Applied Learning Student Questionnaire: Analysis

Carroll County Schools Full STEAM Ahead
December 2018 Survey
February 19, 2019

Executive Summary
Participants and Methods

In December 2018, 50 students participating in the Carroll County Schools Full STEAM Ahead program completed the Applied Learning Student Questionnaire (ALSQ). Full STEAM Ahead is a Fiscal Year 2017 Innovation Fund scaling grant program. Eighty percent of the 62 students currently served by the grant program completed the survey. The ALSQ is designed to measure gains related to student problem solving and communication skills, self-management, and engagement before the program and at the time of the survey.

The ALSQ is a self-report questionnaire that includes 36 items to assess students' attitudes on the following survey constructs:

1. Intrinsic Motivation: motivation stemming from goals of mastery, learning, and rigor. Example: "It is important for me to learn what is being taught in this program."
2. Self-Management/Self-Regulation: effortful and persistent behaviors that are used to guide, monitor, and direct the success of one's learning and performance. Example: "I turn all my assignments in on time."
3. Intent to Persist: aspirations, plans, and goals to pursue additional education and a career in STEM. Example: "I intend to get a college degree in STEM (Science, Technology, Engineering, and Math)."
4. Problem-Solving: inquiry-based learning environment that provides higher-order cognitive tasks and real-world application. Example: "I work out explanations on my own."
5. Implementation Activities: hands-on activities designed to increase exposure to STEM topics and real-world application. Example: "We learn what scientists/technicians/engineers/mathematicians or other STEM professionals do."

Results and Discussion

- **Overall Summary**
    - Students showed statistically significant increases in *Intrinsic Motivation*, *Self-Management/Self-Regulation*, and *Intent to Persist* from before the program to now.
    - The largest student gains observed and the highest "now" score (4.14) were in the *Intrinsic Motivation* construct.
    - The "now" score for *Intent to Persist* was the lowest (3.67) among all constructs, suggesting that the program should increase student engagement with STEM projects and activities.
    - The average program rating for Full STEAM Ahead exceeded the optimal average of 4.00 with an average of 4.40, suggesting that students view the program positively.

- **ALSQ Survey Constructs**
  Table 1 summarizes students' attitudinal gains from before the program to now. Overall, the results suggest that students showed statistically significant increases in *Intrinsic Motivation*, *Self-Management/Self-Regulation*, and *Intent to Persist* from before the program to the time of survey.
    - The largest student gains observed were in the *Intrinsic Motivation* construct.
        - For example, at the start of the program, only 46% of students reported that they liked what they are learning in the program; now, 78% of students like what they are learning.
    - The "now" score for *Intrinsic Motivation* exceeded the optimal average of 4.00 on a 5-point Likert scale (1, Strongly Disagree to 5, Strongly Agree).
    - The lowest "now "score was 3.67 in the *Intent to Persist* construct.

In addition to assessing statistical significance from "before" to "now," effect sizes—a measure of the magnitude of an intervention's impact on students' attitudes—were computed. Specifically, effect sizes were computed using Cohen's *d* and are intended to measure the practical importance of a significant finding.[1] Cohen (1988) classified effect sizes as small, $d < 0.2$; medium, $0.2 \leq d \leq 0.8$; and large, $d > 0.8$.[2] The *Intrinsic Motivation*, *Self-Management/Self-Regulation*, and *Intent to Persist* constructs showed medium effect sizes. The largest effect size observed was for *Self-Management/Self-Regulation* (d=0.76), indicating that the program was moderately effective in enhancing students' ability to plan and manage tasks and behaviors related to their education. For example, after participating in the program, 56% of students said they set aside time to do homework and study, compared to just 34% before the program.

Table 1. Summary of Results by Construct

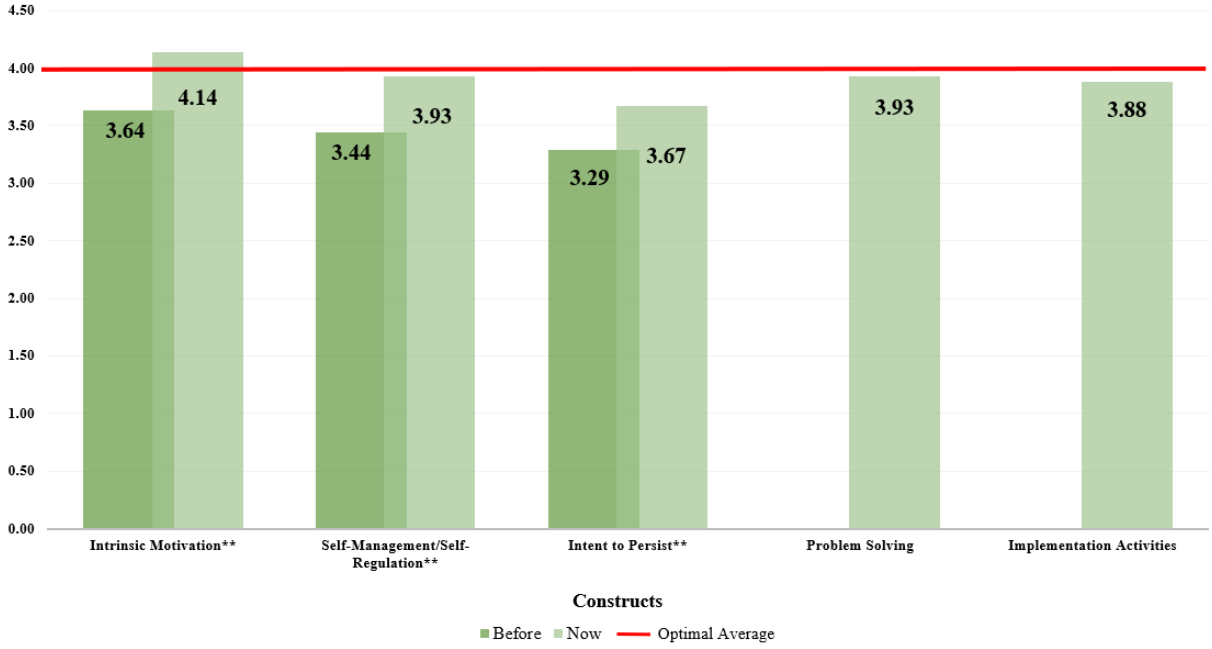
Overall - Constructs					
Constructs		**n**	**Mean[1]**	**Paired Samples t-test[2]**	**Effect Size (interpretation)[3]**
Intrinsic Motivation	Before	50	3.64	p < 0.001**	0.70 (Medium)
	Now	50	4.14		
Self-Management / Self-Regulation	Before	50	3.44	p < 0.001**	0.76 (Medium)
	Now	50	3.93		
Intent to Persist	Before	50	3.29	p < 0.001**	0.50 (Medium)
	Now	50	3.67		
Problem Solving	Now	50	3.93	--	--
Implementation Activities	Now	50	3.88	--	--

Note. Refereence lines are set at 3.50 and 4.00 Please note that only students with matched Pre and Post data were assessed for significance. Desired statistically significant changes are highlighted in green. Negatively worded statements were reverse coded for mean computations. **p<0.001, *p<0.01, †p<0.05. See Tables 5-9 for more detailed information. Effect size (Cohen's d): Small (<.2); Medium (.2 to .8); Large (>.8). Small effect sizes are highlighted in light red; medium effect sizes are highlighted in dark orange; large effect sizes are highlighted in dark green.

[1] Effect sizes were calculated using Stata.

[2] Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed). Hillsdale, NJ: Lawrence Earlbaum Associates.

Figure 1. Constructs



Note. A paired samples t-test was used to compute the p-value. **p<0.001, *p<0.01, †p<0.05.

- **Program Rating**
  Students rated Full STEAM Ahead above the optimal average of 4.00. On a 5-point Likert scale where 1 signifies *very poor* and 5 signifies *excellent*, the average score was 4.40. Eighty-six percent of respondents rated the program as either being excellent or good. These ratings suggest that students view the program positively.

Table 2.Program Rating

Program Rating:	n	Mean	Assessment		(1) Very Poor	(2) Poor	(3) Average	(4) Good	(5) Excellent
All Students	50	4.40	Good		0%	2%	12%	30%	56%

- **Areas for Further Improvement**
  The "now" score for *Intent to Persist* was the lowest (3.67) among all constructs. Of the five sub-items, three items received average ratings below 3.50:
  - Considering a career in STEM,
  - Intending to get a college degree in STEM, and
  - Desiring a career in STEM.

  The *Self-Management/Self-Regulation, Problem Solving,* and *Implementation Activities* constructs also had "now" scores below 4.00. Of the seven sub-items with before and now responses under *Self-Management/Self-Regulation*, all but two saw statistically significant increases. Across the three constructs, the following items received some of the lowest scores:
  - "I set aside time to do my homework and study." (Self-Management/Self-Regulation)

- "In this program, my teacher(s) let us choose our own topics or projects to investigate." (Problem Solving)
- "In this program, we do our work in groups." (Implementation Activities)

Although the *Intrinsic Motivation* construct had the highest overall "now" score, one item within the construct had a particularly low score:

- "I prefer class work that is challenging so I can learn new things." (3.46)

The students' ratings suggest that providing more opportunities for students to self-discover and engage in real-world STEM problems may improve interest in STEM. The program can also increase student self-management skills by giving students more agency over the types of projects they complete in the program. Tables 3-11 include a full analysis of survey results, as well as the specific survey item language.

Table 3. Intrinsic Motivation

	Intrinsic Motivation		n	Mean[1]	Paired Samples t-test[2]	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
1)	I prefer class work that is challenging so I can learn new things.	Before	50	2.98	p < 0.01*	14%	22%	36%	8%	20%
		Now	50	3.46		6%	12%	30%	34%	18%
2)	It is important to me to learn what is taught in this program.	Before	50	3.66	p < 0.01*	4%	6%	30%	40%	20%
		Now	50	4.24		2%	8%	6%	32%	52%
3)	I like what I am learning in this program.	Before	50	3.54	p < 0.001**	2%	12%	40%	22%	24%
		Now	50	4.16		2%	2%	18%	34%	44%
4)	I think I will be able to use what I learn in this program in other classes.	Before	50	3.82	p < 0.01*	2%	6%	30%	32%	30%
		Now	50	4.22		2%	4%	12%	34%	48%
5)	Even when I do poorly on a test, I try to learn from my mistakes.	Before	50	3.66	p < 0.001**	6%	10%	26%	28%	30%
		Now	50	4.38		2%	0%	10%	34%	54%
6)	I think that what I am learning in this program is useful for me to know.	Before	50	3.66	p < 0.001**	4%	2%	34%	44%	16%
		Now	50	4.20		2%	0%	14%	44%	40%
7)	I think that what we are learning in this program is interesting.	Before	50	3.62	p < 0.001**	0%	12%	36%	30%	22%
		Now	50	4.16		0%	2%	24%	30%	44%
8)	Understanding STEM (Science, Technology, Engineering, and Math) is important to me.	Before	50	4.04	p = 0.15	2%	6%	18%	34%	40%
		Now	50	4.28		4%	0%	8%	40%	48%
9)	I enjoy STEM (Science, Technology, Engineering, and Math) in general.	Before	50	3.74	p < 0.01*	4%	6%	26%	40%	24%
		Now	50	4.14		6%	2%	2%	52%	38%

Note. [1]Reference lines are set at 3.5 and 4. [2]Please note that only students with matched Pre and Post data were assessed for significance. Desired statistically significant changes are highlighted in green and undesired statistically significant changes are highlighted in red. **p<0.001, *p<0.01, †p<0.05. Highest percentages are highlighted in gray.

Table 4. Self-Management / Self-Regulation

Self-Management/Self-Regulation		n	Mean[1]	Paired Samples t-test[2]		1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
10) I turn all my assignments in on time.	Before	50	3.16	p < 0.001**		4%	20%	40%	28%	8%
	Now	50	3.96			2%	2%	26%	38%	32%
11) I miss class often. (negatively worded)	Before	50	2.44	p = 0.67		32%	18%	30%	14%	6%
	Now	50	2.38			42%	12%	20%	18%	8%
12) I am often late for class. (negatively worded)	Before	50	2.34	p = 0.08		36%	22%	24%	8%	10%
	Now	50	2.10			50%	18%	14%	8%	10%
13) I set aside time to do my homework and study.	Before	50	3.12	p < 0.001**		10%	14%	42%	22%	12%
	Now	50	3.62			6%	8%	30%	30%	26%
14) When I say I'm going to do something, I do it.	Before	50	3.46	p < 0.001**		4%	18%	28%	28%	22%
	Now	50	4.12			0%	4%	24%	28%	44%
15) I am a hard worker.	Before	50	3.70	p < 0.001**		0%	10%	32%	36%	22%
	Now	50	4.16			2%	2%	14%	42%	40%
16) I finish whatever I begin.	Before	50	3.44	p < 0.001**		6%	16%	28%	28%	22%
	Now	50	4.10			2%	4%	16%	38%	40%

Note. [1]Reference lines are set at 3.5 and 4. [2]Please note that only students with matched Pre and Post data were assessed for significance. Desired statistically significant changes are highlighted in green. **p<0.001, *p<0.01, †p<0.05. Highest percentages are highlighted in gray. Statements 11 and 12 are negatively worded; signficance is measured in the reverse direction as the other statements.

Table 5. Intent to Persist

Intent to Persist		n	Mean[1]	Paired Samples t-test[2]	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
17) I am considering a career in STEM (Science, Technology, Engineering, and Math).	Before	50	3.02	p < 0.001**	14%	12%	42%	22%	10%
	Now	50	3.42		8%	8%	32%	38%	14%
18) I intend to get a college degree in STEM (Science, Technology, Engineering, and Math).	Before	50	3.02	p < 0.01*	12%	14%	42%	24%	8%
	Now	50	3.40		6%	8%	36%	40%	10%
19) I can see myself working in STEM (Science, Technology, Engineering, and Math).	Before	50	3.04	p < 0.001**	14%	16%	32%	28%	10%
	Now	49	3.52		8%	8%	24%	41%	18%
20) Someday, I would like to have a career in STEM (Science, Technology, Engineering, and Math).	Before	50	3.08	p < 0.01*	12%	10%	44%	26%	8%
	Now	50	3.48		8%	10%	30%	30%	22%
21) I intend to graduate from high school.	Before	50	4.28	p = 0.03†	4%	6%	8%	22%	60%
	Now	50	4.52		2%	2%	6%	22%	68%

Note. [1]Reference lines are set at 3.5 and 4. [2]Please note that only students with matched Pre and Post data were assessed for significance. Desired statistically significant changes are highlighted in green. **p<0.001, *p<0.01, †p<0.05. Highest percentages are highlighted in gray.

Table 6. Problem Solving, Now Only

	Problem Solving	n	Mean[1]		Assessment	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
22)	In this program, my teacher(s) tells me how to improve my work.	50		4.22	Good	0%	0%	16%	46%	38%
23)	In this program, my teacher(s) lets us choose our own topics or projects to investigate.	50		3.44	Action	6%	8%	42%	24%	20%
24)	In this program, I work out explanations on my own.	50		3.66	Attention	2%	6%	28%	52%	12%
25)	In this program, I have opportunities to explain my ideas.	50		3.92	Attention	2%	4%	22%	44%	28%
26)	In this program, we plan and do our own projects and/or experiments.	50		3.72	Attention	6%	2%	36%	26%	30%
27)	In this program, we work on real-world problems.	50		3.74	Attention	6%	8%	18%	42%	26%
28)	In this program, we have class discussions.	50		4.24	Good	0%	4%	12%	40%	44%
29)	In this program, we investigate to see if our ideas are right.	50		4.00	Good	0%	2%	24%	46%	28%
30)	In this program, we need to be able to think and ask questions.	50		4.20	Good	0%	0%	16%	48%	36%
31)	In this program, we are expected to understand and explain ideas.	50		4.14	Good	0%	2%	22%	36%	40%

Note. [1]Reference lines are set at 3.5 and 4.0. Assessment: Good = 4.0 or higher; Attention = Below 4.0; Action = Below 3.5. Highest percentages are highlighted in gray.

Table 7. Implementation Activities, Now Only

Implementation Activities	n	Mean[1]	Assessment	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
32) In this program, my teacher(s) takes notice of students' ideas.	50	3.90	Attention	2%	4%	22%	46%	26%
33) In this program, my teacher(s) shows us how new information relates to what we have already learned.	50	4.28	Good	0%	0%	18%	36%	46%
34) In this program, we learn what scientists/ technicians / engineers / mathematicians or other STEM professionals do.	50	3.76	Attention	0%	8%	32%	36%	24%
35) In this program, we do our work in groups.	50	3.68	Attention	4%	6%	28%	42%	20%
36) In this program, we interact with scientists / technicians / engineers / mathematicians or other STEM professionals.	50	3.80	Attention	4%	6%	24%	38%	28%

Note. [1]Reference lines are set at 3.5 and 4.0. Assessment: Good = 4.0 or higher; Attention = Below 4.0; Action = Below 3.5. Highest percentages are highlighted in gray.

Table 8. Educational Plans

What is the highest level of education you plan to achieve?	Before		Now		*Change*[1]	
	n	%	n	%		
High School	28	57%	23	49%	-5	-8%
2-year college	7	14%	8	17%	1	3%
4-year college	8	16%	11	23%	3	7%
Graduate School	5	10%	2	4%	-3	-6%
Professional School	1	2%	3	6%	2	4%
Total	**49**	**100%**	**47**	**100%**		
Average[2]	**2.10**		**2.41**		**p = 0.164**	

[1] Change from Before to Now. Increases are highlighted in green; decreases are highlighted in red. [2]To compute averages, the following codes were applied: High School (1), 2-year college (2), 4-year college (3), Graduate School (4), Professional School (4). [3]Paired samples t-test, p-value: **p<0.001, *p<0.01, †p<0.05.

Table 9. Student Changes in Educational Plans

Educational Aspirations Now	n	%
Lower than before	1	2%
Same as before	39	83%
Higher than before	7	15%
Total	**47**	**100%**

Table 10. Demographics

Ethnicity	n	%
Asian	1	2%
Black	6	12%
Hispanic	4	8%
Native American/Alaskan	2	4%
White	29	58%
Multiracial	6	12%
Other	2	4%
Total	**50**	**100%**

Grade	n	%
9th	9	19%
10th	33	69%
11th	4	8%
12th	1	2%
Other	1	2%
Total	**48**	**100%**

Gender	n	%
Female	17	35%
Male	32	65%
Total	**49**	**100%**

Table 11. Participation

How long have you participated in this program?		n	%
	0 semesters	2	4%
	1 semester	28	56%
	2 semesters	10	20%
	3 semesters	5	10%
	4 or more semesters	1	2%
	Don't Know	4	8%
	Total	**50**	**100%**

Did you participate in this program during the summer?		n	%
Summer Participation	Yes	12	24%
	No	38	76%
	Total	**50**	**100%**

Appendix A. Construct Reliabilities

Table A1. Construct Reliabilities

Constructs		Cronbach's alpha	*Reliability Interpretation*
Intrinsic Motivation (9 items)	Before	0.868	*Very Good*
	Now	0.892	*Very Good*
Self-Management/Self-Regulation (7 items)	Before	0.649	*Somewhat low*
	Now	0.632	*Somewhat low*
Intent to Persist (5 items)	Before	0.729	*Good*
	Now	0.737	*Good*
Problem Solving (10 items)	Now	0.848	*Very Good*
Implementation Activities (5 items)	Now	0.762	*Good*

Cronbach's Alpha Reliability Key: Cronbach's alpha is a measure of the internal consistency of items in a construct. This statistic ranges from 0 to 1; the higher the value the better. An alpha of 0.80 or higher is considered to have achieved very good measurement reliability; an alpha of 0.65 is considered acceptable (Field, 2009).

Reliability	Interpretation
0.90 and above	Excellent reliability; at the level of the best measures
0.80 – 0.90	Very good
0.70 – 0.80	Good; in the range of most. There are probably a few items which could be improved.
0.60 – 0.70	Somewhat low. This measure needs to be supplemented by other measure (e.g., more surveys) to determine outcomes. There are probably some items which could be improved.
0.50 – 0.60	Suggests need for revision of measure, unless it is quite short (ten or fewer items). The test definitely needs to be supplemented by other measure (e.g., more tests).
0.50 or below	Questionable reliability. This measure should not contribute heavily to the outcomes and needs revision.

From: J. C. Nunnally, Psychometric Theory. New York: McGraw-Hill, 1967, pp. 172-235.

Reference:

Field, A. (2009). *Discovering Statistics Using SPSS, 3rd Edition.* Thousand Oaks, CA: Sage Publications.