THE BASICS STUDY STUDENT QUESTIONNAIRE MEASURES, SPRING 2016

Project Overview:
The Barriers and Supports to Implementing Computer Science (BASICS) study is a three-year exploratory research project funded by the National Science Foundation (#1339256) as part of the CS10K program – an ambitious effort to have 10,000 well-trained computer science teachers in 10,000 schools. The BASICS study seeks to contribute to this effort in part by creating and sharing valid and reliable tools to measure implementation of an introductory computer science curriculum (Exploring Computer Science, or ECS) and the key supports and barriers that affect implementation. Over the course of three years, researchers at Outlier Research & Evaluation at UChicago STEM Education, a Center at the University of Chicago developed and then administered this questionnaire to students in classes using ECS in school districts across the country. BASICS is not, in any way, an evaluation of ECS. Rather, the BASICS study focused on the ECS curriculum as it is widely used to teach introductory high school computer science.

This instrument was created using an approach that built from earlier Outlier studies of instructional resource implementation. In that earlier work, Outlier developed a conceptual framework for implementation measurement that systematically organizes instructional resources into components. It also organizes the factors affecting implementation into several categories (Century, Cassata, Rudnick & Freeman, 2012). Because the questionnaires were developed with this conceptual foundation (and adapted for use with the ECS materials, informed by a group interview with the ECS developers about the main components), they can be customized for use with instructional resources beyond ECS. Please contact us for additional information.

Over the course of questionnaire development, the instrument was reviewed to assess content validity and usability by an ECS team member and an ECS teacher advisor, and administered three times to students in introductory computer science classes using the Exploring Computer Science curriculum. All rounds of data collection included enough respondents to perform psychometric analysis to achieve optimal reliability and validity (n=232 in Spring 2014; n=957 in Spring 2015; and n=714 in Spring 2016).

We are sharing *all* of the items used in the final administration so that individuals interested in *using only subscales that demonstrated reliability* (i.e., internal consistency; see Cronbach's α for each scale) can do so, while others interested in seeing or using items that were removed to improve model fit may have that option. Items that were excluded from the final subscale

versions due to low factor loading or large or significant modification indices on other scales are listed below scales from which they were removed. **Technical information** about the instrument is included at the end of this document.

Questionnaire Overview:
The questionnaire is organized into three sections: (1) items and scales for measuring **implementation of the ECS curriculum**, (2) items and scales for measuring **contextual factors** that influence how students engage in the CS class, and (3) items for capturing **student socio-demographics**. The headers used here were not shown to respondents as they took the questionnaire.

Descriptive statistics from our 2016 administration of this questionnaire are available here.

References Cited

Century, J., Cassata, A., Rudnick, M., & Freeman, C. (2012). Measuring Enactment of Innovations and the Factors that Affect Implementation and Sustainability: Moving Toward Common Language and Shared Conceptual Understanding. Journal of Behavioral Health Services & Research. 39 (4) 343-361.

Please acknowledge Outlier in any publications using all of part of this instrument using the following citation: Outlier Research & Evaluation (September, 2017). *BASICS Study ECS Student Implementation and Contextual Factor Questionnaire Measures* [Measurement scales]. Chicago, IL; Outlier Research & Evaluation at UChicago STEM Education | University of Chicago. Retrieved from http://outlier.uchicago.edu/basics/resources/Measures-StudentImplementation/

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The Student Instrument

Implementation This section includes student report items of: a) teacher instruction with the ECS curriculum (i.e., student perception of strategies that 2teachers enact during instruction to support student learning) and b) student engagement in the class.

Student Perception of Teacher Instruction with the Exploring Computer Science (ECS) Curriculum

Subscales

Teacher Facilitation of Student Autonomy (Cronbach's α=0.81)

Prompt	Items	Response Scale
How often in the past month did your teacher ask you to do the following?	Make my own goals for learning computer science.	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Make my own choices about assignments related to my computer science class.	
	Work in my computer science class without the teacher telling me what to do or managing my work time.	

Teacher Facilitation of Cognitively Demanding Work (Cronbach's α=0.92)

Prompt	Items	Response Scale
Think about what happened in your computer science class in the past month. During that time, how often did your teacher ask you to do the following?	Analyze data (organize, process, manipulate, or evaluate data).	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Explain the logic and reasoning supporting my solutions to problems.	
	Explain why I agreed or disagreed with the work of other students in class.	
	Communicate my thought processes to others.	
	Problem solve when something didn't work the way I wanted it to work.	

Excluded Item:
Consider alternative approaches to my work.

Teacher Facilitation of Student Interest (Cronbach's α=0.92)

Prompt	Items	Response Scale
How often in the past month did your computer science teacher do the following?	Asked me to consider relationships between what I was learning in the lesson and real world problems (meaning actual events or situations within or outside of school).	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Connected a lesson or classroom activities to my own life (e.g., by asking about my past experiences, or applying content to my daily life).	
	Made activities and projects interesting to me by sharing relevant stories, using humor, bringing in guest speakers, etc.	
	Connected lesson content with current events.	

Descriptive items

Student Grouping Strategies

Prompt	Items	Response Scale
How often did you do the following in your computer science class in the past month?	I worked with a partner (2 people).	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	I worked in a small group (3 or more people).	
	I worked with the whole class.	
	I worked independently/alone.	

Student Self-Report of Engagement in a Class Using the Exploring Computer Science (ECS) Curriculum

Subscales

Student Contribution to Small Group Work (Cronbach's α=0.91)

Prompt	Items	Response Scale
In the past month, how often did you do the following when working in a small group?	Contributed to group work (verbally or nonverbally).	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions
	Worked collaboratively with other students.	

	Shared responsibility for activity and project work with group members.	5 - Once or more per class session

Student Engagement in Discussion (Cronbach's α=0.90)

Prompt	Items	Response Scale
How often did you do the following in your computer science class in the past month?	Talked to other students about my computer science work.	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Responded to questions other students had about their computer science work.	
	Discussed what I was learning with other students in the class.	

Student Engagement in Cognitively Demanding Work (Cronbach's α=0.93)

Prompt	Items	Response Scale
Think very carefully about your work in computer science class over the past month. During that time, how often did you do the following?	Problem solved when something didn't work the way I wanted it to work.	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Considered alternative approaches to my work.	
	Analyzed data (organized, processed, manipulated, evaluated data).	
	Explained the logic and reasoning supporting my solutions to problems.	
Excluded Item: Communicated my thought processes to others.		
Excluded Item: Explained why I agreed or disagreed with the work of other students.		

Students Work Autonomously (Cronbach's α=0.80)

Prompt	Items	Response Scale
How often did you do the following in your computer science class in the past month?	Set my own goals for learning computer science in class.	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Made my own choices about assignments in computer science class.	
	Worked on my own without the teacher telling me what to do or managing my work time.	

Student Risk-Taking (Cronbach's α=0.89)

Prompt	Items	Response Scale
How often did you do the following in your computer science class in the past month?	Asked questions when I was confused about activities or assignments.	1 - Never 2 - A few classes 3 - About half the class sessions 4 - Many class sessions 5 - Once or more per class session
	Tried new things in class even when I was not sure how to do them.	
	Tried something I thought I might fail.	
	Answered questions even when I was not sure if it was correct.	

Contextual Factors

This section includes items that measure the presence and extent of a range of factors that can influence: a) student engagement in and attitude toward computer science as a field of study generally, and b) student feelings about their current computer science class more specifically.

Computer Science: General

Subscales

Computer Science Interest (Cronbach's α=0.94)†

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements?	I am interested in learning more computer science.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	I am interested in taking more computer science classes in school (high school or after high school).	
	I am interested in doing computer science outside of school time.	

Computer Science Ability Beliefs (Cronbach's α=0.89)

Prompt	Items	Response Scale
	I am better at computer science than most of the other kids at my school.	
	I am very good at computer science.	
	I can figure out how to solve the most difficult problems in my computer science class if I try.	

Excluded Item: I have the ability to learn computer science.

Perceived Relevance of Computer Science to Future/Future Time Perspective (Cronbach's α=0.90)

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements?	Computer science is necessary for me to accomplish what I want in school.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	Computer science will help me reach my goals for college/career.	
	What I learn in computer science will benefit my future.	

Excluded Item: I think it is useful for me to learn computer science.

Computer Science Identity (Cronbach's α=0.84)†

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements?	Kids like me do computer science.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	I like computer science more than other kids at my school.	
	I think I could become a computer scientist one day.	

Excluded Item: I do computer science in my free time.

Descriptive items

School Community Support for Computer Science

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements?	Teachers and administrators at my school think that computer science is just as important as math and science.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	Guidance counselors at my school think that computer science is just as important as math and science.	
	My teachers are encouraging me to do more with computer science.	

	My guidance counselor is encouraging me to do more with computer science.	

Community Values/ Perceptions of Support for Computer Science: Friends & Family

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements?	My friends think it would be good to choose a job/career in computer science.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	My friends think it is important for students to take computer science.	
	My family members think it would be good for me to choose a job/career in computer science.	
	My family thinks it is very useful for me to take this course.	
	My family thinks I should take more computer science courses.	

Interest in More Computer Science Courses

Item	Response Options
If you had the opportunity to take more computer science courses in the future, would you?	Yes
	No

Interest in Computer Science Career†

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements?	I am interested in pursuing a career in computer science.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	I think I would enjoy a career in computer science.	

Beliefs & Values about Computer Science

Item	Response Options (respondents select one)
Select the one statement that you agree with the most about introductory computer science in high schools.	Introductory computer science should be required for all high school students.
	Introductory computer science should only be required for some high school students (for example, students in a CTE program, or a school computer science "major," pathway," or "cluster" with computer science requirements).
	Introductory computer science should only be offered to high school students as an elective option.

Friends and Family in Computer Science

Items	Response Options
Do you know anyone outside of school who works in computer science? (For example, working as a Computer Programmer, Software Developer, Web Developer, Network Administrator, etc.)	Yes
	No
	Response Scale (using slider bar)
[If "YES" to above] On a scale of 0-5 where "0" = Not at all and "5" = A great deal, how much has this person or these people influenced your interest in continuing to learn computer science? Please drag the slider to the appropriate influence level.	0 (not at all)
	1
	2
	3
	4
	5 (a great deal)

Friends and Family Interest in Computer Science

Items	Response Options
Do you have friends or family members who are interested in computer science?	Yes
	No
	Response Scale (using slider bar)
[If "YES" to above] On a scale of 0-5 where "0" = Not at all and "5" = A great deal, how much has this person or these people influenced your interest in continuing to learn computer science? Please drag the slider to the appropriate influence level.	0 (not at all)
	1
	2
	3
	4
	5 (a great deal)

School/District Computer Science Requirement

Item	Response Options
Is this computer science course required for you?	Yes
	No
	I don't know

Prior Computer Science Experience at School

Items	Response Options
Before your current computer science class, had you taken any other computer science classes at school?	Yes
	No
[If "YES" to above] What computer science course(s) had you taken before your current computer science class?	[Open response]

Prior Computer Science Experience Outside of Formal School

Items	Response Options
Have you ever participated in computer science activities or programs somewhere outside of school hours (such as at an after school program, online, or at a camp or summer program)?	Yes
	No
[If "YES" to above] Where did you previously take a computer science class or program outside of school hours? Select all that apply.	After school program at my school
	After school program somewhere else (e.g., Boys and Girls Club, etc.)
	Online program
	Summer program/camp
	Other

Prior Computer Science Experience: Content

Item	Response Options
[If "YES" to participation in CS outside of school hours OR "YES" to prior CS experience in school] What topic(s) did you learn about during your computer science activity or program? Select all that apply.	Programming/Coding
	Robotics
	Security/Cyber Security
	Web design
	Game design
	App making
	Other

Computer Science: Feelings About the Class

Subscales

Attitude/Motivation for Class (Cronbach's α=0.96)

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements about your computer science class?	I like my computer science class.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	I think my computer science class is interesting.	
	I enjoy my time in computer science class.	
	I like doing the activities we do in my computer science class.	

Sense of Belonging (Cronbach's α=0.95)†

Prompt	Items	Response Scale
How much do you agree or disagree with the following statements about your computer science class?	I feel that I am supported in this computer science class.	1 - Completely Disagree 2 - Mostly Disagree 3 - Slightly Disagree 4 - Slightly Agree 5 - Mostly Agree 6 - Completely Agree
	I feel that I am a part of this computer science class.	
	I feel that I am accepted in this computer science class.	
	I feel comfortable in this computer science class.	

Note: This scale was adapted from one validated in a University of Washington multi-institution study about connections to community at the undergraduate level (for more details, see: http://www2.ee.washington.edu/research/community/Community/Belonging.html).

Descriptive items

Challenges Enrolling in Computer Science

Item	Response Options (respondents select up to three)
There may have been some things that made you consider NOT taking this computer science course. Pick up to three statements that are most true for you. If none of these are true for you, select the option at the bottom of the list to tell us	It was difficult to fit this course in to my schedule.
	I didn't know what the course was about.
	I wasn't sure I would have all of the skills I would need.
	The course conflicted with an elective I wanted to take.
	I thought I needed a computer at home to take the course (and I didn't have one).
	No one in the school told me about the course (e.g. teacher, counselor, principal, etc.).
	My family did not want me to take this computer science course.

none of these were true for you.	No one I knew was taking the course.
	People in the school advised me against taking introductory computer science (e.g. teacher, counselor, principal, etc.).
	Other
	None of these were true for me.

Recommendation of Computer Science Class

Items	Response Options
Would you recommend that another student take this computer science class?	Yes
	No
[If "YES" to above] Please explain why you would recommend this computer science class to another student.	[open response]
[If "NO" to above] Please explain why you would not recommend this computer science class to another student.	[open response]

Student Socio-Demographics

These descriptive items ask about the characteristics of students that are also potential correlates of engagement in and experience with computer science learning.

Student Characteristics

Items	Response Options
What grade are you in?	[List grade response options for your study]
How old are you?	[List age response options for your study]
I identify my gender as:	Male
	Female
	Other
	Prefer not to answer
Which of the following best represents your racial and/or ethnic identity? Select all that apply.	[List response options]

Access to Technology at Home

Items	Response Options
Do you have access to technology in your home now?	Yes
	No
[If "YES" to above]: Select all the technology you have access to in your home.	Computer (desktop or laptop)
	Tablet (e.g., Kindle Fire, iPad, etc.)
	Smart phone
	Internet access

School Context

Items	Response Options
Are you in a CTE (Career and Technical Education) program?	Yes
	No
	I don't know
What region do you live in?	[List school districts/regions for your study]
Where do you go to school?	[List school names by district/region for your study and a "My school is not on the list" option] [1]
What is your computer science teacher's last name?	[List teacher last names by district/region for your study] [2]

[1] If "My school is not on the list" was selected, participants were prompted to write in the name of their school.
[2] If "My teacher is not on the list" was selected, participants were prompted to write in the name of their teacher. If you plan to administer this student questionnaire along with the corresponding BASICS teacher questionnaire with the intent of linking student responses to their classroom teacher's responses, this item is needed.

† The Year 3 (spring 2016) BASICS instrument included these subscales/items for the first time. Items grouped as scales showed strong internal consistency and performance in CFA analyses; we recognize that future work can further validate these scales with more samples of high school students.

Technical Information about the Student Instrument

The BASICS team recognized that not everyone in the community would want/need to use the entire BASICS Student Questionnaire. Rather, we suspect it is more likely that researchers and evaluators will find value in certain components, or categories of the instrument. For example, an evaluator may need validated Student Questionnaire subscales to systematically measure implementation from the student perspective (e.g., *Student Engagement in Cognitively Demanding Work*) but may not need any contextual factor subscales to measure potential supports and barriers to engagement in CS (e.g., *Computer Science Ability Beliefs*), or vice versa.

Moreover, we view the questionnaire categories as completely distinct from one another (i.e., the implementation subscales are distinct from the contextual factor subscales) and not part of one larger, multi-dimensional construct. Thus, in the final round of psychometric analysis, our approach was to compute internal reliability for all subscale measures, and then a series of CFA for each primary category/component of the Student Questionnaire, using a split half sample approach (student sample only, as the teacher sample was too small), randomly splitting the student sample into two approximately equivalent subsamples in order to cross validate our models with a different group of students. This allowed us to look at each category/component separately and make decisions about items within the category subscales to retain or drop based only on the overall improvement of that "set" of category/component subscales. The categories are: a) **implementation** – teacher facilitation, b) **implementation** – student engagement, and c) **contextual factors** that can influence facilitation of, and engagement in implementation.

Following each administration of the questionnaire to different populations, the team assessed model fit using a variety of goodness-of-fit indices: chi-square value (χ^2) and ratio to degrees of freedom ($\frac{\chi^2}{df}$); Root Mean Square Error of Approximation (RMSEA); Comparative Fit Index (CFI); and Tucker-Lewis Index (TLI). We used established recommendations for each fit index value, and considered a model to be a "good fit" if it yielded a non-significant chi-square value (noting that large samples often result in inflated values); $\frac{\chi^2}{df} \leq 3$; RMSEA < 0.06; and CFI and TLI ≥ 0.95 (Hu & Bentler, 1999, Brown, 2006). In other models, we used CFI and TLI ≥ 0.90 and RMSEA < 0.08 to indicate an acceptable fit.

Results:
In the final year of instrument refinement, confirmatory factor analysis of the **Student Questionnaire implementation – teacher facilitation components** (i.e., student report of teacher instruction with the curriculum) and subsequent refinement of them yielded three statistical factors representing teacher facilitation of aspects of ECS practice and a good overall statistical fit including TLI of 0.97, CFI of 0.97, and RMSEA of 0.07. This model was used for cross validation analysis with the second half of the student sample to test the refined factor structures (TLI of 0.97; CFI of 0.97; RMSEA of 0.07), and was identical. The three statistical factors, or constructs, of the final implementation – teacher facilitation model include: *Teacher*

Facilitation of Student Autonomy, Teacher Facilitation of Cognitively Demanding Work, and Teacher Facilitation of Student Interest.

CFA of the **Student Questionnaire implementation – student engagement components** (i.e., student engagement in the class) and subsequent refinement of them yielded five statistical factors representing student engagement in ECS and a good overall statistical fit including TLI of 0.97, CFI of 0.97, and RMSEA of 0.057. This model was used for cross validation analysis with the second half of the student sample (TLI of 0.97; CFI of 0.98; RMSEA of 0.05), and was also acceptable. The five statistical factors, or constructs, of the final implementation – student engagement model include: *Student Contribution to Small Group Work, Student Engagement in Discussion, Student Engagement in Cognitively Demanding Work, Students Work Autonomously, and Student Risk-Taking*.

And finally, CFA of the **Student Questionnaire "contextual factor" (attitudes) components** (i.e., subscales for measuring the supports and barriers that influence student engagement in the CS class) of the first model resulted in six factors. A second order model yielded two latent constructs and good statistical fit (TLI of 0.97; CFI of 0.97; RMSEA of 0.06). This model was used for cross validation analysis with the second half of the student sample (TLI of 0.95; CFI of 0.96; RMSEA of 0.08), and was acceptable. The two constructs of the final student "contextual factor"/attitude model are: Attitude Toward CS (subscales: *Computer Science Interest, Computer Science Ability Beliefs, Perceived Relevance of CS to the Future,* and *Computer Science Identity*) and Attitude Toward the CS Class (subscales: *Motivation for Class* and *Sense of Belonging*).

Further details coming soon