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## The Effects of Pedagogy on Student Achievement in Science Classrooms

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DOI: <https://doi.org/10.69670/mje.1.2.2><https://www.williamwoods.edu/academics/mje>**Brittany E. Kiser****Abstract**

This mixed-methods study was designed to determine whether a correlational relationship exists between student achievement on the Florida Grade Eight Statewide Science Assessment and the predominant pedagogical practice (student-centered, teacher-directed) found across the three grade levels (six, seven, eight) of associated middle schools. Data was gathered by mining historical public domain and Likert scale surveys of middle school (grades six through eight) science teachers (N = 97). Data analysis procedures included Spearman's *rho* correlation coefficient utilizing the Statistical Package for Social Science. Concerning student performance on this assessment, significant differences were established in the following categories: use of formative assessment in the classroom setting, teacher providing traditional notes, and collaborative student group work. Additionally, significant differences were identified regarding school socioeconomic status and school-wide science pedagogical approach. Implications for instructional practices in science classrooms, as well as for teacher preparation programs and current educator professional development, are discussed.

**Keywords**

science education; pedagogy; student-centered; student achievement; middle school

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## **Introduction**

The current era of accountability in education frequently sources its measure of success through standardized examinations and student performance on said examinations. The push for accountability solely through assessment has left public education ensnared in a “system of performance” whose main focus is employing divisive measures to set a ranking system (Tienken, 2017, p. 109). As a result, a large body of research has taken shape over time as to ways in which the achievement of students can be attributed to teachers, socioeconomics, curricular materials, home life, and the student as the learner. The assessment of a student’s academic achievement (performance) primarily involves the quantitative evaluation of a student’s proficiency in a given subject area, typically through a summative assessment, which may be standardized, norm-referenced, or criterion-referenced in nature (Webb, 2007). Students in the United States were not performing optimally according to these measures. For example, nationwide, students ranked 496 on the Program for International Assessment (PISA) 2015 science assessment, barely surpassing the international mean score of 493 (OECD, 2016). This is echoed in the 2015 National Assessment of Educational Progress (NAEP), as American students scored an average of 154 out of 300 points in the sciences (Institute of Education Sciences, 2016). Results were similarly disheartening in Florida, in which middle school students who achieved the accepted level of proficiency were only 50% and 52% in the years 2017 and 2018, respectively, on the Grade Eight Statewide Science Assessment (SSA) (Florida Department of Education, 2018).

Recent years have seen a growing interest in understanding the metrics associated with how classroom instructional approaches impact student learning, reaching beyond the typical mathematics and English language arts to include science (Oliver et al., 2021; Zvoch et al., 2021). Pedagogy, when widely defined, can be classified as either student-driven or teacher-centered. Frequently interchanged with student-led, student-centered, and learner-centered, student-centered instruction involves creating a classroom setting that centers on the learner’s needs, with tasks and activities designed to connect with them (Turner, 2011). In short, this teaching mode encompasses any form of instructional delivery that places the student at the center of the learning process. Conversely, teacher-led instructional delivery is associated with traditional teaching methods, such as lectures and whole-group demonstrations (Odom & Bell, 2015; Zvoch et al., 2021). This method of instruction clearly delineates the teacher from the student, the former as the provider of knowledge and the latter as the passive receiver.

Faced with the aforementioned data, it is reasonable to conclude that further investigation into the relationship between instruction and student performance in the sciences may lead to a different lens of understanding, particularly from the perspective of the teacher, which could be leveraged to inform instructional practices not only for current classroom educators but for preservice teachers as well. This study aimed to examine whether there is a positive association between instructional approach, specifically the contrast between student-driven and teacher-centered methods, in public middle schools of a large, urban school district and student performance on the Grade Eight Statewide Science Assessment. Interestingly, classroom educators cite these types of standardized assessments as specific barriers to implementing student-centered instruction in the

classroom (An & Mandrila, 2020). The following research questions and hypotheses guided this study:

1. In a large, urban school district, is one predominant modality of grades six through eight science teachers, mixed pedagogies versus student-driven pedagogy, correlated with higher student achievement than the other?
2. What school characteristics (i.e., demographics, average years of teacher experience, etc.) are associated with a predominance of student-driven pedagogy or mixed pedagogies?  
 $H_1$ : Schools with a greater tendency toward student-driven instruction will demonstrate higher student achievement on the Grade Eight Statewide Science Assessment.

$H_0$ : No significant difference in student achievement on the Grade Eight Statewide Science Assessment will exist between schools with differing predominant pedagogies.

### Literature Review

The publication of *A Nation at Risk* in 1983 led to the development of metrics specifically geared toward quantifying school performance (Guthrie et al., 2007). Over the years, legislation concerning this continued to evolve. More recent notable legislation includes the introduction of Adequate Yearly Progress (AYP) through the 2002 No Child Left Behind Act, as well as the individual statewide assessment changes that came about as a result of the Every Student Succeeds Act in 2015 (Figlio & Ladd, 2015). Ultimately, mandates such as these led to a climate of high-stakes accountability in K-12 schools (Tienken, 2017).

From a certain viewpoint, the desire for accountability is understandable when considering the historical performance of K-12 science. Internationally, the 2015 Trends in International Mathematics and Science Study (TIMSS) showed the top performers to be Singapore, Korea, Slovenia, the Russian Federation, and Chinese Taipei, while the Programme for International Student Assessment (PISA) indicated similar results—the highest achieving countries included Singapore, Japan, Estonia, Finland, and Canada (Institute of Education Sciences, 2016; Organization for Economic Cooperation and Development, 2016). The poor achievement in United States national scores was clear, which included mediocre performances on the TIMSS and PISA in 2015, both of which demonstrated marked decreases from the prior examinations in 2011 (Institute of Education Sciences, 2016; Organization for Economic Cooperation and Development, 2016). In Florida, the low performance is echoed. Between the years of 2012-2016, the average passing rate of students on the Statewide Science Assessment ranged from 47% to 50% (Florida Department of Education, 2016). An important difference among these standardized exams is their organization—in Florida, the Grade Eight Statewide Science Assessment (SSA) covers content addressed in grades six, seven, and eight. In contrast, the others purportedly look at one year's content.

Given the substandard performance, the classroom teacher's role must be considered. In general, pedagogical approaches can be classified as either teacher-led or student-centered. The teacher-led

classroom is most often visualized as the traditional learning environment, in which the teacher is the giver of knowledge and students are passive receivers, and stand-and-deliver lectures alongside whole-group demonstrations are common (Odom & Bell, 2015; McNulty & Quaglia, 2007; Wu & Huang, 2007; Cartlidge, 2023). Although the teacher-led classroom may appear to be superficially engaging, there is generally very little differentiation, and the focus of the learning always returns to the teacher (Odom & Bell, 2015; McNulty & Quaglia, 2007; Wu & Huang, 2007; Cartlidge, 2023).

On the contrary, characteristics of the student-centered classroom tend to focus on relevant, authentic classroom activities with an abundance of opportunities for student-talk and inclusive of student voice and choice (McNulty & Quaglia, 2007; House, 2008; Webb, 2007; Turner, 2011; Bremner et al., 2022). These learning environments emphasize scaffolding of instruction, using formative assessment to drive instruction, and the real-world application of skills (McNulty & Quaglia, 2007; House, 2008; Webb, 2007; Turner, 2011; Bremner et al., 2022). More recent research also addresses the budding technological aspects of student-centered instruction, which can be leveraged for differentiation and supporting authentic learning, among other advantages (An & Mindrila, 2020). There have been a few studies linking the traits of a student-centered classroom to increased achievement on summative assessments, improved understanding of complex scientific concepts, and heightened rigor in both instruction and student thinking skills (Odom & Bell, 2015; Tassell, 2013; Nam, Choi & Hand, 2011; House & Telese, 2015). However, other studies have contraindicated these findings, noting that inquiry-based instruction, such as the type central to student-centered pedagogy, was not necessarily linked to positive student performance (Su, 2014; Cartlidge, 2023). Years later, Bara and Xhomara (2020) confirmed this, showing that a minimal positive correlation exists between student-driven instructional practices and the student's academic achievement.

Like any reported correlational studies, other research will expand upon and sometimes contradict the initial results. In recent studies of classroom approaches of teacher-centered versus student-centered learning, the efficacy of aspects of both methods has been upheld (Bremner et al., 2022; Cartlidge, 2023; Mitani, 2021). Ultimately, studies agree that a mixture of student-centered and teacher-directed learning takes place in the classroom to be most effective for the modern learner (Areepattamannil, et al., 2020; Bara & Xhomara, 2020). Although some research exists, available literature specifically connecting the pedagogical methods of the classroom teacher to student achievement via standardized assessment scores in science is sparse in the United States (U.S.).

This paper focuses on the instructional delivery of science content; however, the curriculum's standards cannot deny the discussion of science education. Whereas the Next Generation Science Standards (NGSS) have been widely lauded as the answer to increased cognitive complexity in science instruction, and this curricular framework has been adopted by roughly half of all states in the U.S., there remain those states that have declined this educational program. Florida is one of the states that has rejected the NGSS and instead employs the Next Generation Sunshine State Standards for Science (NGSSSS). Several key differences exist between these curricular frameworks, chief among them being the focus. NGSS centers on applying performance skills in science, including engineering concepts. At the same time, NGSSSS concentrates on the ability to recognize and retain science content. Interestingly, both K-12 curricular structures were developed with the same goal of teaching science at a high level of rigor.

## Conceptual Design and Theoretical Framework

This study's conceptual design relied upon Robert Marzano's (2007) research, specifically that instructional methods used before, during, and after classroom interactions significantly impact student performance. Marzano's work cataloged distinct instructional methods that teachers can employ to enhance student performance in the classroom, and these 60 components represent effective instruction and were amalgamated into the *Marzano Art and Science of Teaching and Learning Map* (Marzano, 2007). This *Learning Map* was then utilized as a framework in this study for classroom indicators that can lead to increased student achievement.

A dual perspective, both psychological and philosophical, underpinned the theoretical framework for this study. Theories from the psychological viewpoint include Vygotsky's Zone of Proximal Development, Piaget's Theory of Cognitive Development, and Bruner's Constructivist Theory. Each of these ideas interlocks with the next to support the development of this study. Vygotsky (1978) asserts the importance of the teacher as the guide during the learning process. Similarly, Piaget's work (1952/1965) incorporates planned learning experiences meant to assist learners in building their own understanding. In tandem, Bruner's (1960) constructivism emphasizes that knowledge development is established by active over passive learning. The propositions of Dewey (1938/1997) further support the philosophical perspective that education should center on the learner and how the learner builds knowledge, an idea now closely associated with student-centered instruction.

## Methods

The study design was mixed-methods, constructed as ex post facto correlational research. The research was designed in this manner to secure an accurate and impartial picture that is representative of middle school science classrooms school-wide. To that end, both qualitative and quantitative data were collected through public data mining and teacher surveys to understand the effect of teachers' pedagogical approaches on student performance on a standardized assessment. The qualitative data was carefully selected also to inform the degree to which these pedagogies may be correlated with a given school's traits. The combination of the quantitative and qualitative data contributed to shaping the construction of teacher pedagogy in middle school science in the given district.

### Description of the Sample

The study occurred in a large, urban school district in Florida. At the time of the study, the district employed 12,800 classroom teachers; however, the study purposely sampled middle school science teachers only. Of the 35 public middle schools in the district, 34 were attempted to be sampled, and one was omitted owing to its status as a research-prohibited institution. The sample pool consisted of classroom educators teaching science in grades six, seven, and/or eight ( $N = 331$ ).

### Data Collection

The researcher garnered the email addresses of middle school science teachers via a public records request through the school district Office of Communications. The researcher secured permission to present the upcoming study participation opportunity for middle school science department instructional leaders and middle school coordinators of school-based SECME (Science Engineering Communications Mathematics Excellence) clubs at their monthly meetings, requesting that the message be shared with their learning communities. Potential participants (n=331) received an email solicitation for participation in the study and a reminder 14 days later, one day before the survey's close. A visual representation of the data collection procedures can be viewed in Appendix A.

The anonymous digital survey instrument (see Appendix B) comprised 17 questions, beginning with informed consent. Demographic questions included the school's name, years of experience as a teacher, years of experience teaching science at the current school, Title I/non-Title I school, and grade level(s) of science taught. The survey continued with 12 Likert scale questions about instructional practices in the classroom, asking the teacher to identify the frequency (daily, weekly, monthly, quarterly, never) of each in their classroom. As described in the literature, the instructional practices listed were specifically aligned with either student-centered or teacher-led pedagogies (Odom & Bell, 2015; McNulty & Quaglia, 2007; Wu & Huang, 2007; Turner, 2011). No identifiable participant information was collected or released and has since been destroyed.

Student achievement data was collected as test scores after the survey closed from the Florida Department of Education's public website, K-12 Student Assessment Results. On its release, the researcher downloaded the Grade Eight Statewide Science Assessment (SSA) spreadsheet of district and school performance.

### **Data Analysis**

The survey data gathered was aggregated for each school; every school was assigned a series of two randomly assigned letters for data analysis and protection of anonymity. The frequency responses from the Likert Scale questions were transmuted into numeric values of Never = 1, Quarterly = 2, Monthly = 3, Weekly = 4, and Daily = 5.

When ascertaining the extent to which a school practiced student-centered instruction, the teacher-directed frequency categories were inverted. Values were then added together and divided by the number of responses per school, yielding the percentage that a school had a proclivity for student-driven instruction. Accordingly, a school was classified as student-driven for its predominant pedagogy if its numeric values exhibited 60% or more of these traits and as mixed pedagogies if they did not. No schools resulted in 60% or more of teacher-led practices.

The researcher utilized the Statistical Package for Social Science (SPSS) for the remaining data analyses. Spearman's *rho* correlation coefficient was employed to measure the correlation, direction, and strength of the association of each teaching practice with exam scores. Spearman's *rho* correlation was run for every instructional method addressed in the survey instrument in comparison to the school label (mixed pedagogies, student-driven) and the degree to which the survey data indicated the school was partial to student-centered instruction (the complete survey instrument can be viewed in Appendix B). Lastly, the correlation of predominant pedagogy and the extent to which each school self-identified with the use of student-driven pedagogy was

determined by employing Spearman's *rho* correlation coefficient to ascertain the direction and strength of the relationship between student test scores on the Statewide Science Assessment and each of these variables. An alpha value of 0.05 or less was accepted as statistically significant for all statistical tests.

### Findings

As aforementioned, data for this study was collected in both qualitative and quantitative formats. Student test data was accessed via publicly available data mining. The email containing the survey link was sent to the middle school science teachers of 34 schools in the subject district, a total of 331. Of those who received it, 97 participants from 32 schools responded to the survey, with a response rate of 29.3%. Schools were classified as student-centered if respondents cited 60% or more student-driven practices; otherwise, they were classified as using mixed pedagogies. No schools cited 60% or more teacher-centered practices. Schools in the subject district had a mean score of 53.75% on the Grade Eight SSA, with student performance ranging from 23% to 94%. The study results for research questions one and two and the hypotheses are examined below, respectively, highlighting those findings that yielded statistically significant results.

### Pedagogy and Student Exam Scores

The goal of research question one was to examine what if any, relationship exists between pedagogy and student performance on the Grade Eight SSA. The association between student performance on the Grade Eight SSA and the frequency with which schools indicated each individual teaching practice was examined using a two-tailed Spearman's *rho* correlation coefficient. Three characteristics of the pedagogical approach were identified as having statistically significant results concerning student exam scores. All results can be viewed in Table 1.

**Table 1**

*Correlation and Significance of Teaching Practices with Student Exam Scores*

Teaching Practice	Correlation Coefficient	p-value
Frequency of Collaborative Grouping	-0.213	0.036
Frequency of Formative Assessment	-0.293	0.004
Frequency of Inquiry Labs	-0.038	0.714

Frequency of Student Choice in Activities	.007	0.947
Frequency of Teacher as Facilitator of Knowledge	0.007	0.943
Frequency of Student Self-evaluation	0.051	0.619
Frequency of emphasis on process of learning	-0.122	0.233
Frequency of teacher demonstration	0.035	0.733
Frequency of content delivered as notes	0.199	0.050
Frequency of teacher as giver of knowledge	0.045	0.665
Frequency of pre-developed, hands-on activities	0.054	0.602
Frequency of emphasis on product of learning	0.142	0.164

*Note:* Student exam scores originated from the Grade Eight Florida Statewide Science Assessment, which tests in a single exam content taught singularly in grades six, seven, or eight. The frequency of teaching practices originated from the teacher surveys.

The association between student performance on the Grade Eight SSA and the frequency with which schools have their science students operate in collaborative groups found a marginally significant negative association ( $\rho(95) = -0.213$ ,  $p < 0.05$ ). Student test scores on the Grade 8 SSA decline as more schools report their students participating in collaborative groups. Table 1 also depicts that the association between student performance on the Grade Eight SSA and the frequency with which a school indicated employing formative assessment results to guide classroom instruction produced a weak, significant negative association ( $\rho(95) = -0.293$ ,  $p < 0.01$ ). Thus, student performance on the Grade Eight SSA declines the more often a school uses formative assessment to guide classroom instruction. Finally, the connection between the frequency with which a school uses notes to deliver content and student exam scores on the Grade Eight SSA indicated a very weak, marginally significant positive correlation ( $\rho(95) = 0.199$ ,  $p = 0.05$ ).

### **Socioeconomic Status and Patterns of Pedagogy**

Research question two focused on associations between school characteristics and predominant instructional practices employed in science classrooms. The researcher performed a two-tailed Spearman's  $\rho$  correlation coefficient for each school characteristic (years of experience of the science faculty, years faculty have taught at that school, and Title I/non-Title I) as compared to the school-wide pedagogy category of student-centered or mixed pedagogies. One trait, socioeconomics, was established as statistically significant. The results can be viewed in Table 2.

### **Table 2**

*Correlation and Significance of School Characteristics with School-wide Pedagogy Category*

School Characteristic	Correlation Coefficient	p-value
Years of teaching experience	-0.024	0.819
Years teaching science at current school	-0.130	0.204
Socioeconomic status (Title I or non-Title I)	-0.242	0.017

*Note:* Schools that identified utilizing student-driven instructional practices 60% of the time or higher, per the results of the survey, were classified as “student-centered,” while schools that identified utilizing teacher-centered instructional practices 60% of the time or higher those schools were classified as “teacher-driven” (there were none that fit this category). Schools that identified practicing less than 60% of student-driven and less than 60% of teacher-centered pedagogical methods were classified as “mixed pedagogies.”

When running the Spearman’s *rho* correlation coefficient test of the socioeconomic status of Title I or non-Title I and the designated school labels of student-centered or mixed pedagogies, a weak, significant negative correlation ( $rho(95) = -0.242, p < 0.05$ ) was yielded. As shown in Table 2, schools categorized as mixed pedagogies are more likely not to be Title I, whereas Title I schools are more likely to be classified as student-centered.

### Results for Hypotheses

The findings noted above, and the lack of statistically significant results for any other component prove that the null hypothesis ( $H_0$ ) should be accepted and the alternative hypothesis ( $H_1$ ) rejected. No significant difference in student achievement (test scores) on the Grade Eight SSA exists between schools with differing predominant pedagogies.

### Discussion

The results of this study concerning pedagogy, student performance, and school characteristics differed greatly across both variables and tests. This section will delve into the meanings of those statistically significant findings and other notables for consideration. When reviewing the following interpretations and explications of the data, the reader must remember that while there may be correlational findings, these are not causal, and neither does the researcher assert that they are as such.

### Pedagogy and Student Achievement

The first analysis that resulted in significant findings was comparing formative assessment as a tool to modify classroom instruction (independent variable) related to student performance on the Grade Eight SSA (dependent variable). When formative assessment is regularly used to enhance and guide classroom instruction, student exam scores on the Grade Eight SSA are statistically significantly different than those of students in schools that do not. However, the two-tailed Spearman's *rho* correlation coefficient conducted resulted in an extremely weak negative correlation, conflicting with modern educational researchers that tout the importance of regularly administering and implementing with fidelity formative assessments (Slavin, 2019; Marzano, 2007; Doherty & Hilberg, 2008; Bremner, et al., 2022). When drawing upon anecdotal and personal experience spent in many science classrooms across the district, this researcher can rationalize this phenomenon as an underuse of higher-order thinking questions and critical thinking aspects, tending instead toward the lower side of Webb's (2007) Depth of Knowledge, particularly within formative assessments, which in turn poorly prepare students for the rigor of the Grade Eight SSA, corroborated by the research of Mitani (2021).

When comparing student test scores on the Grade Eight SSA to the instructional practice of delivering content in the form of notes, the two-tailed Spearman's *rho* correlation coefficient indicated these variables to have a marginally significant, extremely weak positive correlation, pointing to a possible relationship between this teaching practice and student exam scores on the Grade Eight SSA. This aligns with research that elucidates the importance of explicit instruction in laying a secure foundation of understanding for more difficult concepts (Cartlidge, 2023).

Finally, the relationship between using collaborative groups as a classroom strategy and students' test scores on the Grade Eight SSA revealed a statistically significant finding. According to the two-tailed Spearman's *rho* correlation coefficient test, there is a significant, albeit very weak, negative correlation between these two variables. While many studies purport the value of collaborative work to enhance student learning in the classroom, logical reasoning can also lead to the logical conclusion that performance on an individualized, high-stakes test, such as the Grade Eight SSA, may suffer when this is all students have been exposed to, never having to work through critical thinking tasks on their own. This is further supported by the findings of Mitani (2021).

### **Socioeconomic Status and Patterns of Pedagogy**

The singular statistically significant finding for research question two was related to the school's socioeconomic status (Title I or non-Title I) and the degree to which a school identified as mixed pedagogies or student-centered. Spearman's *rho* correlation coefficient comparing the two yielded a p-value of 0.17, illustrating a weak, significant negative correlation. As a result, schools falling into the category of student-centered are more likely to be Title I, whereas those with mixed pedagogies are more likely not to be. These findings can be reasonably connected to student engagement, which research demonstrates is a key component of the student-centered classroom (Wu & Huang, 2007; Bremner et al., 2022). This idea expands on Lareau's (2011) research by supporting the idea that lower socioeconomic school students require a larger range of engagement tactics than higher socioeconomic status classrooms, where there is likely to be a higher degree of compliance from the students.

### Noteworthy Outcomes

The data revealed a few unexpected trends beyond that of the research questions, mainly masquerading as participant (teacher) confusion or misconception. For example, four participants did not correctly identify their school as Title I or non-Title I by the subject district's provided list. Although this appears trivial, it may point to a larger issue, in that the teachers may be missing other vital components concerning their school site and role there. At the outset of this study, a key presumption was that the teacher participants had been teaching the Florida state standards with fidelity, including addressing the appropriate cognitive complexity of the content. If this presumption is incorrect, it is reasonable to expect that student exam scores on the Grade Eight SSA would be equally affected. Similarly, participants responded to two survey queries, "Teacher Acts as Facilitator of Knowledge" and "Teacher Acts as Giver of Knowledge," with the same frequency, resulting in mean scores of 4.55 ( $sd = .791$ ) and 4.24 ( $sd = .788$ ), respectively. However, educational research equates these two with opposite methods of instruction—the former being student-centered and the latter as teacher-centered—thus, this may point to some misunderstanding on the part of the research participants as to the role of the teacher as a facilitator rather than a provider of knowledge in the classroom (McNulty & Quaglia, 2007; Odom & Bell, 2015; Turner, 2011; Wu & Huang, 2007; Cartlidge, 2023).

Additionally, because many participants likely had some prior relationship with the researcher as connections through work, they may have responded to the survey instrument with what they believed to be the "right" answer, as people have been conditioned psychologically to do, rather than with their honest answer (Bruner, 1960). This may account for a potential explanation, in part, for why the results were as they were, which may have resulted in implicit bias based on the sound instructional practices the researcher may have shared with participants in unrelated interactions that occurred before the study's design and implementation. As discussed later in this text, these situations may be minimized by conducting research outside the home district or hiring an individual with no prior association.

### Limitations

This study had several identifiable limitations, starting with the sample size. Although a response rate of nearly 30% was achieved from the survey, the percentage of teacher respondents per school ranged from 8 to 100 percent. Thus, the data analyzed may not be an entirely accurate view of the schools in question. Equally important to consider is the validity of the survey instrument (see Appendix B) itself, given that it had not been previously tested. In addition, extraneous variables often affecting standardized assessments must also be considered. For example, a student's prior learning experiences outside of grades six through eight classroom instruction may have affected their success on the Grade Eight SSA, the content knowledge, and the content comfort level of the classroom teacher, which in turn may also affect the preferred instructional method and the student's academic progress may have as well. Finally, the ability to generalize the findings of this study may be limited to regions that employ a similar spiraling of curriculum alongside a cumulative, standardized assessment. This is particularly significant in this study, as the State of Florida follows the NGSSS curriculum rather than the NGSS K-12 Framework.

## **Implications**

Societal expectations demand accountability as a metric for the effectiveness of education; therefore, it would behoove all stakeholders to have a firm grasp on the pedagogical approaches that lead to increased student achievement, particularly in the form of standardized exam scores. In conjunction with work such as that by Oliver et al. (2021), Bara and Xhomara (2020), and Zvoch et al. (2021), the study discussed here may be a small piece of this effective methods puzzle.

Considering the results of this study, trends inevitably point to teacher misinterpretation, which can be construed as a need for better professional development and preparation programs for current and preservice teachers. Classroom teachers surveyed demonstrated confusion concerning several pedagogical approaches associated with student-driven and teacher-centered instruction, such as facilitation versus giving knowledge, grouping strategies, formative assessment usage, and cultural settings of their distinct school sites. These misunderstandings may be exacerbated due to the “classic” teaching methods these students-turned-teachers experienced as students themselves (Odom & Bell, 2015; Nelson & Harper, 2006; Allensworth, et al., 2021). On that account, it can be inferred that classroom educators may similarly misinterpret the research-based approaches to effective implementation of student-driven methods, and, when compounded with technology barriers reported by An and Mindrila (2020), results in less than stellar results. Professional development suppliers and teacher preparation program professionals should leverage this information to develop targeted training geared not only to new educators but teachers of all levels, particularly given that an increasing number of schools and districts are having to manage teachers that have very little or no, experience and training for the job (Allensworth et al., 2021).

However, to be effective, these targeted trainings must be built on empirical evidence and model effective instruction, allowing for teachers to act as students and master the highest level of rigor, engaging with content in the student think, student work quadrant of learning (Slavin, 2019; McNulty & Quaglia, 2007; Webb, 2007). In doing so, the classroom educator as the student can expand their understanding through actively constructing knowledge and ultimately develop the skillset vital to the effective teacher (Bruner, 1960; Allensworth et al., 2021).

In a broader sense, at least within the United States, this can be applied to the instructional practices of current science educators and the K-12 science framework. Newer standards for science instruction can be shifted away from content knowledge, such as the NGSSS in Florida, towards those more skill-based, as seen in the NGSS K-12 Framework. In reaching curricular expectations that are both practical and higher level, the classroom educator is compelled to employ a purpose-driven instructional progression.

## **Recommendations for Research**

Based on the results of this study, the author has several suggestions for future research. To begin with, the survey instrument may be piloted by a researcher with no prior relationship with any of the study participants and is also able to follow the survey implementation with site-based observational visits, qualitative in nature, similar to the suggestion for future research put forth by Su (2014). This would help confirm the reliability of the survey instrument. As with most empirical research, this study may be replicated within other Florida school districts or expanded to other

regions that utilize a similar curricular and assessment model, which may dispute or verify this study's results. Similarly, this same study may be piloted with other grade bands, such as the Grade Five Statewide Science Assessment in Florida, which mirrors the spiraled curriculum and assessment of Grade Eight. It would be interesting if this study could be replicated with teachers and students who have "looped"—a single teacher stays with their class as the students change grade levels.

Additionally, it is recommended that this study be performed longitudinally to discover the long-term effects of student-driven instruction on student test scores in accordance with the proposal of Wyss et al. (2013). The study described in this paper tried to address this with regard to the three-year content assessment, though this could be greatly improved by employing a true longitudinal study.

### References

- Allensworth, E., Cashdollar, S., & Gwynne, J. (2021). Improvements in math instruction and student achievement through professional learning around the Common Core State Standards in Chicago. *AERA Open*, 7. <https://doi.org/10.1177/2332858420986872>
- An, Y. & Mindrila, D. (2020). Strategies and tools used for learner-centered instruction. *International Journal of Technology in Education and Science (IJTES)*, 4(2), 133- 143.
- Areepattamannil, S., Cairns, D., & Dickson, M. (2020). Teacher-directed versus inquiry-based science instruction: Investigating links to adolescent students' science dispositions across 66 countries. *Journal of Science Teacher Education*, 31(6), 675–704. [doi.org/10.1080/1046560X.2020.1753309](https://doi.org/10.1080/1046560X.2020.1753309)
- Bara, G. & Xhomara, N. (2020). The effect of student-centered teaching and problem-based learning on academic achievement in science. *Journal of Turkish Science Education*, 17(2), 180-199. [doi: 10.36681/tused.2020.20](https://doi.org/10.36681/tused.2020.20)
- Bremner, N., Sakata, N., & Cameron, L. (2022). The outcomes of learner-centered pedagogy: A systemic review. *International Journal of Educational Development*, 94. <https://doi.org/10.1016/j.ijedudev.2022.102649>

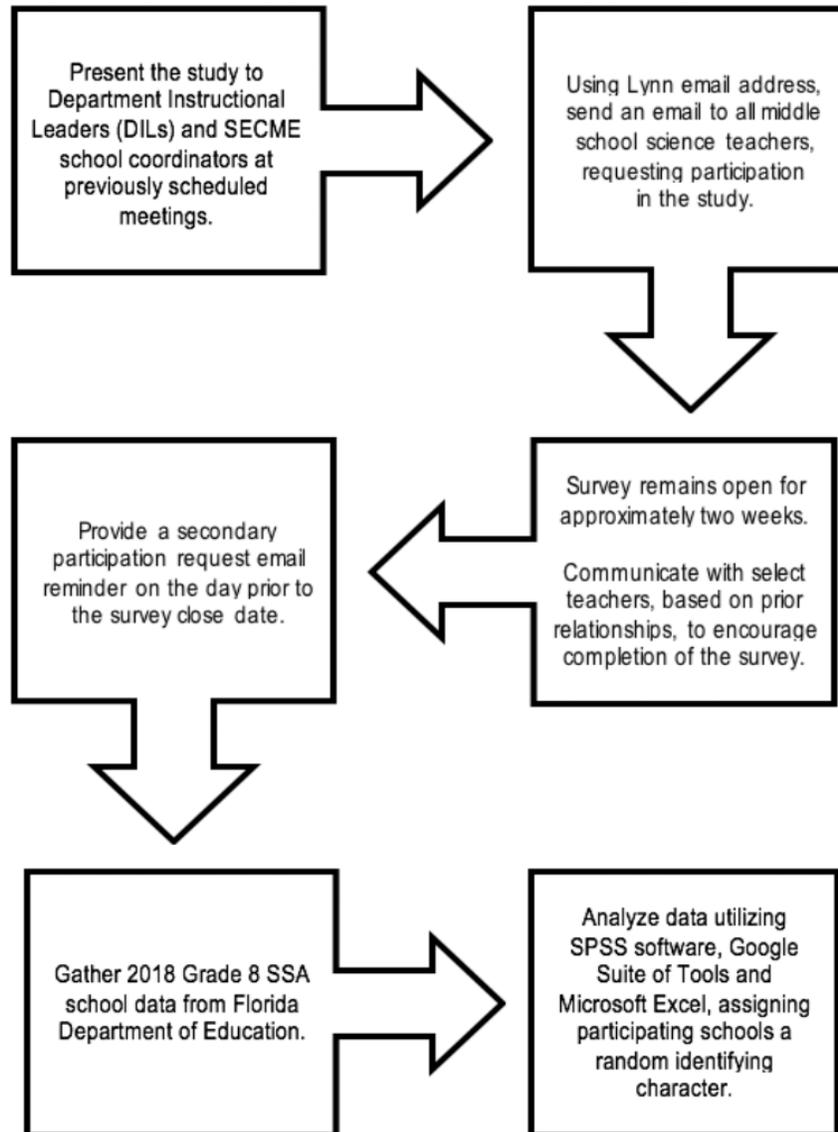
- Cartlidge, B. (2023). The argument for teacher directed learning. *Teaching History*, 57(1), 23–26. <https://search.informit.org/doi/10.3316/informit.006677882927877>
- Dewey, J. (1997). *Experience and education*. New York, NY: Touchstone (Original work published 1938).
- Doherty, R. W., & Hilberg, R. S. (2008). Efficacy of five standards in raising student achievement: Findings from three studies. *Journal of Educational Research*, 101(4), 195-206. <https://doi.org/10.3200/JOER.101.4.195-206>
- Figlio, D.N. & Ladd, H.F. (2015). School accountability and student achievement. In H.F. Ladd & M.E. Goertz (Eds.), *Handbook of research in education finance and policy* (pp. 194-210). Routledge.
- Florida Department of Education. (2016). *Results: district 2015 and 2016 comparison*, Statewide Science Assessment and Biology.
- Florida Department of Education. (2018). *Results: district 2017 and 2018 comparison*, Statewide Science Assessment and Biology.
- Guthrie, J.W., Springer, M.G., Rolle, R. A., & Houck, E.A. (2007). *Modern education finance and policy*. Pearson Education, Inc.
- House, J. D. (2008). Science beliefs, instructional strategies, and life sciences achievement of adolescent students in Japan: Results from the TIMSS 1999 assessment. *International Journal of Instructional Media*, 35(1), 103-113.
- House, J. D., & Telese, J. A. (2015). Engagement in science lessons and achievement test scores of eighth-grade students in Korea: Findings from the TIMSS 2011 assessment. *Education*, 135(4), 435-438.
- Institute of Education Sciences. (2016). 2015 science assessment: National achievement level results. *The Nation's Report Card*.
- Lareau, A. (2011). *Unequal Childhoods: Class, Race, and Family Life*. University of California Press.
- Marzano, R.J. (2007). *The art and science of teaching: A comprehensive framework for effective instruction*. Association for Supervision and Curriculum Development.
- McNulty, R. J., & Quaglia, R. J. (2007). Rigor, RELEVANCE and relationships. *School Administrator*, 64(8), 18-21, 23-24.
- Mitani, H. (2021). Test score gaps in higher order thinking skills: Exploring instructional practices to improve the skills and narrow the gaps. *AERA Open*, 7. <https://doi.org/10.1177/23328584211016470>
- Nam, J., Choi, A., & Hand, B. (2011). Implementation of the science writing

- heuristic (SWH) approach in 8th grade science classrooms. *International Journal of Science & Mathematics Education*, 9(5), 1111-1133. [Doi:10.1007/S10763-010-9250-3](https://doi.org/10.1007/S10763-010-9250-3)
- Nelson, C., & Harper, V. (2006). A pedagogy of difficulty: Preparing teachers to understand and integrate complexity in teaching and learning. *Teacher Education Quarterly*, 33(2), 7-21. [https://teqjournal.org/TEQ%20Website/Back%20Issues/Volume%2033/VOL33%20PDFS/33\\_2/07nelson&harper-33\\_2.pdf](https://teqjournal.org/TEQ%20Website/Back%20Issues/Volume%2033/VOL33%20PDFS/33_2/07nelson&harper-33_2.pdf)
- Odom, A. L., & Bell, C. V. (2015). Associations of middle school student science achievement and attitudes about science with student-reported frequency of teacher lecture demonstrations and student-centered learning. *International Journal of Environmental & Science Education*, 10(1), 87-98. [doi:10.12973/Ijese.2015.232a](https://doi.org/10.12973/Ijese.2015.232a)
- Oliver, M., McConney, A. & Woods-McConney, A. (2021). The efficacy of inquiry-based instruction in science: A comparative analysis of six countries using PISA 2015. *Research in Science Education* 51(2), 595–616. <https://doi.org/10.1007/s11165-019-09901-0>
- Organization for Economic Cooperation and Development (2016). Results from 2015 PISA: Results in focus. *Program for International Student Assessment*.
- Piaget, J. (1965). *Origins of intelligence in the child*. New York, NY: International Universities Press, Inc (Original work published 1952).
- Slavin, R. E. (2019). How evidence-based reform will transform research and practice in education. *Educational Psychologist*, 55(1) 21-31. <https://doi.org/10.1080/00461520.2019.1611432>
- Su, G. (2014). Relationship between science teaching practices and students' achievement in Singapore, Chinese Taipei, and the US: An analysis using TIMSS 2011 data. *Frontiers of Education In China*, 9(4), 519-551. [doi:10.3868/S110-003-014-0043-x](https://doi.org/10.3868/S110-003-014-0043-x)
- Tassell, J. L. (2013). Hazy snapshots in the science and mathematics classrooms: What blurs the focus on cognitive complexity?. *School Science & Mathematics*, 113(1), 1-2. [doi:10.1111/J.1949-8594.2013.00176.X](https://doi.org/10.1111/J.1949-8594.2013.00176.X)
- Tienken, C.H. (2017). The standardized performance trap. *Kappa Delta Pi Record*, 53(3), 107-109. [doi:10.1080/00228958.2017.1334471](https://doi.org/10.1080/00228958.2017.1334471)
- Turner, S. L. (2011). Student-centered instruction: Integrating the learning sciences to support elementary and middle school learners. *Preventing School Failure*, 55(3), 123-131. [doi:10.1080/10459880903472884](https://doi.org/10.1080/10459880903472884)
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Webb, N. L. (2007). Issues related to judging the alignment of curriculum standards and assessments. *Applied Measurement in Education*, 20(1), 7-25. [doi:10.1207/s15324818ame2001\\_2](https://doi.org/10.1207/s15324818ame2001_2)

- Wu, H.K., & Huang, Y.L. (2007). Ninth-grade student engagement in teacher-centered and student centered technology-enhanced learning environments. *Science Education, 91*(5), 727-749.
- Wyss, V. L., Dolenc, N., Xiaoqing, K., & Tai, R. H. (2013). Time on text and science achievement for high school biology students. *American Secondary Education, 41*(2), 49-59.
- Zvoch, K., Holveck, S. & Porter, L. (2021). Teaching for Conceptual Change in a Density Unit Provided to Seventh Graders: A Comparison of Teacher- and Student-Centered Approaches. *Research in Science Education, 51*, 1395–1421. <https://doi.org/10.1007/s11165-019-09907-8>

**Appendix A**

## Visual Representation of Data Collection Procedures



## Appendix B

### Survey Instrument

Educator Experience	Instructional Practice																																																																														
<p><b>What middle school science courses do you instruct, now or in the past three years? *</b> Please check all that apply.</p> <p><input type="checkbox"/> Grade 6 Science</p> <p><input type="checkbox"/> Grade 7 Science</p> <p><input type="checkbox"/> Grade 8 Science</p> <p><b>At what school do you currently teach science? *</b> Choose <span style="font-size: small;">▼</span></p> <p><b>How many years of teaching experience do you possess? *</b></p> <p><input type="radio"/> 0-3 years</p> <p><input type="radio"/> 4-10 years</p> <p><input type="radio"/> 10-20 years</p> <p><input type="radio"/> 20+ years</p> <p><b>How many years have you been teaching science at your current school? *</b></p> <p><input type="radio"/> 0-3 years</p> <p><input type="radio"/> 4-10 years</p> <p><input type="radio"/> 10-20 years</p> <p><input type="radio"/> 20+ years</p> <p><b>My current school is a Title I school.</b></p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Not Sure</p>	<p>Please respond to each instructional practice honestly and to the best of your recollection.</p> <p><b>How often do these instructional practices occur in your classroom? *</b></p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 40%;"></th> <th style="width: 10%;">Never</th> <th style="width: 10%;">Quarterly</th> <th style="width: 10%;">Monthly</th> <th style="width: 10%;">Weekly</th> <th style="width: 10%;">Daily</th> </tr> </thead> <tbody> <tr style="background-color: #f2f2f2;"> <td>Whole-class teacher demonstration</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>Teacher delivers content in the form of notes</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Students work in collaborative groups</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>Formative assessment drives instruction</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Students develop their own inquiry labs</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>Choice is provided for in classroom activities</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Teacher acts as facilitator of knowledge</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>Teacher acts as giver of knowledge</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Students take part in self-evaluation</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>Students complete pre-developed hands-on activities</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Emphasis is on product of learning</td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>Emphasis is on process of learning</td> <td style="text-align: center;"><input type="radio"/></td> </tr> </tbody> </table>		Never	Quarterly	Monthly	Weekly	Daily	Whole-class teacher demonstration	<input type="radio"/>	Teacher delivers content in the form of notes	<input type="radio"/>	Students work in collaborative groups	<input type="radio"/>	Formative assessment drives instruction	<input type="radio"/>	Students develop their own inquiry labs	<input type="radio"/>	Choice is provided for in classroom activities	<input type="radio"/>	Teacher acts as facilitator of knowledge	<input type="radio"/>	Teacher acts as giver of knowledge	<input type="radio"/>	Students take part in self-evaluation	<input type="radio"/>	Students complete pre-developed hands-on activities	<input type="radio"/>	Emphasis is on product of learning	<input type="radio"/>	Emphasis is on process of learning	<input type="radio"/>																																																
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