Keys to Improving Learning: Ways to Transform Teacher Performance

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Abstract
With the new advanced cognitive demands that are placed on today's children, it is imperative that we advance the quality of instruction to meet these higher demands. Proficient inquiry-based instruction provides one approach to begin to address these new challenges. Clear expectations are provided via EQUIP (Electronic Quality of Inquiry Protocol) to guide teachers in their transformation toward instructional practice that is more aligned with the new expectations provided by Common Core State Standards for Mathematics and Next Generation Science Standard.

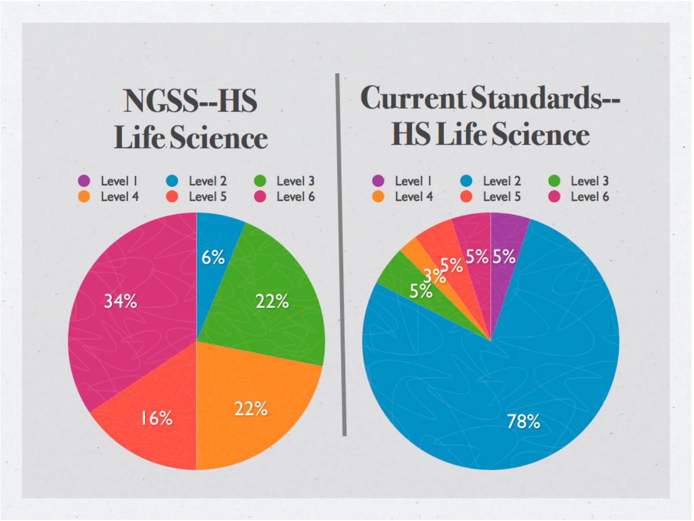
Keywords
Inquiry-Based Instruction; Mathematics Education; Science Education; Student Achievement

INTRODUCTION

The Common Core State Standards for Mathematics (CCSSM) and the Next Generation Science Standards (NGSS) provide a new, rigorous framework outlining what students need to know and be able to do (Achieve, 2013; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Despite clear standards and performance expectations, CCSSM and NGSS do not detail how teachers need to go about facilitating experiences tied with these standards and expectations. This paper summarizes the presentation given at the 2012 Midwest Regional Noyce Conference along with some updated insights. The goal of this paper is to provide specific guidance in how to assist in teacher transformation related to the development of student mastery relative to CCSSM and NGSS. Two specific goals include: identifying teacher factors that lead to increased student achievement and measuring/improving teacher performance relative to these factors.

Teacher expectations are undergoing a radical shift in terms of the expectations that we have for our students. To illustrate this shift, the performance expectations for high school life science, as stated in NGSS, include 50 percent higher order, 44 percent middle level, and 6 percent lower level (Marshall, 2012). This is in direct comparison to a state that was recognized as an A- according to the Fordham Institute ratings (Gross et al., 2005) for its science standards which had expectations in high school life science as 10 percent higher order, 8 percent middle level, and 83 percent lower order (Figure 1). Or, more poignant, 94 percent of the NGSS expectations are high or middle level vs. 18 percent of the previous state science standards being at the high or middle level expectation.

Figure 1. Cognitive Demand Comparison of NGSS High School Life Science va. SC 2005 High School Life Science Standars (Marshall, 2012)



Level 1: Remember; Level 2: Understand; Level 3: Apply; Level 4: Analyze; Level 5: Evaluate; Level 6: Create

Clearly, the bar for minimum achievement has been significantly raised for all students. This suggests that teaching needs to be altered so that student achievement can be maximized relative to the new expectations. Stating such a goal is simple, but the challenge will be to find the means to achieve the goal. What trajectory facilitated by the teacher can potentially lead us to success relative to this goal? No magic bullet exists that will transform this gap between what we seek and where students currently are performing.

On one hand, many scoff at raising standards when so many already lack mastery achievement in the previous setting. However, this also may be seen as an opportunity to engage the disengaged, invigorate those who previously did not see purpose, and challenge the scores of students in each school who are bored. Instead of listing, explaining, and describing, students are now asked to design an experiment, model a complex phenomenon, and analyze real-world data. The move from perfunctory learning to learning that has substance, depth, and relates to the real world has the potential to challenge and enliven all learners if the instruction is facilitated properly.

Why Inquiry?

Effective teachers use many instructional techniques, but inquiry-based instruction is vital to achieving success with CCSSM and NGSS. Effective inquiry in mathematics is detailed in the eight standards of practice that are to be united with the content standards. In science, NGSS uses performance expectations that weave practices, core ideas, and cross-cutting concepts together. Effective inquiry-based instruction is achieved with the concepts, and content is fused with the practices (e.g., engaging in argument from evidence, planning, and carrying out investigations).

Metric for Proficient Inquiry-Based Instruction

The Electronic Quality of Inquiry Protocol (EQUIP) was developed and tested over a five year process and is used by teachers, educational leaders, and researchers who desire to measure the effectiveness of inquiry-based instruction (Marshall, 2009; Marshall, Smart, Lotter, & Sirbu, 2011). EQUIP is framed on four overall constructs: curriculum (What guides the teaching and learning?); instruction (What do I lead?); discourse (How do we interact?); and assessment (How does instruction influence achievement?). There are 19 indicators divided among these four constructs that provide insights into a given teacher's instructional practice (Marshall, Horton, Smart, & Llewellyn, 2008). Further, these insights via a descriptive rubric allow teachers, departments, schools, and projects to target specific areas of improvement. As we know, effective instruction is complex and multidimensional. EQUIP seeks to look solely at one specific aspect of instruction—the components surrounding and relating to inquiry-based instruction. While things such as classroom management and content knowledge of the teacher are vital to the classroom, they are not measured by this instrument. Specifically, effective classroom management is necessary but not sufficient for effective classroom instruction. Further, mastery of content knowledge is critical, but its importance becomes more pronounced when teaching more complex concepts or concepts where numerous alternative conceptions exist.

The entire instrument can be found at the Inquiry in Motion website (www.clemson.edu/iim), so the instrument will not be repeated here. However, several aspects of the instrument are shared below. First, for each indicator, reviewers have four options: Level 1 (Pre-Inquiry)—no inquiry present; Level 2 (Developing Inquiry)—more confirmatory but beginning components of inquiry seen; Level 3 (Proficient Inquiry)—effective inquiry-based instruction has been facilitated; and Level 4 (Exemplary Inquiry). Frequently, individuals feel that because there are four levels the goal is always to attain Level 4. However, the real target is Level 3 and above. Many of the goals advocated in NGSS and CCSSM seek a Level 3—proficiently facilitated inquiry where students are deeply engaged in learning fundamental mathematics and science concepts. Each of the four constructs will be briefly detailed below.

Curriculum

The curriculum construct contains four indicators that focus on the various curriculum issues associated with inquiry-based instruction. Two examples include: 1) standards and 2) organizing and recording information. For the standards, the goal is to unite both the content standards with the practices detailed in NGSS or CCSSM. When practices become united with content, learning becomes meaningful to the learner and the goals of the teacher become purposeful and relevant. For organizing and recording information, the focus becomes the degree to which students are given flexibility to organize data, thoughts, and ideas in non-prescriptive ways.

Instruction

The instruction construct is comprised of five indicators focusing on how instruction is facilitated in the classroom. Instructional strategies and order of instruction are examples of the indictors within the instruction construct. Specifically, instructional strategies explore whether students were engaged in investigations that helped develop conceptual understanding. On one end of the continuum (Level 1), teachers predominantly lecture to cover content. At the other end (Level 4), students are deeply engaged in the investigation, and the efforts promoted strong conceptual understanding. The order of instruction is a critical indicator for inquiry-based instruction. For proficient order of instruction, the teacher has students explore concepts and ideas before explanation occurs, and both the students and teacher are involved in the explanation.

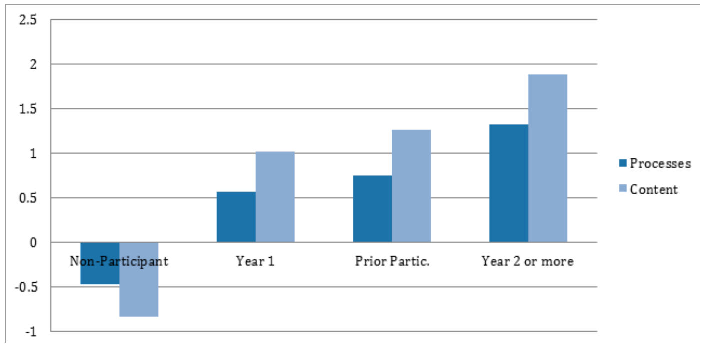
Discourse
The discourse construct focuses on the interactions and environment that is established to promote inquiry-based instruction. This construct contains five indicators and probes the depth and quality of the interactions that are facilitated in the classroom. Specifically, for proficient, are students asked to justify and provide evidence for conjectures? Further, are students challenged to think and interact up to at least the application and analysis levels?

Assessment
The final five indicators are found within the assessment construct which focuses on how assessments of student knowledge and understanding are facilitated to promoted inquiry-based learning. One key involves how prior knowledge is used in the classroom. For proficient inquiry-based instruction, teachers need to be regularly assessing students' prior knowledge and then adjusting instruction based on the data gathered via the assessment. When teachers assess for prior knowledge but do not change instruction based on the findings, as frequently is seen during observations, the purpose of gathering the information in the first place is defeated.

DATA AND RESULTS

An executive summary report released to all principals of schools that have been participating in a professional development effort to bring inquiry-based instruction into science and mathematics classrooms has shown significant growth in both teachers and students of participating teachers. As of summer 2013, data show a clear difference among the virtual control group (students from other districts with similar demographic composition), the control group (non-participating teachers from participating districts), and the study group (participants in the Inquiry in Motion program). Specifically, the data show that the students of teachers who participate in the Inquiry in Motion program significantly outperform students of non-participating teachers on the Measures of Academic Progress (MAP) Test (Northwest Evaluation Association, 2004, 2005). All participating groups also exceed the performance of students from the virtual control group. These trends are seen for student performance in both science content and science process (Figure 2). Data are based on 421 teachers of 29,725 students.

Figure 2. MAP Growth ABOVE Expected for Students of Participating Teachers (5 Years of Analysis)



In addition, classroom observational data of participants (n > 700), as measured using the EQUIP (Electronic Quality of Inquiry Protocol), shows a significant increase in the quality of inquiry-based learning facilitated during the last five years. With several teachers involved in the second/third year of the program, we see continued improvements and sustained higher performance in participating schools.

To put things in perspective, the average student growth per year is 2.56 RIT scores for Concepts and Processes and 3.16 RIT scores for General Science Content Knowledge. Students of participating teachers on average exceed the scores of students of the virtual control group teachers by .6-1.9 RIT scores or about an additional 2-7 months of academic growth.

CONCLUSION

With the added cognitive demands of the new expectations and standards laid forth by NGSS and CCSSM, students need significant and frequent opportunities to explore concepts before explanation occurs. Specifically, if we are asking students to analyze, model, and justify, then they must be active participates in the learning process. Inquiry-based instruction provides one venue for students to demonstrate mastery of these goals and standards. Results show that when teachers become proficient in facilitating inquiry-based instruction that learners outperform the comparison groups of similarly matched students. EQUIP is one mechanism to help guide and facilitate intentionality toward more proficient inquiry-based teaching and learning. EQUIP is available as a .pdf or as an app for iPads via the Inquiry in Motion website (www.clemson.edu, then select research and evaluation tab).

Jeff Marshall *received the Presidential Award of Excellence for Mathematics and Science Teaching; was nationally board certified in AYA Science; and continues to consult, research, write, and present work on inquiry teaching and learning in science education. He has taught at the middle and high school levels and currently works with both pre-service and in-service teachers at Clemson University. His book, entitled Succeeding with Inquiry in Science and Mathematics Classrooms, recently was released by ASCD and NSTA. Marshall (marsha9@clemson.edu) is director of the Inquiry in Motion Institute (www.clemson.edu/iim) and is an associate professor at Clemson University in Clemson, SC.*

REFERENCES

Achieve. (2013). Next Generation Science Standards. Retrieved from http://www.nextgenscience.org/

Gross, P., Goodenough, U., Lerner, L., Haack, S., Schwartz, M., & Schwartz, R. (2005). The state of the state science standards. http://www.edexcellence.net.

Marshall, J.C. (2009). The Creation, Validation, and Reliability Associated with the EQUIP (Electronic Quality of Inquiry Protocol): A Measure of Inquiry-Based Instruction. Paper presented at the National Association of Researchers of Science Teaching Conference: Orange County, CA.

Marshall, J.C. (2012). The Keys to Improving Learning: 19 Ways to Transform Teacher Performance. Paper presented at the Midwest Noyce Conference: Indianapolis, IN.

Marshall, J.C., Horton, B., Smart, J., & Llewellyn, D. (2008). EQUIP: Electronic Quality of Inquiry Protocol. http://www.clemson.edu/iim.

Marshall, J.C., Smart, J., Lotter, C., & Sirbu, C. (2011). Comparative analysis of two inquiry observational protocols: Striving to better understand the quality of teacher facilitated inquiry-based instruction. School Science and Mathematics, 111(6), 306-315.

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). Common Core State Standards for Mathematics. National Governors Association Center for Best Practices, Council of Chief State School Officers: Washington, DC.

Northwest Evaluation Association. (2004). Reliability and validity estimates: NWEA achievement level tests and Measure of Academic Progress. http://www.nwea.org.

Northwest Evaluation Association. (2005). NWEA Reliability and Validity Estimates: Achievement Level Tests and Measures of Academic Progress. Lake Oswego, OR.