Get the Math:

Impact on Students' Use of Algebra

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EXECUTIVE SUMMARY

An embedded assessment approach was used to evaluate the educational impact of *Get the Math*, a multimedia project that employs online videos and interactive, game-like challenges to engage middle and high school students in meaningful algebraic problem solving as they attempt to solve real-world problems involving mathematical content such as proportional reasoning, linear relationships, or quadratic functions. As students worked on the algebraic challenges in three *Get the Math* modules (Math in Music, Math in Fashion, and Math in Basketball), they used accompanying worksheets to record their work. For each module, students completed three challenge tasks: an introductory pretest task (to obtain a baseline of students' reasoning before using *Get the* Math), Take the Challenge (the algebraic problem-solving task presented in a *Get the Math* video and online activity), and Try Other Challenges (related online problem-solving tasks).

Detailed coding schemes were used to analyze the worksheet responses and gain insight into the mathematical completeness and sophistication of 112 students' algebraic reasoning. The scores took into account, not only the correctness of each student's final answer, but also the validity of his or her approach (e.g., applying appropriate formulas, recognizing when a multiplicative approach was needed rather than addition or subtraction), accuracy in executing the approach (e.g., inserting the appropriate terms into a formula), and completeness in performing all of the necessary steps toward a solution. By comparing students' performance while using the *Get the Math* modules to their performance in the pretest tasks, the worksheet data yielded a naturalistic measure of *Get the Math*'s potential to elicit rich algebraic reasoning.

Some key findings are:

- While working on each of the three *Get the Math* modules, students produced significantly more complete and sophisticated solutions than they had in the pretest. Their solutions to both the Take the Challenge and Try Other Challenges tasks were significantly more sophisticated than their scores on the introductory pretest task. Thus, *Get the Math* succeeded in prompting more sophisticated algebraic reasoning performance than students exhibited previously.

- Students' interest in learning more about the algebra topics and their interest in learning algebra via the multimedia format of *Get the Math* varied across the three modules. Interest in both was much higher following the Music module than either the Fashion or Basketball modules, perhaps because the Music module was either the first module students used or because the topic is less gender-specific than either Fashion or Basketball. Reasons for interest often stemmed from either: an interest in the subject matter, appreciating that *Get the Math* demonstrated real-world applications of algebra, or feeling that the format of *Get the Math* made it easier to learn.

- The greatest attitudinal impact of *Get the Math* was in helping students recognize ways in which algebra can be used outside of school. After using *Get the Math*, 64% of the students said they could name ways in which algebra is used in the real world.

- To help us interpret the data, a supplementary teacher survey was conducted with 20 teachers whose students participated in the study. Most teachers rated *Get the Math* positively in terms of its educational value, appeal/engagement for students, and value/usefulness for teachers, and 65% reported that their students had learned or benefited from using *Get the Math*. Those teachers who were less positive about *Get the Math* generally felt that it took too much time away from class, or that the material was too difficult for some students.

INTRODUCTION

Produced by Thirteen/WNET, *Get the Math* (www.getthemath.org) is a multimedia project that combines online video and interactive challenges to help middle and high school students develop algebraic reasoning skills in the context of real-world problems. Designed for classroom use, *Get the Math* is intended to provide teachers with powerful instructional tools that they can incorporate into their lessons, to engage students in algebraic reasoning, and to help students recognize the relevance of algebra to a variety of careers, thus answering the age-old question, "How is this ever going to help me in the real world?"

Get the Math is comprised of six modules, each focusing on a different algebra topic. In each module, a young professional working in a field of interest to teens (e.g., music, fashion, video game design) poses a challenge related to his or her job to two teams of high school students. Viewers can tackle the challenges themselves via an online interactive activity, before watching a video that shows the teams' solutions. Students can then use additional interactive challenges to deepen their understanding of the algebraic concepts explored, while classroom guides and activities help teachers build *Get the Math* tools into their ongoing lessons and assess and provide ongoing feedback on student progress.

To evaluate students' learning from *Get the Math*, summative research was conducted during a rollout in 12 school districts in New Jersey. The research investigated students' algebraic reasoning as they attempted to solve the challenges in three modules, pertaining to music, fashion, and basketball. This reports presents our findings.

METHOD

Research Design

Following from the movement in mathematics education toward blending instruction and assessment (e.g., National Council of Teachers of Mathematics, 2000), the present study adopted an approach of *embedded assessment*. Under this approach, the research did not entail inserting researchers into the participating classrooms to assess children's learning via interviews or paper-and-pencil research instruments that were designed purely for the purposes of the research. Instead, we built our assessments directly into the classroom activities in which teachers and students engaged as part of using *Get the Math*. Specifically, since *Get the Math* is built around students' working on a series of algebraic "challenges" (i.e. meaningful problem-solving activities), we analyzed the strategies and processes that students employed while working on these challenges themselves. By building our evaluation on teacher-led instructional activities, rather than imposing ourselves into classrooms to administer additional assessments for the purpose of the research alone, we could gain insight into the sophistication of students' algebraic reasoning in a naturalistic classroom context.

To help interpret the results of the study, at the end of the study, we also administered a supplementary online survey of 20 mathematics teachers and math supervisors from the participating schools. The survey asked them about their perceptions of *Get the Math* and their students' learning.

Participants

Participants in the study were 112 students, divided fairly evenly between girls (43%) and boys (57%). The participants were drawn from 12 algebra classes in two school districts in New Jersey. Each of the schools serves a diverse community that is primarily middle- to lower-middle socio-economic status (SES). Approximately 20% of the high school students in each of these districts are eligible for free or reduced lunch. The following table presents the ethnic makeup of the high school students in each district:

Ethnicity	School district #1	School district #2
Latino	38%	20%
White	27%	59%
Asian	26%	5%
African-American	9%	16%
Native American	< 1%	< 1%

At the beginning of the study, approximately 1/3 of the students named math or algebra as their favorite subject in school (35%), and the other 2/3 named other subjects instead (65%).

Of the 20 adult staff members who participated in the online teacher survey, 18 were mathematics teachers and 2 were math supervisors. They represented seven of the school districts that took part in this rollout of *Get the Math*. The following two tables present the grades with whom the surveyed teachers used *Get the Math* and the grade levels they teach. (Note that many taught more than one grade or grade level, so the percentages in the tables sum to more than 100%.)

Used *Get the Math* with grade:	Percentage of teachers/supervisors
7	10%
8	10%
9	80%
10	25%
11	10%
12	5%

Teach above/at/below grade level	Percentage of teachers/supervisors
Above	35%
At	75%
Below	55%

As these tables indicate, the great majority of teachers who completed the survey taught at or below grade level, and used *Get the Math* primarily with ninth grade classes. Note, however, that this reflects the 20 teachers who participated in the teacher survey, not necessarily all of the teachers whose students participated in the research.

Procedure

The research focused on learning from the following three *Get the Math* modules:

- ***Math in Music:*** After learning how the hip-hop duo DobleFlo uses math in music production, students are challenged to match different music samples by calculating their tempos in terms of beats per minute. Algebraic concepts include: rates, ratios, and proportions; linear relationships; algebraic and numeric expressions and equations.

- ***Math in Fashion:*** Following a profile of fashion designer and *Project Runway* winner Chloe Dao, students are prompted to alter garment designs, using their sense of style combined with their math skills to hit target price points. Algebraic concepts include: linear relationships; rates, ratios, and proportions; using multiple representations; algebraic and numeric expressions, equations, and inequalities.

- ***Math in Basketball:*** Professional basketball player Elton Brand challenges students to apply algebraic reasoning, using key variables and his own performance stats, to figure out the maximum height a basketball reaches on its way into the basket. Algebraic concepts include: representing and interpreting quadratic functions and relationships; graphing.

As noted earlier, each module includes two interactive, online opportunities for students to attempt to solve algebra problems themselves. In the first ("Take the Challenge"), students attempt to solve the same problem as the teams of teenagers shown in the videos. The second ("Try Other Challenges") presents students with similar but new problems, to allow them to practice and further develop their skills and understanding. Each online challenge is accompanied by a printable, pencil-and-paper worksheet on which students can record their work (e.g., create and solve equations, perform calculations, graph data, etc.) and explain their reasoning as they attempt to solve the problem. Copies of the worksheets for the Music, Fashion, and Basketball modules can be found in Appendices A, C, and E, respectively.

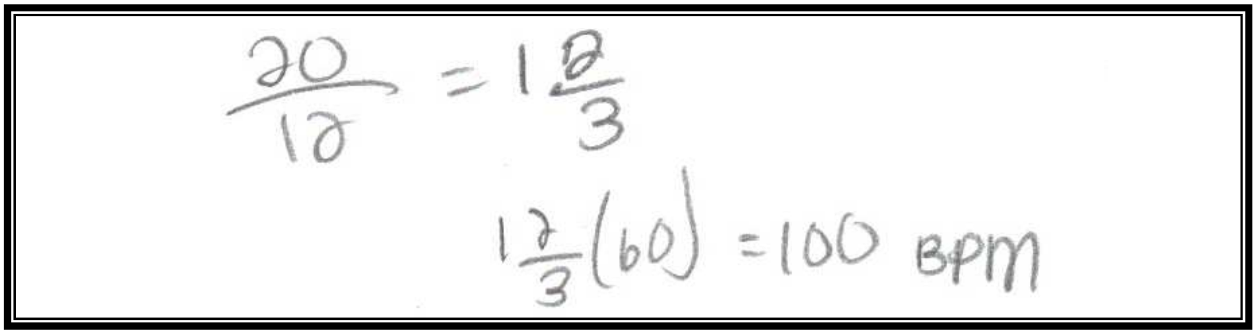
In keeping with the approach of embedded assessment, these worksheets became the primary source of data for the present study. Rather than recycle the worksheets or return them to the students after completing a given lesson, we asked teachers to collect them, and to send them to us in pre-addressed, postage-paid boxes. Detailed coding rubrics were developed to code the sophistication of the algebraic reasoning evident in the students' written work, as described in the "Data Analysis" section below.

Because the measures for the study were embedded assessments that were integral to the *Get the Math* lessons, it was not possible for the study to include an external, no-treatment control group. Simply put, since the assessment tasks simultaneously served as instructional tools, completing the assessment tasks would transform any "control group" into part of the treatment group instead. However, teachers administered introductory "warm-up" tasks to students before the relevant modules (i.e. serving as a pretest); the introductory tasks were essentially isomorphic to the "Take the Challenge" and "Try Other Challenges" tasks. By comparing students' performance in the introductory tasks to their work in the "Take the Challenge" and "Try Other Challenges" tasks, the research adopted a naturalistic, within-subjects design in which each student's prior performance served as his or her own control.

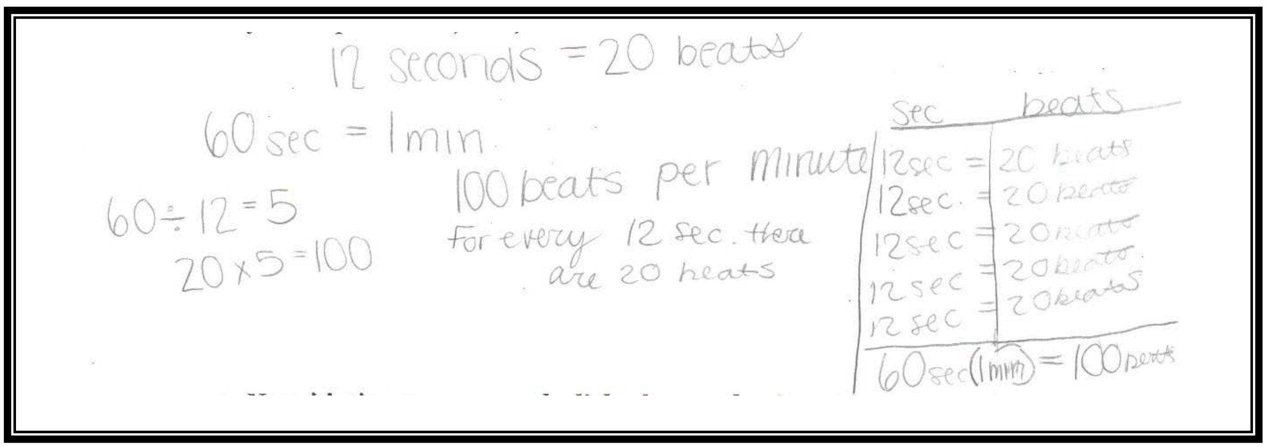
Data Analysis

The design of the coding rubrics was informed by the Common Core Standards for modeling problem solving in high school mathematics (National Governors Association Center for Best Practices, 2010). Following from this approach, the sophistication of students' responses was coded for several aspects of their work on each task: identifying known information and the problem to be solved, planning and executing a solution, and explaining a generalized procedure that could be used to solve other problems of this type in the future. Since the challenges involved fairly complex problems, planning and executing a solution were further subdivided to reflect a student's work on each component of the problem. For example, the Fashion challenges involved making changes to a design in order to meet a particular price point. Separate scores were assigned to students' work in: (a) using the target retail price and markup to find the target wholesale price and (b) making changes to the design, converting the wholesale price to retail, and checking whether those changes were sufficient to meet the target retail price point. (Indeed, this approach to coding is very much in line with recent mathematics assessment under the Common Core Assessment Consortia items. See, for example, the examples of assessments of mathematical reasoning in Partnership for Assessment of Readiness for College and Careers, 2012.)

Like the challenges, the coding rubrics allowed for multiple approaches to solving a given problem. Points were assigned for the sophistication of a student's reasoning within each approach, but the coding rubrics did not favor one valid approach over another. For example, the Music challenges involved finding the beats per minute in a music sample in order to sync up the melody and rhythm tracks. There were several ways in which the problem could be solved correctly, so one student could receive full credit for correctly constructing an equation to find beats per minute:



while another student could receive full credit for constructing a table to find beats per minute:



Within each approach, scores were designed to reflect the mathematical completeness and sophistication of the student's reasoning. The scores took into account, not only the correctness of the student's final answer, but also the validity of his or her approach (e.g., applying appropriate formulas, recognizing when a multiplicative approach was needed rather than addition or subtraction), accuracy in executing the approach (e.g., inserting the appropriate terms into a formula), and completeness in performing all of the necessary steps toward a solution. For example, a student would receive a higher score for using a valid approach but committing a computational error than he or she would for using an approach that was inappropriate overall. Complete coding rubrics for the Music, Fashion, and Basketball tasks can be found in Appendices B, D, and F, respectively.

RESULTS

Impact on Algebraic Reasoning

Model-fitting analyses (specifically, General Linear Model or GLM) were performed to determine whether using a particular *Get the Math* module prompted students to solve the relevant challenges in significantly more correct and sophisticated ways than they had before the lesson (as reflected in the introductory pretest task). For each task, the scores representing a student's plan, solution, and explanation of a generalized procedure were combined into a "total score," representing performance across the task. (We did not include scores for identifying given information in the total score, because the introductory pretest tasks presented this information in the worksheet itself and students did not have to supply it. Since this score could only be awarded in the Take the Challenge and Take Other Challenges tasks, but not the introductory pretest task, we omitted it from the total score to avoid artificially inflating some scores over others.[1])

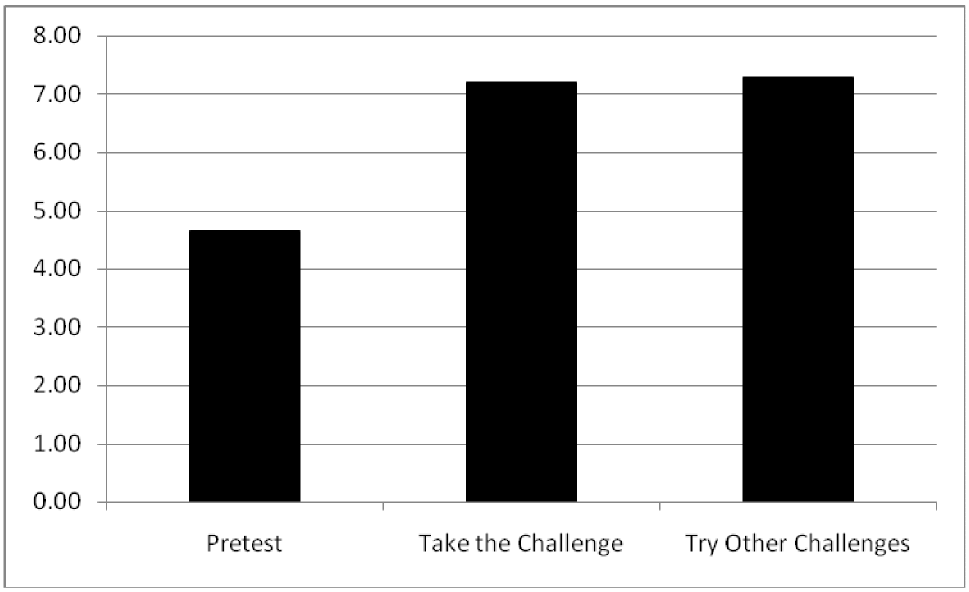
Significant impact on students' algebraic reasoning was found in all three of the modules tested: Music, Fashion, and Basketball. Data will be presented for each of the three modules in turn.

Math in Music

The following figure presents students' mean scores for the Music module. The columns represent performance in the pretest (i.e. the introductory warm-up task administered prior to using the module), the Take the Challenge task (i.e. the challenge shown in the video), and the Take Other Challenges task (which presented similar but new problems).

[1] It is also noteworthy that, because teachers can modify the *Get the Math* materials to best fit their needs and lessons, not all teachers used all parts of a given task. For example, some teachers had their students complete only part of a particular introductory pretest task as a warm-up prior to the lesson. In those cases, we included only those students who attempted all of the parts of the task in our analysis.

Math in Music:
Mean scores for introductory pretest task, Take the Challenge, and Try Other Challenges

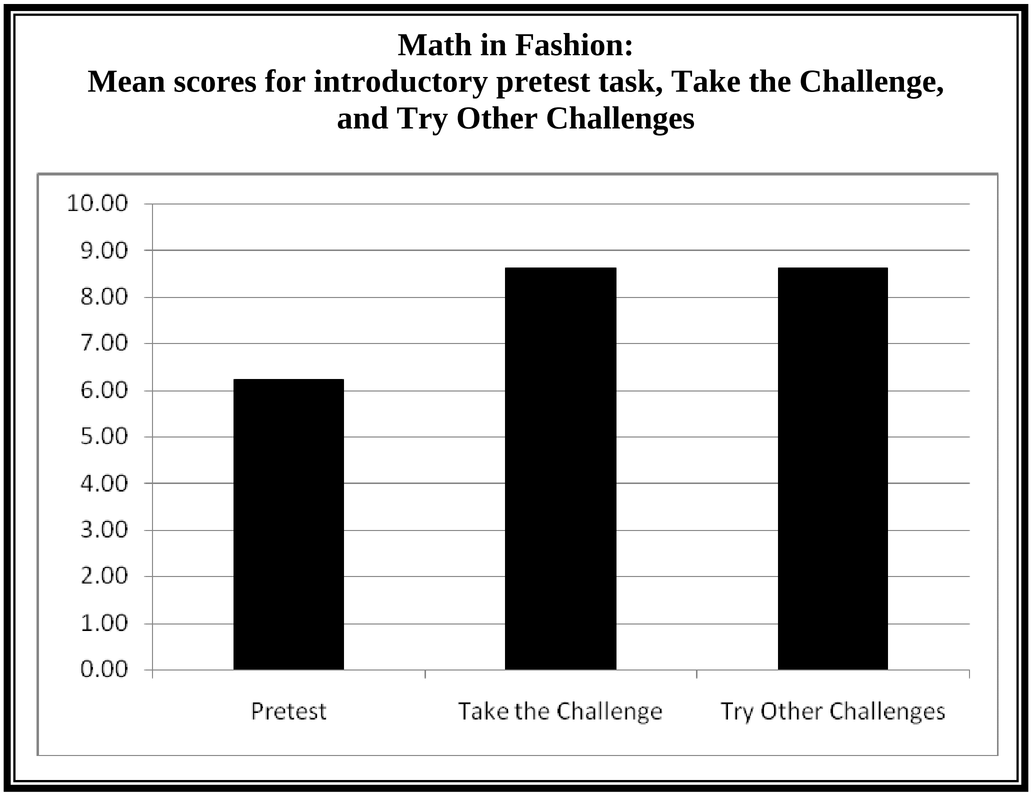


As this figure shows, using *Get the Math* prompted students to produce significantly more correct and sophisticated solutions than they had in the pretest ($F_{1,111} = 1322.74$, $p < .001$). Both their solutions to the Take the Challenge task ($t_{111} = 7.12$, $p < .001$) and the Try Other Challenges task ($t_{111} = 7.76$, $p < .001$) were significantly more sophisticated than their solutions to the introductory task in the pretest. Students performed similarly in the Take the Challenge and Try Other Challenges tasks ($t_{111} = 0.35$, *N.S.*), suggesting that students could not only replicate the solution seen on-screen but also apply the embedded concepts and procedures to new problems.

These effects stemmed from significant growth in both components of the total score: finding beats per second to sync up a melody and rhythm track ($F_{1,111} = 56.86$, $p < .001$) and describing a generalized procedure for solving similar problem ($F_{1,111} = 30.26$, $p < .001$).

Math in Fashion

A similar pattern of data emerged for the Fashion module, as seen in the following figure:

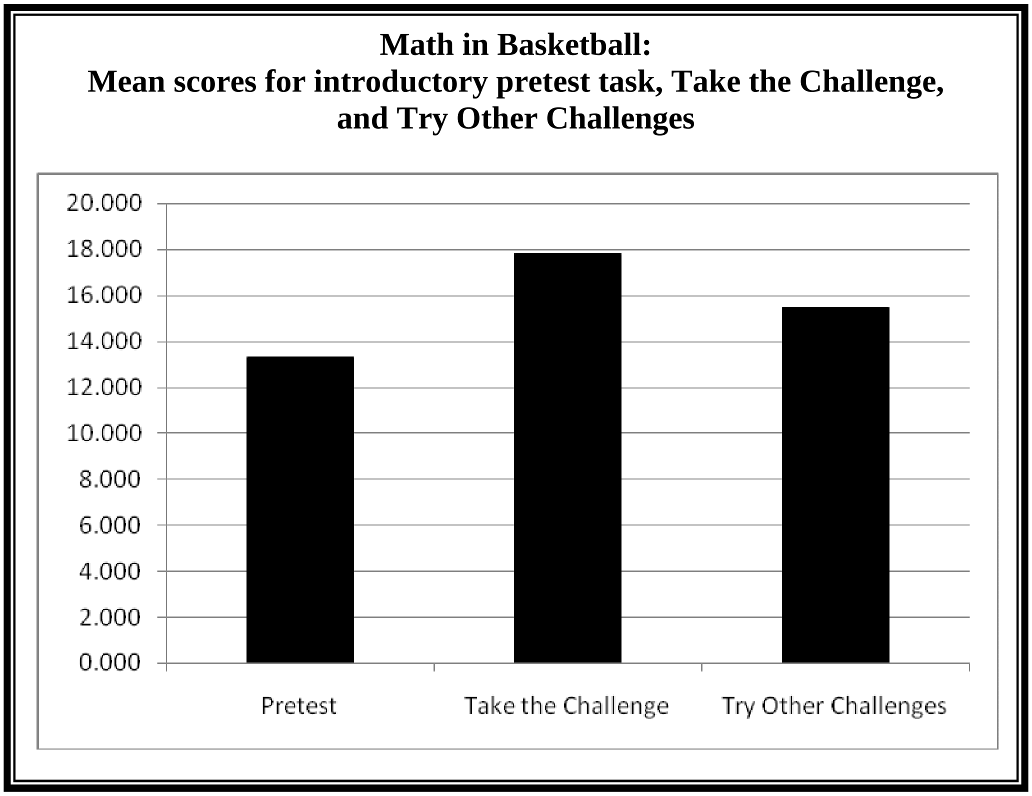


As in the Music module, students produced significantly more sophisticated solutions upon using *Get the Math* than they had in the pretest ($F_{1,111} = 19.98$, $p < .001$). Their solutions to both the Take the Challenge ($t_{111} = 5.23$, $p < .001$) and Try Other Challenges tasks ($t_{111} = 4.47$, $p < .001$) were significantly more sophisticated than their scores on the introductory pretest task. Again, no significant difference was found between students' scores on the Take the Challenge and Try Other Challenges tasks ($t_{111} = 0.03$, *N.S.*), suggesting that students could not only replicate the solution seen on-screen but also apply the embedded concepts and procedures to new problems.

These effects were attributable to significant growth in several components of the total score: planning and solving to find the target wholesale cost ($F_{1,111} = 14.53$, $p < .001$ and $F_{1,111} = 21.32$, $p < .001$, respectively), and making changes in the design to reduce the cost below the target price point ($F_{1,111} = 40.51$, $p < .001$). No difference was found in describing a generalized procedure for solving similar problems ($F_{1,35} = 0.39$, *N.S.*).

Math in Basketball

Finally, similar results were found for the Basketball module, too, as demonstrated by the following figure:



Consistent with the data from the previous two modules, use of the *Get the Math* Basketball module prompted students to produce significantly more correct and sophisticated solutions than they had in the pretest ($F_{1,111} = 12.21$, $p = .001$). Both their solutions to the Take the Challenge task ($t_{111} = 7.14$, $p < .001$) and the Try Other Challenges task ($t_{111} = 3.50$, $p = .001$) were significantly more sophisticated than their solutions to the introductory task in the pretest. Unlike the other two modules, however, students also performed significantly better in the Take the Challenge task than in the Try Other Challenges task ($t_{111} = 3.91$, $p < .001$), suggesting that the impact of this module was strongest for the challenge presented on-screen, although learning was evident in the context of other, related problems as well.

These effects stemmed from several components of the total score: solving for the times when the ball would reach a given height, such as 10 feet ($F_{1,110} = 11.07$, $p < .001$), finding the time when the ball would reach its maximum height ($F_{1,110} = 9.02$, $p < .001$), and finding the maximum height of the ball ($F_{1,110} = 30.18$, $p < .001$).

No differences were found in students' ability to construct a quadratic equation ($F_{1,110} = 0.26$, *N.S.*), probably because 81% of the students constructed the equation correctly in the introductory pretest task, leaving relatively little room for growth. There was only one instance in which students' performance declined following the pretest – namely, in explaining a generalized procedure for solving similar problems ($F_{1,110} = 3.80$, $p = .05$). Since the explanation was the last part of the task and followed solving the presented problem, it seems likely that this was attributable to fatigue after working on a complex problem for an extended period of time, especially when it was the second (Take the Challenge) or third (Try Other Challenges) time that the student worked on a similar type of problem.

Effects of Gender and Favorite Subject

Although one might expect some of the *Get the Math* topics to appeal more to one gender than the other (e.g., basketball, fashion design), this did not appear to affect their performance in the relevant modules. Boys and girls demonstrated similar levels of sophistication in their algebraic reasoning overall ($F_{1,100} = 0.39$, *N.S.* for Music; $F_{1,31} = 0.13$, *N.S.* for Fashion; and $F_{1,100} = 2.09$, *N.S.* for Basketball), and similar learning from *Get the Math* ($F_{1,100} = 0.55$, *N.S.* for Music; $F_{1,100} = 1.20$, *N.S.* for Fashion; and $F_{1,31} = 0.14$, *N.S.* for Basketball).

Overall, students whose favorite subject was math or algebra performed better than other students in the Music and Basketball tasks ($F_{1,100} = 12.90$, $p = .001$ and $F_{1,100} = 12.73$, $p = .001$, respectively), but not the Fashion tasks ($F_{1,31} = 0.03$, *N.S.*). However, favorite subject did not impact significantly on the effects of *Get the Math* on either the Music or Basketball tasks. The students showed similar growth regardless of whether math or algebra had been their favorite subject at the beginning of the study ($F_{1,100} = 0.68$, *N.S.* for Music; and $F_{1,31} = 1.24$, *N.S.* for Basketball), although girls' performance showed a slightly greater decline than boys in the Fashion task ($F_{1,100} = 3.78$, $p < .10$).

Impact on Attitude

Impact on attitude was assessed in three respects: (1) interest in learning more about the specific algebraic topic covered in a given *Get the Math* module, (2) interest in learning about other algebraic topics via *Get the Math*'s multimedia format, and (3) attitudes toward algebra in general (outside the context of *Get the Math*), particularly its applicability to life outside school.

Attitudes toward Algebra

Before the students used *Get the Math*, and after they used all three of the targeted modules, students were asked to indicate their agreement or disagreement with a set of three attitudinal statements about algebra (using a five-point scale of "Strongly disagree," "Somewhat disagree," "Neutral," "Somewhat agree," and "Strongly agree"). The statements were:

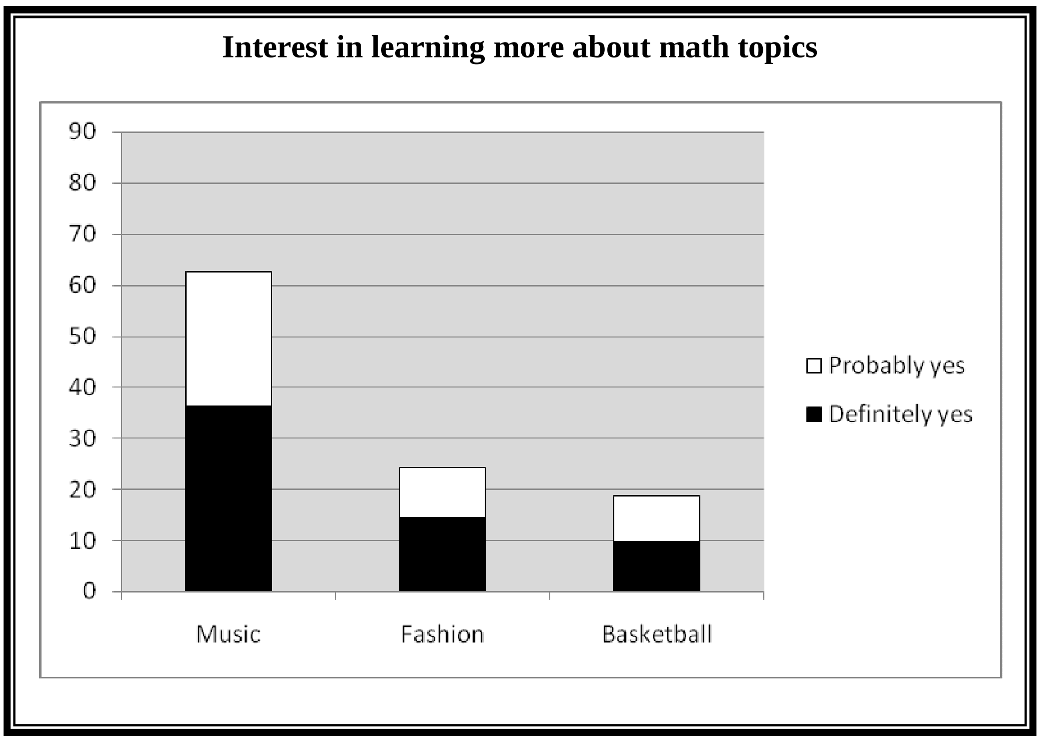
- Algebra is useful in solving problems in real life.
- I can describe some ways that algebra can be used in real-life situations.
- The things I do in algebra class have nothing to do with the real world.

From pretest to posttest, students did not show any significant change in their ratings to these questions ($t_{35} = 0.18$, *N.S.*). However, results were somewhat more encouraging for attitudinal questions that were more closely tied to *Get the Math*, as discussed below.

Interest in Learning More

At the end of each module, a questionnaire asked students whether they would like to learn to more about the algebra content presented in the module (e.g., "Would you want to learn more about how to figure out and match rhythms like this?") and whether they would like to continue learning algebra via the *Get the Math* format (i.e. "Would you want to learn about other algebra topics this way, with videos and online challenges?"). In both cases, children indicated their responses on a five-point scale: "Definitely yes," "Probably yes," "In the middle," "Probably no," or ""Definitely no."

Learning about topics: The following figure shows the percentage of students who said they would definitely (the black part of each bar) or probably (the white part of each bar) want to learn more about the topic of each module:



As one might expect, students' interest in the algebra topics varied by topic. Students were most interested in learning more about matching rhythms as in the Music module (63% either "Definitely yes" or "Probably yes"). Fewer students were interested in learning more about designing fashions to meet specific price points as in the Fashion module (24%) or figuring out the path for a basketball to score a basket (19%).

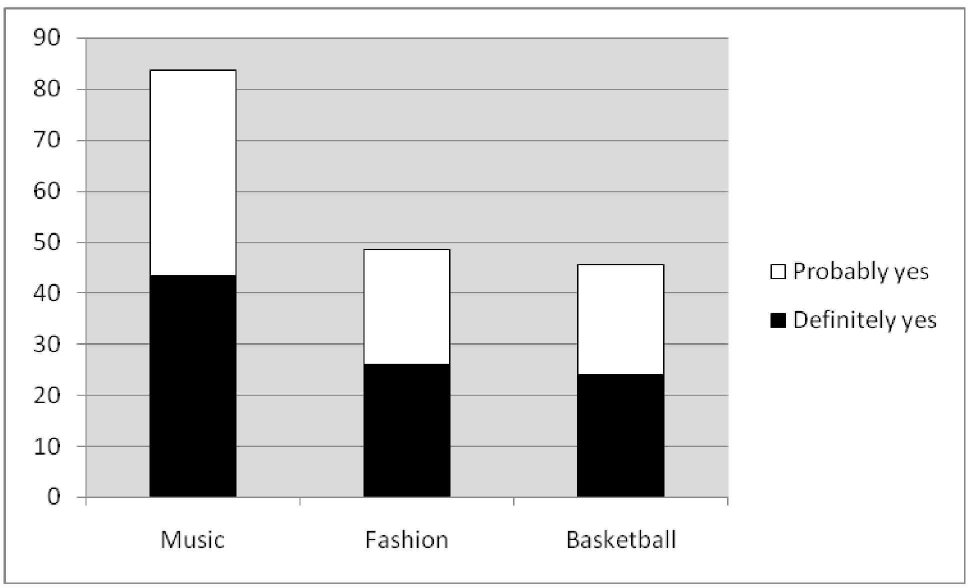
We cannot be certain why so many more students were interested in the music topic than the other two, but it may be either because Music was often the first module used, or because the topic is less gender-specific than either Fashion or Basketball. Indeed, although boys and girls did not differ significantly in their interest in learning more about the topics presented in any of the modules ($F_{1,90}$ = 0.00, *N.S.* for Music; $F_{1,103}$ = 0.01, *N.S.* for Fashion; $F_{1,31}$ = 1.01, *N.S.* for

Basketball), girls said they were more interested in learning via *Get the Math*'s multimedia format after using the Fashion module, as discussed below.

Interest in learning more about the topics in the Music and Basketball modules did not differ significantly as a function of whether the students' favorite subject was math ($F_{1,90}$ = 0.00, *N.S.* for Music; $F_{1,103}$ = 1.57, *N.S.* for Basketball). However, after using the Fashion module, children whose favorite subject was math indicated marginally greater interest than other students in learning more about designing fashions to meet specific price points ($F_{1,102}$ = 2.83, $p < .10$).

Learning via the *Get the Math* format: In contrast to their interest in these specific algebra topics, students were far more interested in continuing to learn algebra (in general) via the *Get the Math* format, as indicated by the following figure:

Interest in learning via the *Get the Math* format



After using the Music module, 84% of the students said they would "definitely" or "probably" want to continue learning algebra via *Get the Math*'s multimedia format (which is approximately 1/3 more than the number who wanted to learn more about the music topic), and approximately ½ of the students said they would want to learn more through this format after using the Fashion (49%) and Basketball (46%) modules (which is more than double the number who said they would want to learn more about these topics).

Students rated their interest in learning via the *Get the Math* format similarly, regardless of whether math or algebra had been their favorite subject at the beginning of the study ($F_{1,90}$ = 0.29, *N.S.* for Music; $F_{1,102}$ = 0.68, *N.S.* for Fashion; $F_{1,103}$ = 0.05, *N.S.* for Basketball). Thus, interest in learning more via this format did not depend on whether students found math highly appealing beforehand.

Girls and boys also showed similar levels of interest in learning algebra via the *Get the Math* format after using the Music and Basketball modules ($F_{1,91}$ = 1.65, *N.S.* for Music; $F_{1,104}$ = 0.04, *N.S.* for Basketball). However, girls rated their interest in the format more highly than boys after using the Fashion module ($F_{1,103}$ = 3.89, p = .05), perhaps because the appeal of the Fashion topic skewed more toward girls.

Reasons for interest: Students tended to offer similar reasons for their interest in the topics and the format. Reasons for interest often stemmed from either: an interest in the subject matter in which the mathematics content was embedded, appreciating that *Get the Math* demonstrated real-world applications of algebra, or feeling that the format of *Get the Math* made it easier to learn. For example:

> *"I want to work in the fashion industry and this would be good information to know. Also, because I like challenges, and it's a fun way to learn because it's interactive."*
>
> *"Because it's interesting and you can challenge yourself and learn more how to solve problems in the videos or online."*
>
> *"It's easier to learn. Instead of just looking at an equation, I can combine the thing I hate (math) with the thing I love (music)."*
>
> *"Kids will probably pay attention better than someone that keeps on talking."*
>
> *"It's FUNducational!!!"*
>
> *"It is finally good to know why we need algebra in life."*

Conversely, many of the children who were not interested explained that they did not feel these particular topics were relevant to them, that it was "too much work," or that they prefer more traditional modes of instruction. For example:

> *"Because I don't like clothes and designing."*
>
> *"It doesn't help me in any aspect. I mean, I wish I was a singer, but hey, one in a million..."*
>
> *"It's boring and it takes too long."*
>
> *"I hate math, and it's bad enough without having to do pointless problems."*
>
> *"Hard to understand because my teacher did not teach it to me before."*
>
> *"I rather take notes and let the teacher teach."*

Thus, key elements in students' interest appeared to be not only their attitudes toward algebra and math in general, but also their affinity for this style of teaching and their interest in the contexts in which the algebra was embedded. *Get the Math* was a good fit for students who were interested in subjects such as basketball or fashion, and/or who enjoyed learning in this way, whereas it was less well suited to students who were less interested in these topics and/or preferred traditional classroom instruction.

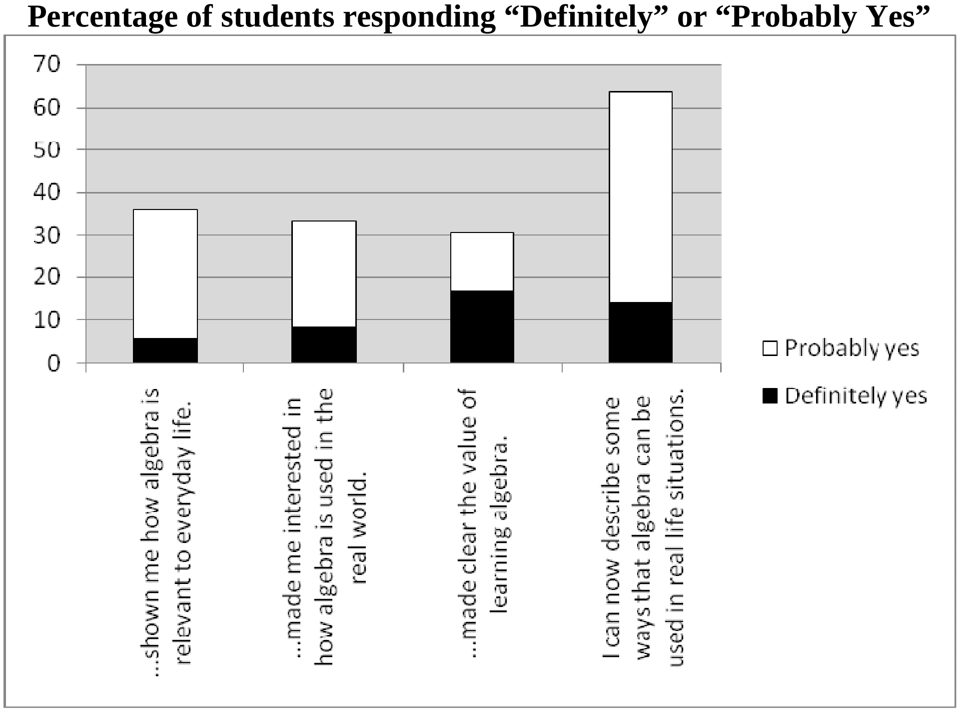
Attitudes Regarding *Get the Math*

Finally, after the students used all three modules, a questionnaire asked them to rate their agreement or disagreement with four statements about *Get the Math* (using a five-point scale of "Strongly disagree," "Somewhat disagree," "Neutral," "Somewhat agree," and "Strongly agree"). The four statements were:

- My experience with *Get the Math* has shown me how algebra is relevant to everyday life.
- My experience with *Get the Math* has made me interested in how algebra is used in the real world.
- My experience with *Get the Math* has made clear the value of learning algebra.
- I can now describe some ways that algebra can be used in real life situations.

The following figure shows the percentage of students who responded either "Definitely yes" or "Probably yes":

"My experience with *Get the Math* has…": Percentage of students responding "Definitely" or "Probably Yes"



As this figure shows, the greatest attitudinal impact of *Get the Math* was in helping students recognize ways in which algebra can be used outside of school; after using *Get the Math*, approximately 2/3 of the students (64%) said they could name ways in which algebra is used in the real world. Approximately 1/3 of the students said that *Get the Math* either showed them how algebra is relevant to daily life (36%), made them interested in how algebra is used in the real world (33%), or made the value of learning algebra clear (31%).

Teacher Perceptions

As noted earlier, to help us interpret the study's data, we conducted a supplementary online teacher survey with 20 teachers (including two math supervisors) whose students participated in the study.

Perceptions of *Get the Math*

We asked teachers to rate *Get the Math* on several dimensions: educational value, appeal/engagement for students, and value/usefulness for teachers. In each case, teachers indicated their ratings on a four-point scale of "Great-Good-Fair-Poor." The following table summarizes their responses:

	Great	Good	Fair	Poor
Educational value	25%	50%	25%	0%
Appeal/engagement for students	20%	45%	30%	5%
Value/usefulness for teachers	35%	40%	20%	5%

As this table shows, teachers generally rated *Get the Math* positively, with 65% to 75% rating it either "Good" or "Great" on all three dimensions, and very few rating it "Poor." In addition, when asked how easy or difficult it was for teachers to use *Get the Math*, 75% felt it was either "fairly easy" (55%) or "very easy" (20%) to use.

Across the interview, reasons for positive perceptions of *Get the Math* most often stemmed from its connecting algebra to real-world applications, and its ease of use. Complaints generally centered on the amount of time taken away from class, or the material being too difficult for some students. For example:

> "*It relates math to the real world.*"

> "*Directions were very easy to follow, and the handouts and lesson plans were excellent.*"

> "*The problems were too difficult for a majority of students to figure out alone without assistance from the teacher.*"

> *"Activities were very time consuming as compared to the number of problems completed. [In addition,] computer response time was slow due to poor bandwidth."*

Perceptions of Learning

Consistent with their ratings of its educational value, 65% of the teachers reported that their students learned or benefited in some way from *Get the Math*; 25% said they weren't sure, and only 10% felt that their students hadn't learned. The most commonly reported benefit was helping students see the applicability of algebra to the real world outside school. A few teachers also appreciated that *Get the Math* engaged students in thinking and reasoning, and a few others believed that the appeal of its topics helped draw students into algebra. For example:

> *"If we can pique their interest by catering to subjects they already like, such as basketball, we can show students that math is a practical tool that can be used and isn't some rote process that requires memorization and precision."*

> *"They learned to work together, and to use logical reasoning and think of solutions on their own."*

> *"My students are below grade level, so some of the material in the basketball challenge was difficult. But, they like basketball, so I think the lesson made them think about the things that influence a free-throw in ways they would never have done before."*

Future Use

Given teachers' generally positive perceptions of *Get the Math*, and its significant effects regarding algebraic reasoning, it is not surprising that 80% of the teachers said they either "might use" (40%) or "definitely will use" (40%) *Get the Math* with other students in the future. As one teacher put it, "*We may not use every unit with all students but will definitely use the some of [the] units to introduce concepts. This will vary from classroom to classroom but will be suggested and encouraged in our curriculum guide."*

CONCLUSIONS AND IMPLICATIONS

Taken together, the data from this study demonstrate that students' use of *Get the Math* can prompt sophisticated levels of algebraic reasoning while working on its mathematical challenges -- significantly more sophisticated than the reasoning students exhibited in the introductory pretest tasks before they used *Get the Math*.

Naturally, since each *Get the Math* module is designed to be used as part of a teacher-led classroom lesson, and this study did not include any in-person observations of use in the classroom, we cannot say how much of the observed impact stemmed directly from the *Get the Math* materials versus the surrounding classroom lessons. In the case of *Get the Math*, however, this distinction is actually somewhat beside the point. *Get the Math* is not intended to be used in isolation, but rather, as a tool for teachers to incorporate into their regular instruction. (Indeed, several students and teachers mentioned the need for teacher support in tackling the algebraic challenges in *Get the Math*.) As a tool for teacher-led use in the classroom, *Get the Math* succeeded in spurring students on to significantly more sophisticated reasoning.

Get the Math is designed to be adaptable, in that teachers can modify lesson plans and printables to fit their needs and constraints. Despite the fact that, under our approach of embedded assessment, researchers were not present to conduct live observations of classroom use, both worksheet data and verbal responses from students and teachers suggest that teachers used *Get the Math* in a variety of ways. In some cases, students worked on *Get the Math* challenges individually, whereas others worked together in groups or even as an entire class. (For at least one teacher, the latter was a necessity due to technical constraints: *"We did not have a computer for each student to use. We had to do it as a class."*) Some students and teachers pointed to the opportunity for group work as a strength of the materials. In addition, some teachers used all of the challenges in their entirety, while others used different parts of the challenges at different times. For example, in one school district, teachers administered only part of the introductory Fashion task as a warm-up before the lesson (i.e. finding the target wholesale price, but not making changes to the design), but later used the entire task when students worked on the Take the Challenge and Try Other Challenges tasks.

Effects were more mixed for impact on students' attitudes, which appeared to be influenced greatly by their individual interest in each topic and their preferences for different styles of teaching and learning. It is not surprising, though, that some of the most positive attitudinal results reflected students' understanding of the real-world applicability of algebra outside the classroom, since this is the core around which the educational approach of *Get the Math* is built. Teachers, too, believed that this was one of the primary benefits of *Get the Math* for their students.

Finally, on a methodological note, it is worth noting the value of the embedded assessment approach used in this research. By carefully structuring the format of the *Get the Math* worksheets and developing detailed coding rubrics, it was possible to gain insight into students' algebraic reasoning, even without any face-to-face interaction with the students themselves. Certainly, we would not argue that all research or all classroom assessment should adopt this approach, since some questions can only be answered via live observation of or interaction with teachers and learners. Nevertheless, as Common Core mathematics assessment moves in similar directions (see, e.g., Partnership for Assessment of Readiness for College and Careers, 2012), the present data speak well to the potential for such approaches to yield meaningful information about students' thinking.

Education is never a matter of "one size fits all," so it is understandable that comments from students and teachers suggest that the topics and format of *Get the Math* may strike a more resonant chord for some students than for others. However, its significant impact on algebraic reasoning in all three of the modules that were tested indicates that *Get the Math* has the potential to serve as a powerful and adaptable resource to support teachers' classroom instruction.

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