaching methodologies, the integration of social justice issues within the 5Es Instructional model emerges as a powerful tool for equipping students with both mathematical proficiency and a socially conscious mindset.

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References

- [1] Sinay, E., & Nahornick, A. (2016). Teaching and learning mathematics research series I: Effective instructional strategies. Toronto, Ontario, Canada: Toronto District School Board: Research Report No. 16/17-08.
- [2] Kele, A., & Sharma, S. (2014). Students' beliefs about learning mathematics: Some findings from the Solomon Islands. *Teachers and Curriculum*, 14(1).
- [3] Griffin, P., & Care, E. (2015). *Assessment and Teaching of 21st Century Skills: Methods and Approach* (1st ed.). Springer Dordrecht.
- [4] Skovsmose, O., K. Yasukawa, & Ravn, O. (2011). Scripting the world in mathematics and its ethical implications. *Philosophy of Mathematics Education Journal*, 26.
- [5] Atweh, B., & Brady, K. (2009). Socially Response-able Mathematics Education: Implications of an Ethical Approach. *Eurasia Journal of Mathematics, Science and Technology Education*, 5(3), 267-276.
- [6] Ernest, P. (2002). Empowerment in mathematics education. *Philosophy of mathematics education journal*, 15(1), 1-16.
- [7] Ogena, E., & Tan, M. (2006). Formulation of National Learning Strategies in Science and Mathematics Education. First Draft.
- [8] Bernardo, A. B. I. (1998). The overlooked phenomenon in science and mathematics education reform in the Philippines: The learning process. In E. B. Ogena & F. G. Brawner (Eds.), *Challenges for development: Science education in the Philippines* (pp. 79-108). Taguig: NAST/SEI/UP-CIDS..
- [9] Skovsmose, O. (1998). Linking mathematics education and democracy: Citizenship, mathematical archaeology, mathemacy and deliberative interaction (pp. 195-203). *Zentralblatt für Didaktik der Mathematik*, 30(6).
- [10] Boaler, J. (1993) Encouraging the transfer of 'school' mathematics to the 'real world' through the integration of process and content, context and culture. *Educ Stud Math* 25, 341-373.
- [11] Main, P. (2022, December 02). Carl Rogers' Theory. Retrieved from <https://www.structural-learning.com/post/carl-rogers-theory>
- [12] Elizabeth de Freitas (2008) Troubling teacher identity: preparing mathematics teachers to teach for diversity, *Teaching Education*, 19:1, 43-55.
- [13] Gutstein, E. (2006). The Real World As We Have Seen It: Latino/a Parents' Voices On Teaching Mathematics For Social Justice, *Mathematical Thinking and Learning*, 8:3, 331-358.
- [14] Wright, P. (2016). Social justice in the mathematics classroom. *London Review of Education*. Vol. 14(2):104-118.
- [15] Butters, L. (2022). "Teaching Social Justice Issues Through Mathematics Curriculum". Research in the Capitol. 13. <https://scholarworks.uni.edu/rcapitol/2022/all/13>
- [16] Gutierrez, R. (2002). Enabling the Practice of Mathematics Teachers in Context: Toward a New Equity Research Agenda, *Mathematical Thinking and Learning*, 4:2-3, 145-187.
- [17] Stinson, D. W., Bidwell, C. R., & Powell, G. C. (2012). Critical pedagogy and teaching mathematics for social justice. *The International Journal of Critical Pedagogy*, 4(1).
- [18] Fernando, M. T., Guzon, A. F., Punzal, C., Vistro-Yu, C. P., Yap, R., Azada-Palacios, R., & Rodill, T. (2022). Teachers Exploring the Use of Social Justice Investigations in Mathematics Teaching in the Philippines. *Intersection Vol. 15 (1), Editorial board*, 23-26.
- [19] 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, Co: BSCS*, 5, 88-98.
- [20] Ranjan, S., & Padmanabhan, J. (2018). 5E approach of constructivist on achievement in mathematics at upper primary level. *Educational Quest*, 9(3), 239-245.
- [21] Omotayo, S. A., & Adeleke, J. O. (2017). The 5E Instructional Model: A Constructivist Approach for Enhancing Students' Learning Outcomes in Mathematics. *Journal of the International Society for Teacher Education*, 21(2), 15-26.
- [22] Tezer, M., & Cumhur, M. (2017). Mathematics through the 5E Instructional Model and Mathematical Modelling: The Geometrical Objects. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(8), 4789-4804.
- [23] Ms, R., Herman, T., & Dahlan, J. A. (2017). The Enhancement of Students' Critical Thinking Skills in Mathematics through The 5E Learning Cycle with Metacognitive Technique. In *International Conference on Mathematics and Science Education* (pp. 101-106). Atlantis Press.
- [24] Cahyarini, A., Rahayu, S., & Yahmin, Y. (2016). THE EFFECT OF 5E LEARNING CYCLE INSTRUCTIONAL MODEL USING SOCIO-SCIENTIFIC ISSUES (SSI) LEARNING CONTEXT ON STUDENTS' CRITICAL THINKING. *Jurnal Pendidikan IPA Indonesia*, 5(2), 222-229.
- [25] Martin, D. B. (2010). Liberating the production of knowledge about African American children and mathematics. In *Mathematics teaching, learning, and liberation in the lives of Black children*, 13-46.

