Findings from EMC² Second Year (2020-2021)

Essential Math for College and Careers (EMC²) is a course designed by the GEARUP program at Vermont Student Assistance Corporation (VSAC) in collaboration with the Vermont State College System and the Vermont Agency of Education. The course aims to meet the needs of students who might otherwise graduate high school without the skills or confidence to succeed in college level math courses. Students who leave high school unable to meet entrance requirements for credit-bearing college level math courses must spend time and money to overcome those entrance barriers. Studies show mixed results for students who leave high school without strong math proficiencies. This course emphasizes understanding math concepts over learning procedures. This is done through actively engaging students in real-life problem-solving and critical thinking tasks in which they work together to solve problems and communicate solutions.

The EMC² course was first piloted during the 2019-2020 school year. Student and teacher surveys were administered in May 2020 to assess what went well that first year and identify areas in need of improvement. Results of these surveys were promising and are discussed in detail in a separate report.

During the 2020-2021 school year, three high schools in Vermont participated in the EMC² course. These schools were BFA-Fairfax HS, Rutland HS, and South Burlington HS. All three offered the course in the spring semester and two of the three teachers were new to the course. This represents a decrease from eight participating schools the prior year, which we believe was mostly due to pandemic-related school closures in spring of 2020 affecting recruitment efforts. However, although the number of participating high schools fell, the total enrollment remained strong (38 students).

In May 2021, all EMC² teachers and students were invited to participate in a survey to share their feedback about the course. To measure improvement in math skills, students from two of the schools completed the Accuplacer QRAS at the beginning and end of the course. The third school declined to administer the Accuplacer QRAS. This report summarizes the results of both the surveys and the Accuplacer QRAS.

Summary of key findings

- Survey response rates were high, with all three teachers and 79% of the 38 students completing the survey. Such strong participation rates suggest students and teachers felt highly invested in the course.
- A large proportion of students reported positive outcomes following the course. For example:
    - 73% of students reported feeling better about math after taking the course compared to before taking it. 27% of students said their feelings did not change, and none reported feeling worse about math after the course.
    - 75% of students reported improved math skills after taking the course compared to before taking it. The remainder said their skills did not change.
    - 62% of students reported improved confidence in their math ability after taking the course compared to before taking it. Only 3% (one student) reported worse confidence. The remainder said their confidence did not change.
- When asked if they would recommend EMC^2 to other students, 62% of students answered "yes" and 34% answered "maybe." Only 3% (one student) said they would not recommend the course.
- Results suggested the perceived impact of EMC^2 on students' futures ranged from neutral to positive:
    - 48% said EMC^2 made them feel better about passing postsecondary math courses, and the remaining 52% said the course had no effect.
    - 31% said EMC^2 either helped them prepare for their existing postsecondary plans or improved their confidence in achieving those plans, and the remaining 69% said the course did not impact their plans.
- Teachers this year, like last year, strongly endorse this course as effective for strengthening students' skills and confidence.
- Two of the teachers felt the course went well overall despite challenges presented by the remote/hybrid schedules used this year, while one teacher thought the course did not work well for their students.
- Accuplacer scores were higher at the end of the course than at the beginning of the course. This increase was statistically significant but modest, with a mean improvement of approximately 8 points between the pre-test (*Mean* = 238, *Standard Deviation* = 19) and post-test (*M*=246, *SD*=12).

Student Survey Results

Participants

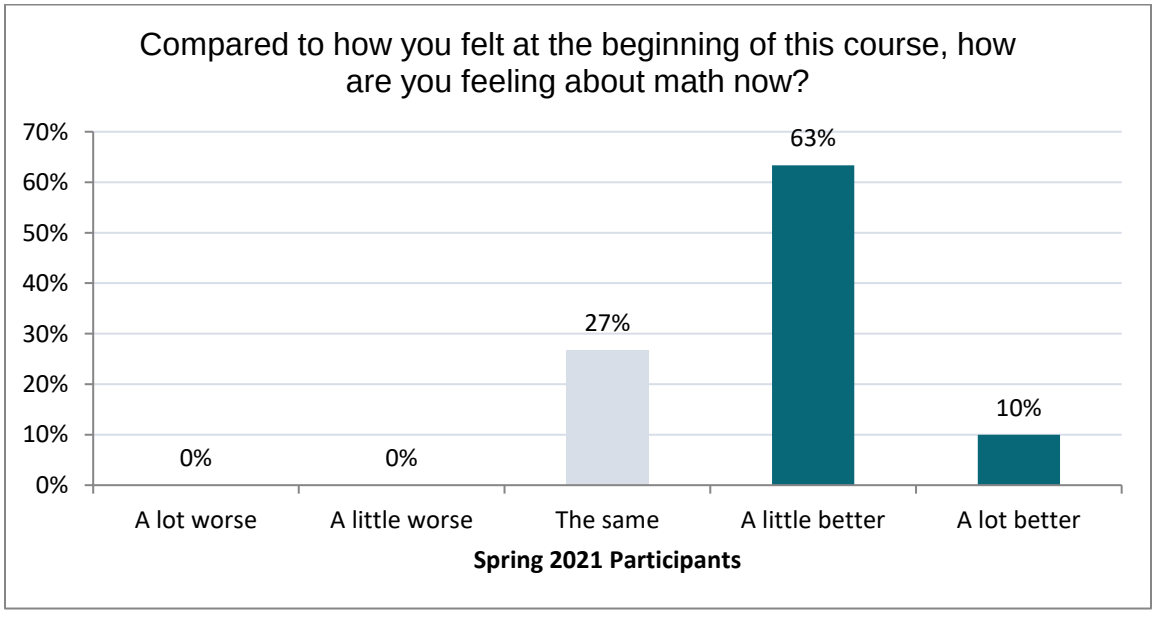
Across the three schools, 38 students were participating in the course when the survey was administered. A total of 30 of these students responded to the survey, for an overall participation rate of 79%. Among participating students:

- 89% of participating students were seniors; the rest were juniors.
- 75% had taken Algebra 2 or equivalent and 18% had taken Pre-Calculus.
- 33% were female, 50% were male, 3% provided an alternative answer, and 13% skipped the question.
- 50% said at least one parent/guardian had formal education or training after high school, 39% said their parents/guardians did not have any formal education/training after high school, and 11% did not know.

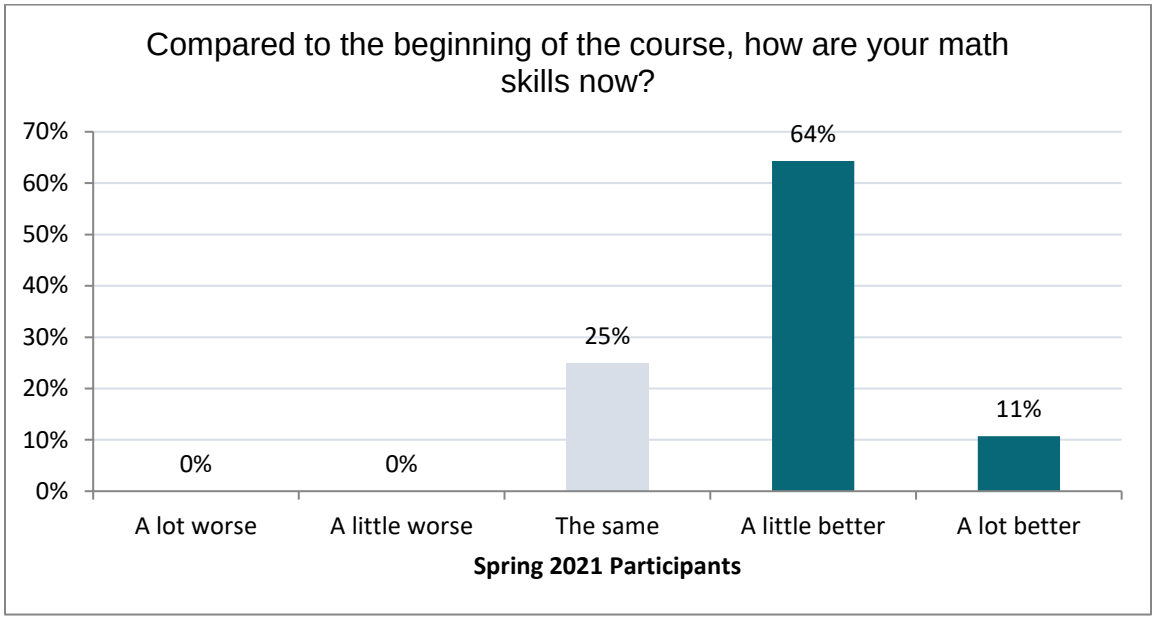
Student-reported outcomes after taking EMC[2]

Overall positive responses from students overwhelmingly outnumbered negative responses, and frequency of neutral responses varied by question.

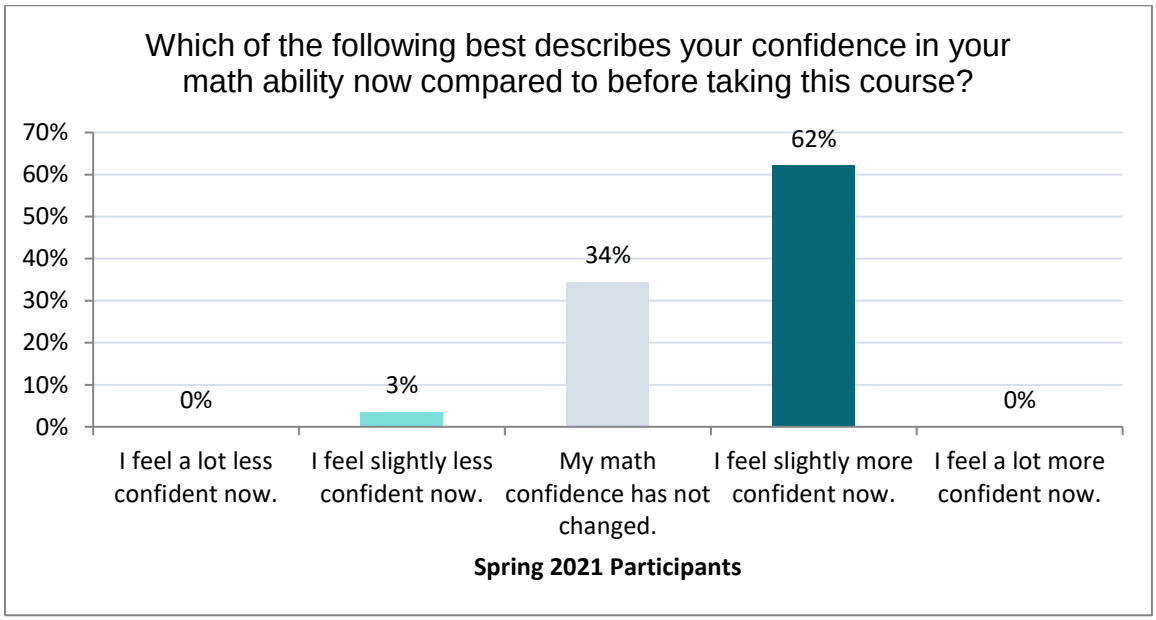
- 73% of students reported improved attitudes toward math (60% in 2020):



- 75% believe their math skills improved (73% in 2020):



- 62% reported increased confidence in their math ability (45% in 2020):

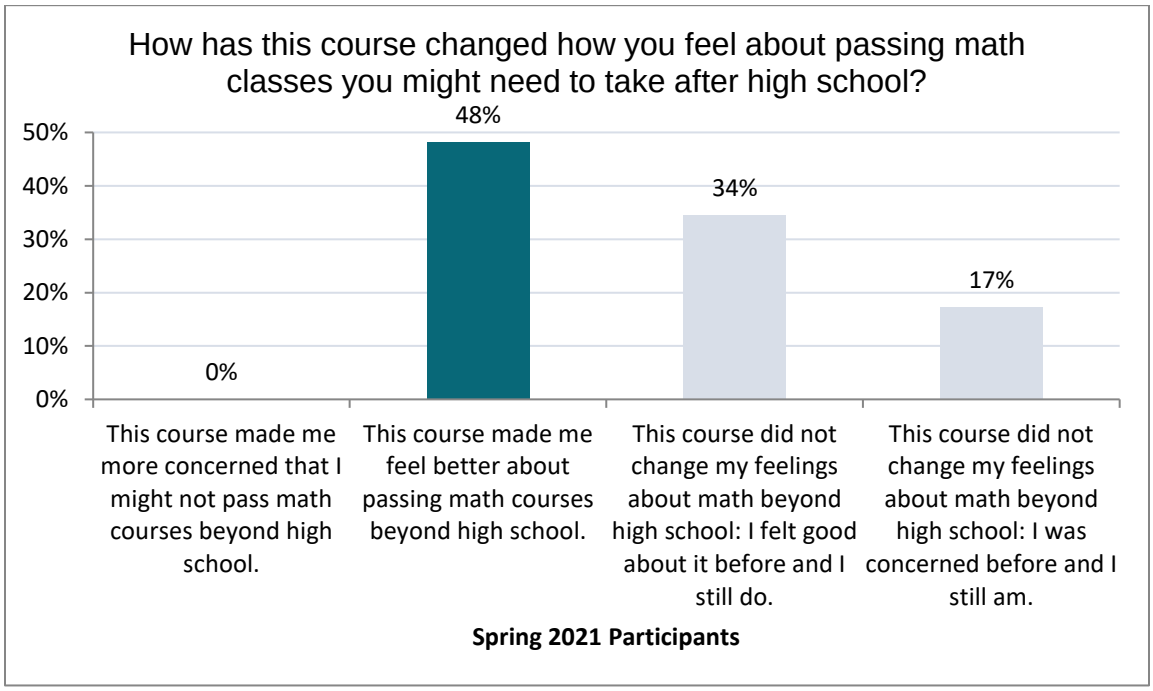


Impact of EMC^2 on students' futures

The majority of students reported having plans to pursue postsecondary education or training. 47% planned to attend a college or university, 20% planned to attend trade school, an apprenticeship, or some other training program, and 3% planned to enter the military.

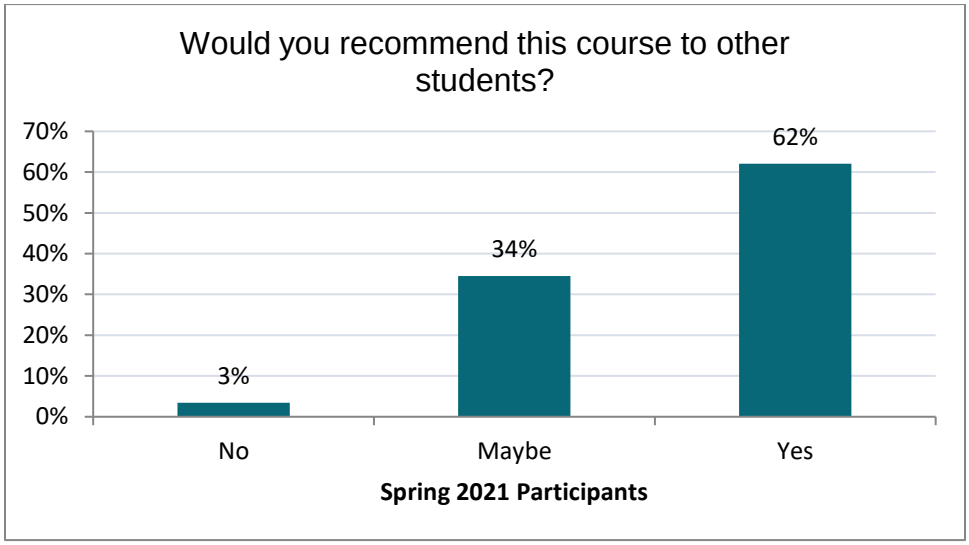
Survey responses indicated that although the course did not cause students to change their postsecondary plans, the course positively impacted students' confidence and helped students prepare for their plans.

- When asked how the EMC^2 course changed or influenced their plans for the future, 69% of students said the course didn't impact their plans. However, 15% said the course improved their confidence about using math in the future, 8% said it helped them gain knowledge relevant to their postsecondary plans, and 8% said it helped them prepare for their existing postsecondary plans.
- 48% said EMC^2 made them feel better about passing postsecondary math courses (33% in 2020):



Student feedback about who should take EMC²

Student responses indicated strong support for the EMC² course. 62% of students said they would recommend the course to other students, whereas only 3% (one student) would not recommend the course. The remaining 34% answered "maybe."



Students were given the option of explaining why they would or would not recommend the course. The student who answered "No" explained that math throughout high school "…has been the same stuff just repeated and repeated. This class was kind of pointless for me."

Among students who would recommend the course:

- 39% of responses included sentiments that the course deepens understanding of math concepts. For example, "A lot of useful everyday practical math was involved in this course. It has really helped me and I'd like others to have that same help." "It is a class that actually presents real world problems for math that you need to solve." "If you are having a hard time with math this course is good for you because it allows you to get a better understanding."
- 56% of students mentioned that the course was a good way to review past math content and/or prepare for their future educational plans. For example, "I would suggest this class to Seniors preparing for college." "I would recommend this course to other students if they want to have their math skill intact before heading to college or where ever there going."
- 22% of students cited enjoyment or quality of the class as a reason to recommend it. For example, "It's fun for a math class."

Among the ten students who answered "Maybe," six shared their reasoning:

- Two focused on the student's needs, saying it "depends on what their skillset is" and "if they need math help."
- Two referenced effort level, saying the class is "not as easy as I thought it would be" and that it is "a fun class… but it can be brutal at times."
- Two more mentioned complaints about the course itself. One said, "the class seemed kind of all over the place for me" and the other said, "some of the questions were a little too complicated for the course itself."

The only student who would not recommend the course answered that "math is boring," suggesting they may not recommend any math course regardless of its quality.

Students also gave feedback about what type of student is a good fit for the course. Common topics included the following:

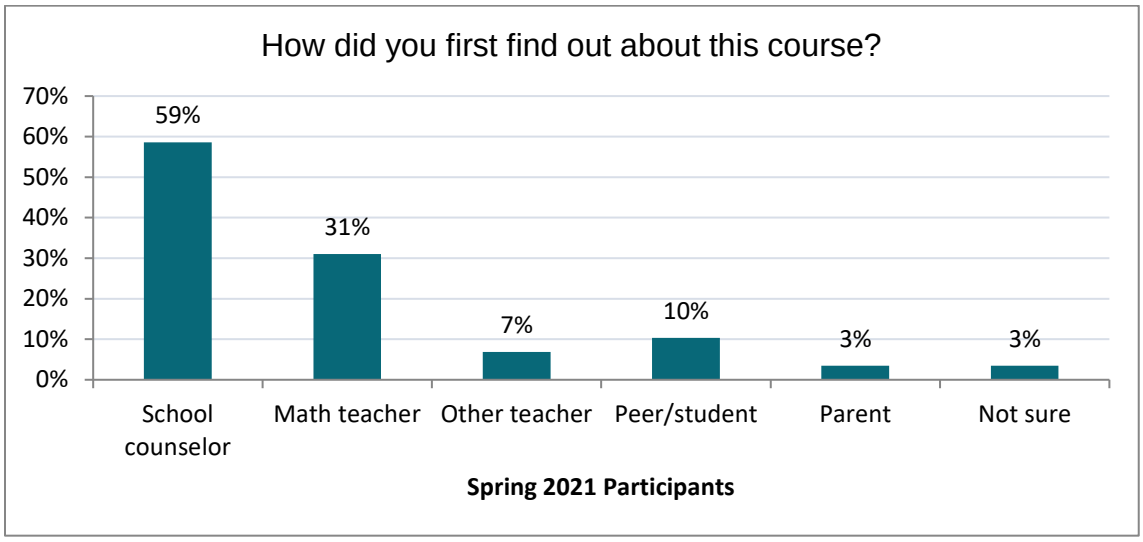
- Students who struggle with math or dislike math (36% of responses)
- Students who want to review math concepts in preparation for their futures (21%)
- Students who are smart or good at math (18%)
- Students who are willing to put in hard work (18%)
- Students who are interested in the unique content or style of the course (7%), such as "someone who is looking for a class that teaches real-world math" or "someone willing to learn more adaptively."
- 10% of students said "any kind of student" would be a good fit for this course.

Student perceptions of the course recruitment process

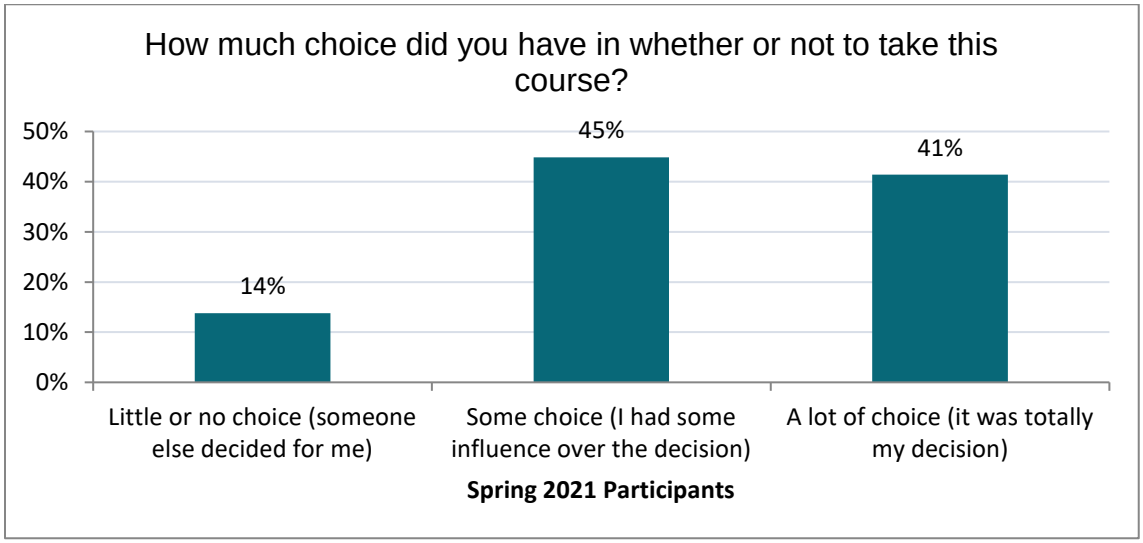
Enrollment for EMC^2 for the 2020-2021 school year typically would begin in March of 2020. We had expected students to have conversations with their math teachers and their school counselors that spring about the EMC^2 course and reasons to enroll the following school year. Unfortunately, school closings due to COVID meant this process could not happen in person, and it was unclear whether these conversations happened virtually or not at all. To gain a better understanding of how this years' students were recruited into EMC^2, we added two new questions to the spring 2021 survey that focused on the course enrollment process.

First, we asked students how they first heard about the course. The majority reported first hearing about EMC^2 from their school counselors (59%) and/or math teachers (31%). Smaller proportions reported hearing about the course from other teachers (7%), students (10%), and parents (3%). These results confirm that, as expected, most students are being

recruited for the course by school counselors and math teachers at their school. However, the fact that 10% (three students) first heard about the course from their peers suggests that news of the course is beginning to spread by word of mouth.



We also asked students how much choice they had in whether to take the course. Most students (86%) believed they had at least some influence over the decision. This finding is promising because we expect these students to feel more invested in the course. The remaining 14% of respondents (4 students) felt they had "little or no choice" in whether to take the course. Although this group included one student who provided overwhelmingly negative feedback on the course, the remaining three students' responses on the survey did not appear different from those who felt they had a say in their enrollment.



Student feedback about the course overall

The survey included two open-answer questions requesting feedback on (a) what about the course went well and (b) what did not work or should be improved. A surprisingly high proportion of students not only answered these questions but provided thoughtful and constructive feedback. Response rates on these questions were 83% and 77%, respectively.

Responses about what went well focused on the following themes:

- Aspects of the course approach or design such as use of real-world examples, group work, and level of detail in equations (36% of students)
- Specific activities or topics covered, such as graphing and reviews (16%)
- Aspects of the classroom environment such as the teacher, the freedom to ask questions without judgment, and "the enthusiasm in class" (12%)
- Pace or ease of the course (12%)
- 8% of students used this space to say, "keep doing what you're doing."
- 16% of the students provided answers like "I don't like math" or "don't have any."

When asked what did not go well or needs improvement, 6 students (26%) used the space to say they could not think of anything to improve. The remaining responses focused on the following:

- Questions were worded badly or too complex (22%)
- Specific component of the course, such as "the homework" or "small activities" (13%)
- Aspects of course logistics, such as the way assignments were posted, the need to work online, and limited space to write down answers (13%)
- Organization of the topics covered (9%)
- Workload too high (9%)
- Other ("make it more fun" and "less math") (9%)

Students were asked the optional question, "Is there anything else you want to tell us?" The only student who responded to this prompt shared the following advice: "Try to push this type of class in more places, it was really helpful."

Finally, students were asked if they would like to be contacted for a possible follow-up survey. Two students answered in the affirmative and provided their contact information.

Differing responses observed between students who did and did not take Algebra 2

After the 2019-2020 pilot year, notable differences were observed between students who had taken Algebra 2 and those who had not. Such differences were less prominent this year, but we observed three trends among the 7 students who had not taken Algebra 2.

First, a larger proportion of students who had not taken Algebra 2 felt they had limited choice in whether to take EMC[2]:

- 43% felt they had little or no choice (compared to 5% among Algebra 2 takers)
- 14% felt they had a lot of choice (compared to 48% among Algebra 2 takers)

Second, fewer reported improved confidence in their math ability after taking EMC[2]:

- 100% said their confidence did not change (by contrast, 14% of Algebra 2 takers said their confidence did not change and 81% said their confidence improved)

Finally, fewer would recommend the course to other students:

- 43% answered "yes" (compared to 67% among Algebra 2 takers)
- 43% answered "maybe" (compared to 33% among Algebra 2 takers)
- 14% answered "no" (compared to none among Algebra 2 takers)

Conclusions from the student survey

The high participation rate and detailed quality of students' individual comments were notable, especially for a voluntary student survey about a math course. Responses showed evidence of the positive impact this course had on many students, such as increased confidence about their math ability and improved attitudes toward future math courses and math in general. These findings were similar to those observed on surveys completed in spring 2020 after the project's pilot year, and where differences were noted, they appeared to reflect improved outcomes this year. Importantly, there was no evidence that the course had a negative impact on students: In each survey year, all but one student would consider recommending the course to others, and even the negative feedback students gave was remarkably constructive in nature.

Teacher Survey Results

About the teachers and their courses

All three EMC^2 teachers participated in the end-of-year survey. One had taught EMC^2 last year and two were new to the course this year. All were highly experienced, having taught math for 10 or more years.

EMC^2 was taught during the spring semester at all three schools. All teachers reported completing Units 1-4 of the EMC^2 course, and one also completed Unit 5. By contrast, during the 2019-2020 school year, two of the eight teachers reported having completed the course through Unit 7 and one also completed Unit 8. We believe the remote/hybrid teaching models used by participating schools in 2020-2021 affected the teachers' ability to complete as many course units as they would in a typical year.

The extent to which the course met its goal

The stated goal of the course was to *strengthen students' foundational math skills and conceptual understanding, making them better prepared for post-secondary career and learning opportunities.* During the pilot year, seven of the eight teachers thought the course met or partially met its goal. This year, however, the teachers were evenly split: One thought the course met its goal, one thought the course partially met its goal, and one thought the course did not meet its goal.

Feedback about whether the course reached the intended student population

When we asked teachers what kind of students are the best fit for EMC^2, they gave the following answers:

- "Motivated students" who want to improve their math
- "Reluctant learners" who aspire to college but are not well suited for a course like precalculus
- Students who need a "refresher course" but "have retained some prior content knowledge"

We also asked if the course reached the intended students. Two teachers said at least some of the students this year were the intended audience. The third teacher said, "With one or two exceptions, I really didn't have this type of student in my class this semester."

Feedback about the course overall

Like the student survey, the teacher survey included two open-answer questions requesting feedback on what went well this year and what needs to be changed or improved. They also provided feedback via discussions during an end of year meeting. Their feedback is summarized below:

- Teachers this year, like last year, strongly endorsed this course as effective for strengthening students' skills and confidence.
- One teacher wanted to "scrap these materials" because the "problems are overly complex for the students we are trying to reach. There's not enough practice. The assessments require a level of thinking beyond the capabilities of most of my students."
- Another teacher felt the exact opposite: "This course is amazing - the focus on applied problems and collaborative problem solving is so critical! Can't wait to teach this next year under less abnormal circumstances."
- Teachers shared the math pathways at their respective schools, which included EMC^2 as a fourth-year course after Math 3, Algebra 2, or Statistics. The course was often offered as an alternative before taking precalculus.
- Teachers noted that the students in the course this year had some exposure to Algebra 2 concepts even if they did not pass Algebra 2. This pattern contrasts somewhat with feedback received after the course's pilot year, when there was significant concern among teachers that many students struggled due to a lack of exposure to Algebra 2.

Conclusions from the teacher survey

During the pilot year (2019-2020), responses on the teacher survey were more positive and more cohesive. In spring 2021 there were only three teachers to survey and their feedback was divided: two shared generally positive feedback and one had serious concerns. The varied nature of teacher feedback this year could be explained at least in part by differences in how their schools handled COVID-era remote/hybrid learning, which in turn affected how the course was run at each school. The nature of teaching during a pandemic also makes it difficult to say how many of the issues teachers identified this year resulted from the use of hybrid/remote learning versus from the course itself.

Accuplacer QRAS Test Results

Participants

The Accuplacer Quantitative Reasoning, Algebra, and Statistics (QRAS) test was used to measure the extent to which students' math test scores improved from the beginning to the end of the EMC^2 course. The pre-test was administered between January 25 and February 9, 2021, and the post-test was administered between June 1 and June 7, 2021. A total of 32 students across two schools (BFA-Fairfax and South Burlington) took the Accuplacer. Of these, 5 took the pre-test only, 4 took the post-test only, and 23 took both. Analyses focused on the 23 students who completed both the pre-and post-test but scores for the other 9 students did not appear systematically different.

Results

Students increased their Accuplacer scores a mean of 8.3 points (*SD*=19.4) between the beginning and end of the EMC^2 course. Although the size of this increase is modest, a paired-samples *t*-test confirmed that the change was statistically significant ($t(22)=2.05$, $p=.026$, one-tailed).

Because there was variability in how schools delivered the course this year, we explored whether Accuplacer results differed by school. We found that students at one school raised their scores an average of 14.8 points (*SD*=20.4), a difference that was statistically significant ($t(11)=2.51$, $p=.029$, two-tailed). Students at the other school increased their scores 1 point on average (*SD*=16), a difference that was not statistically significant ($t(10)=0.24$, $p=.81$, two-tailed). It is worth noting that these schools had equivalent numbers of students complete the Accuplacer (n=12 and n=11 students, respectively). Also, the students were not starting at vastly different skill levels: There was no significant difference between the schools on pre-test scores ($t(21)=0.95$, $p=.35$, two-tailed).

One possible explanation for the difference in Accuplacer outcomes between the schools is that the course was more effective at one school than the other. Feedback from the teachers adds some support to this idea. At the school that showed improvement on the Accuplacer, the teacher reported following the EMC^2 course materials very closely and also progressed further into the course curriculum. By contrast, the teacher at the other school reported more difficulty adapting the course to their hybrid teaching model, which meant

straying from the EMC^2 curriculum and materials more often and ultimately not progressing as far into the curriculum.

Another possibility is that the Accuplacer scores are simply not a good measure of what students learned in this course. The Accuplacer was not designed to measure the precise skills EMC^2 targets under the best of circumstances. Furthermore, there were challenges with administering the Accuplacer (e.g., a fire drill) that may have affected students' ability to concentrate, especially at the school that did not show improved scores. It is also important to consider that neither school was able to complete the full EMC^2 curriculum this year, largely due to the challenges of the hybrid teaching models used during the pandemic. It is possible that if these students had participated in the course in a typical year, they would show clearer improvement on the Accuplacer, despite the fact that it was not designed as an EMC^2 assessment.

Conclusions from the Accuplacer QRAS test

Despite small sample sizes and heterogeneous nature of the Accuplacer results, the modest increase in scores observed among participants this school year offers hopeful optimism that EMC^2 is positively impacting students' math learning. It would be helpful to administer the Accuplacer again in a future year to see whether there is a greater improvement in scores when the course is taught in person under more typical circumstances. Although schools participating in EMC^2 are not required to administer the Accuplacer again after this one instance, we hope they might consider doing so to help us better understand the impact this course has on its students.