What is your time worth? A meaningful introductory project in algebra

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ABSTRACT

There have been many recent policy and program changes in K-12 education across the United States, particularly in area of mathematics. Changes, such as the Common Core State Standards for Mathematics and standards-aligned year-end summative assessments, require an increase in student-centered, cognitively demanding activities in the classroom. The authors describe an Algebra 1 project that incorporates pre-algebra critical focus areas, Algebra 1 content standards, and several Common Core Standards for Mathematical Practice. "What is Your Time Worth?" is a five-part project requiring students to research a job, find their hourly wage, calculate the taxes and take-home pay for a hypothetical work week, and determine the number of hours of work required for them to purchase durable and consumables goods of their choosing, all while making their thinking and reasoning explicit to their classmates and their teacher—both verbally and in their written work. This realistic, multiple-day, money management activity is a great way to teach important Algebra 1 concepts and problem-solving skills, while keeping students engaged and motivated.

Keywords: Mathematics standards, student-centered project, motivation, Common Core, remediation

INTRODUCTION

Across the United States, changes in K-12 education policies and programs require teachers to modify their professional growth plans, curricula, and instruction to meet new expectations. Changes are particularly significant in the area of mathematics, where the Common Core State Standards for Mathematics (CCSSM) and other college and career ready standards (e.g., Indiana Academic Standards for Mathematics), along with standards-aligned year-end summative assessments, "represent a significant departure from *what* mathematics is currently taught in most classrooms and *how* it is taught" [authors' italics] (Sztajn, Marrongelle, & Smith, 2011, p. 3).

To productively prepare students to meet these rigorous standards and assessments, mathematics teachers need to move away from routine direct instruction and traditional assessments and toward student-centered activities and performance and formative assessments. Furthermore, as described by Posamentier (2013), "Motivating students to be (enthusiastically) receptive is . . . a critical aspect of the Common Core State Standards" (para. 1). One effective way to harness and sustain student motivation is to have students apply their knowledge and skills to real-world contexts (Eberly Center, 2015); that is, through meaningful, realistic tasks, activities, and projects (Bell, 2010).

Student motivation has been linked to several academic indicators, including: grades, state standardized test scores, college admissions test scores, and high school graduation rates (Eccles, 2008; Lotkowski, Robbins & Noeth, 2004; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). Several studies have shown that students with low levels of academic motivation are at higher risks for high school dropout and long-term unemployment (American Psychological Association, 2012; Archambault, Janosz, Fallu, & Pagani, 2009; Janosz, Le Blanc, Boulerice, & Tremblay, 2000). Furthermore, research has shown that academic motivation tends to decline as students progress through school (Gillet, Vallerand, & Lafreniere, 2012; Gottfried, Fleming, & Gottfried, 2001).

Over the past four years, the first author (Jessica, a fifth-year secondary mathematics teacher) has begun to incorporate activities and projects into her mathematics courses that not only require her students to access key concepts and use math flexibly in problem-solving contexts (Student Achievement Partners, 2013), but also provide sufficient motivation by presenting students with "practical application[s] of genuine interest to the class" (Posamentier, 2013, para. 10). One particular project she utilizes in her Algebra 1 course is called "What is Your Time Worth?" Jessica uses this project as part of a start-of-year review of fundamental and requisite pre-algebra concepts that also introduces students to the general structure of her course, which emphasizes mathematical understandings, reasoning, modeling, and communicating.

Although cautioned by her colleagues about engaging her ninth grade students in middle grade content—warranted advice to an early career professional in an evaluation-intense era—Jessica feels that, pragmatically, making certain her students have developed the requisite knowledge and skills necessary to participate productively in Algebra 1 is crucial. Furthermore, Jessica's district only implemented the Common Core State Standards for Mathematics at all

grade levels within the past two years. As such, the majority of her students do not arrive to her Algebra 1 course with requisite K-8 experiences, understandings, skills, and mathematical habits of mind to be successful in Common Core high school Algebra 1 mathematics.

Although the project originated partly with one of her colleagues, Jessica has extensively broadened the scope and expectations of the initial project's concept. The project, as detailed below, should comprise portions of approximately eight 50-minute class periods.

THE PROJECT

The "What is Your Time Worth?" project is a multiple day, realistic, money management activity that students complete individually. The project requires students to find a fictitious job, one they could actually maintain as a secondary school student, and determine their: (1) annual income (earnings before taxes), (2) federal, state, and local taxes, and (3) take-home pay after taxes. Students are also required to determine the number of hours they would need to work in order to purchase durable and consumables goods of their choice, including: (a) the cost of dinner and a movie for the student and a date, (b) fashion and personal care items, and (c) gaming and entertainment expenses (Piper Jaffray Companies, 2013).

The project outline, its five component parts, and timeline are given below:

(a) Part 1 (Day 1 of Project) – Find a Job
(b) Part 2 (Day 2 of Project) – Determine Annual Income
(c) Part 3 (Days 3-4 of Project) – Determine Taxes
(d) Part 4 (Day 5 of Project) – Determine Take-Home Pay
(e) Part 5 (Days 6-8 of Project) – Determine What Your Time is Worth

The project should account for at most 15-25 minutes of any day's lesson (for a 50-minute class period). For example, when the "Determine Annual Income" component of the project is incorporated into a lesson—preferably during the first week of class— only 15-25 minutes of the lesson should involve students' determining the annual income for the job they have selected. The remaining class time should be spent on other Algebra 1 (or Integrated Mathematics 1) tasks, activities, assessments, or course requirements.

Mathematical Content and Practice Standards

The project aligns in part with the seventh grade Ratios and Proportional Relationships domain (NGA Center & CCSSO, 2010). This critical focus area involves students using their understanding of "ratios and proportionality to solve percent problems, including those involving discounts, interest, taxes, tips, and percent increase or decrease" (NGA Center & CCSSO, 2010, p. 46). Furthermore, "The study of proportional relationships is a foundation for the study of functions, which continues through High School and beyond" (Common Core Standards Writing Team, 2011, p. 11).

The project also aligns with content from the seventh and eighth grade Expressions and Equations domain, and content specific to Algebra 1, including (NGA Center & CCSSO, 2010, pp. 49, 54, 64-65): (1) solving real-life and mathematical problems using numerical and algebraic expressions and equations; (2) interpreting expressions that represent a quantity (and their component parts) in terms of its context; (3) creating equations in one variable and using them to solve problems; (4) representing constraints by equations and interpreting solutions as viable or non-viable options in a modeling context; (5) understanding equation solving as a

process of reasoning, and articulating and explaining the reasoning in that process.

In addition to content, the project engages students in mathematical practice standard MP2 (Reason abstractly and quantitatively), since students are required to "make sense of quantities and their relationships in problem situations . . . [and attend] to the meaning of quantities, not just how to compute them" (NGA Center & CCSSO, 2010, p. 6). Students also engage in mathematical practice MP4 (Model with mathematics) through the use of mathematics in real-world situations by creating a model budget and thinking about how best to spend their money (NGA Center & CCSSO, 2010). Also related to MP4, students are asked to "interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose" (NGA Center & CCSSO, 2010, p. 7). Students engage in practice MP3 (Construct viable arguments and critique the reasoning of others) by communicating their thinking and reasoning to their classmates and teacher (Jessica) and by responding to the thinking and reasoning of their classmates. Finally, students engage in mathematical practice MP6 (Attend to precision) throughout the project by the requirement that they explain their mathematical thinking and reasoning in all of their verbal and written work (NGA Center & CCSSO, 2010).

In the following sections, the authors describe Jessica's implementation of the project by making each of the project's components more explicit.

Part 1: Find a Job

Students are first asked to find a job they would be both interested in and could actually maintain as a high school student. Students are given 15-25 minutes of class time to look for jobs online. Jessica typically uses netbooks or reserves the computer lab for this part of the project. Because many of Jessica's students are too young to work (U.S. Department of Labor, 2016), they are told to find a position they would be able to hold when they turn 16 years old. In addition, students are encouraged to find a realistic job at a nearby locale. Many of Jessica's students enjoy this informal job search and most decide on jobs at venues such as fast-food restaurants, movie theaters, and pet stores. One student (Louis) found a job as a caddie for a professional golfer. Although quite excited about this high paying, travel intense position, Jessica directed Louis to find a job that would keep him closer to home and school.

Once students select their job, they are required to write a description of what they would be expected to do at their position. If there is job information on the job-posting site, students are allowed to use this information as part of their description. If no job details are provided, students are asked to write what they expect the position to entail, such as: Will they need to "work well" with other people? Will they have to cook, work the cash register, clean floors, etc.?

Students must also find the hourly wage for their position. If the hourly wage is not listed on the job-posting site, students can use the state minimum wage (U.S. Department of Labor, 2016). The detailed position description, including the hourly wage, should be completed outside of class. One student (Rachel) who could not find the hourly wage for a position she desired at a local movie theater asked if she could call the theater's manager. Jessica allowed Rachel to call the theater and Rachel was given the hourly wage information. Jessica made a point to observe Rachel's resourcefulness to her classmates having read that "recognizing students' efforts" (p. 8), was one of several recommended instructional strategies for motivating and engaging students (Southern Regional Education Board, 2013).

Parts 2 – 4: Determine Annual Income, Taxes, and Take-Home Pay

In Part 2 of the project, students determine the number of hours they anticipate working during the school year, holiday breaks, and over the summer. Students must factor in the number of hours they could reasonably work during the school year, their employer's days and hours of operation, the dates (of the year) their employer is open, and the maximum number of hours they anticipate their employer would allow them to work during summer and holiday breaks. In addition, students are asked to factor in typical raises they might receive for their chosen job, provided such information is available.

At the end of Part 2, students a divided into groups of four and asked to share their job descriptions, projected annual incomes, and how they determined their annual incomes. Such discussions should include the following pre-algebra and algebra understandings and skills (NGA Center & NCSSOO, 2010, pp. 49, 54, 64-65): (1) descriptions of the equations students created and solved, using their hourly wages, hours worked, and weeks worked; (2) constraints students identified on their hours and weeks worked, and how these constraints impacted their equations and results; (3) descriptions for how students solved their equations as a process of reasoning and explanations of their reasoning; and, (4) how students interpreted their expressions, equations, and solutions.

In Part 3, Jessica demonstrates how to determine the taxes that would be taken out of a "typical" paycheck. Jessica usually spends parts of two class periods in the computer lab helping students locate and utilize necessary tax information and forms (Internal Revenue Service, 2016). Students then use all available tax documents to calculate the federal, state, local, and FICA (Federal Insurance Contributions Act – Social Security and Medicare) taxes that would be deducted from their paycheck during a typical school "work" week.

Jessica usually spends a portion of one class period discussing the purpose of taxes (National Center for Families Learning, 2016) and having students discuss their mathematical work (e.g., calculations and thinking) with their classmates. Students are asked to make their thinking and reasoning clear throughout their written work—which frequently requires students to use complete sentences. Jessica also posts links to the websites used during class on her teacher webpage, so that students (and their parents or legal guardians) can easily access the information outside of school.

In Part 4, students are asked to determine their weekly and hourly take-home pay. After calculating their take-home pay, students again get into groups of four and discuss the differences between their hourly and weekly wages (income before taxes) and what they actually take home. Jessica asserts that several students have been surprised to see they actually make quite a bit less than the hourly wage advertised by their employer.

Part 5: Determine What Your Time is Worth

In the final part of the project, students find out what their time is worth. First, students are asked to determine the cost of a date with a significant other. For their date, students determine the cost for two people to dine at a local restaurant. At the restaurant, students are required to choose at least one appetizer, two beverages, two entrees, and at least one dessert. Jessica typically uses netbooks or reserves the computer lab for 20-25 minutes to allow students to search for online menus. After calculating the cost of their meals, students must determine the tax they would pay and the amount they would leave for a 15-20% tip. This part of the project

provides students with a productive way to practice using percentages in a realistic situation. Students then select a movie they would like to see on their date and calculate the cost for two movie tickets and any snacks (including drinks) they wish to purchase.

After determining the cost of their date (dinner, movie, and snacks), students must then decide on an item that they would like to purchase. This item can be something they have been asking their parents or guardians to buy for them or something they have been saving their own money for to buy for themselves or someone else (e.g., cell phone, clothes, video game). Once students decide on an item to purchase, they are asked to research the item online and determine how much it costs at three or more different retailers. Students may choose online retailers (e.g., Amazon, Forever 21) or local brick-and-mortar stores they frequent. Students must then decide from which store they will purchase their item and calculate the tax (and potential shipping) on that item.

After calculating the cost of their date and the item of their choice, students are asked to determine the number of hours (and weeks) they would need to work in order to pay for these durable and consumable goods. Students are then divided into groups of four one last time and asked to share the cost of their date, the restaurant they dined at, the movie they went to, the item they purchased, the number of hours (and weeks) they needed to work to pay for their date and item, and the thinking and reasoning they engaged in to determine their answers.

As in Part 2, such discussions should include pre-algebra and algebra standards involving (NGA Center & NCSSOO, 2010, pp. 49, 54, 64-65): (1) descriptions of the equations students created and solved; (2) how students interpreted expressions representing quantities (and their component parts) in terms of their context, (3) any constraints students identified and how these constraints impacted their equations and results; (4) descriptions for how students solved their equations as a process of reasoning and explanations of their reasoning; and, (5) how students interpreted their expressions, equations, and solutions as viable or non-viable options in a modeling context. In addition to reinforcing their research and calculation skills, and supporting their capacity to reason and articulate their thinking, Jessica has noticed that students begin to realize how much time and effort it takes to pay for things they typically take for granted.

Project Conclusion

At the end of the project, students are required to write two to three paragraphs describing what they learned through engaging in the project. Jessica has begun to see students consider the idea that earning enough money to pay for social and material goods requires not only time and effort, but also mathematics knowledge and skills. Specifically, Jessica has noticed students begin to consider the role mathematics plays (and will continue to play in their future) in helping them manage their money. Although Jessica has not requested that students present their completed projects or summarize their findings to their classmates, this is a component that she would like to add in the future.

CONCLUSION

Jessica anticipates that it will take another two to three years before her "What is Your Time Worth?" project is no longer needed primarily as a review of pre-algebra knowledge and skills and to bolster students' experiences with the Standards for Mathematical Practice. Such a perspective is hardly unique regarding the Common Core and other college and career ready

standards (e.g., Louisiana Department of Education, 2016). As asserted by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) (2013), "Remediation may be necessary, particularly during transition years" (p. 12). The need for math remediation in high school is not a new phenomenon. According to Huebner and Corbett (2008), many students start the ninth grade unprepared to succeed in rigorous mathematics courses. Huebner and Corbett (2008) assert, "This is especially true for our nation's most underserved students, who often begin high school far behind in math. Making up this lost ground requires intensive remediation and other support, which many schools are unable to offer" (p. 1).

Jessica believes the "What is Your Time Worth?" project has had a positive impact on motivating her Algebra 1 students by requiring them to use mathematics in practical, realistic situations. In addition, many of Jessica's students have shown a strong interest in the project, even those students who typically have done very little work. One particular student (Kyrie), who had consistently refused to complete any homework assignments throughout middle school (grades 6-8), worked exceptionally hard on the project and even completed it early.

The authors believe that realistic activities, such as the "What is Your Time Worth?" project not only helps students develop requisite mathematical content and practice standards and prepare for standards-aligned year-end summative assessments, but also prepare for life outside of the classroom. Finally, as an early-career professional, Jessica feels certain that implementing such student-centered projects now will help her to continuously improve her instruction, so that both she and her students continue to grow.

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