STEM Innovations, LTD

Codelicious Impact Report

2021-2022

INTRODUCTION AND BACKGROUND

Codelicious partnered with STEM Innovations, LTD to conduct an impact study of the Codelicious program across the 2021-22 school year. This impact study included case studies of two partnering school districts and associated schools, as well as an examination of a small number of other schools. The purpose of the impact study was to examine the impact of participation in Codelicious curriculum/coursework on student outcomes as measured by the Codelicious pre/post assessment for each course.

Codelicious has a holistic approach to integrating computer science (CS) into the classroom and is designed around four pillars: coding, unplugged, digital citizenship, and hardware. Codelicious is distinctively different from other options in the CS K-12 curriculum space, as it has differentiation at the heart of the design of the curricula, coupled with the flexibility to be offered as a stand-alone course or integrated into existing content classes.

Codelicious is a vibrant and expansive series of curricula spanning K-12 with focus on programming, graphic design, and engineering that is designed to meet the learner where they are and move them forward in powerful ways. Individual Codelicious courses (with respective curriculum organized in modules) can be customized for the respective school or district to fit the needs of scheduling and content with flexibility to be offered as a full-year course, or shorter durations. Each course includes the syllabus, lesson plans, standards map, and content housed within a learning management system (LMS). The lessons are designed to be delivered as collaborative project work for students with the intent of engaging every student in the

classroom. Codelicious coursework has been designed so that it may be delivered in face-to-face and online K-12 education instructional settings.

Each Module is comprised of a Lesson Plan for each day of instruction. Within the lesson plans, detailed outlines for each Activity were provided which include: 1) allotted time for the activity, 2) description of activity, 3) learning objectives, 4) materials and resources, 5) vocabulary, 6) instructional procedures, and 7) challenge activity. There are numerous hyperlinked documents, resources, and handouts for student use. The instructional model provides within the procedures for each lesson step-by-step directions for students to enter code and examine the results. The Challenge Activity within each lesson is where there are opportunities for students to apply and extend their learning.

METHODS

The impact study utilized quantitative methods to examine archival pre/post assessment data (2021-22) that were provided to STEM Innovations, LTD by Codelicious. The guiding question for this study was: "Do students of teachers who use Codelicious curriculum experience gains in computer science knowledge and skills from pre to post assessment?"

The methods utilized for the impact study varied depending upon the data that were provided. Available pre/post data were matched using student identifier numbers in order to only include students who had completed both assessments. Students who only had a pre or post assessment were not included in the analysis. Data analysis methods included dependent samples *t*-tests for overall growth from pre to post and Chi-square tests of proportions for item-level analysis of statistically significant differences by item. However, for Pike Township kindergarten through grade 2 data only included a total number of correct items on the pre/post.

Therefore, this analysis was limited to only dependent samples *t*-tests to examine differences from pre to post.

This report includes two "case studies" which focus on Pike Township (case study one) and Barr Reeve (case study two). Additionally, Codelicious also provided additional data from other participating schools. A summary of the schools and data that were included in this impact study report are provided in Table 1.

Table 1. Summary of Codelicious Impact Study Data

School Name	Grade and/or Course	Number of Matched Students
Pike Township	Kindergarten - CSF	229
Pike Township	Grades 1 and 2 - CSF	693
Pike Township	Grades 3 and 4 - CSF	355
Pike Township	Grades 5 - CSF	51
Barr Reeve	Grades 7 and 8 - CSA	125
Patterson Joint Unified, Immaculate Heart of Mary, Most Precious Blood	CS Foundations	1,078
Immaculate Heart of Mary and River Forest Middle School	CS Applications	32
GEO Academies	HS JavaScript	7
Total		**2,570**

CASE STUDY 1: PIKE TOWNSHIP

Pike Township is the first district that was examined in this analysis. Pike Township participants included students (n= 1,328) in kindergarten through grade five who participated in the Computer Science Foundations course in the 2021-22 school year. Individual student-level demographics were not made available for this impact study. The school district provided estimated percentages at the class-level. However, provided demographic estimates appeared to be incomplete with some categories not adding up to 100%. Therefore, our decision was to not include this data for descriptive purposes in the narrative of this report.

Kindergarten

Pike Township implemented the Computer Science Foundations: Kindergarten course with their students in 2021-22. According to the curriculum description on the Codelicious website, students in this course, "Explore foundational computer science skills. Learn programming concepts including algorithms, loops, and debugging. Discuss internet safety, growth mindset, respecting differences, and STEM careers."

There were 250 students in the Pike Township kindergarten sample who completed both the pre and post assessment. Data from students who completed only the pre or the post assessment were not included in our analysis. For Kindergarten, only the number of total correct items for pre and post were provided for analysis. Therefore, we include only an examination of the change for purposes of determining if there was a significant difference in performance on the pre/post assessment for Kindergarten students in Pike Township. Details on the participant group, as well as findings for Pike Township students in kindergarten are detailed in Table 2 and Figure 1.

Table 2. Pre/Post Participation Data for Pike Township - Kindergarten

Classroom Code	Number of Students	Percentage of Group
P1	6	2.6%
P2	4	1.7%
P3	15	6.6%
P4	10	4.4%
P5	14	6.1%
P6	14	6.1%
P7	10	4.4%
P8	25	10.9%
P9	22	9.6%
P10	24	10.5%
P11	10	4.4%
P12	17	7.4%
P13	14	6.1%
P14	13	5.7%
P15	16	7.0%
P16	15	6.6%
Total	**229**	**100%**

Overall Kindergarten Pre-Post Average Score Comparison

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 2.57) to posttest (average correct = 8.83); $t(228)=18.29$, $p<.001$. The effect size was extremely large ($d=5.18$) suggesting a strong impact on student scores from programming.

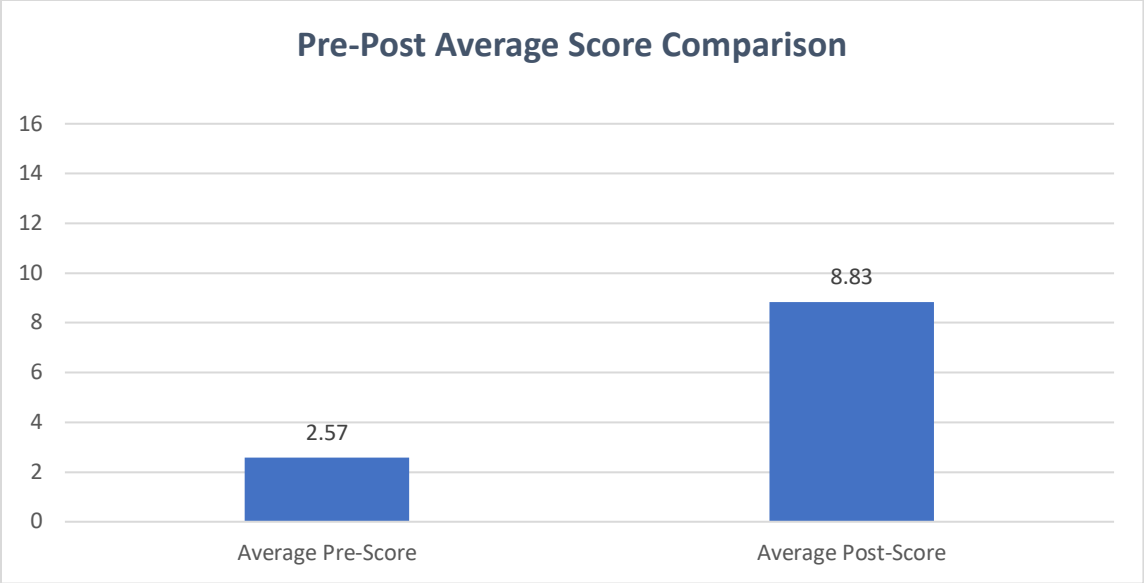

Figure 1: Pre-Post Average Score Comparison – Pike Township - Kindergarten

Grades 1 and 2

Pike Township implemented the Computer Science Foundations: 1st Grade and Computer Science Foundations: 2nd Grade courses with their students in 2021-22. According to the curriculum description on the Codelicious website, students in the 1st grade course, "Acquire foundational coding skills with free play and criteria-driven exploration. Review loops, triggering blocks, debugging. Discuss self-monitoring screen time, giving peer feedback, and STEM careers" According to the curriculum description on the Codelicious website, students in the 2nd grade course, "Expand knowledge of foundational computer science skills and apply to progressively challenging projects. Discuss strategies to keep information safe and how modern technology has changed the way we live."

There were 693 students in the Pike Township grades 1 and 2 sample who completed both the pre and post assessment. Data from students who completed only the pre or the post assessment were not included in our analysis. For Grades 1 and 2, only the number of total

correct items for pre and post were provided for analysis. Therefore, we include only an examination of the change for purposes of determining if there was a significant difference in performance on the pre/post assessment for students in grades 1 and 2 in Pike Township. Details on the participant group, as well as findings for Pike Township students in grades 1 and 2 are detailed in Table 3 and Figure 2 below.

Table 3. Pre/Post Participation Data for Pike Township - Grade 1 and 2

Classroom Code	Number of Students	Percentage of Group
P17	15	2.2%
P18	12	1.7%
P19	11	1.6%
P20	12	1.7%
P22	10	1.4%
P23	13	1.9%
P24	14	2.0%
P25	18	2.6%
P26	18	2.6%
P27	12	1.7%
P28	18	2.6%
P29	15	2.2%
P30	18	2.6%
P31	22	3.2%
P32	19	2.7%
P33	17	2.5%
P34	14	2.0%
P35	13	1.9%
P36	15	2.2%
P37	16	2.3%
P38	16	2.3%
P39	12	1.7%
P40	12	1.7%
P41	15	2.2%
P42	12	1.7%
P43	17	2.5%
P44	18	2.6%
P45	11	1.6%
P46	10	1.4%
P47	16	2.3%

P48	19	2.7%
P49	19	2.7%
P50	21	3.0%
P51	16	2.3%
P52	19	2.7%
P53	20	2.9%
P54	14	2.0%
P55	17	2.5%
P56	16	2.3%
P57	15	2.2%
P58	1	.1%
P59	3	.4%
P60	1	.1%
P61	1	.1%
P62	4	.6%
P63	14	2.0%
P64	15	2.2%
P65	13	2.0%
P66	11	1.6%
Total	**693**	**100%**

Overall Grades 1 and 2 Pre-Post Average Score Comparison

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 7.54) to posttest (average correct = 14.39); $t(690)=26.60$, $p<.001$. The effect size was extremely large ($d=6.77$) suggesting a strong impact on student scores from programming.

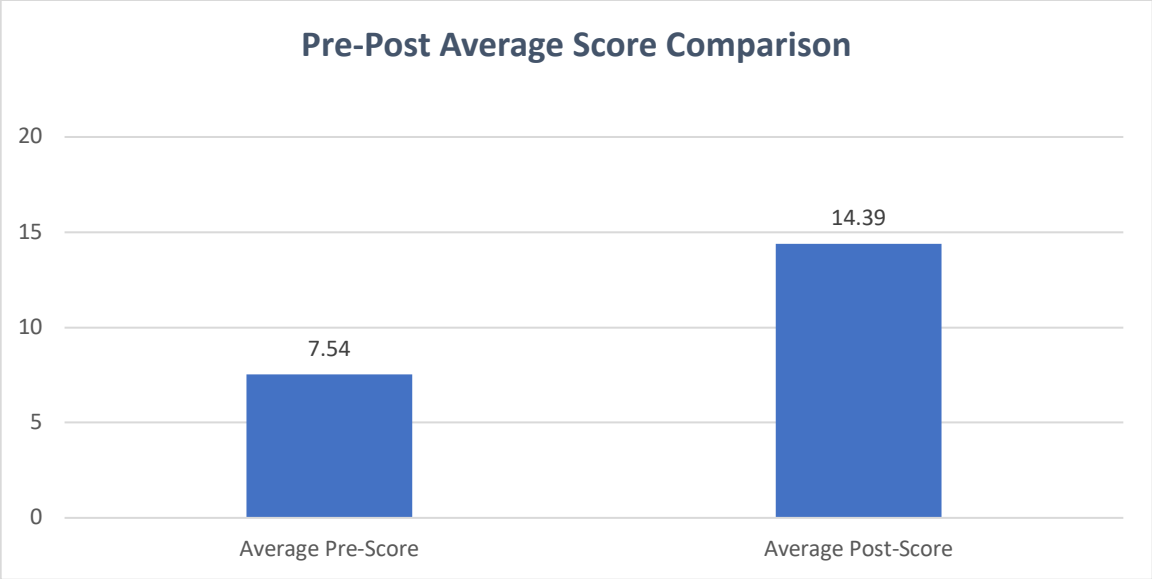

Figure 2: Pre-Post Average Score Comparison – Pike Township – Grades 1 and 2

Grades 3 and 4

Pike Township implemented the Computer Science Fundamentals 3rd and 4th grade courses with their students in 2021-22. According to the curriculum description on the Codelicious website, students in the 3rd grade course, "Explore fundamental computer science skills by building, coding and debugging projects. Expand understanding of variables, loops, and conditionals. Discuss internet safety, real world technology, and STEM careers." According to the curriculum description on the Codelicious website, students in the 4th grade course, "Establish fundamental computer science skills. Understand concepts like variables, parameters, and comparison operators. Discuss ethical Internet behaviors and problem-solving strategies, and STEM careers."

There were 355 students in the Pike Township grades 3 and 4 sample who completed both the pre and post assessment. Data from students who completed only the pre or the post assessment were not included in our analysis. The data provided for grades 2 and 4 for analysis

included the full assessment data, including the responses for each item on each pre and post assessment. Therefore, our analysis included an examination of differences from pre/post assessment total number of correct overall by student, as well as an item level analysis to determine how students from Pike Township performed on various areas of the test. Details on the participant group, as well as findings for Pike Township students in grades 3 and 4 are detailed in Tables 4 and Figure 3 below.

Table 4. Pre/Post Participation Data for Pike Township Grades 3 and 4

Classroom Code	Number of Students	Percentage of Group
P67	2	.6%
P68	7	2.0%
P69	12	3.4%
P70	1	.3%
P71	5	1.4%
P72	19	5.4%
P73	5	1.4%
P74	9	2.5%
P75	14	3.9%
P76	9	2.5%
P77	3	.8%
P78	13	3.7%
P79	8	2.3%
P80	11	3.1%
P81	15	4.2%
P82	9	2.5%
P83	14	3.9%
P84	12	3.4%
P85	2	.6%
P86	14	3.9%
P87	12	3.4%
P88	17	4.8%
P89	12	3.4%
P90	8	2.3%

P91	2	.6%
P92	15	4.2%
P93	11	3.1%
P94	16	4.5%
P95	8	2.3%
P96	14	3.9%
P97	20	5.6%
P98	9	2.5%
P99	6	1.7%
P100	6	1.7%
P101	7	2.0%
P102	8	2.3%
Total	**355**	**100%**

Overall Pre-Post Average Score Comparison

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 8.56) to posttest (average correct = 10.29); $t(354)=9.99$, $p<.001$. The effect size was extremely large ($d=3.26$) suggesting a strong impact on student scores from programming.

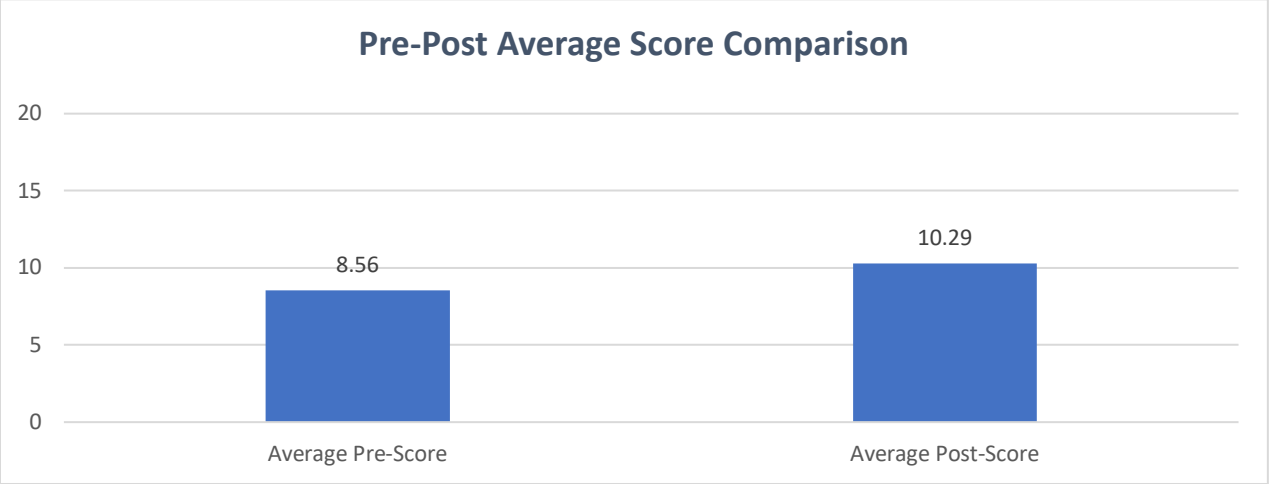

Figure 3: Pre-Post Average Score Comparison – Pike Township – Grades 3 and 4

Item-Level Pre-Post Comparison

Chi-square tests of proportions were conducted at the item-level to look for statistically significant differences in average correct scores over time. Out of the 21 items on this assessment, students demonstrated growth on 19 items (90%) with statistically significant growth on 6 items (29%). Table 5 below designates items with statistically significant growth by an asterisk (*) in the Growth column.

Table 5. Pre/Post Assessment Data Item Level Analysis for Pike Township Grades 3 and 4

Item	Average Correct		Growth (percentage points)
	Pre	Post	
Item 1: Which word means the steps or procedures to be followed by computers to complete a specific task?	31%	43%	12%*
Item 2: Which definition best describes a loop?	57%	70%	13%*
Item 3: Which definition best describes debugging?	58%	67%	9%
Item 4: Which word means a piece of reusable code that contains all of the procedures needed to perform a certain task?	30%	39%	9%
Item 5: Which definition best describes a variable?	44%	42%	-2%
Item 6: Which definition best describes a coordinate plane?	22%	34%	12%*
Item 7: What type of block is this?	39%	70%	32%*
Item 8: ... and what type of block is this?	26%	32%	6%
Item 9: This block helps to create a(n) _____.	63%	75%	11%
Item 10: ... and this block helps to create a(n) _____.	28%	38%	10%
Item 11: Select the code that matches the following algorithm: When the green flag is clicked, the object will move up 10 units in a loop repeated 5 times.	50%	64%	14%*
Item 12: When used together, which statement is true about the scripts below? Check all that apply.	9%	21%	12%*
Item 13: Which of the following best describes the conditional statement below?	59%	63%	5%

Item 14: Identify the bug in the code below.	35%	34%	-1%
Item 15: Which of the following is NOT a way to be safe online?	59%	67%	8%
Item 16: When a device isn't working properly, which of the following is NOT an appropriate troubleshooting strategy?	50%	60%	10%
Item 17: Select the correct model for how computers process information.	41%	44%	3%
Item 18: Which steps are included in an iterative design process? Check all that apply.	6%	15%	9%
Item 19: Which is the best example of positive feedback?	75%	77%	2%
Item 20: When using other's work online, it is a sign of respect to include _____.	41%	46%	6%
Item 21: Which statement about assistive technology (AT) is true?	41%	46%	5%

Grade 5

Pike Township implemented the Computer Science Fundamentals 5th grade course with their students in 2021-22. According to the curriculum description on the Codelicious website, students in the 5th grade course, "Reinforce fundamental programming concepts and experiment with advanced coding. Understand the application of Booleans, loops, and arrays. Evaluate online activity and the impacts of computing on society."

There were 51 students in the Pike Township grade 5 sample who completed both the pre and post assessment. Data from students who completed only the pre or the post assessment were not included in our analysis. The data provided for grade 5 for analysis included the full assessment data, including the responses for each item on each pre and post assessment. Therefore, our analysis included an examination of differences from pre/post assessment total number of correct overall by student, as well as an item level analysis to determine how students

from Pike Township performed on various areas of the test. Details on the participant group, as well as findings for Pike Township students in grade 5 are detailed in Table 6 and Figure 4 below.

Table 6. Pre/Post Participation Data for Pike Township Grade 5

Classroom Code	Number of Students	Percentage of Group
P103	11	21.6%
P104	1	2.0%
P105	5	9.8%
P106	1	2.0%
P107	1	2.0%
P108	2	3.9%
P109	9	17.6%
P110	4	7.8%
P111	1	2.0%
P112	2	3.9%
P113	2	3.9%
P114	5	9.8%
P115	3	5.9%
P116	4	7.8%
Total	**51**	**100%**

Overall Pre-Post Average Score Comparison

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 3.47) to posttest (average correct = 5.80); $t(50)=5.90$, $p<.001$. The effect size was extremely large ($d=2.83$) suggesting a strong impact on student scores from programming.

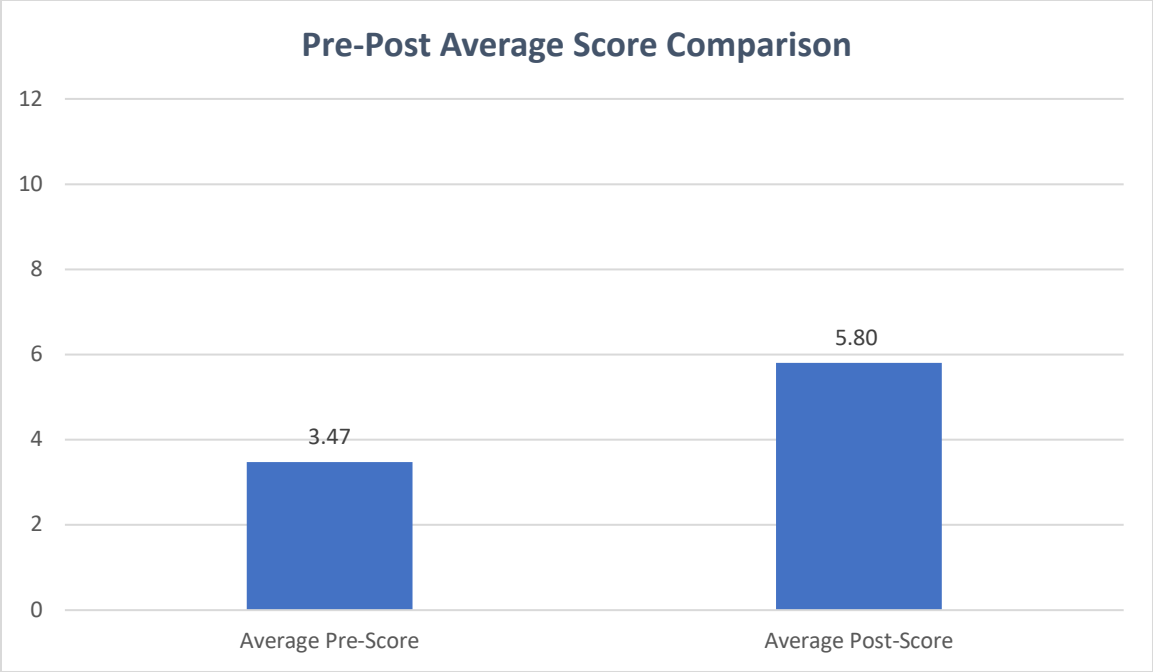

Figure 4: Pre-Post Average Score Comparison – Pike Township – Grade 5

Item-Level Pre-Post Comparison

Chi-square tests of proportions were conducted at the item-level to look for statistically significant differences in average correct scores over time. Out of the 12 items on this assessment, students demonstrated growth on 11 items (92%) with statistically significant growth on 10 items (83%). The table below shows items with statistically significant growth designated by an asterisk (*) in the Growth column (Table 7).

Table 7. Pre/Post Assessment Data Item Level Analysis for Pike Township Grade 5

Item	Average Correct		Growth (percentage points)
	Pre	Post	
Item 1: Algorithm	8%	27%	20%*
Item 2: Program	27%	47%	20%*
Item 3: Variable	24%	39%	16%*
Item 4: Binary	22%	57%	35%*
Item 5: Loop	63%	80%	18%*

Item 6: Conditional	41%	65%	24%*
Item 7: Code Block 1	43%	75%	31%*
Item 8: Code Block 2	33%	53%	20%*
Item 9: Code Block 3	25%	35%	10%
Item 10: Code Block 4	55%	80%	25%*
Item 11: Which coding elements are used in this Scratch code block? (Check all that apply - 5 points)	6%	22%	16%*
Item 12: Which careers listed below use computer science skills? (Check all that apply - 6 points)	0%	0%	0%

CASE STUDY 2: BARR REEVE

Barr Reeve Schools

Barr Reeve Schools implemented the Computer Science Applications course with their students in 2021-22. According to the curriculum description on the Codelicious website, students in the course, "Use JavaScript and design best practices to solve real-world problems. Expand understanding of concepts including functions, conditionals, and arrays. Discuss collaboration and problem-solving techniques."

The Barr Reeve sample included students (n=125) who completed both the pre and post assessment. Data from students who completed only the pre or the post assessment were not included in our analysis. The data provided for analysis included the full assessment data, including the responses for each item on each pre and post assessment. Therefore, our analysis included an examination of differences from pre/post assessment total number of correct overall by student, as well as an item level analysis to determine how students from Barr Reeve performed on various areas of the test. Details on the participant group, as well as findings for Barr Reeve students are detailed in Table 8 and Figure 5 below. Table 9 includes student demographics for the 125 students which were included in the sample for analysis.

Table 8. Pre/Post Participation Data for Barr Reeve Grades 7 and 8

Teacher Name or Class Code	Number of Students	Percentage of Group
1BR7	25	20.0
1BR8	17	13.6
2BR7	24	19.2
2BR8	17	13.6
3BR7	24	19.2
3BR8	18	14.4
Total	**125**	**100.0**

Table 9 – Barr Reeve Student Demographic Profile

Student Demographics	Frequency	Percentage
Trimester		
1	42	33.6
2	41	32.8
3	42	33.6
Grade Level		
7	73	58.4
8	52	41.6
Race		
American Indian or Alaskan Native	3	2.4
White	120	96.0
Did not provide	2	1.6
Ethnicity		
Hispanic or Latino	2	1.6
Not Hispanic or Latino	121	96.8
Did not provide	2	1.6
Gender		
Female	68	54.4
Male	55	44.0
Did not provide	2	1.6
ELL Status		
Not ELL	123	98.4
Did not provide	2	1.6
Free or Reduced Lunch		
Yes	23	18.4
No	100	80.0
Did not provide	2	1.6

Overall Pre-Post Average Score Comparison

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 8.34) to posttest (average correct = 12.64);

t(124)=15.23, *p*<.001. The effect size was extremely large (*d*=3.16) suggesting a strong impact on student scores from programming.

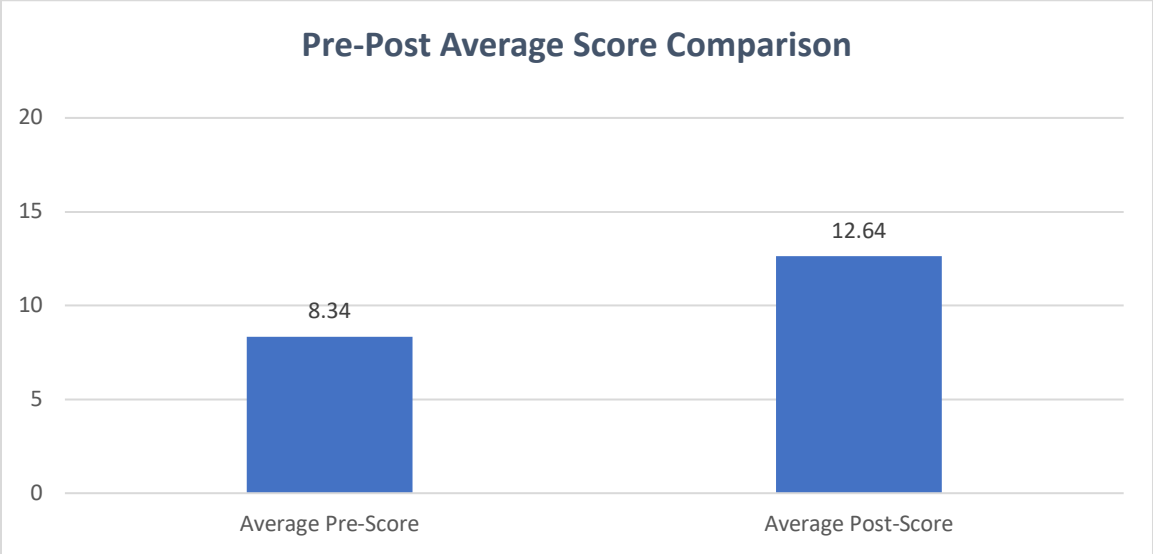

Figure 5: Pre-Post Average Score Comparison – Barr Reeve

Pre-Post Average Score Comparison by Trimester

While student average scores across Trimesters demonstrated significant increases from pre-post, One-Way ANOVA findings showed Trimester 3 students expressed significantly greater growth compared to Trimester 1 students (*p*<.001).

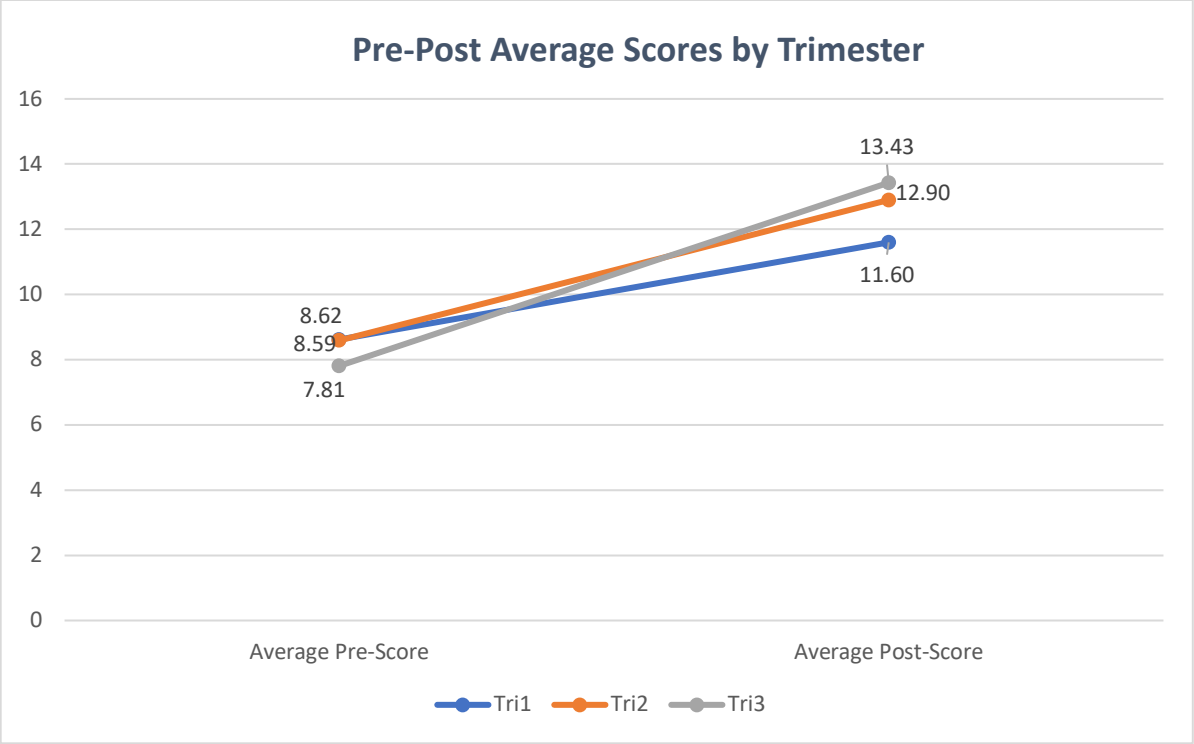

Figure 6: Pre-Post Average Score Comparison – By Trimester

Pre-Post Average Score Growth by Demographics

There were three demographic groups for Barr Reeve which contained a large enough sample to compare for differential impact through the use of independent samples *t*-tests. These included grade level, gender, and free/reduced lunch status. Findings of the Barr Reeve differential analysis are presented in the Table 10 below.

Table 10. Student Performance by Demographic Group for Barr Reeve

Student Demographic	Pre-Post Growth (Points)	Significant Difference
Grade Level		Yes, 8th graders had significantly more growth
7	3.63	
8	5.25	
Gender	4.93	
Female	3.58	

Male		Yes, females had significantly more growth
Free/Reduced Lunch Status Yes No	 3.52 4.51	Yes, non-FRL students had significantly more growth

Item-Level Pre-Post Comparison

Chi-square tests of proportions were conducted at the item-level to look for statistically significant differences in average correct scores over time. Out of the 25 items on this assessment, Barr Reeve students demonstrated growth on 23 items (92%) with statistically significant growth on 13 items (52%). Table 11 below shows items with statistically significant growth designated by an asterisk (*) in the Growth column.

Table 11. Pre/Post Assessment Data Item Level Analysis for Barr Reeve

Item	Average Correct		Growth (percentage points)
	Pre	Post	
Item 1: Which of the following is the markup language that controls the styling of website content, text, and images?	23%	82%	59%*
Item 2: What HTML attribute creates a unique identifier for a tag to be individually styled in CSS?	25%	56%	31%*
Item 3: What are pixels?	66%	91%	26%*
Item 4: Which word means a container that stores a piece of data?	22%	39%	18%*
Item 5: Which of these is NOT a primitive JavaScript data type?	7%	12%	5%
Item 6: What is a structure in programming that executes code based on the result of a comparison?	10%	25%	14%*
Item 7: Which of the following statements best describes a while loop?	29%	38%	9%

Item 8: Which JavaScript operator allows the value of a variable to be increased by one each time a loop is run?	59%	73%	14%*
Item 9: What is a data structure that stores a collection of values?	22%	20%	-2%
Item 10: What is the underlined symbol in the code below called?	29%	35%	6%
Item 11: Which of the following JavaScript concepts is implemented in the bock of code below?	43%	66%	23%*
Item 12: Classify the block of code below.	26%	32%	6%
Item 13: What are the underlined values called?	26%	30%	5%
Item 14: A _____ variable is surrounded by quotation marks.	21%	26%	5%
Item 15: The _____ is used by JavaScript to manipulate HTML and CSS in order to create interactive website features.	30%	26%	-5%
Item 16: In order to invoke, or run, a function it must be declared and _____ .	14%	30%	15%*
Item 17: Which line of code is syntactically correct?	26%	78%	53%*
Item 18: Which line of code has a mistake in syntax?	16%	45%	29%*
Item 19: What is the correct output for the block of code shown?	29%	35%	6%
Item 20: What is the correct code for the output shown in the console?	10%	23%	14%*
Item 21: Which of the following cyber security measures is a physical precaution?	22%	50%	28%*
Item 22: Which of the following is a strong password?	90%	98%	9%
Item 23: How should you respond to a cyberbully?	90%	100%	10%
Item 24: Which of the following is information you can safely share online with anyone?	89%	99%	10%
Item 25: Which careers listed below use computer science skills? (select all that apply)	10%	54%	44%*

OTHER PARTICIPATING SCHOOLS

Computer Science Fundamentals (CSF) Course

There were three other schools included in this impact study that implemented the Computer Science Fundamentals course in 2021-22 (Patterson Joint Unified, Immaculate Heart of Mary, and Most Precious Blood). This sample included students who completed both the pre and post assessment. Data from students who completed only the pre or the post assessment were not included in our analysis. The data provided for analysis included the full assessment data, including the responses for each item on each pre and post assessment. Therefore, our analysis included an examination of differences from pre/post assessment total number of correct overall by student, as well as an item level analysis to determine how students from other schools performed on various areas of the test. Details on the participant group, as well as findings for other schools students are detailed in Table 12 and Figures 7-8 below.

Table 12. CSF Pre/Post Participation Data for Other Schools

Classroom Code	Number of Students	Percentage of Group
O1	1	.1%
O2	15	1.4%
O3	4	.4%
O4	5	.5%
O5	16	1.5%
O6	17	1.6%
O7	9	.8%
O8	1	.1%
O9	170	15.8%
O10	206	19.1%
O11	24	2.2%
O12	14	1.3%
O13	17	1.6%
O14	6	.6%

O15	156	14.5%
O16	193	17.9%
O17	224	20.8%
Total	**1,078**	**100%**

Overall Pre-Post Average Score Comparison – Other Schools – Computer Science

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 8.70) to posttest (average correct = 10.94); $t(1077)=21.23$, $p<.001$. The effect size was extremely large ($d=3.47$) suggesting a strong impact on student scores from programming.

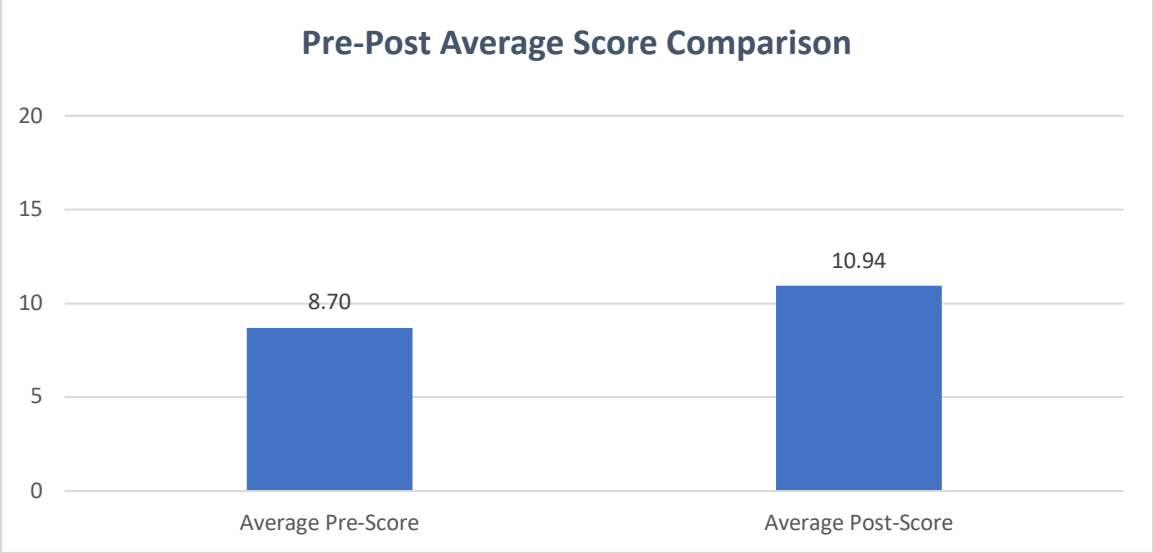

Figure 7: Pre-Post Average Score Comparison – Computer Science

Pre-Post Average Score Comparison by School

While all schools demonstrated significant increases from pre-post, One-Way ANOVA findings showed IHOM started significantly higher at pre-test compared to Patterson and My Precious Blood and finished significantly higher than both schools at post-test ($p<.001$). Patterson

and My Precious Blood started at statistically similar levels at pre-test, but My Precious Blood finished statistically higher at post-test compared to Patterson (p<.05).

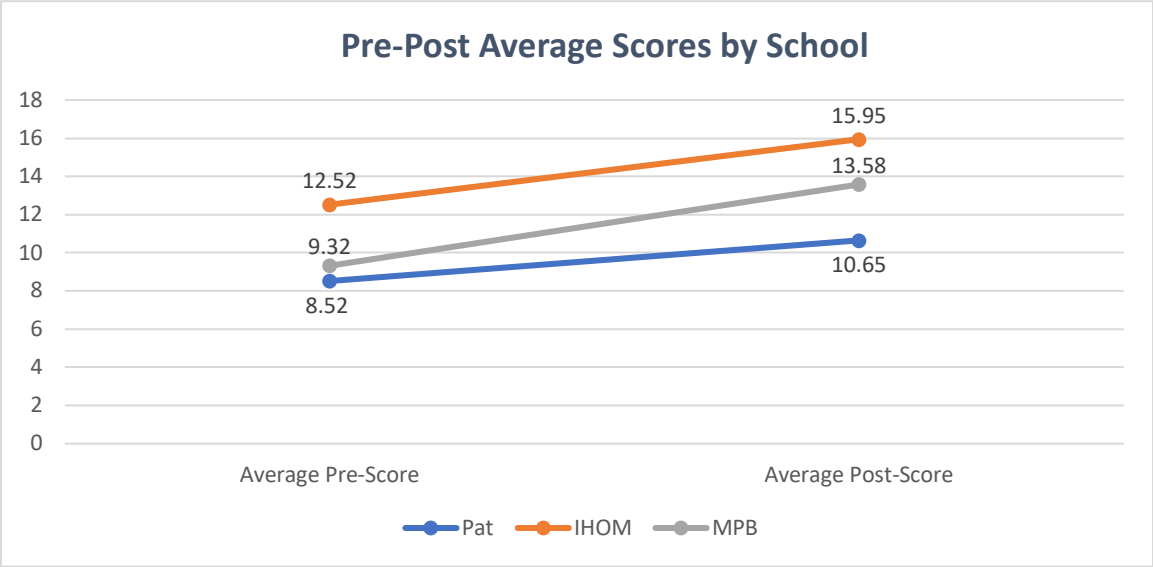

Figure 8: Pre-Post Average Score Comparison – By School

Item-Level Pre-Post Comparison

Chi-square tests of proportions were conducted at the item-level to look for statistically significant differences in average correct scores over time. Out of the 21 items on this assessment, students demonstrated growth on 20 items (95%) with statistically significant growth on 9 items (43%). Table 13 below shows items with statistically significant growth designated by an asterisk (*) in the Growth column.

Table 13. CSF Pre/Post Assessment Data Item Level Analysis for Other Schools

Item	Average Correct		Growth (percentage points)
	Pre	Post	
Item 1: Which word means the steps or procedures to be followed by computers to complete a specific task?	33%	51%	18%*
Item 2: Which definition best describes a loop?	53%	78%	24%*

Item 3: Which definition best describes debugging?	59%	72%	13%*
Item 4: Which word means a piece of reusable code that contains all of the procedures needed to perform a certain task?	30%	26%	-5%
Item 5: Which definition best describes a variable?	42%	46%	3%
Item 6: Which definition best describes a coordinate plane?	24%	30%	6%
Item 7: What type of block is this?	41%	67%	26%*
Item 8: ... and what type of block is this?	28%	40%	12%*
Item 9: This block helps to create a(n) _____.	57%	78%	21%*
Item 10: ... and this block helps to create a(n) _____.	29%	38%	9%
Item 11: Select the code that matches the following algorithm: When the green flag is clicked, the object will move up 10 units in a loop repeated 5 times.	51%	69%	18%*
Item 12: When used together, which statement is true about the scripts below? Check all that apply.	10%	26%	15%*
Item 13: Which of the following best describes the conditional statement below?	54%	65%	11%
Item 14: Identify the bug in the code below.	34%	40%	6%
Item 15: Which of the following is NOT a way to be safe online?	59%	72%	13%*
Item 16: When a device isn't working properly, which of the following is NOT an appropriate troubleshooting strategy?	54%	64%	10%
Item 17: Select the correct model for how computers process information.	39%	42%	3%
Item 18: Which steps are included in an iterative design process? Check all that apply.	6%	11%	5%
Item 19: Which is the best example of positive feedback?	75%	82%	7%
Item 20: When using other's work online, it is a sign of respect to include _____.	41%	45%	4%
Item 21: Which statement about assistive technology (AT) is true?	47%	55%	8%

JavaScript Course

GEO Academies was only one school who was included in this impact study who had completed the high school JavaScript course. The matched pre/post assessment student sample which was included for analysis was very small (n=7). The data set was formed from students who had a matched ID in both pre- and post- files and also had the same teacher code in both files (Table 14).

Table 14. JavaScript Pre/Post Participation Data for GEO Academies

Teacher Name or Code	Number of Students	Percentage of Group
GACSAP10	4	57%
CACSAP11	1	14%
CACSAP7	2	29%
Total	**7**	**100%**

Overall Pre-Post Average Score Comparison

Dependent samples *t*-tests were conducted and revealed a statistically significant increase in scores from pretest (average correct = 9.43) to posttest (average correct = 21.71); $t(6)=13.38$, $p<.001$. The effect size was extremely large ($d=5.01$) suggesting a strong impact on student scores from programming.

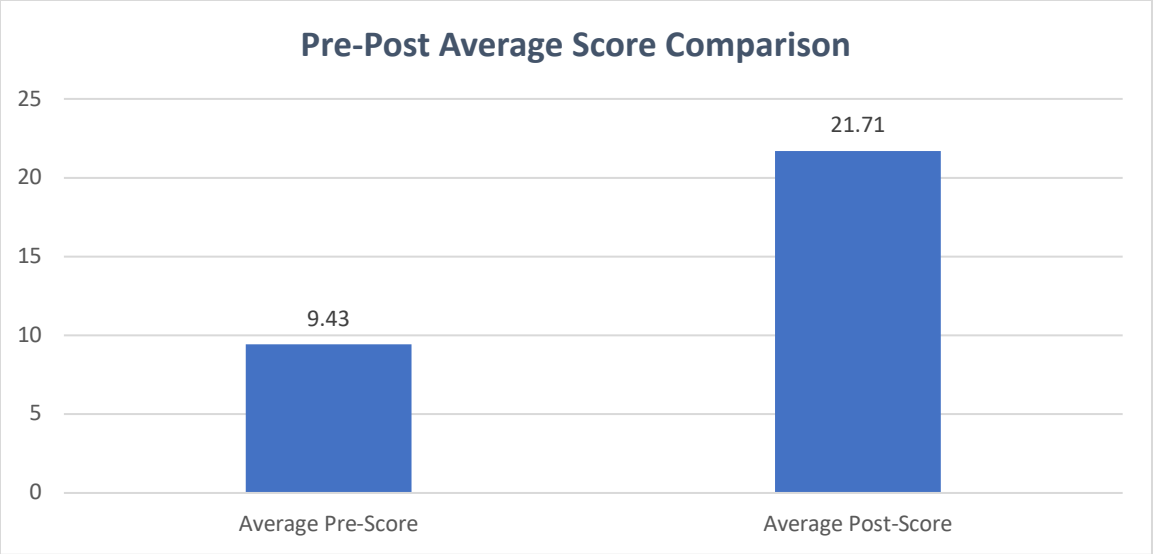

Figure 9: Pre-Post Average Score Comparison – By School

Item-Level Pre-Post Comparison

Chi-square tests of proportions were conducted at the item-level to look for statistically significant differences in average correct scores over time. Out of the 25 items on this assessment, students demonstrated growth on 22 items (88%) with statistically significant growth on all of these items. Table 15 designates items with statistically significant change by an asterisk (*) in the Growth column.

Table 15. JavaScript Pre/Post Assessment Data Item Level Analysis for GEO Academies

Item	Average Correct		Growth (percentage points)
	Pre	Post	
Item 1: Which of the following is the markup language that controls the styling of website content, text, and images?	0%	86%	86%*
Item 2: What HTML attribute creates a unique identifier for a tag to be individually styled in CSS?	57%	100%	43%*
Item 3: What are pixels?	71%	100%	29%*
Item 4: Which word means a container that can store one piece of data at a time?	29%	100%	71%*
Item 5: Which of these is NOT a primitive JavaScript data type?	43%	100%	57%*

Item 6: What is a structure in programming that executes code based on the result of a comparison?	29%	57%	29%*
Item 7: Which of the following statements best describes a while loop?	29%	100%	71%*
Item 8: Which JavaScript operator allows the value of a variable to be increased by one each time a loop is run?	29%	100%	71%*
Item 9: What is a data structure that stores a collection of values?	29%	100%	71%*
Item 10: What is the underlined symbol in the code below called?	29%	100%	71%*
Item 11: Which of the following JavaScript concepts is implemented in the block of code below?	14%	71%	57%*
Item 12: Classify the block of code below.	29%	100%	71%*
Item 13: What are the underlined values called?	43%	100%	57%*
Item 14: A _____ variable is surrounded by quotation marks.	29%	100%	71%*
Item 15: The _____ is used by JavaScript to manipulate HTML and CSS in order to create interactive website features.	29%	100%	71%*
Item 16: In order to invoke, or run, a function it must be declared and _____ .	0%	100%	100%*
Item 17: Which line of code is syntactically correct?	43%	43%	0%
Item 18: Which line of code has a mistake in syntax?	43%	100%	57%*
Item 19: What is the correct output for the block of code shown?	29%	43%	14%*
Item 20: What is the correct code for the output shown in the console?	29%	86%	57%*
Item 21: Which of the following cyber security measures is a physical precaution?	43%	86%	43%*
Item 22: Which of the following is a strong password?	100%	14%	-86%
Item 23: How should you respond to a cyberbully?	71%	86%	14%*
Item 24: Which of the following is information you can safely share online with anyone?	100%	100%	0%
Item 25: Which careers listed below use computer science skills? (select all that apply)	0%	100%	100%*

SUMMARY AND RECOMMENDATIONS

The 2021-22 Codelicious impact study included an examination of two partnering school districts and associated schools (case studies), as well as an examination of a small number of other schools. The purpose of the impact study was to examine the impact of participation in Codelicious curriculum/coursework on student outcomes as measured by the Codelicious pre/post assessment for each course. Findings from this study are summarized in Table 20.

Table 20. Summary of Findings

School Name	Grade and/or Course	Number of Matched Students	Overall Growth Significance and Effect Size
Pike Township	Kindergarten - CSF	229	yes, extremely large
Pike Township	Grades 1 and 2 - CSF	693	yes, extremely large
Pike Township	Grades 3 and 4 - CSF	355	yes, extremely large
Pike Township	Grades 5 - CSF	51	yes, extremely large
Barr Reeve	Grades 7 and 8 - CSA	125	yes, extremely large
Patterson Joint Unified, Immaculate Heart of Mary, Most Precious Blood	CSF	1,078	yes, extremely large
GEO Academies	HS JavaScript	7	yes, extremely large

Findings of this impact study indicate that participation in Codelicious curriculum (e.g., CSF, CSA, JavaScript) enabled students at elementary, middle, and high school levels to experience powerful gains in computer science knowledge and skills from pre- to post-assessment. There are three key findings of the 2021-22 Codelicious impact study:

Key Finding #1: Participation in the Computer Science Fundamentals (CSF) course enabled elementary students (n = 2,281) to experience significant growth from pre- to post-assessment with extremely large effect sizes.

Key Finding #2: Participation in the Computer Science Applications (CSA) course enabled middle school students (n = 135) at Barr Reeve to experience significant growth from pre- to post-assessment with extremely large effect sizes.

Key Finding #3: Though a smaller than desired sample size, participation in the JavaScript course enabled high school students (n = 7) to experience significant growth from pre- to post-assessment with extremely large effect sizes.

It is recommended that Codelicious engage in annual examination of student outcomes of participation in coursework for informing continuous improvement and timely enhancements of the curriculum. However, there are specific recommendations that have emerged from this impact study:

Recommendation #1: Codelicous should consider examining items of difficulty (those assessment items with lower percentages correct at post) for participating schools/students in this impact study as potential areas to strengthen the various coursework curriculum.

Recommendation #2: Based upon findings of the Barr Reeve case study, Codelicious should examine the impact of multiple years of experience with Codelicious on student outcomes and learning (e.g., eighth grade students had more significant gains that seventh grade students).

Recommendation #3: Codelicious should work with partners to make available more demographic data to use for in-depth analysis at the student level of pre- and post-assessment outcomes. This was possible with Barr Reeve data which revealed female students experienced significantly higher gains than male students.