Changes in Elementary Students' Engineering Knowledge Over Two Years of Integrated Science Instruction (Research to Practice) Strand: Engineering across the K-12 curriculum: Integration with the Arts, Social Studies, Science, and the Common Core

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Strand: Engineering across the K-12 curriculum: Integration with the Arts, Social Studies, Science, and the Common Core

Introduction

In part due to an increased global demand for engineers, recent K-12 education reform efforts in the U.S. and other nations have put a focus on engineering as a strategy for improving STEM education and integration[1-3]. In particular, there is a growing consensus that students need exposure to engineering early on in elementary school, when their initial career interests are beginning to develop[2]. While efforts to provide engineering opportunities for elementary children have increased in the last decade[3, 4], the creation of the *Next Generation Science Standards* (NGSS)[5] has made explicit suggestions for introducing engineering into science curricula, positioning it to become an integral part of science education.

The inclusion of engineering in elementary classrooms has necessitated the creation of a new body of research to consider topics such as how to integrate engineering content in developmentally appropriate ways, what type of learning outcomes should be expected, and what pedagogical approaches are most effective with students in these early years. Researchers have begun to examine how engineering can be successfully integrated into elementary classrooms[6-8] and how the inclusion of authentic engineering lessons impacts student learning[9, 10] Researchers have not yet developed an adequate understanding of the learning potential these young elementary students have in this early period of engineering education. One key aspect to understanding this learning potential is to begin research related to investigating how continued exposure to engineering across different grade levels effects student learning. In addition, contextual factors (such as the curriculum used and the amount of time spent on engineering in the classrooms) must be understood to draw implications about student learning potential.

One contextual factor that is likely to influence student learning potential is related to the actual implementation of engineering lessons. How teachers implement lessons is likely to vary not only from school to school, but also from teacher to teacher[11] based on the individual contexts. For example, teachers face unique time constraints that influence how much classroom time is available for engineering lessons[12] . In addition, all teachers already have many curricular standards to address in their classrooms and the addition of engineering does not mean a reduction in other areas such as language arts. Teachers are given the challenge of continuing to meet current standards, while simultaneously adding additional engineering and science standards. The amount of classroom time actually devoted to engineering, at least in part, is due to logistical constraints and competing priorities[12].

The purpose of this study is to assess how elementary students' knowledge of engineering changes when limited instruction is received over two consecutive years as part of their science curriculum. Specifically, the research questions are:

- How does students' knowledge of engineering change during two consecutive years of instruction?
- Are those changes significantly different between those students receiving engineering instruction during second and third grade and those receiving it during third and fourth grade?
- Are those changes significant different between those students with and without previous engineering experience?

Background

Through a National Science Foundation five-year funded project, researchers in Engineering Education from Purdue University's Institute for P-12 Engineering Research and Learning (INSPIRE) partnered with a large school district to provide professional development for elementary teachers to integrate engineering into their classrooms. INSPIRE provided a weeklong summer academy and a three-day follow-up academy in the second summer. In addition, an on-site teacher liaison provided ongoing support to teachers. During each academy, teachers studied the work of engineers and how to solve ill-structured problems though the engineering design cycle[4]. Teachers participated in activities designed to prepare them for lessons which introduce engineering and technology to students and implement an *Engineering is Elementary* (*EiE*) unit[13]. The learning goals for the first-year academy were to:

1. Convey a broad perspective of the nature and practice of engineering
2. Articulate the differences and similarities between engineering and science thinking
3. Develop a level of comfort in discussing what engineers do and how engineers solve problems with elementary students
4. Use problem-solving processes (i.e., science inquiry, model development, and design processes) to engage their students in complex open-ended problem solving[14]

In the second summer academy, teachers' concerns and interests were addressed, participants shared their experiences with same-grade teachers, and advised new teachers that were participating in their first-year summer academy. The learning goals for the second-year academy were to:

1. Identify opportunities to augment science or mathematics learning through engineering
2. Comfortably discuss what engineers do and describe select types of engineering
3. Use engineering design process and model development process to engage elementary students in complex open-ended problem solving
4. Assess student learning across multiple dimensions through engineering activities[14]

Trained teachers integrated engineering instruction in their classrooms for second, third, and fourth grade students, using resources selected in agreement between the project's leader and the district and the school administration. *EiE* unit selection was based on grade level, complexity of the design activity, and science curriculum and standards alignment. Mid-project, the *EiE* unit was changed for grades 2 and 4 to achieve better science curriculum and standards alignment. For second grade, this was a change from a design challenge based on chemical engineering to one based on agricultural engineering. For grade 4, this was a change from a design challenge based on package engineering to one based on geotechnical engineering.

Students received an average of 14 hours of engineering instruction (*SD* = 8 hours) during the year. This instruction, based on hands-on and collaborative learning, included preparatory lessons focused on what is technology, engineering, and engineering design process; brainstorming about technology; new critical vocabulary (e.g. design, plan, test); and sometimes a model-eliciting activity[15]. After preparation, teachers taught the four lessons in the grade-level selected *EiE* unit (*The Best of Bugs: Designing Hand Pollinators* for second grade, *Marvelous Machines: Making Work Easier* for third grade, and *A Stick in the Mud: Evaluating a Landscape* for fourth grade). Some teachers concluded their engineering instruction by revisiting definitions of technology and engineering or implementation additional engineering design process focused lessons.

To study student learning over two consecutive years of engineering instruction, we selected all those students in the project that received engineering instruction during academic years 2011-2012 and 2012-2013 and performed pretests and posttests for both years to accumulate a total of four data points per student for the study. The project was introduced to teachers of grades two through four; therefore eligible students were those in grades two and three during 2011-2012 and grades three and four during 2012-2013.

Literature

The *Next Generation Science Standards* (NGSS) were developed and published on 2013 in order to address new ways of understanding science and the importance of integrating engineering[5]. In fact, the National Research Council[5] suggests that the learning focus in K-12 science should include practice and experiences in the real world besides the understanding of the natural world. They acknowledge the pervasiveness of technology and include the human-made world as a complement to the natural world. As Katehi and colleagues[3] have suggested, introducing engineering into K-12 curriculum may improve science, technology, engineering, and math (STEM) outcomes and promote an interest in STEM careers. They also highlight the potential for engineering to be a natural integrator for science, math, and technology. They explain how engineering habits of mind, such as system thinking or creativity that are inherent to the engineering design process may support science, math, and technology learning.

In particular, the Museum of Science at Boston[13] has developed a set of units called *Engineering is Elementary* (*EiE*). Cunningham and Hester[4] suggest that, through this resource, elementary teachers can integrate engineering with science in order to improve students' engagement and problem-solving skills and increase students' technological literacy. *EiE* units connects science topics such as weather, water, or sound to engineering fields (e.g. mechanical, environmental, or electrical) through design challenges targeted for specific grade levels, contextualized in a particular country (e.g. India, USA, or El Salvador), and set in a elementary aged child's story[13].

Some researchers are analyzing the impact of these resources for integrating engineering into elementary curricula[16-18]. For example, Karatas and colleagues[19] performed a phenomenographic study with 20 sixth-grade students to understand elementary students' views about engineering and its differences compared to science. For this, researchers collected student interviews and drawings of engineer(s) working and showed inconsistencies in students' views of what an engineer actually does; in some cases, this view changed even as the interview was ongoing. The author suggests that this instability may show the absence of engineering instruction. Likewise, other researchers have designed a variety of instruments for assessing students' engineering design process knowledge[18] and their conceptions about what engineering or technology is[16] or what engineers do[20]. Studies analyzing students' outcomes as baseline[16,17] or pre and post *EiE* intervention[9,21] found that students' initial conceptions of engineering link engineering with engines, fixing, and building. However, after one year of *EiE* instruction, students' engineering conceptions move away from building and fixing towards designing[9].

These instruments include qualitative and quantitative approaches to engineering knowledge assessment. Researchers[17, 22] have used open-ended instruments such as drawings, concept maps, and interviews to assess students' outcomes after implementing *EiE* units in elementary classrooms. As a qualitative measurement, a group of researchers have designed a coding scheme that allows systematic quantification of students' drawings about the work of an engineer[22, 23.] These researchers found that students' preconceptions about engineering practice were highly focused on fixing and manual labor; however, after receiving engineering instruction in the classroom their conceptions were shifting towards design[10]. Other researchers have shown how conceptions about engineering can be elicited using conceptual maps[24]. For example, after an intervention, students' conceptual maps had a low number of misconceptions compared to the total number of map entries (an average of 0.42 misconceptions over 34.10 concepts per student) and maps were heavily linked with personal experiences showing students' own meanings rather than memorized facts[24]. Another instrument used for measuring engineering knowledge among elementary students assesses students' conceptions about the engineering design process through recording and coding interviews about a design challenge[18]. Researchers found that students receiving engineering instruction have significantly higher scores on the posttest, showing a better understanding of the engineering design process, regardless of non-significant differences for pretests between control and treatment groups[18].

Although qualitative instruments have shown potential for assessing students' understandings of engineering, quantitative instruments have better potential for assessing larger populations. Dyehouse, Diefes-Dux, & Capobianco developed a multiple-choice instrument[14, 16] to measure engineering design process, work of engineers, and technology conceptions, as well as science knowledge related to an engineering challenge. During the development phase of the instrument, researchers found that students from third and fourth grades in a treatment group (receiving engineering instruction) had significantly higher scores compared to a control group (without engineering instruction). However, no analysis has been made since the instrument was revisited and improved.

This study provides an analysis of students' engineering knowledge using the latest version of the multiple-choice instrument mentioned and a better understanding of how engineering knowledge evolves over two years of limited instruction according to grade and previous engineering instruction. The results may provide some insight into when engineering should be integrated into the curriculum and how limited instruction may affect students' understandings.

Method of Study

Participating Schools and Teachers

During the first year of the project, teachers within one school district were recruited through email to participate in the first summer academy; those participating teachers became cohort 1. For a school to be eligible, at least four teachers had to commit to participation for a minimum of two consecutive years. During the following years, new teachers within participating schools were recruited and new schools were added. There were a total of five teacher cohorts. This study includes teachers from all five cohorts (cohort 1, n = 8; cohort 2, n = 10; cohort 3, n = 9; cohort 4, n = 38; and cohort 5, n = 7) from four schools. Table 1 shows general information about the schools.

Table 1. Participating Schools

School	Years Teaching Engineering	Teachers	Students	Years in Project	Title1	Location
1	5	12	45	5	Yes	Urban
2	5	17	102	5	No	Urban Fringe
3	3	18	83	2 as control; 3 with treatment	No	Urban Fringe
4	4	25	100	4	Yes	Urban Fringe

For the last two years, 101 teachers were part of the project. Among those teachers, 72 had students that submitted pre and posttests during the two years of study. Regarding gender, 92% of the teachers were female and the majority of the teachers were white (55%). An average 9 (M = 9.04, SD = 4.43) students were eligible for this analysis within each classroom. During the 2011-2012 academic year, 60% of teachers were new to the project, 13% had one year of experience, and 27% had two to four years of experience in the project. Similarly, during the 2012-2013 academic year, 16% of teachers were new to the project, 48% had one year of experience, and 36% of them had two to four years of experience in the project.

Student Participants

Students in participating classrooms were asked for student assent and parental consent to complete pre and posttests of the Student Knowledge Test[14]. Pretests were administered at the beginning of each school year; posttests were administered at the end of each school year. Only students who completed pre and posttests both years were included in this study (n = 330). In addition, students were separated into three groups, based on their initial grade level and previous exposure to engineering lessons. The first group of students (G2New) comprised those whose first exposure to engineering lessons was in second grade and then had engineering lessons again in third grade (n = 162). The second group (G3New) first had exposure to engineering in third grade and continued to have engineering lessons in fourth grade (n= 80). The third group (G3Exp) had exposure to engineering in second, third and fourth grade, but were part of this study during the two last years of their exposure (n = 88).

Table 2 shows participating students demographic information.

Table 2. Student Demographics

Group	Students	Gender		Ethnicity [a]					
		Male	Female	HI	WH	AA	AP	MU	UN
Grades 2 – 3, No Experience (G2New)	162	41%	59%	48%	25%	15%	6%	1%	5%
Grades 3 – 4, No Experience (G3New)	80	47%	53%	26%	22%	26%	17%	2%	7%
Grades 3 – 4, Experience (G3Exp)	88	46%	54%	41%	31%	15%	9%	0%	4%
Total	330	45%	55%	41%	25%	18%	10%	1%	5%

[a] HI = Hispanic, WH = White, AA = African American, AP = Asian or Pacific Islander, MU = Multiethnic, UN = Unknown

Measurements: The Student Knowledge Test (SKT)

The Student Knowledge Test (SKT) was developed in 2008 and revised the following year[14]. The purpose of the instrument was to assess the student learning outcomes associated with the Purdue University INSPIRE Academy. The INSPIRE Academy is a teacher professional development (TPD) program that integrates engineering into science curriculum. The instrument was designed to test conceptions about the engineering design process and technology, in addition to science and engineering practices related to the specific content of the *EiE* unit taught. Therefore, each grade had a different version of the instrument. Each grade had seven science related items and eight engineering and technology related items. Four of the engineering items were repeated across all three grades (an example can be found in the Appendix). Only those items related to engineering (design process, practices, and technology) were included in this study to mitigate a possible over-alignment of science knowledge scores. Among those engineering-related items, four items were repeated across the second, third, and fourth grades and four were related to the *EiE* unit content (pollinators and agricultural engineers, simple machines and industrial engineers, or land forms and geotechnical engineers).

Initially the instrument had both open-ended and close-ended items; however, validation analyses led to two revisions to the instrument[12, 14]. The first revision dropped all open-ended questions and ambiguous items, and standardized the number of items per grade to fifteen. Due to changes in the *EiE* units taught in the 2nd and 4th grades, the second revision adapted those items assessing knowledge specific to the *EiE* unit taught and was first used during academic year 2011-2012.

Research Design

For the purpose of this study, data collected during 2011-2012 and 2012-2013 academic years was analyzed using a mixed-design Analysis of Variance (ANOVA). This type of analysis allows for analyzing dependent and independent data points. This is a common procedure for analyzing quasi-experimental designs where data is gathered before and after an intervention[25]. In this case, four data points were gathered, where minimal engineering instruction took place between the first and second data points (first academic year), no intervention occured during second and third data points (summer vacation), and minimal engineering instruction took place for the second time between third and fourth data points (second academic year). Grade and student experience were analyzed as between-groups variables. For grade, there were two groups, those receiving engineering instruction during second and third grade, and those receiving it during third and fourth grade. For student experience, there were also two groups, those new to engineering instruction and those who had experienced it the previous academic year (2010-2011). In addition, time and total engineering SKT scores (out of 8) were analyzed as within group variables.

Results

The mixed design ANOVA shows that there was a positive and significant effect of engineering instruction over the course of two academic years, $F(3, 981) = 64.71$, $p < 0.05$. Mauchly's test indicated that the assumption of sphericity had been met, $\chi^2(5) = 10.97$, $p > 0.05$; therefore *F*-values are not biased. Among all participants, regardless of their grade or experience, significant gains in engineering knowledge occurred during both academic years (Figure 1), but as expected, not during the summer period ($p > 0.05$). Table 3 shows the effect of time on SKT scores. Additionally, significant differences in engineering knowledge were found between grade levels, $F(1, 327) = 56.59$, $p < 0.05$, and between students with and without experience, $F(1, 327) = 31.67$, $p < 0.05$, regardless of time when data was collected (Figure 2. Effect of Grade and Experience in SKT ScoresFigure 2).

Table 3. Estimated Marginal Engineering-Score Means for Time x Grade x Student Experience

Group	Student Experience	Starting Grade	Time	*M*	*SE*	95% Confidence Interval	
						Lower Bound	Upper Bound
G2New	No	2	Pre-test Year 1	1.944	0.110	1.729	2.160
			Post-test Year 1	3.593	0.139	3.319	3.866
			Pre-test Year 2	2.741	0.148	2.450	3.031
			Post-test Year 2	3.309	0.149	3.015	3.603
G3New	No	3	Pre-test Year 1	2.273	0.149	1.980	2.566
			Post-test Year 1	3.580	0.189	3.208	3.951
			Pre-test Year 2	4.080	0.200	3.686	4.473
			Post-test Year 2	4.580	0.203	4.181	4.979
G3Exp	Yes	3	Pre-test Year 1	3.425	0.156	3.118	3.732
			Post-test Year 1	3.463	0.198	3.073	3.852
			Pre-test Year 2	4.488	0.210	4.074	4.901
			Post-test Year 2	5.138	0.213	4.719	5.556

Since the instrument is used to assess gains in engineering knowledge longitudinally, initial scores are expected to be low on the scale (which measures between 0 and 8) to prevent reaching the ceiling at future data collection points. The results show that although the scores were increasing, there is still room for measuring improvement in students' engineering knowledge, since the highest score means for the group was 5.14 (Table 3). Likewise, during the 2011-2012 academic year, only one student achieved the maximum score on the pretest and no student achieved the maximum score on the post-test. While during the 2012-2013 academic year, three students achieved the maximum score on the pretest and five students achieved it on the posttest.

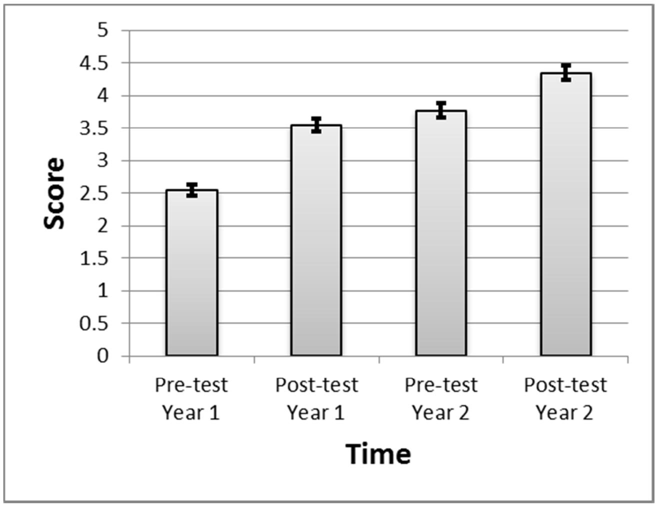

Figure 1. Effect of Time in overall SKT Scores

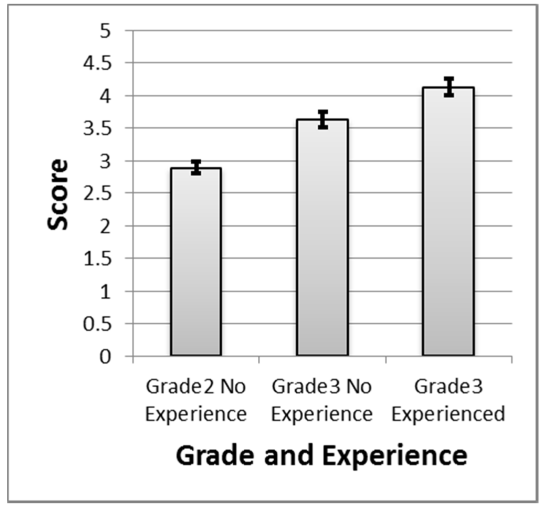

Figure 2. Effect of Grade and Experience in SKT Scores

Results also indicate that there was a significant interaction between time and grade, $F(3, 981) = 11.85$, $p < 0.05$, and between time and experience, $F(3, 981) = 5.17$, $p < 0.05$. Figure 3 shows how scores in different periods of time changed according to grade and student experience.

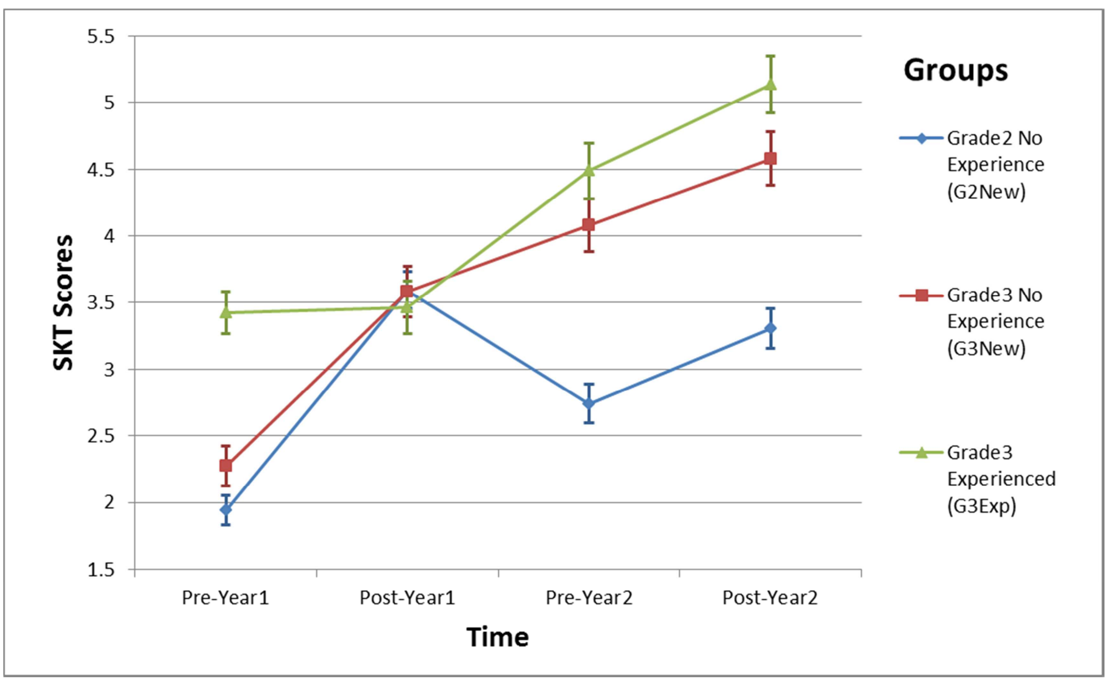

Figure 3. Interaction between Time, Grade, and Student Experience

Grade Interacting with Time

The engineering knowledge score varied across years and is significantly different between those students who were tracked during second and third grade and those tracked during third and fourth grade, as reported before. For students in third grade during the 2011-2012 academic year, the cumulative increment in engineering knowledge was linear; in other words, they were able to retain over the summer what they learned during the first year of this study, and build upon their understandings during the second year. In contrast, the engineering knowledge of those students who were in second grade during the 2011-2012 academic year decreased over the summer and scores are not significantly different between year one and two for this group (Figure 4). Analysis of contrasts indicates that there are not significant differences between students starting in second grade and students starting in third grade in their engineering scores during the first year; however, the summer and second academic periods show significant differences between grades, $F(1, 327) = 24.28$, $p < 0.05$ and $F(1, 327) = 8.57$, $p < 0.05$ respectively.

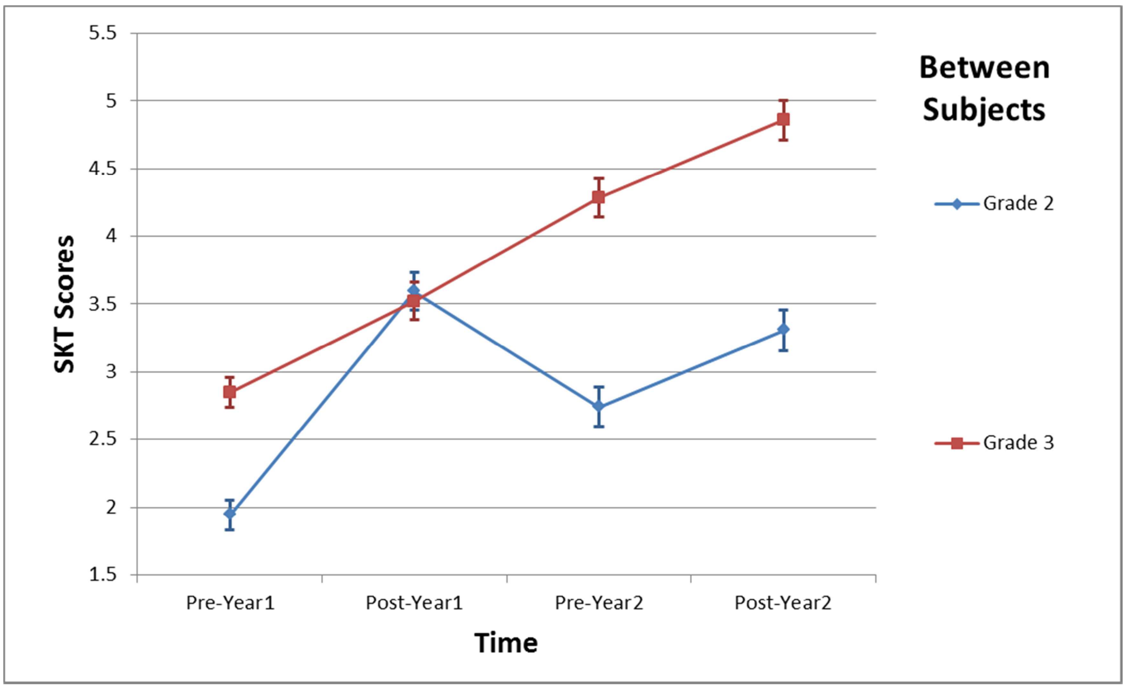

Figure 4. Interaction between Time and Grade

Student Experience Interacting with Time

Within third grade, some students received engineering instruction during the previous year (n = 88), when they were in second grade, while others received engineering instruction in third grade for the very first time (n = 80). Also followed in this study are second grade students into the end of their third grade year (n=162). Table 4 lists the mean scores for each group at the beginning and end of each year of the study. Students with previous exposure to engineering (G3Exp), on average, had significantly higher pretest scores than their third grade peers who had not yet had engineering exposure, $F(2,327) = 28.46$, $p<0.00$. G3Exp students experienced smaller gains pre/post during third grade, whereas those that were new to engineering (G2New and G3Exp) experienced larger learning gains. The G3New group ended the third grade with posttest scores comparable to the G3Exp group. Analysis of contrasts indicates that there is a significant difference in engineering knowledge gains between students receiving engineering instruction for their first time compared to those who had previous instruction, $F(1, 327) = 18.15$, $p < 0.05$, but there is not a significant difference for the second year of instruction. G3Exp students had higher scores during their fourth grade academic year compared to those who first had engineering in third grade. In addition, G3Exp students ended the two years with significantly higher engineering scores than G3New students, $F(2, 327)= 28.70$, $p<0.00$.

Table 4. Summary of Engineering SKT Scores

Group	Time				
	Pre Year 1	Post Year 1	Pre Year 2	Post Year 2	2-Year Average
G2New (n = 162)	1.94	3.59	2.74	3.33	2.90
G3New (n = 80)	2.27	3.58	4.08	4.58	3.63
G3Exp (n = 88)	3.43	3.46	4.49	5.14	4.13
Students' Average	2.55	3.55	3.77	4.34	

Discussion

Despite the minimal time spent on engineering in these classrooms, students in second, third, and fourth grade showed significant improvement in their understanding of basic engineering concepts. This is consistent with previous studies where hands-on engineering lessons have been integrated into elementary classrooms [9, 10, 18, 21, 23]. Students who have engineering lessons integrated into their third and fourth grades are able to retain their level of knowledge and further build upon it during the next academic year. These results indicate stability in their retention of basic engineering and technology concepts and are promising that as students progress, they have potential to retain this knowledge. Also promising, is that at the end of the two years, on average, those that experienced engineering lessons in second, third, and fourth grade (G3Exp) ended with the highest scores. Taken together, these results support that continuous exposure to hands-on engineering design lessons equips students to have a better understanding of basic engineering and technology concepts than exposure in one year alone.

All students in this study are situated in the same Piaget's stage of development[26], in which children are able to classify operations in a more general level compared to previous years (ages seven to 11). This skill is required to transfer the engineering design cycle knowledge[4] into new topics and engineering challenges. However, younger students may be just entering such this developmental stage; this may explain why some of the learning diminishes between second and third grade. This incipient cognitive development may hinder the process of transferring their knowledge about the engineering design process, learned during the first-year of instruction, into new topics and engineering challenges introduced during the second academic year of engineering instruction. In contrast, third grade students, which are typically in the middle of this developmental stage, are capable of building on their engineering knowledge during a no-instruction period (summer).

Although second grade students with no engineering experience showed a decreasing engineering score between academic periods, those third grade students who had engineering experience had the biggest change in engineering knowledge during a no-instruction period; this means that those students with engineering exposure during second grade were able to retain the most engineering knowledge during a no-instruction period between their third and fourth grades, compared to those who were first introduced to engineering in the third grade. These results corroborate that learning is a process and even though second grade students may not be developmentally ready for transferring engineering concepts to other contexts, engineering exposure at this age may prepare them for better retention in future engineering instruction.

Finally, the analysis shows a significant increment in engineering scores for group G2New during their third grade instruction (2012-2013 academic year) but no significant change for group G3Exp during their third grade instruction (2011-2012 academic year). Both groups had previous engineering experience; however, the *EiE*[13] units taught for each group were different: G2New used *The Best of Bugs: Designing Hand Pollinators* while G3Exp used *A Work in Process: Improving a Playdough Process*. Designing a hand pollinator may be better preparation for the third grade unit (simple machines). This likely makes sense at the pollinator unit is less complex than designing a playdough recipe providing an easier introduction to engineering. However, further analysis, item-by-item, should be conducted to understanding how subject difference is playing a role in engineering knowledge scores. Additional studies are recommended in this regard.

Limitations

As with all research, this study has limitations. First, this research was conducted on students from one school district, and it is unknown how well these results would generalize to all students in the U.S. The results of this study are also limited to the curriculum implemented in classrooms and instructional time spent on engineering. Other limitations to the study are related to measurement issues. Learning gains are measured by only one instrument, the SKT, with only eight items. Because some of the engineering items remained the same each year, the SKT is not as sensitive of an instrument as if each grade level had its own version. In addition, this study did not include a control group, so it is unknown how previous exposure to the engineering items on the SKT influenced students' answers on subsequent administrations of it.

Implications and Future Research

This research adds to the newly growing body of research around elementary students 'potential to learn engineering concepts. It is the first such related study that examines students' knowledge over two years of classroom engineering instruction. These findings support that students with exposure in second, third, and fourth grade are able to retain and build on their understanding of basic engineering and technology concepts beyond that of their peers with less exposure. This is an important finding as students with multiple exposures may be better prepared to move forward with more challenging engineering and technology concepts. Consistent with other research, this study supports that significant changes in basic engineering and technology understanding are shown from third and fourth grades. This may imply that in the third grade (particularly if it is their second year of exposure) students are more developmentally ready for taking the basic concepts to another level. However, it is important for future studies to analyze how this developmental process functions over the course of more than two consecutive years, and how experienced students may build on their learning when they are not receiving engineering instruction. Likewise, it is important to analyze how engineering instruction helps science understanding, regardless of science content being linked to engineering instruction.

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Appendix – Student Knowledge Test Example of Items

<u>Directions</u>: For each of the questions below, choose the BEST answer and circle the letter. Choose only one answer for each question.

Examples of Across-Grade SKT Items

- When an engineer is told to design a new technology, the first thing an engineer does is
  A. Test B. Improve <u>C. Ask</u> D. Create

- Which is an example of technology?
  A. lightning B. rabbit <u>C. scissors</u> D. river

Examples of Within-Grade SKT Items

- (2nd Grade) Mark is an agricultural engineer. In his job, he is likely to
  A. fix a tractor. B. pick corn and beans.
  <u>C. create ways to prevent plant disease</u>. D. plant flowers in the park.

- (3rd Grade) Juan is an industrial engineer. For his job, Juan might
  A. design the recipe for a really strong cleaning solution
  B. clean offices
  C. build new cars
  <u>D. design assembly lines</u>

- (4th Grade) Samantha is a geotechnical engineer. In her job, she is likely to do all of the following EXCEPT
  A. talk with others about what they need and want.
  B. test properties of soils in a project area.
  <u>C. run a machine that digs up soil and rock.</u>
  D. plan a process to reduce erosion.