Twelve Years of Growth and Success at Douglas L. Jamerson Elementary School Center for Mathematics and Engineering

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Abstract

Douglas L Jamerson Jr. Elementary School (DLJ) opened as a U.S. Department of Education Magnet School in August 2003 in the 26th largest public school district in the country with over 75 elementary schools. Utilizing a three-year Magnet School grant, DLJ established a Center for Mathematics and Engineering to developed and then implement its integrated, whole school curriculum with engineering as the core and the connector. The results of this careful planning and meticulous attention to details produced an elementary school environment that fosters student creative thinking with the expectation of quantitative metrics to gauge that creativity. The merit of this total emersion of engineering into an elementary curriculum is reflected in student scores on standardized test as well as a plethora of awards and acknowledgements for the school including being named the top elementary STEM program in the nation by the 2015 Future of Education Technology Conference, (http://www.pcsb.org/jamerson-es). This paper promotes the school's accomplishments and provides insight into the DLJ educational philosophy. It presents the structure of the program, discusses impediments to its success, reviews student scores on statewide tests, and indicates the schools ranking in comparison to other elementary school within their district over the last five years.

Introduction

Douglas L Jamerson Jr. Elementary School opened in 2003 in an inner city low-income neighborhood. The school has a student/teacher ratio of 13.25% and a K-5 student population (43% female) that exceeds 560 students. Details provided in Table 1. With no special enrollment criteria, DLJ definitely functions as a typical neighborhood school. Its “walk to school” location facilitated the creation of a student population that is ethnically integrated without a school district student assignment plan. This open enrollment practice draws students from the entire school district. The school’s Title I services address the free lunch needs for approximately 35% of the student body.

Table 1: School Demographics

	PK	KG	1st	2nd	3rd	4th	5th
Grade Enrollment	16	93	98	93	91	89	90

	Asian	other	Hispanic	Black	White
Race Ethnicity	9	28	40	244	249

The succinct and practical way to broadcast DLJ's success is provided in Table 2. These results are striking. However, for readers who are not familiar with the Florida Comprehensive Aptitude, http://www.fldoe.org/accountability/assessments/k-12-student-assessment/results/2014.stml , Test (FCAT) a quick review is provided.

Table 3**: 2015 FCAT Science 2.0 Test Results**

82% of DLJ 5th graders scored at Level 3 or above.
46% of DLJ 5th graders scored at Level 5. (This ranks D.L. Jamerson as the top elementary school in the school district and in the top 5% in the State)
The percentage of African-American students achieving level 3 or higher increased from less than 5% in 2008 to over 65% in 2015.

The FCAT is a set of Statewide tests in language arts, mathematics, and science conducted at the same times of year but administered at different grade levels. Table 2 provides the 2015 Science FCAT score results. The use of "Levels" reflects the standard practice in Florida to identify students working at their respective grade level as Level 3. When a student's scores reflect Level 5 status this means that the student is working two grade levels above the grade he or she is currently enrolled in. A 3rd grader with Level 5 FCAT scores is performing at the 5th grade level.

A complete presentation of the FCAT scores for DLJ students in all three categories, language, mathematics, and science, is available[1]. These results mimic the results summarized in Table 2. So of these three available scores, why are FCAT science scores so revealing when engineering is the school's passion?

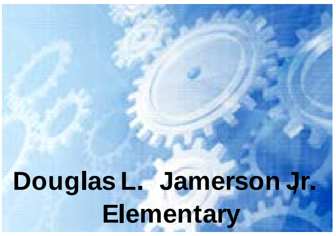
Science requires both verbal and mathematics skills as well as creative thinking. Linking engineering and an engineering challenge to the underlying science and math concepts that explain it help students "own" the whole concept – including the math and the language to express the challenge. Add in the engineering reality that when things don't work the way they're supposed to work, we have to "redo" using the best of what is available and you start already creatively thinking students down the road to logical thinking, troubleshooting, and defining root causes. However, best of all – its habit forming!

Students employ the Jamerson Engineering Design Process; Plan, Design, Check, and Share, from the first day of kindergarten through the last days of 5th grade. This practice provides a stable problem solving strategy that students continue to use with deeper and more complex interpretations as their knowledge of math, science, and language increases over the years. That success is demonstrated by successful execution of FCAT science questions.

Beyond the world of standardized testing, this inner city elementary school has been named a Magnet School of Excellence by Magnet Schools of America for the last five years straight (through 2015). The school has been national recognized by the Parent Teachers Association (PTA) and has also been recognized locally five times during that same period for excellence in elementary education. DLJ also received the nationally competitive, highly recognized elementary school FETC 2016 STEM Excellence Award. This award, given by the Future of Education Technology Conference, http://fetc.org/stem_awards.html , ranks D.L. Jamerson Jr. as the #1 elementary STEM program in the nation! In 2014, School Digger.com ranked Douglas L. Jamerson Jr.

Elementary to be better than 76% of elementary schools in Florida. At the same time, the same statewide rating entity determined that the Pinellas County school district is ranked 43rd of the 69 Florida school districts. Thus, this ranking process placed D.L. Jamerson Elementary School in the top 25% of all the elementary schools in Florida even though it is resident in a school district with a 62% ranking in the State.

In summary, from this manuscript's introduction perspective, D.L Jamerson Jr. Elementary is a "complete service" neighborhood school. DLJ has an elementary education curriculum that addresses student STEM needs, has excellent statewide test scores, has public recognition that their program exceeds the general education expectations of an elementary school, and has the national elementary education community acknowledgement of its success. Of course, a prime interest of this manuscript is the fact that this elementary education program is 100% engineering driven.



Background

There are many approaches to introducing engineering into the elementary school environment. Many of these pathways have been presented at the American Association for Engineering Education annual conference. The Society conducts workshops on this topic and has also published papers on various approaches. Readers are encouraged to explore the ASEE website, https://www.asee.org/search?q=elementary+education , for more details.

The DLJ program was developed in partnership with the University of South Florida College of Engineering; a National Science Foundation designated Regional Center for Advanced Technological Education in Florida, FLATE; the U.S. Department of Education's Magnet Program; and the School District of Pinellas County in Florida. This effort may be distinguishable among projects reported in ASEE publications in that it represents an approach that is totally integrated into the school's entire curricula and implemented within every subject taught in each of the multiple class grade levels in this K-5 school.

For example, when the engineering related lesson is on force and motion, the same topic is presented in classroom language and math lessons as well as a force and/or motion activity conducted by the Physical Education Teacher during that class's physical education period. Engineering is also integrated into all levels of music and art education at DLJ, where those specialist teachers incorporate the same Engineering Design process into their everyday music and art activities. The program's fundamental strategy provides a foundation for hands-on and contextual learning for all subjects while fostering creative thinking and critical evaluations.

The total immersion approach adopted by DLJ does downplay the focus and attention on determining the effectiveness of a specific individual activity or lesson. This feature is actually appreciated by the faculty since it represents a counter point to the current trend in elementary education to test children after each learning experience. At DLJ, this testing, especially at the primary level, contributes minimal information when the activity is part of a long-term skills development effort. The focus is not the immediate effectiveness of a specific integrated engineering experience in the language arts period but what happens to the student's overall comprehension skill by year's end. Thus, lower attention on the measured effectiveness of engineering related activities allows teachers to focus on the School District criteria related to student grade level performance.

DLJ's attention to District grade level expectations also complements the learning style at DLJ. The school distributes its classroom centric instruction primarily through individual classroom teachers within at least 3 classrooms at each grade level. Student talents and abilities are normally distributed and there is no grouping of mainstream students by sections, test scores, and/or perceived ability. Every teacher at each grade level is expected to present the same curriculum with the topics framed by state standards and the order of these presentations driven by school wide published lesson plans that are horizontally and vertically integrated.

Table 3: **School FCAT rating**

Reporting Year	School State Rating
15 - 14	A
14 - 13	A
12 - 13	A
11 - 12	A
10 - 11	A
9 - 10	B
8 - 9	A
7 - 8	B
6 - 7	C

Although DLJ teachers follow school district guidelines as to the number and type of student evaluation experiences, they do not focus on particular lessons in the curriculum. This drastically reduces discussions about one teacher's performance compared to another as long as all teachers are accountable to a school wide expectation. The metric that deals with the impact of the entire program of study and thus indirectly the level of student learning in each classroom is the District funding related practical gauge of the school's "grade" which, in turn, is founded on standard test scores. Table 3 indicates that DLJ has no issue with that scoring practice. In addition, since the school grade is based on the standardized score statistics built from every student in every class room, DLJ does get the intended long term effectiveness from its short term individual curriculum activities.

Model Implementation

The adoption of a whole school integration engineering education model may not be for every school. Although this model works very well in one ordinary school, the model's implementation in any elementary school requires a great deal of energy and constant preparation. However, DLJ's program works and it can work anywhere in the country.

Focused professional development, and high standards for academic excellence are foundational to DLJ success. The main method for this professional development incorporates engineering faculty’s direct involvement in classroom teacher professional development during designated time periods at the elementary school. This approach establishes and demonstrates the intent of the school and engineering faculty as well as optimize direct interactions with the education challenges the school faces.

That professional development effort has produced a learning community where all students at DLJ have integrated learning opportunities that stimulate their intellectual curiosity, require them to demonstrate they have learned how to learn, and enable them to become productive and effective citizens. DLJ does this using engineering as its integration focus for every student in all classes and at all grade levels. DLJ does not have an "engineering" class period with a separate engineering teacher. Every teacher is expected to make engineering connections in all their lessons all the time.

K-5 educators are attracted toward engineering as an education vehicle because it is compatible with their tactile project based approach to teaching. Since engineering technology's mufti is, by definition, “hands-on” and always driven by project success, it is easy to convince elementary school educators that engineering oriented projects are fun ways to have students apply math practices to learn science principles. In fact, most K-5 teachers already use "science fair" type projects with their latent but heavy component of backyard engineering as the basis for typical elementary school science lessons. The challenge is to extend this application of engineering ideas, design, and technology to the level that elementary engineering education is a specific defined and structured approach to an integrated STEM education platform as well as a pedagogical tool for integrating the "reading, writing, and arithmetic" elements of K-5 education. Results at DLJ as summarized by its State rating (Tables 2 and 3) suggest that their approach does meet this challenge.

This paper presents D.L. Jamerson Jr. Elementary School’s engineering integrated experience for elementary education as a productive practical model to insert engineering into an elementary school. The paper does not address interesting questions as to how effective program specific activities were. This manuscript does not attempt to individually indicate what the level of student learning was nor the level of understanding before and after a specific lesson. Such measures at appropriate curriculum breaking points are in place and are exercised by the DLJ teachers at appropriate times. The grade level FCAT scores for DLJ 3rd and 5th graders with a corresponding analysis are published[1]. However, at this point in the document, engineering college readers should recognize that the primary element for success is college faculty member shared passion with an elementary school. Thus, the first step for implementation of DLJ's model is the engagement and/or intensification of a relationship with a specific elementary school. This "Field of Dreams" approach, "If you build it they will come" works. As is the case at DLJ, other elementary schools will interact directly with a target elementary school and the program's impact will spread in a variety of ways.

In summary, the implementation of DLJ's elementary school education platform requires an investment of time and energy. One unique aspect of the curriculum which requires school wide modifications to its professional development plan, is the fact that the DLJ approach does not have a specific engineering instructional period but integrates the engineering content throughout the science, language arts, mathematics, and physical education standards driven component of its educational mission. This is a President Truman's "buck stops here" approach that forces each teacher to find ways to use these subjects to strengthen the understanding of the engineering topics being taught which then, in turn, enrich the student's core "reading, writing and arithmetic" learning experiences.

The entire elementary school staff typically needs extensive (and content integrated) professional development to meet this teaching expectation. That professional development content is best delivered by the same engineering college faculty member but it has to relate quickly to elementary school student knowledge and skills objectives, which are still fundamentally demonstrated ability in reading, writing and arithmetic. However, the rewarding news can be paraphrased from Henry Petroski when he observed that when presented to children on their own terms, the excitement of engineering is immediately apparent and fully comprehendible[2]. Thus, a bottom line but perhaps wordy secular mantra for this implementation process is to engage the students with activities after the teachers comprehend the engineering science and design principles of those activities. As to the actual DLJ lessons and activity details, DLJ teachers will be eager to share what they have and know with you. Just reach out to them at HEFTY@pcsb.org.

Course of Study

The use of engineering as a tool for elementary education realistically requires a course of study that generates continuous reinforcement of the engineering elements over a student's entire time period in the school. The DLJ faculty put an engineering based elementary education plan in place to obtain vertical alignment and spiral learning that also met this rigorous repetitive regime. Table 4 outlines that idea as it related to the District mandated Gravitational Force and Resultant Motion Strand. Although every grade level was expected to develop engineering based content at their grade level for all subject strands taught, each grade level had the leeway to structure how to go about teaching to State defined standards connected to each strand. As the curriculum developed and the elementary engineering education expertise in the faculty matured, this spiral alignment was refined and fortified.

Table 4 provides the fundamental vertical alignment for the Gravitational Force and Resultant Motion unit in the physical science subject strand. The four other school district designated science strands have similar matrix structures. However, to enhance the reader's understanding of the DLJ approach, the force and motion strand is discussed to highlight the synapse that breaches the junction between the six years of engineering activities and the school district's expectations of student performance.

Example Curriculum Strand

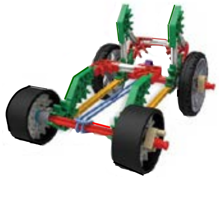
The rudimentary concepts in the force and motion topic area are immediately familiar to the students and lessons developed have a tactile nature that reinforces learning. For example, the students in the kindergarten classes certainly read about Goldilock's adventure and the chair construction activity was absolutely grade appropriate[6]. However, the children were also asked to predict what would happen to the chairs when a choice from two dolls that looked the same but with different masses was set in the chair. The dolls were attached to spring scales and the children had to notice the needle positions before they could pick up the dolls. Thus, the visual position of the scale needle with its alternative non-standard units (high, low) reinforced the child's own measurement system units (heavy, light) to collaboratively predict which doll would break the chair. The children were also required to draw the sketch for each doll and the scale with the needle's position. Connecting details to drawings is an important cognizant skill to be developed at this grade level.

The "weight" theme continued in 1st grade via the reading of folk tales. This reading progression reflected the increased skills in the first grade reader and also provided an avenue to bring the work concept into their reading experience. This, in turn, led to energy conversations and the required lessons on healthy diet. 2nd grade student math skills allowed a shift from a just reading focus to a few design challenges that demanded the dexterity and patience of an older child. From 3rd grade on, the math skill set drove the engineering technology activities to a higher performance platform with reinforcement about work, simple machines, mechanical advantage, and calculations that connect those reading efforts to scalar quantities. By the 4th and 5th grades, the focus tightens on reading for comprehension and students have district assigned science texts and word problem math programs that can be supported by relatively sophisticated engineering technology based projects.

Although reading, not science, is the Jamerson faculty designated path to the engineering activity, the school year at D.L. Jameron is sectioned to cover specific science areas by school district mandate. Thus, the faculty accepted the learning strands for the nature of science, physical science, earth science, and life science and then built the reading elements at each grade level around those science strands. Themes were developed in each of these strands that vertically carried through each grade level in a hands-on manner analogous to the force and motion theme reviewed in Table 4. However, when it came to an engineering activity that required a scalar that quantizes the result, student improvements in mathematics by the 3rd grade classes did shift the traditional primary grouping to just Kindergarten through 2nd grade. This shift from intermediate to primary may be of note to some elementary educators but for DLJ it just triggered a convenient grade level regrouping for the assignment of and progress through the engineering themes in the corresponding science strand. It is mentioned to the reader because the shift will happen in the elementary school you work with and it does represent an internal indicator that the curriculum program is working.

For the 4th graders, the actual hands-on component of the Force and Motion unit is important. However it is subservient to the deliberate sequence of lessons, research, and informational readings about vehicle function and design. These language arts activities also include informal discussions about transportation, as well as Florida's land, water, and rail transportation system's cost and efficiency.

The fourth grade rubber band powered vehicle construction project is not a trial or

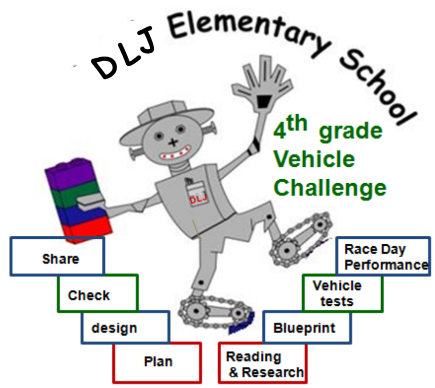


discovery process. Each group must follow their blueprint and that document's elements are scaled and labeled. These diagrams represent the students' first attempt to produce the "some assembly required" type diagrams that are, for example, included in the box with the new kitchen faucet, ceiling fan, or outdoor grill. The team is

Table 4:	Gravitational Force and Resultant Motion Strand	
Grade	**Engineering Science Concepts**	**Examples**
Kdgn.	Introduces **forces as a push or pull** through fairy tales such as *Goldilocks and the Three Bears* and *Humpty Dumpty*.	• Building chairs to support the mass of 2 different Goldilocks dolls. • Finding ways to prevent Humpty from falling off the wall, to protect his body, and to protect his landing.
1st	Introduces **work** through the folk tale of *John Henry*.	• Building puff "steam engines" • Building a lunch box with foods that would provide energy for John Henry.
2nd	Introduces **potential** and **kinetic energy** as well as **friction.**	• Building a marble drop that meets specific design criteria.
3rd	Introduces **mechanical advantage** of **work** through **simple machines** as well as finding **mass in grams** and **weight in Newton's.**	• Designing a pulley system with specific mechanical advantage requirements.
4th	Introduces **calculations of the scalars; volume, density, power**, **live load and dead loads** and the **buoyant force vector** as well as the introduction of **free body diagrams** and **technical drawings.**	• Building and testing clay dugouts. • Calculating buoyant force and creating free body diagrams. • Sketching technical drawing of a K'Nex car. • Building K'Nex cars to test and complete calculations.
5th	Introduces **various types of bridge designs**, various forces acting on a bridge (**tension**, **torsion**, and **compression)** and how to **calculate their strength**, **distributive load,** state of **failure** or **equilibrium**.	• Calculating forces and showing applied forces through free body diagrams. • Designing and building a model bridge that will meet specific design criteria. • Completing a cost analysis of their bridge design.

not allowed to alter their vehicle design during the construction phase. If that action is required, they must "return to the drawing board" before the desired modifications are transferred to the actual vehicle. The groups may assemble their "K'Nex" parts any way they wish to create any car shape they desire if the team has a blueprint from the start.

The vehicle itself now becomes the test bed for data acquisition on its expected performance. Since the grade level math expectation includes linear relationships, when the students plot the number of rubber band twists vs. distance traveled, any data deviation from linearity is emphasized. Certainly, the students expect to race their vehicles but they don't know what that racetrack surface will be. This triggers several sets of investigative experiments that explore vehicle behavior with respect to the number of wraps of the rubber band, the surface friction (carpet, title, concrete), and the mass being transported. These hands-on explorations are conducted during the science lesson and/or the math lesson time slots. With this measurement and analysis phase completed the final phase of the learning experience, the competition, begins. Although racing was expected, the task of racing the vehicle (best of three tries) to rest as close to the finish line as possible does bring the students back to their data set before they attempt to accomplish the task.



In summary, the 4th grade student experience with the Force and Motion Unit meets student, teacher, and school needs. The students have hands-on experience in the design, test, and competition of their vehicles within an engineering environment. The 4th grade teachers have an across grade classroom uniform student experience. This permits individual student expertise to be aggregated to assess total grade performance. The school can match this curriculum activity mapped to address the Common Core Standards as developed within the Measurement and Data Domain summarized in Table 5.

In this case, the 4th grade "K'Nex" vehicle design challenge is an early fall semester activity that uses primary grades skill expectations as specified from standards from Kindergarten through 3rd grade. This planned juxtaposition allows the faculty to assess the performance of the Force and Motion lessons to this point in the students' studies. Although the mathematics skills associated with this challenge are challenging for new fourth graders, the project's entertainment value and real-world connections (St. Petersburg Florida hosts a Grand Prix on its city streets) are attractive to this age group. Project data analysis, discussion, debate, and conclusions components attenuate student uncertainty about the use of a simple but new to the students' algebraic expression that connects distance and time with speed.

Table 5: Common Core Standards, Measurement/Data Domain for Vehicle Activity

Grade	**Measurement and Data Domain**
Kindergarten	K.MD. 1.1 - Describe measureable attributes of objects.
First Grade	1.MD. 1.2 - Express the length of an object as a whole number.
Second Grade	2.MD. 1.1- Measure the length of an object by selecting and using appropriate tools.
	2.MD. 4.9- Generate measurement data by measuring the length of several objects to the nearest whole unit.
Third Grade	2.MD. 1.1- Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.

Implementation Cautions

Engineering faculty secure in the validity of the premise that engineering technology education elements within the elementary school environment can make a systemic impact have to engage in elementary engineering education on a contiguous basis. Of the many viable options for action, the long-term commitment to help integrate engineering into a public school has the highest probability of triggering system changes in the way K-5 grade level children are taught. The pitfalls and rewards for these efforts are clear.

The time investment of interested members of the engineering educator community will increase the likelihood of the long-term impact of systemic engineering education in elementary schools and also remove a major pitfall. It is important that the engineering faculty member maintain an individual long-term personal involvement with the elementary school. The other choice, the "Little League" organization approach, does work but only after the elementary school is very secure about what they are doing. In the "Little League model" (or any other community activity model), the expertise required is gleaned by the organization from a stream of adults with a vested interest. Typically, this means parents of current players. Thus, the needed long-term commitment to Little League, or youth soccer, scouting, etc., continues after, in a year or so, individual parents move on with their child to the next activity level. This model with its sincere but short-term personnel investment works because no one has to be told what is supposed to be done. This approach will not sustain a systemic infusion of engineering technology-based principles into the dynamic elementary school education environment. Engineers with children in the system or engineering educators with temporary funding to create or present hands-on experiences can certainly help while the funding lasts or their children are in the target school. However, the long term approach is for that parent or engineering faculty member to remain involved way after their short term motivation is over.

The authors suspect that Rock ‘n Roll would have really gotten better if Elvis hadn't left the building but really believe that the engineering faculty mentor can't leave the building. The good news is that the actual time spent physically in the elementary school follows a first order decay function. This translates to the fact that a lot of time in the building is needed at first but "virtual" time in the building will work as time marches on. It is the secure knowledge on the elementary school's part that you are available if needed that is the key point of this specific implementation caution. Without that continuity and long term presence the major pitfall to systemic success, the teachers losing sight of the overall goal by just focusing on their individual classroom activities, is bound to happen.

Finally, here is a mild closing caution. It is counterproductive to drive the process by having the elementary teacher do it your way. The engineer's way gets directly to the point since that's what engineers are trained to do, but typically that approach will not be sustained in an elementary school classroom. The optimal approach is to let elementary teachers show you how they do it their way and then keep adding and subsequently tweaking their new content knowledge and challenges to complement their methods based expertise.

Conclusion

Learning in a cooperative, hands-on contextualized environment is a positive experience for students of all ages. Engineering in elementary school epitomizes this experience for K-5 students. The total integration of the K-5 curriculum and strong alignment among and between grade levels are key elements of Jamerson's students' success. Any elementary school in the country can use and teach engineering principles as the basis for the child's complete elementary education learning experience. However, the school cannot easily create that holistic experience by itself. Nor can it accomplish that integrated engineering education mission with good but standalone or isolated engineering lessons and activities.

The engineering education community must get involved in the integration process and those engineering faculty member(s) must have a long-term commitment to the target school. Initially, that commitment will be a very large time, talent, and tenacity investment on the engineers' part. Big hurdles included the elementary educator's lack of engineering knowledge as well as their typically weak math backgrounds; finding the right materials to support the engineering challenges; building meaningful hands-on activities with learning objectives that specifically project into the next grade level; and integrating grade level language, math, science, and social science within every engineering project. Unfortunately, the investment to overcome these hurdles will, in most engineering colleges, not have much impact on that engineer's tenure, promotion and research professional career.

This paper fundamentally broadcasts and celebrates D.L. Jamerson, Jr. Elementary School's success with engineering as its foundational education vehicle. This paper does not focus on Research to Practice or on Evaluation. However, if engineering educators wish to argue that engineering works in elementary education, then DLJ is an impeccable example of that principle.

The authors appreciate that most of the creation, operation, and faculty development details needed to successfully execute the engineering curriculum at D. L. Jamerson are not provided. It is anticipated that readers appreciate that these details are important but extensive. As the curriculum was being developed that progress was reported through a series of papers and presentations at the ASEE annual meetings.

To facilitate readers who want these details, those key publications are isolated below in Table 6 as a list in reverse chronological order. Thus, the methods used in the earliest stages of the project are reflected in the content of the Table 6(e) listed paper, while the curriculum structure, philosophy, and maturity are indicated in the other table listings. However, the most exciting publication news is that the DLJ faculty are now publishing their results[3,4,5,6]. They are also pursuing graduate degrees and curriculum publications using their school as thesis and background materials, respectively. Their extension into the professional development domain for other elementary teachers is a teacher reward and exactly what is needed to transfer and amplify the concepts relayed to teachers by engineering faculty into the complex multifaceted but effective learning environment in an elementary school classroom.

Table 6: Curriculum Structure and Faculty Professional Development

Title	ASEE Conference & Exhibition	Paper Listing
(a) Engineering an Elementary School Environment to Enhance Learning	2008	-1487
(b) Integration of Elementary Engineering Elements into the Language Arts Program	2007	-1901
(c) Supporting Math and Science through Elementary Engineering in Elementary Ed.	2007	-1857
(d) Engineering is Elementary; An Engineering And Technology Curriculum for Children	2007	- 8
(e) Essential Element Examples of Elementary Engineering in Elementary Education	2006	-1158

The engineering faculty member's major reward is obvious, but ironic. As it did at D.L. Jamerson, the impact of a successful effort will ripple through the target school's community and district as well as verify the curious fact about working very hard on something you like that is difficult. Ironically, that type of work, especially when it has a significant social impact, is really just fun and the harder the work the more fun it is!

The final conclusion with its action suggestion is also obvious but only ironic if the engineering education community does not respond. The work that DLJ is doing is really exemplary. They took their school out of the elementary education comfort zone and never looked back. They know what they are doing is hard and they are having fun doing it. So take a few moments and let them know you know they know what they are doing.

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