Framing Computer Science Education Meeting Summaries
Meeting Summary #4: Writers Workshop #1 – November 19th, 2015

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K12 computer science education in the United States. Guided by a steering committee with representation from The Association for Computing Machinery (ACM) and the Computer Science Teachers Association (CSTA), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, Code.org is convening a series of the meetings with "Thought Leaders," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K12 computer science framework. The Stakeholder Meeting focuses on sharing and communication about computer science education work among interested state and organizational leaders. Finally, Writers Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "concept themes" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts and sub-practices will be organized by grade band as illustrated in the figure below.

	Concept Theme 1	Concept Theme 2	Concept Theme 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
K-2	Statement 1… Statement 2…		
3-5			
6-8			
9-12			

The framework also contains "cross-cutting themes". Cross-cutting, themes by definition, must speak to all or most of the concepts themes, and all or most of the grade bands. The framework writers will consider the cross-cutting themes as they work to develop the framework. Examples of cross-cutting themes from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science cross-cutting themes include Abstraction, Computational Thinking, and Systems and System Models

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the fourth in the series of meeting summaries.

Summary of Writers Workshop #1 – November 19th, 2015

Who were the Writers?

The following Writers attended this meeting:

Julie Alano, Hamilton Southeastern High School
Derek Babb, Omaha North Magnet High School
Julia Bell, Walters State Community College
Tiara Booker-Dwyer, Maryland State Department of Education
Leigh Ann DeLyser, CSNYC
Diana Franklin, Center for Elementary Mathematics and Science Education, University of Chicago
Dan Frost, University of California, Irvine
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Maya Israel, University of Illinois Urbana-Champaign
Vanessa Jones, Austin Independent School District
Rich Kick, Newbury Park High School
Heather Lageman, Maryland State Department of Education
Todd Lash, Kenwood Elementary
Irene Lee, Santa Fe Institute
Carl Lyman, Utah State Office of Education
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Dianne O'Grady-Cunniff, Charles County Public Schools
Anthony Owen, Arkansas Department of Education
Minsoo Park, Champaign School District
George Reese, University of Illinoi Urbana-Champaign
Bryan Twarek, San Francisco Unified School District
Nicki Washington, Winthrop University
David Weintrop, Northwestern University

Development Staff:
Baker Franke, Code.org
Katie Hendrickson, Code.org
Rachel Phillips, Code.org
Pat Yongpradit, Code.org

Process Advisors:
Heather King, Outlier Research & Evaluation, University of Chicago

What did the Writers do and how did they work together?

The Structure

Introductions and Overview: First, the whole group shared introductions and heard statements from Rachel Phillips, the Director of Research and Evaluation at Code.org. Phillips spoke about the need for the framework to speak to students and teachers that have little computer science knowledge or

experience. She also emphasized that the framework should be based upon research as much as possible, given that so little research on computer science education has been published, relative to other disciplines. To document the research that informs the framework, Phillips proposed that the Writers create an annotated bibliography to be used throughout the writing process so that decisions could be supported by research when possible.

Meeting Purpose Discussion: Next, the whole group discussed the purpose of the workshop, and the definitions of terms, such as practice, concept theme, and standard. The goal of the workshop was for writing teams to meet in person and begin developing the "sub-themes" and "sub-practices" that will make up the framework. The rubrics agreed upon in the Thought Leader meetings (reprinted below; see Meeting Summaries #1 and #2 for more information) were also used by the writers as they populated the framework grid with sub-themes and sub-practices. The writing teams also used their in-person time together to create a plan for working on their respective assignments remotely, in preparation for the second Writers Workshop in January 2016.

Concept Themes (AM1)

The following were proposed as criteria for concept themes. Concept themes should meet the majority of the criteria (but need not meet all).

- **Broad importance**. Any concept theme should be broadly important to the field and should cut across K12.
- **Integration/application/reliability**. Concept themes should have the potential to be integrated into other K12 content areas.
- **Low threshold, high ceiling**. All grades from K to 12 should be able to access the concept theme.
- **Useful tool for understanding CS**. Concept themes should be intellectually constructive.
- **Future proof.** Though the future cannot be predicted with any certainty, the potential future of the field should be taken into account (i.e., what computing innovations may arise within the next five years, and would they be attended to by the concept theme?).

Practices (AM2)

The following were proposed as criteria for practices. Included practices should:

- **Capture important behaviors that computer scientists engage in.**
- **Be required to fully explore and understand the framework concepts.**
- **Help students engage with course content through the development of artifacts.**
- **Rest on important "processes and proficiencies" with importance in CS.**

Note: Some AM2 participants wondered where to put boundaries on the practices, asking whether they should be wholly unique and quintessential to computer science, or whether they should overlap with other disciplines. Some argued that using the same or similar language to other disciplines would help teachers make connections between computer science and the disciplines they are more familiar with, which could make the framework more accessible to a wider audience. Ultimately, the group agreed to use the proposed criteria above.

The Process

Group Norms: The group discussion process was guided by the following "group norms." These were provided by the development staff and shared at the beginning of the meeting.

1. **What is best for teachers and students?**
   The ultimate purpose of the framework is to serve the needs of teachers and students, and this should be held in careful consideration throughout the process.

2. **Less is more.**
   The framework should aim to be concise rather than exhaustive.

3. **Don't reinvent the wheel.**
   Resources and ideas that already exist in the field should be utilized whenever possible.

4. **Research-backed and research-forward.**
   The framework should be supported by research, and should help foster a research agenda for the field.

5. **Aligned to national standards structures and process norms.**
   Both the process by which the framework is generated, and the framework itself, should follow the high standards put forth by similar efforts. In particular, the process for creating the framework should be as transparent as possible.

6. **A step toward something more.**
   While the goal of in-person meetings is to produce the best work possible, we also need to recognize that revisions will be necessary.

7. **Aim for 75% agreement.**
   Every participant need not completely agree to each decision. To keep the process moving, we will aim for each decision to have about 75% "agreement."

Small Group Discussion: The Writers then split into small groups to generate their best list of sub-themes or sub-practices. The development staff formed the groups to ensure diversity of background and expertise.

Small Groups:
Computing Devices and Systems: Alano[+], O'Grady- Cunniff*, Lyman, Gruwell
Networks and Communication: Lageman[+], Washington*, Own, Bell
Data and Information: Babb[+], DeLyser*, Frost, Moix
Programs and Algorithms: Twarek[+], Kick*, Franklin
Impact and Culture: Booker-Dwyer[+], Lee*, Jones, Weintrop
Practices: Park[+], Lash*, Israel, Reese

Group Roles: Development staff designated one person from each small group as a facilitator (+), and another as the lead writer (*). Facilitators were responsible for scheduling, organizing, and task management, while lead writers were responsible for editing.

Report Out and Whole Group Discussion: Each small group reported their list of sub-themes and sub-practices to the whole group, both verbally and through Google documents, where all participants provided comments. Lingering thoughts, ideas, and questions were collected throughout the meeting for discussion and consideration at future gatherings.

What did the Writers decide?

Framework Goals: The group decided to rename the "Framework Goals" (see Meeting Summaries #1 and #2) to the "Framework Vision," which more closely represented what the statements represented.

Computational Thinking: The Practices group brought the idea of computational thinking up for discussion. They pointed out that some of the practices fit under the definition of computational thinking, while others do not. They proposed to highlight some practices as belonging to computational thinking to ensure that they addressed computational thinking in the framework. **The larger group agreed that the practices that fit under computational thinking should be highlighted in some way.**

Cross-Cutting Themes: The group acknowledged that while there was a draft list of cross-cutting themes from Thought Leader meetings (see Meeting Summaries #1 and #2), others would likely arise organically and should be added to the list.

Placement of Data in the Framework: After each Concept Theme small group generated their draft list of sub-themes, the whole group discussed theme overlaps. The first overlap was between the Data and Information group and the Programs and Algorithms group. The Data and Information group said that they were planning to focus on analysis and process rather than data lists. They noted that they were approaching "data" from a data science lens, not a data processing lens. **They decided that the Programs and Algorithms group could take on concepts surrounding data processing.**

Digital Citizenship: Both the Networks and Communication and the Impact and Culture groups included digital citizenship in their list of sub-themes. One participant asserted that digital citizenship should be a cross-cutting theme because of its importance to all of the concept themes. Some pointed out that the International Society for Technology in Education (ISTE) standards address digital citizenship and asked whether digital citizenship should be left to the ISTE standards. **The group decided that they would address digital citizenship as a cross-cutting theme but would make it clear that the framework is not responsible for teaching the breadth of digital citizenship as addressed in the ISTE standards.**

Potential Consolidation of Concept Theme Categories: There was some confusion about the definitions of "systems" and where it should be placed in the framework. Some thought that systems belonged in Networks and Communication, while others thought it should go under Computing

Devices and Systems. This led to a discussion of whether the two categories should be collapsed. Some participants felt that networks and hardware were too intimately connected to be in separate categories, while others felt that teachers and students would not have the prior knowledge to understand why they would be collapsed into the same category. **The participants held a vote, and decided 17 to 5 that the Networks and Communication and the Computing Devices and Systems categories should be kept separate.**

Application Program Interfaces: The Data and Information group proposed Application Program Interfaces (APIs) as a cross-cutting theme because of their growing prevalence in the field. APIs are sets of tools, protocols, and graphic user interfaces (GUIs) used to create applications. The group decided that APIs were essentially interfaces and that interfaces were already included in the cross-cutting themes. **They agreed to leave APIs out of the list of cross-cutting themes.**

Checklist for Writing Statements: Statements are the units that will make up the cells of the framework (see Page 1 of this document for examples). The development staff proposed a checklist that writers should use as they generate statements:

Checklist for Writing Statements:

- **Are there biases in the statements?** Biases could include those against race, ethnicity, gender, socioeconomic status or disability status.
- **Is research used?** If so, the specific research should be referenced and documented.
- **Does it address a cross-cutting theme?**
- **Will it be understandable to teachers?** Are statements written in clear, simple language?
- **Does it adhere to definitions put forth by the writing team?**
- **Is it written as a statement of fact?** The writers should avoid statements that are written like standards (i.e., "the student should…").
- **Is it appropriate for the designated grade band?**
- **Is there an assumption of prior knowledge?**

Grade Band Designations: Few of the writers have deep experience in the learning sciences, so it was decided that Rachel Phillips of Code.org (a learning scientist) would assist groups in separating their statements by grade band. **The groups agreed to write their statements in progressions and that grade band designations would be decided later.**

Shared Definitions of Terms: The group spent some time searching for a comprehensive glossary of common computer science vocabulary (e.g., if statements, loops, programming, coding.). They were not able to find a resource to suit their needs, so **they agreed that they would eventually need to create a glossary.**

Considerations for Alignment Between Writing Teams: The development staff pointed out the need for consistency within the framework. They proposed a list of considerations but acknowledged that these would each need to be discussed further as writing progressed.

Considerations For Alignment

- **Use existing tools and resources, such as Bloom's Taxonomy.**
- **Grain size (specificity) of statements should be common.**
- **Optimal number of statements for each concept/practice and grade band.**
- **Consistent formatting: Bullet points? Sentences? Fragments? Narrative?**
- **What does "for all students" mean at the high school level? Assume elective? Required?**

Next Steps: Groups scheduled a weekly check-in via Google hangouts. Groups were tasked with writing all of their high school level statements prior to the next in-person meeting in January.

Framing Computer Science Education Meeting Summaries
Meeting Summary #5: Writers Workshop #2 – January 27th-28th, 2016

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K12 computer science education in the United States. Guided by a steering committee with representation from The Association for Computing Machinery (ACM) and the Computer Science Teachers Association (CSTA), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, Code.org is convening a series of the meetings with "Advisors," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K12 computer science framework. The Stakeholder Meetings focus on sharing and communicating about computer science education work among interested state and organizational leaders. Finally, Writers Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "concept themes" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts will be organized by grade band, while the sub-practices will be organized through a narrative learning progression, both of which are illustrated in the figures below.[1]

The framework also contains "cross-cutting themes". Cross-cutting themes, by definition, must speak to all or most of the concepts themes, and all or most of the grade bands. The framework writers will consider the cross-cutting themes as they work to develop the framework. Examples of cross-cutting themes from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science cross-cutting themes include Abstraction, Computational Thinking, and Systems and System Models.

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[1] In prior Meeting Summaries, sub-practices were also described as being organized by grade bands. However, at Writers Workshop #2, it was decided that practices would be organized around a narrative learning progression instead of specific grade bands (see below for more information on this decision).

	Concept Theme 1	Concept Theme 2	Concept Theme 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
Description of Practice			
Example Grade 12 Learning Goals			
Example K-12 Learning Progression			

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the fifth in the series of meeting summaries.

Summary of Writers Workshop #2 – January 28th, 2016

Who were the Writers?

The following Writers attended this meeting:

Derek Babb, Omaha North Magnet High School
Julia Bell, Walters State Community College
Tiara Booker-Dwyer, Maryland State Department of Education
Leigh Ann DeLyser, CSNYC
Caitlin Dooley, GA Department of Education
Dan Frost, University of California, Irvine
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Maya Israel, University of Illinois Urbana-Champaign
Vanessa Jones, Austin Independent School District
Heather Lageman, Maryland State Department of Education
Todd Lash, Kenwood Elementary
Irene Lee, Santa Fe Institute[2]
Diana Franklin, Center for Elementary Mathematics and Science Education, University of Chicago[2]
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Dianne O'Grady-Cunniff, Charles County Public Schools
Anthony Owen, Arkansas Department of Education
Minsoo Park, Champaign School District
Shaileen Pokress, Project Lead the Way
George Reese, University of Illinois Urbana-Champaign
Alfred Thompson, Bishop Geurtin High School, Nashua, NH
Bryan Twarek, San Francisco Unified School District
Nicki Washington, Winthrop University
David Weintrop, Northwestern University

Development Staff:
Katie Hendrickson, Code.org
Rachel Phillips, Code.org
Pat Yongpradit, Code.org

Process Advisors:
Courtney K. Blackwell, Outlier Research & Evaluation, University of Chicago
Jennifer Childress, Achieve Inc.

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[2] Lee and Franklin participated remotely via Skype.

What did the Writers do and how did they work together?

The Structure

Review and Overview: At the end of Writers Workshop #1, the writing groups scheduled weekly check-ins via Google hangouts and were tasked with writing all of their high school level concept statements prior to Writers Workshop #2. These concept statements laid the groundwork for the second workshop.

On Day 1 of Writers Workshop #2, Katie Hendrickson began by reviewing the agenda and group norms for the workshop, as well as introducing two new elements to the meeting structure.

First, the "parking lot," which existed both digitally on Google docs and in the room on poster paper, was a place where writers could post questions that come up during discussions but were peripheral to the immediate task at hand. The intention of the parking lot was to keep discussions on point while acknowledging new questions that might arise and could be saved for later conversations.

Second, Hendrickson introduced socrative.com, a polling platform that provided a quick, easy, and anonymous way to gather group input on topics and discussion points. She emphasized that polling was for data gathering purposes only and not for making definitive decisions on a topic.

Meeting Purpose Discussion: Next, Hendrickson described the goals for the workshop. For Day 1, the Practices group was tasked with developing the K8 practice statements and structure, and the Concept groups were tasked with completing the initial steps of writing learning progressions as well as planning any revisions they might make as a result, to their high school concept statements. For Day 2, the Practices group continued refining the structure and K12 practice statements, and the Concept writers were tasked with polishing and finalizing the high school layer of the framework for their respective concept theme (see Meeting Summary #1 for a description of themes).

After reviewing the workshop goals, Pat Yongpradit led a discussion on the use of the word "framework" to describe the current initiative, given concerns over the varying definitions that "framework" can have in different educational contexts. He showed the group the K12 framework for science education in hard copy and pointed the group to an online PDF version. He asked the group to look through the table of contents and skim through the PDF to see what a "framework" looks like in order to show the structural similarities between the K12 science framework and the CS framework they are developing. He made explicit that this is what they mean by "framework" and noted that when discussing the project with people who may be unfamiliar with the initiative, the writers may want to refer to their work as "guidelines" since "framework" may be misinterpreted as a curricular framework, which is the more common understanding for educators.

Yongpradit also described how the CS framework will be different than the science framework, in that they are taking a web-first mentality, meaning the CS framework is being written and built primarily as an online document, which may be downloaded as a PDF and potentially a hard copy down the line. The web-first mentality came up in later discussions around the level of details to provide in concept statements, since the online environment enables interactive tools like links and pop-ups that can be used to house additional details not critical to the core framework document.

The Process:

Group Norms: The group discussion process was guided by the following "group norms." These were provided by the development staff and shared at the beginning of the meeting on both days.

1. **What is best for teachers and students?**
   The ultimate purpose of the framework is to serve the needs of teachers and students, and this should be held in careful consideration throughout the process.

2. **Less is more.**
   The framework should aim to be concise rather than exhaustive.

3. **Don't reinvent the wheel.**
   Resources and ideas that already exist in the field should be utilized whenever possible.

4. **Research-backed and research-forward.**
   The framework should be supported by research, and should help foster a research agenda for the field.

5. **Aligned to national standards structures and process norms.**
   Both the process by which the framework is generated, and the framework itself, should follow the high standards put forth by similar efforts. In particular, the process for creating the framework should be as transparent as possible.

6. **A step toward something more.**
   While the goal of in-person meetings is to produce the best work possible, we also need to recognize that revisions will be necessary.

7. **Aim for 75% agreement.**
   Every participant need not completely agree to each decision. To keep the process moving, we will aim for each decision to have about 75% "agreement."

Day 1:

Whole Group Practices Discussion: Prior to the workshop, the whole group had provided input on the draft practice statements for the Practices group to consider for revision. The Practices group integrated any action items into their revisions but they encountered several items that needed clarification and input from the whole group. For each of the four questions, they presented the issue for 5 minutes, took clarifying questions from the rest of the group for 5 minutes, had the rest of the group comment silently in the Google doc for 5 minutes, and then polled the group using socrative.com using pre-determined choices as well as new options that arose during the discussions.

Four Questions: The Practices group identified four questions for the larger group discussion. The intention was to gather the larger group's thoughts to inform the Practices group work for the rest of the day. No decisions were made during this process.

Question 1: Abstraction
Should it be a cross-cutting concept *and* a practice? Will that be confusing to those using the Framework? If abstraction is a practice, how does decomposition relate to it? Some reviewers questioned whether there should be a separate practice just for decomposition.

    a.   Yes, we should include it in the practice.
    b.   No, we shouldn't include it in the practices, it is a concept.
    c.   No, it should not be a practice, but a cross cutting concept.
    d.   Yes, we should include it with emphasis on decomposition.
    e.   No, we would rather have decomposition as practice.
    f.   Yes, we should include abstraction as a practice AND as a cross-cutting concept.

The group was mainly split between response choices a (22%), c (33%), and f (26%).

Question 2: Grade level bands for practices
Should there be grade level bands? What are other options?
    a.   We should have practices by grade level bands.
    b.   No, we should have overall practice statements; leave grade level band descriptors to standard writers.
    c.   We should have progression descriptions on where kids should start and end.

The majority of the group chose option b (59%), with an additional 22% choosing option c.

Question 3: Computational Thinking (CT)
How should it be called out? How should it be labeled? Do we call some practices CT, some Computational Doing and some "other"? Do we even include the phrase? Should we overtly delineate practices that are uniquely computational and how so?
    a.   Group practices into two categories: 4 practices of CT, and 3 practices of Interpersonal or professional practices.
    b.   Break down 4 practices of CT further: 2 practices of Computational Thinking, and 2 practices of Computational Doing.
    c.   It is not necessary to call out CT.
    d.   Add descriptive text near the heading of the practices, talking about what CT is and how it fits/permeates what we've done with practices.

The majority of the group selected choice d (68%).

Question 4: Mutual exclusivity
Are elements in practices mutually exclusive?
    a.   Overlapping descriptors of practices are to be expected.
    b.   All practices should be mutually exclusive.

The entire group selected choice a.

Learning Progression Presentation: Next, Rachel Phillips and Leigh Ann DeLyser led a group discussion around learning progressions. They both have a background in learning and development theories. They described how "learning progressions" are often viewed as pushing down concepts by removing complexity, but reiterated that simply making something more or less complex does not necessarily make a developmentally appropriate learning progression. Drawing on the work of developmental theorist Jerome Bruner, and Doug Clements' work on developmental learning trajectories in math, Phillips and DeLyser described the high-level view of learning progressions and

then turned to a more concrete example of what a learning progression might look like. The group debated the appropriate level of the concept statements, given students would enter CS at different times in their schooling and with varying degrees of experience in CS. While the group maintained the decision from the last workshop to aim for the "average" student, many noted that they would rather aim high than "dumb down" concepts for the lower grades. One Practices team member emphasized the importance of not aiming for the top or the bottom, but something in the middle where educators and curriculum writers can have the flexibility to decide whether more or less is needed for their individual student populations.

Learning Progressions Activity: The Practices group left the whole group to address the feedback from the socrative.com polls. The Concept writers split into their working groups to begin working on their learning progressions. Yongpradit presented a 5-step process for thinking about learning progressions, with the goal of getting through Step 3 by the end of the workshop. That is, writers were tasked with developing the learning progressions, figuring out what prerequisite knowledge needs to be included, and identifying broader structures that repeat over and over again. As the groups went through the process, the development team checked in several times to address any questions or help groups work through any issues.

Steps for Developing K12 CS Concept Learning Progressions:

1. Start at the level of sub-concepts that could stretch across different grade bands.
2. Brainstorm a structured collection of prerequisite knowledge (concept mapping).
3. Identify the structures that repeat in the progressions over and over again, increasing in complexity.
4. Chunk the ideas and group into grade bands.
5. Write the concept statements.

Small Groups:[3]
Computing Devices and Systems: O'Grady-Cunniff*, Gruwell~
Networks and Communication: Lageman[+], Washington*, Owen, Bell
Data and Information: Babb[+], DeLyser*, Frost, Moix
Programs and Algorithms: Twarek[+], Pokress~, Franklin (remote)
Impact and Culture: Booker-Dwyer[+], Lee*(remote), Jones, Weintrop, Dooley
Practices: Park[+], Lash*, Israel, Reese, Thompson

Practices Group Report Out and Discussion: At the end of Day 1, the Practices Group reported what they had come up with in light of earlier feedback on their four questions. While they came to consensus around the issues of abstraction, computational thinking, and mutual exclusivity, they remained undecided on the issue of grade level bands for practices. The major contention came from the morning's socrative.com polling results, where the majority (71%) voted for no overall practice statement or grade band descriptors. The Practices group acknowledged this majority opinion, but also felt strongly about providing some information in the Framework that addresses

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[3] As described in the Writers Workshop #1 Summary, the development team designated one person from each small group as a facilitator ([+]) and one as a lead writer (*). Facilitators were responsible for scheduling, organizing, and task management, while lead writers were responsible for editing. Two Concept Writers (~) also volunteered to help the Practices group, but their primary affiliation was with their Concept groups.

how practices might look across the K-12 spectrum. They felt that more discussion was needed amongst the entire group before moving forward.

The discussion focused on the level of guidance that the framework should provide for educators and curriculum writers, given that some may take the framework at face value and use it as a prescriptive tool for writing standards and/or developing lesson plans. The writers felt the framework should provide some guidance but also acknowledged that 1) Schools differ in how and what grades they teach CS; 2) students differ in their prior CS and educational experiences more generally; and 3) The CS education field lacks research on developmental learning trajectories in CS, such that it is unclear what specific practices should be learned at specific grade levels.

Next, the Practices group shared an example of a hybrid approach to guidance based on the NRC framework for K12 science education. This approach used an umbrella statement regarding a specific practice and provided example goals for students to reach by grade 12. It also included an example narrative learning progression. The whole group took another socrative.com poll with the following options:

a. Some prescription: Use umbrella statements and example goals and statements like NRC.
b. No specific guidance on goals: Use umbrella statements only.

The majority of (79%) chose Option a. As a result, the Practices group provided each Concept writers group with their proposed umbrella statement for one of the practices in the style of the NRC framework. A representative from the Practices team worked with each Concept group to obtain feedback on and clarify the statements.

Wrap-Up: Day 1 concluded with a wrap-up by the development staff. They went over the next steps and expectations for completing the learning progressions by the next workshop at the end of February.

Day 2

Overview: The development team began with an overview of the agenda and norms, as well as a discussion about the upcoming review process for the Framework. There will be two public review periods, the first to give the writers some understanding of how people in the field are reacting to the framework, and the second to give the writers a chance to respond to and take into account the initial review comments and feedback. The goals of the review process are to include the larger CS field in the development of the framework, to be as transparent as possible with that process, and to obtain quality feedback that can be integrated into the next iteration of the Framework draft.

Small Group Work: Next, writers split into their writing groups to make revisions to their high school level concept statements based on the prior day's conversation about learning progressions.

Small Group Review and Discussion: The whole group came together to review each other's high school concept statements. The development team outlined a round-robin review process to ensure efficient and effective reviews.

Review Process:

1. Writers break up into their small groups, with the exception of one group (denoted as "Group A" for this example) for whose statements will be reviewed.
2. Members from Group A split themselves up so that each of the other small groups has a representative from the statements under review.
3. Individuals spend 5 minutes silently reading, reviewing, and commenting on Group A's statements following the "Concept Statement Checklist" (outlined below).
4. Individuals write down their two concerns about the current versions of the statements.
5. Within their small groups, the writers share their top two concerns.
6. Small groups spend five minutes discussing their concerns and come up with two group recommendations for Group A's concept statements, including the group's rationale for those recommendations.

Concept Statement Checklist

The development team provided the Concept Writers with a checklist to use when reviewing each other's statements. The intention was to provide writers with the criteria that were provided to them at the first meeting to guide the development of the statements. These criteria were also written in a format similar to the one that will be provided for the public Framework review. The purpose of the checklist was not for writers/reviewers to focus on each item during their review process but rather choose one or two items that most resonate with their personal background to use as a lens for reviewing the Framework. For example, a high school computer science teacher may take on the "developmentally-appropriate" lens when reviewing the Framework.

Concept Statement Checklist:

- **Importance**: Is this a core idea of computer science? Is it important and essential for all students? How does it make for a CS literate person? What benefit does it have for the person and society?
- **Powerful in application:** Is knowing the concept or performing the practice useful? Useful for solving problems, illuminating other ideas downstream, and helpful for understanding a larger body of knowledge? Do they elicit extensions, interdisciplinary connections, and show potential for transfer?
- **Relevance and Clarity**: Are the statements understandable by teachers and relevant to students? If you are new to computer science, do you feel like the framework's structure and statements are approachable/inviting?
- **Diversity**: How well do the framework statements describe a diverse, equitable, and accessible vision of computer science?
- **Research**: Are the statements supported by research? How can the statements be revised to reflect CS education research? Do the statements point to possible areas of research?
- **Developmentally appropriate**: Is it developmentally appropriate and suitable for the high school layer?
- **Interdisciplinary**: Is a framework statement useful and applicable outside of the domain of CS as well? Are there opportunities to make interdisciplinary connections? Does this complement concepts and practices in math, science, etc.?
- **College and Career readiness**: How well do the concepts and practices contribute to career and college readiness?

Whole Group Discussion: Next, the group came together to discuss the granularity of concept statements. Yongpradit presented four example statements with varying degrees of specificity and asked the group to think about which example was most appropriate for the Framework. Discussion

focused on whether all concept statements need to have the same level of specificity or whether there could be different levels of granularity depending on the different concept domains. An emphasis on ensuring statements focused on the core and essential components of the concept domains emerged, as did discussions around the web-first notion of the Framework enabling more in-depth explanations or examples to be accommodated through pop-ups and links instead of in the statements themselves.

What did the Writers decide?

Abstraction is a Practice (for now): The group decided to keep moving forward with Abstraction as a practice, with the understanding that this is not a final decision and will be brought up again at the next Writers Workshop at the end of February.

Computational Thinking: Whereas the group originally decided to highlight certain practices that fit under the definition of Computational Thinking, they decided that this distinction was not clear-cut. They did not want to suggest that by doing only those practices would ensure that students engage in Computational Thinking. **The group did want to highlight Computational Thinking somewhere in the Framework and decided to include it as part of the descriptive text at the beginning of the Practices document.**

Mutual Exclusivity: The group decided that elements in the Framework are not—and should not be — mutually exclusive. **Overlapping descriptors across concepts and practices are to be expected**.

Grade Level Bands for Practices: The group discussed at length the pros and cons of using grade level bands for the practices. They ultimately decided to use the NRC science framework model. This model provides umbrella statements describing a particular practice, outlines associated grade 12 goals, and includes a narrative description of the learning progression from kindergarten through high school. Importantly, they will make explicit that these are *example* goals and *example* progressions, as the group felt strongly that their role is to **advise, not prescribe** what happens at the classroom or standards writing levels.

Public Review Preparation: Given that the first public review will only include the high school level concept statements, the group decided to include a note on the review form regarding their intentions for the learning progressions to provide context for the reviewers. The note will make clear that the high school statements are not the only part of the Framework and to expect the next review period to include the learning progressions and K-8 concept statements.

Glossary: In the first Writers Workshop meeting, the group decided to create a glossary for the Framework to ensure a shared definition of terms. They have put together a draft glossary using definitions from the draft Massachusetts Digital Literacy and Computer Science Standards[4], and the glossary will be released for public review with the high school materials. Additionally, the group decided that the glossary should include other educational terms (e.g., "diverse learners") in addition to computer science vocabulary since a range of individuals from different backgrounds may use the Framework.

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[4] http://www.doe.mass.edu/boe/docs/FY2016/2015-12/item6-StandardsDraft.pdf

Specificity of Concept Statements: The group decided that concept statements should focus on what is **core and essential** to the concept domain in question, with the understanding that different concept domains may have different degrees of specificity. If something is not core and essential but provides clarity to a concept that is often misunderstood, then the writers will include it in the concept statement. If something is not a clarifying example but provides a more in-depth understanding of a concept, it can be used as a pop-up in the online version of the Framework for those who want more information.

Next Steps: Writing groups will finish the high school concept statements for public review beginning February 3rd, 2016. Concept Writers will also continue to work on their K-8 concept statements. The Practices Writers will continue to work on their practice statements, including the overarching description, the example goals, and the example of narrative learning progression.

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K-12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K-12 computer science education in the United States. A steering committee with representation from the Association for Computing Machinery (ACM), the Computer Science Teachers Association (CSTA), Code.org, the National Math and Science Initiative (NMSI), and the Cyber Innovation Center (CIC), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, is convening a series of the meetings with "Advisors," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K-12 computer science framework. The Stakeholder Meetings focus on sharing and communicating about computer science education work among interested state and organizational leaders. Finally, Writers Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "concept themes" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts will be organized by grade band, while the sub-practices will be organized through a narrative learning progression, both of which are illustrated in the figures below.[1]

The framework also contains "Crosscutting Concepts." Crosscutting Concepts, by definition, must speak to all or most of the concept themes, and all or most of the grade bands. The framework writers will consider the crosscutting themes as they work to develop the framework. Examples of Crosscutting Concepts from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science crosscutting concepts include Abstraction, Computational Thinking, and Systems and System Models.

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[1] In prior Meeting Summaries, sub-practices were also described as being organized by grade bands. However, at Writers Workshop #2, it was decided that practices would be organized around a narrative learning progression instead of specific grade bands (see the Writers Workshop #2 Summary for more information on this decision).

	Concept Theme 1	Concept Theme 2	Concept Theme 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
Description of Practice			
Example Grade 12 Learning Goals			
Example K-12 Learning Progression			

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the sixth in the series of meeting summaries.

Who were the Writers?

The following Writers attended this meeting:

Julie Alano, Hamilton Southeastern High School
Derek Babb, Omaha North Magnet High School
Julia Bell, Walters State Community College
Tiara Booker-Dwyer, Maryland State Department of Education
Josh Caldwell, Code.org (Advisor, contributing to writing teams)
Leigh Ann DeLyser, CSNYC
Caitlin Dooley, Georgia Dept. of Education
Diana Franklin*, Center for Elementary Mathematics and Science Education, University of Chicago
Dan Frost, University of California, Irvine
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Maya Israel, University of Illinois Urbana-Champaign
Vanessa Jones, Austin Independent School District
Rich Kick•, Newbury Park High School
Heather Lageman*, Maryland State Department of Education
Todd Lash, Kenwood Elementary
Irene Lee, Santa Fe Institute
Carl Lyman, Utah State Office of Education
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Dianne O'Grady-Cunniff, Charles County Public Schools
Anthony Owen, Arkansas Department of Education
Minsoo Park, Champaign School District
Shay Pokress, Project Lead the Way
George Reese, University of Illinois Urbana-Champaign
Alfred Thompson, Bishop Guertin High School
Bryan Twarek, San Francisco Unified School District
Nicki Washington, Winthrop University
David Weintrop, Northwestern University

Development Staff:
Katie Hendrickson, Code.org
Baker Franke, Code.org*
Rachel Phillips, Code.org
Pat Yongpradit, Code.org

Process Advisors:
Jennifer Childress, Achieve, Inc.
Heather King, Outlier Research & Evaluation, University of Chicago

• only present on 2/29, participated virtually on 3/1
* only present on 3/1

What did the Writers do and how did they work together?

Update on Timeline of Framework

On February 18th, 2016, the Framing CS Advisors, Steering Committee, some State Stakeholders, and Writers agreed to extend the deadline for the final Framework document. The final Framework document was originally due in June 2016. The new deadline is September 2016. There will be two additional in-person meetings for Writers: one in mid-July, to coincide with the national CSTA conference, and another in early August. There will also be an additional public review period that will take place in May and June 2016.

The Structure

Introductions and Overview:

First, Katie Hendrickson of the Development Team gave an overview of the day's activities. The goals of Day 1 were to review the first round of public feedback from the February 3rd-17th review period, and to prepare all of the practice or content statements for all grade bands for internal review on Day 2 of the Workshop. She briefly touched on the purpose and location of the "Parking Lot" document, which is intended to be a place to keep any lingering thoughts, ideas, or questions that should be addressed at a later time, so as not to disturb the flow of the Workshop.

Pat Yongpradit of the Development Team also spoke broadly about the feedback received from the open review of the high school concepts and practices. He noted that much of the feedback was constructive, and that the feedback was often very detailed, which demonstrated the level of commitment the reviewers had to improving the framework. He also shared some recent news related to CS education, including the proposal to include four billion dollars in the United States federal budget for K-12 CS education.

The Process

Principles: The principles were reviewed with the whole group.

1. **What is best for teachers and students?**
   The ultimate purpose of the framework is to serve the needs of teachers and students, and this should be held in careful consideration throughout the process.

2. **Less is more.**
   The framework should aim to be concise rather than exhaustive.

3. **Don't reinvent the wheel.**
   Resources and ideas that already exist in the field should be utilized whenever possible.

4. **Research-backed and research-forward.**
   The framework should be supported by research, and should help foster a research agenda for the field.

5. **Aligned to national standards structures and process norms.**
Both the process by which the framework is generated, and the framework itself, should follow the high standards put forth by similar efforts. In particular, the process for creating the framework should be as transparent as possible.

6. **A step toward something more.**
While the goal of in-person meetings is to produce the best work possible, we also need to recognize that revisions will be necessary.

7. **Aim for 75% agreement.**
Every participant need not completely agree to each decision. To keep the process moving, we will aim for each decision to have about 75% "agreement."

Small Group Discussions: The small groups are delineated below. These small groups have been writing their respective portions of the framework since the first Writers Workshop in November 2015.

Day 1: The small groups were asked to review all of the public review feedback from the "I like" and "I wonder" categories. They were asked to pull out feedback that could apply to the whole group of Writers, as opposed to feedback that may be specific to a particular concept group, and share with the whole group. During the whole group discussion, the writers and development team created a list of the major themes in the feedback, and created a plan to address each major theme.

Then, the small groups were asked to begin addressing the feedback specific to their content. They were provided with a worksheet, created by the Development Team, to organize the original concept or practice statement, the feedback, and the rationale for how (or if) the feedback is addressed. These worksheets will be complied in an appendix of the final Framework document.

The Practices group asked the whole Writers group for feedback on their practices so far. The Practices group asked the Writers to work in groups to collectively give their feedback. Rather than have the Writers give feedback in their usual Small Groups (see below), they put the Writers into different groupings, so that they had the opportunity to work with new people. These small groups shared their feedback with the whole group, and in a Google document for consideration by the Practices group.

Day 2: The small groups worked on incorporating public feedback into their statements and also worked to prepare their content for review by Advisors at the end of the week.

Small Groups:
Computing Devices and Systems: Alano[+], O'Grady-Cunniff*, Gruwell, Lyman
Networks and Communication: Lageman[+], Washington*, Owen, Bell
Data and Information: Babb[+], DeLyser*, Frost
Programs and Algorithms: Twarek[+], Kick*, Franklin, Moix
Impact and Culture: Booker-Dwyer[+], Lee*, Jones, Weintrop, Dooley
Practices: Park[+], Lash*, Israel, Reese, Thompson, Pokress

Group Roles: As noted in previous summary documents, development staff designated one person from each small group as a facilitator (+), and another as the lead writer (*). Facilitators were responsible for scheduling, organizing, and task management, while lead writers were responsible for editing.

Report Out and Whole Group Discussion: Throughout the two-day workshop, the small groups reported out to the whole group and discussed their work. Their discussions and decisions are detailed below.

What did the Writers decide?

Addressing Misconceptions about the Framework Audience: One piece of public feedback that arose frequently was that the Framework was not accessible to various audiences, including students and teachers. The Writers acknowledged that the Framework would not necessarily be accessible to those audiences but that this was the intention. The purpose of the Framework is to provide standards and curriculum writers with the information they need to generate standards and instructional materials, and to provide state and district stakeholders with the information they need to make decisions about CS education in their communities. The group also noted that these boundaries had already been written into the Framework documents but that the messages were not necessarily being heard. They clarified that the intended Framework audience would be 40% curriculum developers and standards writers; 35% state and district decision-makers; 20% teachers and teacher leaders; 5% researchers and academics; fewer than 1% interested parents; and 0% students. **The group agreed that a graphic representation of the Framework audiences might be a better way to convey that information.**

Tie-ins to Content from Other Disciplines: Another piece of feedback had to do with the amount of explicit tie-in to other disciplines. For example, some feedback asked for the Framework to clearly include where the CS Framework overlapped with mathematics standards, or criticized the Framework for including practices or concepts that the reviewer felt were under the domain of mathematics or engineering. The Writers were concerned that including connections to other disciplines may lead to some practitioners thinking that they were already addressing CS concepts or practices via other subject areas, and that they would disregard the CS concepts or practices, even if a CS educator would not agree that they were addressing the CS content. The Writers felt that it was important to acknowledge interdisciplinary connections but that it was sometimes a struggle to keep connections illustrative rather than prescriptive. **They agreed that the Framework should remain focused on CS content and that explicit connections to other disciplinary standards could be detailed in an appendix to the Framework.**

Simplifying Language: Various reviewers noted that the Framework language was not accessible to lay people, and that it was inconsistent throughout. Reviewers noted that many acronyms were unclear or undefined, and that some of the discipline-specific language could have different meanings outside of computer science. **The Writers agreed that they would need to decide on consistent language to be applied in later versions of the Framework. They also noted that they would include a glossary with the Framework that should clarify some of the issues Reviewers had.**

Reviewing Full Progressions: Some Reviewers noted that it was difficult to review only the high school practices and concepts without seeing the K-8 portion of the Framework. Originally, the Development Team told Writers that they could choose which of their K-8 statements to release during the next public feedback round. **However, the group decided that they should plan to release all of their statements for public review, so that the reviewers could better judge the progressions in their entirety. The Writers may also include guidelines for the Reviewers that indicate the type of feedback they would like.**

Use of a Technical Editor: The Development Team shared that they planned to work with a technical editor to help ensure that the language and formatting of the Framework were clear and accessible. The Writers were concerned that an editor with little CS content knowledge could unintentionally alter the meaning of statements. However, the chosen editor has a decade of experience editing CS education content. The Writers proposed having a conversation with the editor to ensure clear understanding of the computing-specific language used throughout the Framework. **The Writers agreed that the technical editor would be a key asset in refining the Framework for its final release.**

Location of Additional Information in the Framework Documents: One writer pointed out that language might differ for content intended for different target audiences. For example, a second grade teacher might describe a term to her students differently than a high school teacher would. This led to a discussion about other information that Reviewers thought was missing, such as artificial intelligence, security, human-computer interactions, and problem-solving. Yongpradit proposed a solution by sharing some conceptual drafts of the eventual Framework website. The website design allows for expansion that can contain extra information, including richer and more technical details about the statements, and also videos, pictures, and examples. **The Development Team asked the Writers to clearly label which parts of their statements should be included in the expanded parts of the website.**

Use of Exclusionary Statements in the Framework: Some public Reviewers were concerned that concepts included in the Framework would be too advanced for K-12 students. In many cases, Reviewers pointed out that even college students would likely be unable to demonstrate mastery of some topics. The Writers agreed but pointed out that many of their statements did not call for students to "master" many of the advanced topics, but simply understand them. For example, a statement about recursion would not necessarily ask students to generate their own recursive algorithms but instead to know what a recursive algorithm is. Another Writer pointed out that there may be a middle ground between these two extremes, such as asking students to correctly modify a recursive algorithm. **The Writers agreed to use "exclusionary statements" to put boundaries on what the Framework was asking of students, and in particular, whether the framework was asking students to understand something versus being able to *do* something.**

Internal Feedback on Practices: The Practices group asked for detailed feedback from the other Writers. The Writers were split into small groups (different from their Concept groups) and reviewed three Practices. The Practices group asked the Writers to pay attention to the language used, whether they agreed with statements, and to look for any glaring gaps. **The Writers entered their feedback into Google documents for the Practices group to synthesize and address.**

External Reveal of Crosscutting Concepts: The Development team proposed that the Crosscutting Concepts be included in the materials available during the next public review period. The Development team asked the Writers to discuss which Crosscutting Concepts they were most certain would actually Crosscutting Concepts, since the list of Crosscutting Concepts was still open for discussion. For example, the Systems and Computing group decided during their writing process that Systems should be removed from their content area and be considered a Crosscutting Concepts instead. The list for consideration was:

- **Ethics/Security**
- **Invention/Innovation**
- **Patterns/Abstraction**
- **Automation/Scale/Optimization**
- **Systems**

One Writer pointed out that there was negative feedback from the public review concerning the statements that included references to automation. The concern was that mastery of those concepts was too advanced for K-12 students. The group agreed that the exclusionary statements should help clarify the intended scope of those statements. **Overall, the group agreed to continue to refine the list of Crosscutting Concepts as they wrote their statements, so that the crosscutting statements could be ready for public review.**

Crosscutting Concept – Systems Thinking: The group held another discussion about the newest crosscutting concept: Systems. One writer mentioned that the computer scientist Alan Kay advocated for "systems thinking" as an important concept. Members of the Development team agreed that the public comments also supported the inclusion of "systems thinking" in that Reviewers wanted to deemphasize hardware (using the term "systems" alone implied hardware to some) in favor of promoting thinking about systems broadly, not only hardware systems. The Writers firmed their collective understanding of "systems thinking" by clarifying that "systems thinking" referred to the perspective that a system contains many components, and that decisions made about one component necessarily influences all other components in the system. Some Writers felt that Kay's authority was powerful enough on its own to warrant the inclusion of "systems thinking," while others felt that the phrase "systems thinking" could mean different things in different fields, and that perhaps "thinking about systems" would be a more appropriate label. The Development teams asked the Writers to consider only the meaning behind the phrase when deciding whether it should be included, and that wordsmithing could take place at a later date. **Ultimately, the Writers agreed to included "systems thinking" or "thinking about systems" as a crosscutting concept.**

Practice --"Fostering an Inclusive Computing Culture": Some Writers were concerned that the practice "Fostering an Inclusive Computing Culture" was unlike the other practices in that it promoted certain values, and that those values could not necessarily be assessed, when the eventual standards are written (to be clear, the Framework is not to be used for assessment; the Writers were merely playing out possible scenarios in the use of the Framework). There was also concern that the inclusion of those values could render that portion of the Framework "politically unviable," in the sense that policymakers would not support a document that some may view as pushing particular values on students. The group emphatically agreed that the field of computer science was in need of real change, and that inclusion and diversity was absolutely essential. The group suggested that this

practice category could still be included if all statements were explicitly focused on observable behaviors. Some pointed out that these practices were of a different kind than the others, and that teachers may not have experience implementing these kinds of practices. One Writer suggested that the practices in this category take inspiration from Universal Design or accessibility standards, so that the practices were "politically viable." A member of the Development team asked whether Equity and Diversity should be included in the crosscutting concepts, since they could apply to so many areas of the Framework. The Practices group shared their concern that Equity and Diversity might be easily forgotten if it was not explicitly called out in the Framework, and that the crosscutting concepts would not necessarily be called out explicitly. One Writer suggested that the Practices group contact groups such as the National Alliance for Partnership in Equity (NAPE) for advice on how best to include practices promoting equity and diversity in the Framework. **The Practices group asked for more time to consider the feedback provided by the other Writers before coming to a decision about how Equity and Diversity should be included in the Framework.**

Next Steps: The Writers were tasked with preparing their content for feedback from the Advisors. They were also asked to prepare their content – for all grade bands – for the second round of public review in March and April.

Framing Computer Science Education Meeting Summaries
Meeting Summary #7: Writing Workshop #4 – April 9th – 10th, 2016

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K-12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K-12 computer science education in the United States. A steering committee with representation from the Association for Computing Machinery (ACM), the Computer Science Teachers Association (CSTA), Code.org, the National Math and Science Initiative (NMSI), and the Cyber Innovation Center (CIC), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, is convening a series of the meetings with "Advisors," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K-12 computer science framework. The Stakeholder Meetings focus on sharing and communicating about computer science education work among interested state, district, and organizational leaders. Finally, Writing Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "concept themes" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts will be organized by grade band, while the sub-practices will be organized through a narrative learning progression, both of which are illustrated in the figures below.[1]

The framework also contains "Crosscutting Concepts." Crosscutting Concepts, by definition, must speak to all or most of the concept themes, and all or most of the grade bands. The framework writers will consider the crosscutting themes as they work to develop the framework. Examples of Crosscutting Concepts from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science crosscutting concepts include Abstraction, Computational Thinking, and Systems and System Models. Crosscutting Concepts are internally integrated into the Concept statements of the framework and do not constitute a third external dimension as opposed to analogous Science frameworks.

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[1] In prior Meeting Summaries, sub-practices were also described as being organized by grade bands. However, at Writing Workshop #2, it was decided that practices would be organized around a narrative learning progression instead of specific grade bands (see the Writers Workshop #2 Summary for more information on this decision).

	Concept Theme 1	Concept Theme 2	Concept Theme 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
Description of Practice			
Example Grade 12 Learning Goals			
Example K-12 Learning Progression			

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the sixth in the series of meeting summaries.

Summary of Writers Workshop #4 – April 9th – 10th, 2016

Who were the Writers?

The following Writers attended this meeting:

Julie Alano, Hamilton Southeastern High School
Derek Babb, Omaha North Magnet High School
Julia Bell, Walters State Community College
Tiara Booker-Dwyer, Maryland State Department of Education
Leigh Ann DeLyser, CSNYC
Dan Frost, University of California, Irvine
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Maya Israel, University of Illinois Urbana-Champaign
Vanessa Jones, Austin Independent School District
Rich Kick, Newbury Park High School
Heather Lageman, Maryland State Department of Education
Todd Lash, Kenwood Elementary
Carl Lyman, Utah State Office of Education
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Dianne O'Grady-Cunniff, Charles County Public Schools
Anthony Owen*, Arkansas Department of Education
Shay Pokress*, Project Lead the Way
Alfred Thompson, Bishop Guertin High School
Bryan Twarek, San Francisco Unified School District
Nicki Washington, Winthrop University

Advisors:
Karen Brennan, Harvard Graduate School of Education

Development Staff:
Debbie Carter, Editor
Katie Hendrickson, Code.org
Pat Yongpradit, Code.org
Lian Halbert, Code.org

Process Advisors:
Jennifer Childress, Achieve, Inc.
Courtney Blackwell, Outlier Research & Evaluation, University of Chicago

*Only present on 4/10

What did the Writers do and how did they work together?

The Structure

Introductions and Overview:
Katie Hendrickson of the Development Team provided an overview of the two-day workshop. Writers were tasked with revising as much of the Framework content as possible, incorporating the second round of public feedback from the March 18th to April 5th review period and Advisor feedback. The main goal was to have a draft of the Framework ready to share with Advisors for additional feedback and input at the Stakeholder meeting April 11th.

She reviewed the "Parking Lot" document, which is intended to be a place to keep any lingering thoughts, ideas, or questions that should be addressed at a later time, so as not to disturb the flow of the Workshop. Additionally, she noted that they did not build in any formal breaks to the workshop agenda but expected the Writers to take short breaks as needed, as well as slightly more time for lunch.

Pat Yongpradit of the Development Team reviewed the Framework Principles and Vision Statement, as well as reviewed the major feedback themes and reviewer impressions from the second round of public reviews. He set the theme for the workshop—"Get Real!"—by providing an update on the current state of CS education in the U.S., followed by Bryan Twarek and Todd Lash, who provided a more in-depth look at two of the big themes that arose from the feedback: balancing the breadth versus depth of the Framework and revising language to focus on the "doing" of CS.

The Process

Principles: The principles were reviewed with the whole group.

1. **What is best for teachers and students?**
   The ultimate purpose of the framework is to serve the needs of teachers and students, and this should be held in careful consideration throughout the process.

2. **Less is more.**
   The framework should aim to be concise rather than exhaustive.

3. **Don't reinvent the wheel.**
   Resources and ideas that already exist in the field should be utilized whenever possible.

4. **Research-backed and research-forward.**
   The framework should be supported by research, and should help foster a research agenda for the field.

5. **Aligned to national standards structures and process norms.**
   Both the process by which the framework is generated, and the framework itself, should follow the high standards put forth by similar efforts. In particular, the process for creating the framework should be as transparent as possible.

6. **A step toward something more.**
   While the goal of in-person meetings is to produce the best work possible, we also need to recognize that revisions will be necessary.

7. **Aim for 75% agreement.**
   Every participant need not completely agree to each decision. To keep the process moving, we will aim for each decision to have about 75% "agreement."

Framework Vision Statement: The whole group reviewed the vision statement.

A framework that will empower students to…

- **Be informed citizens** who can critically engage in public discussion on CS-related topics.

- **Develop** as learners, users, and creators of CS knowledge and artifacts.

- **Better understand** the role of computing in the world around them.

- **Learn, perform, and express** themselves in other subjects and interests.

Small Group Discussions: The small groups are delineated below. These small groups have been writing their respective portions of the framework since the first Writers Workshop in November 2015.

Small Groups:[2]
Computing Devices and Systems: Alano[+], O'Grady-Cunniff*, Gruwell, Lyman
Networks and Communication: Lageman[+], Washington*, Owen, Bell
Data and Information: Babb[+], DeLyser*, Frost
Programs and Algorithms: Twarek[+], Kick*, Moix
Impact and Culture: Booker-Dwyer[+], Jones
Practices: Lash*, Israel, Thompson, Pokress

Jigsaw Group Discussions: The jigsaw groups are delineated below. These groups were put together by the Development Team as a way for Writers to provide input and feedback on other areas of the Framework outside of their particular Concept/Practices focus. Each group had one person from the focal Concept team to help provide context and explanation. This grouping strategy also allowed Writers to become more familiar with the other Framework areas, which helped them revise their own sections to ensure clarity and consistency across the entire Framework document.

Day 1 Jigsaw Groups:
Impacts of Computing: Jones, Lyman, Alano, and Frost
Networks, Communication, and the Internet[3]: Washington, DeLyser, and Carter
Algorithms and Programming: Twarek, Brennan, Lageman, and Bell

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[2] As described in the Writers Workshop #1 Summary, the development team designated one person from each small group as a facilitator ([+]) and one as a lead writer (*). Facilitators were responsible for scheduling, organizing, and task management, while lead writers were responsible for editing.

[3] Formerly "Networks and Communications"

Data and Analysis: Babb, Kick, Booker-Dwyer, and O'Grady-Cunniff
Computing Systems[4]: Gruwell, Israel, Thompson, and Hendrickson
Practices: Lash, Moix, Childress, and Yongpradit

Day 2 Jigsaw Groups:
Impacts of Computing: Booker-Dwyer, Lyman, DeLyser, and Frost
Networks, Communication, and the Internet[5]: Lageman, Washington, and Owen
Algorithms and Programming: Twarek, Brennan, Alano, and Bell
Data and Analysis: Babb, Kick, Thompson, and Gruwell
Computing Systems[6]: O'Grady-Cunniff, Jones, Moix, Hendrickson, and Yongpradit
Practices: Pokress, Lash, Israel, Childress, and Carter

Day 1:
Prior to the workshop, the Development Team aggregated reviewers' feedback from the second round of public review of the CS Framework. They provided the Writers with time at the start of the two-day workshop to individually review a data spreadsheet containing specific actionable revisions (e.g., what to cut, reword, or re-level for age-appropriateness), a document with major feedback themes, and document containing the raw feedback. Following this individual review time, Yongpradit summarized the feedback from the second round of public review (detailed below). Of note, he shared that the overall impression of CS framework draft increased from the first round of reviews to the second round, with over 79% of second-round reviewers saying the Framework is "very good" or "excellent."

Overall Framework Strengths

- Comprehensive, encompasses critical concepts
- Great that this document exists at all, it's timely
- Like the focus on equity and diversity
- Examples are great
- Huge improvement from last round
- Like inclusion of Crosscutting Concepts
- Like inclusion of glossary
- Great thing for CS to be adding focus on problem solving and persistence.
- Generally good progressions of knowledge

Practices Strengths

- Learners at all levels will benefit from the practices
- Comprehensive, essential, seem to have picked the "right" practices
- Like the breakdown between the 4 Computational Thinking and the 3 surrounding practices

Concept Strengths

- Covers the breadth of CS and most important concepts
- Big improvement in language and clarity

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[4] Formerly "Computing Devices and Systems"
[5] Formerly "Networks and Communications"
[6] Formerly "Computing Devices and Systems"

Next, Yongpradit set the theme for the workshop—"Get Real!"—by sharing the broader context of the Framework development efforts, especially in light of the recent federal CS for All funding initiative and Hour of Code. He emphasized five topics described below.

Get Real! Topics

1. **Standards reality:** States will use the Framework to create their own standards.
2. **Scale**: There are approximately 140,000 schools in U.S. with over 55 million students. Imagine *all* of them learning CS, based on everything stated in this Framework.
3. **Less is more**: Focus does not equal watering down.
4. **Curriculum is full**: Most schools will integrate CS into other core disciplines already being taught, especially in K-8.
5. **Audience**: The Framework will be read by a wide audience (e.g., parents, educators, administrators, policymakers, researchers, curriculum writers, standards writers)

Twarek and Lash led a more in-depth discussion around the breadth versus depth of the Framework in light of the reality that states and districts will use the document to write future standards. They emphasized that the current Concepts are too broad for realistic standards writing and lack active language invoking the "doing" of CS. Twarek noted that the issue is **not the number of words, but the number of ideas within a concept statement,** while Lash emphasized the need to refocus statements with active verbs to ensure **high fidelity translations to standards**. They tasked the Writers to consider the following as they revise the Framework:

1) Cut any concepts that are not essential, with a focus on fewer concepts in the earlier grades;
2) Trim concept statements to only contain one big idea, with the intent that each statement will only lead to one or two standards; and
3) Ensure easy integration with other subjects, especially in the K-5 and 6-8 grade bands.

Next, Hendrickson explained the revision process and jigsaw grouping strategy, noting each jigsaw group had two two-person subgroups where possible for a "divide and conquer" due to the large amount of material to review. Each subgroup was tasked with reviewing half of the statements/practices. Hendrickson reminded groups to designate group roles, including a facilitator, timekeeper, and a writer/documenter, as well as outlined the following revision process strategies.

Revision Process Strategies—Concept Statements

1. What is the big idea for each concept statement?
2. Is it <u>absolutely</u> essential?
3. Can the big idea be more clear and explicit?
4. Are all of the biggest big ideas represented in the overview?

Revision Process Strategies—Practices

1. What are the main actions (verbs, phrases) in a practice overview statement?
2. Are the main actions said clearly and explicitly? Are there more details that should be added to the overview statement that are essential to the big idea to help with clarity (depth not breadth)?
3. What are the main actions in the end-of-grade 12 goals? Are they stated clearly and explicitly?
4. What are the main actions in the progression narrative? Are they stated clearly and explicitly?
5. Are all of the practices in the overview statement, end-of-grade 12 goals, and progression narrative <u>important</u> and <u>applicable</u> across concept areas?

After spending approximately one hour in their jigsaw groups, the Writers came back together to their original small groups to revise their K–12 progressions. Hendrickson provided strategies for addressing the progressions, including focusing on jumps from one grade band to another; condensing adjacent grade band statements if content could be combined; and writing a short one to two sentence description overview of the progression.

Next, Karen Brennan, one of the Framework Advisors, led a discussion around the problems Writers encountered in their progression revisions thus far and how they might go about address such problems. Issues included smoothing out statements across grade bands, ensuring the developmentally-appropriateness of statements, and making connections across statements within the same Concept areas.

Then, Hendrickson addressed the need for Writers to document how they addressed reviewer feedback. She asked each group to create a copy of the worksheet that the Development Team put together, which consisted of a single table with a column on the left that was pre-populated with overarching feedback themes, a column in the middle with broad suggestions and guidance for revisions, and a column on the right for Writers to document specific examples of how they addressed the reviewer recommendations and/or questions. Writers could also add additional major themes to the worksheet if they felt they should be addressed. The Writers spent the remainder of Day 1 working on documenting their revisions, and at the end of the day, Hendrickson provided a short wrap up and preview of Day 2's agenda.

Day 2:
Writers began Day 2 by individually reviewing feedback from Advisors, followed by a whole group debrief discussion regarding the feedback led by Hendrickson and Yongpradit. Writers spent the rest of the morning revising the Framework in their original small groups and documenting changes in the pre-populated worksheet (described above).

Next, DeLyser led the whole group in a discussion around making statements more active to better reflect that CS is about doing. Indeed, reviewers critiqued the Framework concepts for focusing too

much on the "knowledge in the head" and not enough on the actual doing of computer science. Writers then worked in their original small groups to review each sub-concept and revise it with more active verbs if the sub-concept reflected actions professionals take when practicing CS and can be demonstrated in projects and artifact production.

Following this revision session, Yongpradit reviewed the jigsaw grouping strategy and the "divide and conquer" approach as well as reminded Writers to designate group roles. Writers were tasked to focus specifically on making the Framework language simpler and less technical, and the Development Team emphasized that the framework was not the space to teach technical CS vocabulary. Yongpradit presented a suggested approach for this revision process.

Review Process Strategies—Language Focus

1. Can we use simpler words? (Not just technical terms)
2. Check out the data for "The language is clear and understandable to CS novices."
3. Identify technical terms and determine if the <u>exact</u> term essential to CS and for <u>all</u> students. If essential, consider moving technical terms to descriptive materials and using simpler words in the concept statement while retaining the original meaning.
4. Use suggestions tool to suggest alternate words/phrases.

After spending an hour in the Day 2 jigsaw groups, Writers went back to their original small groups and spent the rest of the day revising their Concepts/Practices based on the jigsaw group suggestions related to language. At the end of the day, Hendrickson provided a short wrap up and discussed the Stakeholder meeting occurring the following day.

What did the Writers decide?

Impacts of Computing Grade Band Progression: Given the broader nature of Impacts of Computing on the "individual, cultural, social, ethical, and legal aspects of computing and how computing can extend human capabilities," the Writers felt that this Concept greatly aligns to social studies and cultural studies. **As such, they decided to draw on the College, Career, and Civic Life (C3) Framework, the International Society for Technology in Education (ISTE) Standards, and the Maryland Technological Literacy Standards as they developed their grade band progressions.** For example, they took the notion that students take a deep dive into different cultural groups in 3rd-5th grade to develop the sub-concepts for this grade band around how computing has impacted such cultural groups. Similarly, 6th-8th grade focuses on the trade-off between inventions and innovations, such that the Writers tied this idea into their 6-8 grade band sub-concepts.

K-5 Teacher Feedback: In discussing feedback from the second round of public reviews, the Writers felt they would benefit more from knowing what grade the reviewers teach. They also wanted more feedback from K-5 classroom teachers. **The Writers and Development Team decided to target K-5 teachers when sending out the next public review notice as well as ask reviewers to report what grade they teach**. While not formally decided, the Development Team will also consider hosting teacher focus groups to get richer feedback regarding whether the elementary grade band statements are developmentally appropriate, whether teachers feel like they can translate the

Framework into practice, if and how they will implement CS, and challenges to such implementation.

Reorganization of Practices: Throughout the workshop, the Practices team discussed reviewer feedback related to making diversity and equity more apparent throughout the Framework. No formal decision was made to change the order of the Practice statements, **but the Writers will reconsider the order of the Practices throughout the revision process**.

Human-Computer Interaction: During one of the jigsaw groups, Writers from the Computing Devices and Systems group and the Impacts of Computing group realized they had overlapping concepts regarding Human-Computer Interaction (HCI). They agreed that if ultimately the concern is with students understanding how things are designed versus doing the actual design, HCI should be in the Impacts section. **The Writers from both groups decided to keep HCI in the Impacts section and bolster the descriptive material with material that the Devices group had written. Additionally, they added a statement in the Devices section calling out that HCI is covered in Impacts.**

Models and Simulations: Writers from the Data and Information group and Programs and Algorithms group discussed the Models and Simulations sub-concept in light of reviewer feedback and overlap across the two sections. **The Writers decided that Data and Information would keep this sub-concept and Programs and Algorithms section will change the title of the "Data structure and representation" sub-concept to just "Data structure" since the data representation will be covered in the Data and Information section. Additionally, the Data and Information section will add material from the Programs and Algorithms group into the descriptive materials.**

Simplifying Language: Similar to the first round of public reviews, reviewers from the second round noted that the Framework language was not accessible to lay people and inconsistent throughout. The Writers engaged in several discussions regarding whether simplification was appropriate and how/where to present specific vocabulary if they think certain terms are essential. **The Writers decided to use their best judgment to simplify language and include more technical terms in the descriptive material as much as possible, agreeing that simplicity of language will mean a lot for the acceptance of the Framework. Additionally, the Development Team brought on an Editor, who will help create a consistent voice for the framework.**

Practice 1: The Practices group initially changed the title of Practice 1 to "Recognizing and defining design opportunities" because reviewers thought "Computational problems" was to narrow. The Writers considered a range of different terminologies, including "Defining opportunities for computational thinking," "Problem solving for computing," and "Computational expression." They ultimately circled back to "Computational problems" with a more focused definition and **decided to call Practice 1 "Recognizing and defining computational problems."**

Reviewing Grade Band Stories: The Development Team intended for the Writers to spend the afternoon of Day 2 in small groups based on grade band expertise to review all of the sub-concepts within a single grade band across the entire Framework. However, the Writers decided they would benefit more from continuing revisions within their Concept groups, and the Practices team reported that they were still refining the grade appropriateness, such that it would not be productive

for someone to provide feedback at this point. **The Writers decided to work on the grade band stories offline.**

Revising Framework for June Public Review: Given the feedback from Advisors and the extensive revisions currently underway by the Writers, **the Development Team decided to hold an additional workshop in May for Lead Writers, Advisors, and the Practices Team. The goal of this two-day meeting will be to identify and address any remaining major concerns prior to the third public review period in June.**

Next Steps: The Writers were tasked to continue making revisions in light of the second round of public review and Advisor feedback. The Development Team will provide specific next steps and deadlines for Writers following the Stakeholder meeting on April 11th.

Framing Computer Science Education Meeting Summaries
Meeting Summary #8: Advisor Meeting #3 – May 22nd, 2016, New Orleans, LA

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K-12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K-12 computer science education in the United States. A steering committee with representation from the Association for Computing Machinery (ACM), the Computer Science Teachers Association (CSTA), Code.org, the National Math and Science Initiative (NMSI), and the Cyber Innovation Center (CIC), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, is convening a series of the meetings with "Advisors," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K-12 computer science framework. The Stakeholder Meetings focus on sharing and communicating about computer science education work among interested state and organizational leaders. Finally, Writing Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "core concepts" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts will be organized by grade band, while the sub-practices will be organized through a narrative learning progression, both of which are illustrated in the figures below.[1]

The framework also contains "Crosscutting Concepts." Crosscutting Concepts, by definition, must speak to all or most of the concept themes, and all or most of the grade bands. The framework writers will consider the crosscutting themes as they work to develop the framework. Examples of Crosscutting Concepts from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science crosscutting concepts include Abstraction, Computational Thinking, and Systems and System Models.

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[1] In prior Meeting Summaries, sub-practices were also described as being organized by grade bands. However, at Writing Workshop #2, it was decided that practices would be organized around a narrative learning progression instead of specific grade bands (see the Writers Workshop #2 Summary for more information on this decision).

	Concept 1	Concept 2	Concept 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
Description of Practice			
Example Grade 12 Learning Goals			
Example K-12 Learning Progression			

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the sixth in the series of meeting summaries.

Summary of Advisors Meeting #3 – May 22nd, 2016, New Orleans, LA

Who were the Advisors?

The following Advisors attended this meeting:

Jill Denner, Education, Training, Research (ETR)
Kathi Fisler, Worcester Polytechnic Institute
Mark Guzdial, Georgia Tech
Helen Hu,* Westminster College
Tammy Pirmann, CSTA
Deborah Seehorn, CSTA
Chinma Uche,* CSTA and Hartford Schools

The following Writers also attended:

Tiara Booker-Dwyer, Maryland State Department of Education
Leigh Ann DeLyser, CSNYC
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Maya Israel*[+], University of Illinois Urbana-Champaign
Rich Kick, Newbury Park High School
Todd Lash, Kenwood Elementary
Minsoo Park, Champaign School District
George Reese, University of Illinois Urbana-Champaign
Hal Speed*, Texas Alliance for Computer Science Education
Alfred Thompson, Bishop Guertin High School
Nicki Washington, Winthrop University

Development Staff:
Katie Hendrickson, Code.org
Miranda Parker, Code.org Intern, Georgia Tech
Pat Yongpradit, Code.org

Process Advisors:
Jennifer Childress, Achieve, Inc.
Heather King, Outlier Research & Evaluation, University of Chicago

*Only present for part of the day
+Participated via videoconference

What did the Writers and Advisors do and how did they work together?

Introductions and Overview:
Katie Hendrickson of the Development Team gave a brief overview of the agenda. The day was split into two sessions; one was for going over feedback and comments from previous meetings that focused on how to delineate grade-bands within the framework concepts, and the other focused on discussing crosscutting concepts and their place in the framework process. She noted that the day's meeting was only one of three; the Writers would stay and continue to work for two additional days without the Advisors. She also reviewed the group norms, which are:

1. **Be here now. Take care of what you need to, but when in the room, be fully present.**
2. **75% rule. If 75% of us agree, that's good enough for now. We won't all agree all of the time.**
3. **Sometimes we will need to cut off discussion to keep on time. We can come back later to resolve things.**
4. **Be cognizant of how much you talk. Let more quiet participants have the chance to speak.**
5. **If something relates to your area of expertise, speak up.**

Next, Pat Yongpradit of the Development Team led the participants through an exercise to recall the principles by which the framework is guided.

Principles:

1. **What is best for teachers and students?**
   The ultimate purpose of the framework is to serve the needs of teachers and students, and this should be held in careful consideration throughout the process.

2. **Less is more.**
   The framework should aim to be concise rather than exhaustive.

3. **Don't reinvent the wheel.**
   Resources and ideas that already exist in the field should be utilized whenever possible.

4. **Research-backed and research-forward.**
   The framework should be supported by research, and should help foster a research agenda for the field.

5. **Aligned to national standards structures and process norms.**
   Both the process by which the framework is generated, and the framework itself, should follow the high standards put forth by similar efforts. In particular, the process for creating the framework should be as transparent as possible.

6. **A step toward something more.**
   While the goal of in-person meetings is to produce the best work possible, we also need to recognize that revisions will be necessary.

Yongpradit also led the participants through an exercise to recall the vision statements that define the framework.

Purpose of the Framework:

A framework that will empower students to…
- Be informed citizens who can critically engage in public discussion on CS-related topics;
- develop as learners, users, and creators of CS knowledge and artifacts;
- better understand the role of computing in the world around them; and
- learn, perform, and express themselves in other subjects and interests.

Next, Yongpradit brought up a point for discussion that pertained to aligning the statements within grade-bands. He asked whether, for example, the K-2 grade band should include statements that aimed for 2nd graders? Or kindergarteners? Or 1st graders? The Writers and Advisors generally reported that they had been thinking of their concept statements as being goals for the end of each grade band, but agreed that using examples in the accompanying framework materials would be the best way to demonstrate how to use the concept statements to create appropriate standards and curricula.

Grade-Band Meeting Revisions:

The participants were split into two groups to examine feedback from previous meetings focused on grade-bands. The task was for each group to make a plan for addressing the comments, and the Development Team noted that there were elementary grade experts present at the Writing Workshops held later in the week. The groups were:

Group A: Data/Computing/Impacts: Booker-Dwyer, DeLyser, Fisler, Gruwell, Guzdial, Hendrickson, Hu, Seehorn, and Speed.

Group B: Networks/Algorithms: Childress, Denner, Kick, Parker, Pirmann, Uche, and Washington.

The groups spent the morning creating plans for addressing grade-band feedback.

Advisor Crosscutting Concepts Discussion

Participants: Childress, Fisler, Guzdial, Hu, Yongpradit

In the afternoon, the Writers worked on revisions and refinements to their respective contributions to the framework, while the Advisors gathered to discuss the crosscutting concepts. The Advisors spent some time reading independently through the crosscutting

concepts writing guide used by the Writers. Yongpradit led the discussion, and asked whether the Advisors had questions about the background, purpose, and philosophy of the crosscutting concepts.

The Advisors asked whether the crosscutting concepts were truly that, or whether they were a 'catch-all' category of things that were important, but that didn't have a place within the framework concepts. The Advisors discussed various concepts, including the evaluation of artifacts and whether they met the desired outcomes or specs; automation; privacy; and process, agency and their roles in computing. The Advisors were in disagreement about which, if any of these, should be added to the list of crosscutting concepts.

To test their ideas, they chose some concept statements from the framework and tried to add in the proposed crosscutting concepts to see if that added value to the concept statements. One example was from the Devices concept, in the 3rd-5th grade band. The concept statement was that computing devices are everywhere, and one Advisor proposed adding that the devices gather information to be used later, as a way to add the concept of agency to the statement; that the devices have the agency to collect information. The Advisors agreed that this added value to that statement, but then discussed how many concepts a concept had to apply to, in order to make it a crosscutting concept. They argued that something like privacy might be very crucial for some concept areas, such as Impacts or Data, but might not apply across enough concepts to be truly crosscutting.

After much discussion, the Advisors added several proposed crosscutting concepts to be vetted by the larger group. These included privacy and agency (to be treated as a single concept); abstraction; "evaluation" of artifacts or ideas; and scale (of systems, networks, etc). The Advisors agreed to bring this list and their broader questions to the larger group. They also wanted to ask the larger group whether the crosscutting concepts should be implicit (used by the writers but not called out in documentation) or explicit (called out in documentation).

One Advisor was concerned that if crosscutting concepts were added to the list, that would inflate many of the statements already written, and disturb the concise language that the Writers had worked to create. She was concerned that it would take much more time to examine each concept statement to see if the crosscutting concepts applied, and then to add to each concept statement. Another advisor proposed that they instead write a document to accompany the framework – similar to the Nature of Science document that accompanied the NGSS – that would make clear connections between concepts that needed to be explicit for standards writers. Another Advisor suggested that they continue to tag concept statements with crosscutting concepts, as a way to imply connections without re-writing concept statements. Some Advisors pointed out that even if tags were used, or if a Nature of Computer Science document was written, those ideas might not make it into the eventual standards, meaning that students and teachers would not be exposed to the crosscutting concepts. Another Advisor pointed out that many of the people in the room were professional development providers, and that they could influence the emphasis of connections as teachers learned the new framework. Others added that the framework is not the final word in CS standards, since it would be updated and changed in the relative short term (on the order of 3 to 5 years), and that future iterations of the framework could better

address the inclusion of crosscutting concepts. **In the end, the Advisors agreed that they would: write a chapter about how to use crosscutting concepts; add guidance for professional development facilitators on how to include crosscutting concepts; and wait for the next version of the framework to be more explicit about crosscutting concepts.**

Framing Computer Science Education Meeting Summaries
Meeting Summary #10: Writing Workshop #6 – July 8th – 9th, 2016

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K-12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K-12 computer science education in the United States. A steering committee with representation from the Association for Computing Machinery (ACM), the Computer Science Teachers Association (CSTA), Code.org, the National Math and Science Initiative (NMSI), and the Cyber Innovation Center (CIC), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, is convening a series of the meetings with "Advisors," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K-12 computer science framework. The Stakeholder Meetings focus on sharing and communicating about computer science education work among interested state and organizational leaders. Finally, Writing Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "core concepts" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts will be organized by grade band, while the sub-practices will be organized through a narrative learning progression, both of which are illustrated in the figures below.[1]

The framework also contains "Crosscutting Concepts." Crosscutting Concepts, by definition, must speak to all or most of the concept themes, and all or most of the grade bands. The framework writers will consider the crosscutting themes as they work to develop the framework. Examples of Crosscutting Concepts from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science crosscutting concepts include Abstraction, Computational Thinking, and Systems and System Models.

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	Concept 1	Concept 2	Concept 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
Description of Practice			
Example Grade 12 Learning Goals			
Example K-12 Learning Progression			

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the sixth in the series of meeting summaries.

Summary of Writing Workshop #6 – July 8th – 9th, 2016

Who were the Writers?

The following Writers attended this meeting:

Derek Babb, Omaha North Magnet High School
Julia Bell, Walters State Community College
Tiara Booker-Dwyer, Maryland State Department of Education
Leigh Ann DeLyser, CSNYC
Dan Frost, University of California, Irvine
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Vanessa Jones, Austin Independent School District
Rich Kick*, Newbury Park High School
Heather Lageman, Maryland State Department of Education
Todd Lash, Kenwood Elementary
Carl Lyman, Utah State Office of Education
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Dianne O'Grady-Cunniff, Charles County Public Schools
Anthony Owen*, Arkansas Department of Education
Minsoo Park, Champaign School District
Shay Pokress, Wyss Institute, Harvard University
George Reese, University of Illinois Urbana-Champaign
Hal Speed, Texas Alliance for Computer Science Education
Bryan Twarek, San Francisco Unified School District

Development Staff:
Debbie Carter, Editor
Katie Hendrickson, Code.org
Miranda Parker, Code.org Intern, Georgia Tech
Rachel Phillips, Code.org
Meg Ray*, Codesters
Pat Yongpradit, Code.org

Process Advisors:
Courtney Blackwell, Outlier Research & Evaluation, University of Chicago
Jennifer Childress, Achieve, Inc.

*Only present on 7/9

What did the Writers do and how did they work together?

The Structure

Introductions and Overview
Katie Hendrickson of the Development Team provided an overview of the two-day workshop. The two main goals were: 1) Revise all Concept statements and Practices based on reviewer feedback from the third and final public review period; and 2) Begin writing the descriptive materials (e.g., cross-cutting concepts and connections, curriculum examples).

Next, Pat Yongpradit of the Development Team reviewed the major feedback themes and reviewer impressions from the final round of public reviews. He then reviewed the new list of Crosscutting Concepts that emerged from the May 22nd, 2016 Advisor meeting (see Advisory Meeting Summary #3).

Hendrickson then reviewed all of the online documents the Writers would be using throughout the workshop, and Rachel Phillips of the Development Team discussed how the reviewer feedback was analyzed. Yongpradit followed with a discussion on the rigor and depth of the Framework and Hendrickson concluded with a review of Writers' tasks for the day.

At the start of Day 2, Hendrickson provided an overview of the day, including a description of and process for the new working groups for writing the descriptive materials. Leigh Ann DeLyser, Lead Writer of the Data and Analysis group, followed with a whole group discussion regarding proposed changes to the "Models" subconcept.

The Process

Small Group Discussions: The small groups are delineated below. These small groups have been writing their respective portions of the framework since the first Writing Workshop in November 2015.

Small Groups:[2]
Computing Systems: Gruwell, Lyman, O'Grady-Cunniff*, Yongpradit[#]
Networks and the Internet[3]: Bell*, Lageman[+], Owen, Phillips[#]
Data and Analysis: Babb[+], DeLyser*, Frost, Hendrickson[#]
Algorithms and Programming[4]: Carter[#], Kick*, Twarek,[+] Moix
Impact and Culture: Booker-Dwyer[+], Childress[#], Jones*, Speed*
Practices: Blackwell[#], Lash, Park*, Parker[#], Pokress[+], Ray, Reese

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[2] As described in the Writers Workshop #1 Summary, the development team designated one person from each small group as a facilitator ([+]) and one as a lead writer (*). Facilitators were responsible for scheduling, organizing, and task management, while lead writers were responsible for editing. Members from the Development Team and Process Advisors ([#]) also joined the small groups to help facilitate and streamline the final revision process.

[3] Formerly "Networks, Communication, and the Internet"

[4] Formerly "Programs and Algorithms"

Descriptive Materials Writing Groups: Prior to the workshop, Writers ranked their interest for the descriptive materials. The Development Team assigned Writers based on preference as well as asked for volunteers to be Lead Writers (*) for each group. The Development Team also participated in the descriptive materials writing groups. These groups are described below.

Descriptive Materials Groups:
Elaboration/Examples: Bell, Gruwell, Pokress, Yongpradit*
Interdisciplinary Connections: Babb*, Booker-Dwyer, Hendrickson, Jones, Kick, Owen, Park
Crosscutting Concepts and Connections: Childress, Frost, Lyman, Phillips, Ray*
Curriculum Examples: DeLyser*, Lageman, Moix, Reese, Speed
PreK Chapter: Blackwell*, Lash, Parker, O'Grady-Cunniff, Twarek

CSTA Focus Groups: The Development Team organized six focus groups of approximately 35 CS teachers and curriculum developers to get feedback on the Framework. The focus groups were held during the annual CS Teachers Association (CSTA) conference on July 11th, and one Writer from each small group (outlined below) facilitated the discussions.

CSTA Focus Group Facilitators:
Computing Systems: O'Grady-Cunniff
Networks and the Internet: Lageman
Data and Analysis: DeLyser
Algorithms and Programming: Twarek
Impact and Culture: Booker-Dwyer
Practices: Pokress

Day 1:

Hendrickson began by providing an overview of the 2-day workshop. She also highlighted the upcoming CSTA focus groups and asked all Writers to provide input and questions they wanted addressed during these focus groups.

Next, Yongpradit summarized reviewers' feedback (detailed below) from the third round of public review of the Framework, which occurred from June 8th – June 29th. During this final review period, both individuals and groups of reviewers provided feedback on the full CS Framework. Yongpradit then reviewed the new Crosscutting Concepts (described below) and facilitated a whole group discussion to ensure all Writers understood them and the rationale for selecting these five specific concepts. He also explained that one of the descriptive materials writing groups would address and expand upon the Crosscutting Concepts on Day 2.

Framework Strengths:

- Well developed, comprehensive, and holistic
- A good K-12 progression
- Inclusive of more than just "coding" and covers the right concepts and practices
- Language is much more accessible than with the first iteration

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Framework Improvements:

- Consistency in voice and vocabulary
- Purpose and relevance of concepts and practices
- K-5 concepts could be more rigorous

Crosscutting Concepts:

- **System Relationships** – Interdependent parts organized for a common purpose.
- **Communication and Coordination** – Reliable exchange of information between autonomous agents (communication) and cooperation toward common outcomes that no agent could produce alone (coordination)
- **Abstraction** – Result of reducing a process or set of information to its set of essential characteristics for computational use
- **Privacy and Security** – Ability to seclude information and express it selectively (privacy) and protection of information systems from theft/damage (security)
- **HCI** – User interfaces, design for humans, technology and social science

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Next, Hendrickson reviewed all of the online documents that the Writers would use in the revision process, and Phillips explained the data analysis process that the Development Team used to draw out the major themes from reviewers' comments (described below). She also explained how the feedback was incorporated into the Writers' revision documents, which included the raw feedback data, review worksheets for each Concept and Practices group, and a copy of the current versions of each Concept/Practices section with tracked comments highlighting specific areas to address in the revision process. Specifically, the revision worksheet included themes deemed most significant based on specific public review period 3 reviewer comments and extrapolations from such comments; feedback from prior reviews that had not yet been adequately addressed; conversations with advisors; and the overall vision and principles of the Framework. Hendrickson also described the color-coding system of the documents, noting that highlighted text represented one of four types of reviewer feedback: 1) The language was above a grade 12 reading level (as determined by a Lexile scoring process); 2) Less than 80% of reviewers agreed that the language was clear; 3) Less than 80% of reviewers agreed that the statement was essential; and 4) Less than 80% of reviewers agreed that the Practices progression description provided sufficient detail (Practices only).

Reviewer Feedback Data Analysis:

1) Gather raw feedback
2) Code feedback into major themes, giving more weight to comments from group reviews since they composed more than one person's opinion
3) Convert themes into actionable ideas
4) Develop revision documents and worksheets

Next, Yongpradit led a discussion regarding the rigor of the Framework, noting that many reviewers felt the progressions lacked depth, both within grade bands and from one grade band to another. He emphasized the main area for improvement as making the Framework more aspirational and encouraged the Writers to focus on making larger jumps in sophistication from one grade band to another as well as going deeper on concepts covered within grade bands. He also stressed that "deeper" did not mean more technical but more rigorous and relevant to students.

Writers then gathered in their small groups and were tasked to consider each comment in the revision documents and make any necessary changes, using "Y" if they decided to the feedback; "K" if they "kind of" addressed the feedback; and "No" if they decided not to address the feedback. Instead of tracking every change made as they did after the first review period, Writers provided examples of how they addressed reviewers' feedback along with short rationales for why they did or did not make changes. The Writers spent the remainder of Day 1 working on documenting their revisions, and at the end of the day, Hendrickson provided a short wrap up and preview of Day 2's agenda.

After the Writers left, the Development Team met to discuss the progress made during Day 1, including any major revisions/resolutions that occurred in the six writing groups. They also discussed the next steps for Writers between the end of the current workshop and the final meeting in August.

Day 2:

Hendrickson provided an overview of the Day 2 activities, tasking the Writers to finish all revisions by midday and spend the afternoon working in their descriptive materials groups. She also reviewed the upcoming deadlines.

Next, DeLyser, Lead Writer of the Data and Analysis group, led a discussion regarding the "Models" subconcept. She explained that many reviewers expressed confusion over this subconcept, especially in light of the overlap between Models and the other two subconcepts of Transformation and Inferences. As DeLyser explained, "A model is defined as a transformation of data used to make an inference." She described the group's process of going through all subconcept statements to determine if and how much of the Models subconcept descriptions overlapped with the Transformation and Inference statements. Given the large amount of redundancy, the Data and Analysis group proposed to remove the Models subconcept and integrate the descriptive material into the Transformation and Inference subconcepts where appropriate. DeLyser asked for the whole group's feedback to help inform whether or not Models should be removed. Following this discussion, the Writers spent the remainder of the morning finishing revisions in their small groups.

In the afternoon, Hendrickson and Yongpradit reviewed the descriptive materials writing process, and the Writers spent the remainder of the day in their descriptive materials small groups. They spent this time determining the content and style of their sections and wrote examples and ideas of what they wanted reflected in the final versions. The goal was to provide the Lead Writer with enough information to complete the section by the end of July.

At the end of the day, Hendrickson and Yongpradit led a short debrief of the workshop's events and reviewed the upcoming deadlines for Framework materials. They also checked in with each Concept

and Practices writing group to get feedback on their overall progress to help inform the structure of the final workshop in August. All groups reported they were more than 80% finished with their final revisions and were confident they would meet the July 18th deadline.

What did the Writers decide?

Computing Systems

Bits: The Computing Systems group received feedback regarding the absence of bits in the Framework. Originally, bits were in the Data and Analysis Concept but were removed following earlier reviewer comments. **The Writers decided that bits were too important to leave out of the Framework and included them in the more appropriate section of Computing Systems.**

Data and Analysis

Models: Writers from the Data and Analysis group proposed removing the "Models" subconcept given negative reviewer feedback**. They decided to remove the Models subconcept and integrate the current descriptions of Models into the Transformation and Inference subconcepts.**

CS vs. Math and Statistics: Reviewers expressed confusion over how the subconcepts in Data and Analysis were different from those covered in math and statistics. **The Writers decided to refocus their section by incorporating more CS into subconcept statements instead of referring to data and analysis more generally.**

Networks and the Internet

Communication Protocols: The Writers considered reviewer comments regarding the use of the word "rules" to describe communication norms. **They decided to change "Communication Rules" to "Communication Protocols" as well as streamline this subconcept to focus more on CS and technology to distinguish it from communication norms more generally.**

Security: Reviewers noted the Security subconcept lacked relevance, especially for the younger grade bands. **The Writers decided to rewrite the K-2 and 3-5 statements to make them more age-appropriate and relevant for young children, including examples such as cyber-bullying and online privacy.**

Impacts of Computing

Human Capabilities: The Writers reviewed the original four subconcepts in light of reviewer feedback regarding redundancy across them. **They decided to remove the Human Capabilities subconcept because it was already covered in the other statements and will now also be addressed in the HCI Crosscutting Concept.**

Reframing the K-12 Progression: Reviewers expressed a lack of depth and complexity across the grade bands, suggesting the statements were too similar and oversimplified at older grade bands. **The Writers decided to reframe the K-12 progressions to include larger jumps between grade bands, moving subconcepts from the 9-12 grade band down to the 6-8 level, and adding more complexity to the high school statements.**

Algorithms and Programming

Revising for Understanding: The Writers focused on revising the Algorithms and Programming subconcepts with simpler language and descriptions that could be understood by a CS novice. **They decided to rewrite subconcept statements and grade band progressions in less technical terminology while maintaining the rigor and original meaning of the statements.**

Practices

Abstraction: Reviewers were confused by the Abstraction subconcept and were concerned that CS novices would not understand the statements. **The Writers decided to included a clearer definition of what abstraction means and how it applies to CS as well as reworked the goal statements and progression description.**

Crosscutting Concepts

Final Crosscutting Concepts: The Writers reviewed the five proposed Crosscutting Concepts: Systems Relationships, Communication and Coordination, Abstraction, Privacy and security, and Human-Computer Interaction (HCI). **They decided to keep all five, and the Crosscutting Concepts and Connections writing group will write the descriptive materials and rationale behind each concept.**

Next Steps: Following the CSTA focus groups, the Development Team will share findings with the Writers as they complete their final revisions to the Concept and Practices sections for the July 18th deadline. Lead Writers of the Descriptive Materials will complete their sections by July 31st, and the Writers will meet one final time in early August to finalize the Framework for a mid-September launch.

Framing Computer Science Education Meeting Summaries
Meeting Summary #11: Writing Workshop #7 – August 6th – 9th, 2016

Overview

What is the "Framing CS" effort?

The Framing CS effort brings together K-12 computer science education stakeholders to agree upon the concepts and practices that all students from kindergarten to twelfth grade in the United States should know. These concepts and practices will comprise a framework for K-12 computer science education in the United States. A steering committee with representation from the Association for Computing Machinery (ACM), the Computer Science Teachers Association (CSTA), Code.org, the National Math and Science Initiative (NMSI), and the Cyber Innovation Center (CIC), along with input from Achieve, Inc. and Outlier Research & Evaluation at the University of Chicago, is convening a series of the meetings with "Advisors," "Stakeholders," and "Writers" to accomplish this task.

The Advisor Meetings (AM) focus on identifying and articulating the concepts and practices that will make up the K-12 computer science framework. The Stakeholder Meetings focus on sharing and communicating about computer science education work among interested state and organizational leaders. Finally, Writing Workshops are designated times when writers communicate and collaborate in person to put "pen to paper" to create the framework.

The final framework will focus on "core concepts" and "practices." Concept themes are categories that contain major content areas in the field of computer science. Each concept theme will include multiple concepts that can be organized by grade band. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will enable students to engage with the concepts. Concept themes and practices will contain "sub-concepts" and "sub-practices" respectively. These sub-concepts will be organized by grade band, while the sub-practices will be organized through a narrative learning progression, both of which are illustrated in the figures below.[1]

The framework also contains "Crosscutting Concepts." Crosscutting Concepts, by definition, must speak to all or most of the concept themes, and all or most of the grade bands. The framework writers will consider the crosscutting themes as they work to develop the framework. Examples of Crosscutting Concepts from the Next Generation Science Standards (NGSS) are Patterns, Structure and Function, and Stability and Change. Proposed computer science crosscutting concepts include Abstraction, System Relationships, Human-Computer Interaction, Privacy and Security, and Communication and Coordination.[2]

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[1] In prior Meeting Summaries, sub-practices were also described as being organized by grade bands. However, at Writing Workshop #2, it was decided that practices would be organized around a narrative learning progression instead of specific grade bands (see the Writers Workshop #2 Summary for more information on this decision).

[2] Prior crosscutting concepts were: Abstraction, Computational Thinking, and Systems and System Models.

	Concept 1	Concept 2	Concept 3
K-2	Statement 1… Statement 2….		
3-5			
6-8			
9-12			

	Practice 1	Practice 2	Practice 3
Description of Practice			
Example Grade 12 Learning Goals			
Example K-12 Learning Progression			

What is the difference between the framework and standards?

The framework does not contain standards. Standards are expectations for what students should know and be able to do that can be assessed. The framework, in contrast, will contain only lists of concepts and practices. It is the expectation that standards will be written by marrying practices and concepts together to create specific, outcomes-focused standards that can be assessed, similar to the structure and format of the Next Generation Science Standards (NGSS). For example, one standard from the NGSS created this way is, "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem," which was constructed by marrying the practice of "Developing and using models" and the concept of "Cycle of matter and energy transfer in ecosystems."

What are the Meeting Summary documents?

Outlier Research & Evaluation, at UChicago STEM Education (formerly CEMSE) at the University of Chicago, observed each meeting, took notes during whole group discussions, observed and took notes during selected small group discussions, and reviewed documents generated by meeting participants. Using that information, Outlier created a general summary of meeting activities with a specific focus on documenting key decisions made about the framework content. This document is the seventh in the series of meeting summaries.

Summary of Writing Workshop #7 – August 6th – 9th, 2016

Who were the Writers?

The following Writers attended this meeting:

Julie Alano, Hamilton Southeastern High School
Derek Babb, Omaha North Magnet High School
Julia Bell, Walters State Community College
Tiara Booker-Dwyer, Maryland State Department of Education
Leigh Ann DeLyser[∞], CSNYC
Caitlin Dooley*, GA Department of Education
Diana Franklin[#], University of Chicago
Dan Frost, University of California, Irvine
Mark Gruwell, Iowa STEM Council Computer Science Workgroup
Maya Israel, University of Illinois Urbana-Champaign
Vanessa Jones, Austin Independent School District
Rich Kick, Newbury Park High School
Heather Lageman*, Maryland State Department of Education
Todd Lash, Kenwood Elementary
Carl Lyman, Utah State Office of Education
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Dianne O'Grady-Cunniff, Charles County Public Schools
Anthony Owen, Arkansas Department of Education
Minsoo Park, Champaign School District
Shay Pokress[#], Wyss Institute, Harvard University
George Reese[+], University of Illinois Urbana-Champaign
Hal Speed, Texas Alliance for Computer Science Education
Alfred Thompson, Bishop Guertin High School
Bryan Twarek*, San Francisco Unified School District
Nicki Washington, Winthrop University
David Weintrop[^], Northwestern University

Development Staff:
Debbie Carter, Editor
Katie Hendrickson, Code.org
Miranda Parker, Code.org Intern, Georgia Tech
Pat Yongpradit, Code.org

Process Advisors:
Courtney Blackwell[~], Outlier Research & Evaluation, University of Chicago
Jennifer Childress, Achieve, Inc.
Heather King[#], Outlier Research & Evaluation, University of Chicago

[^]Present 8/6; [+]Participated remotely 8/6; [~]Present 8/6- 8/7; Present 8/6-8/8; [∞]Present 8/7-8/9; [#]Present 8/8-8/9.

What did the Writers do and how did they work together?

The Structure

Introductions and Overview

At the start of Day 1, Brenda Wilkerson, the CS4All and IT Programs Cluster Manager for Chicago Public Schools (CPS), provided insight on what the CS Framework will means for CPS. Katie Hendrickson of the Development Team then provided an overview of Day 1 and reviewed group norms. The main goal for Day 1 was reviewing and making any final revisions to Concept statements so that by the end of the day, Writers could review and provide any remaining feedback on all statements through an online survey. Hendrickson then provided several updates on Framework progress that occurred since the last workshop in July (see Meeting Summary 10).

At the start of Day 2, Hendrickson reviewed the day's agenda, including the Day 2 goals, which were to finalize the concept statements and complete all of the descriptive materials for those statements. Next, Hendrickson and Yongpradit reviewed results from the Concept statement survey that the Writers completed at the end of Day 1 and led a full group discussion around concept statements that were identified as needing revision by at least three Writers in the survey.

At the start of Day 3, Hendrickson went over the Day 3 agenda, explaining the focus for the day was on ensuring coherency in the Concepts and associated descriptive materials across the Framework. Yongpradit provided an example of coherency to explain how grade band descriptive materials should connect between Concepts, followed by a discussion led by both Hendrickson and Yongpradit on making the Concept and subconcept overviews consistent across the Framework. Hendrickson finished by summarizing general feedback from the three public review periods for the Writers to keep in mind as they made their final revisions.

At the Start of Day 4, Hendrickson reviewed the day's agenda, and she and Yongpradit led a discussion of "Framework Talking Points" to provide Writers with clear and consistent language and ideas for how to talk about the Framework with others in the field and the general public. Cameron Wilson, COO and VP of Government Relations for Code.org and Code.org representative on the Framework Steering Committee, also provided insight based on his experience in the CS education policy landscape.

The Process

Small Group Discussions: The small groups are delineated below. These small groups have been writing their respective portions of the framework since the first Writing Workshop in November 2015.

Small Groups:[3]
Computing Systems: Alano[+], Gruwell, Lyman, O'Grady-Cunniff*, Yongpradit[#]
Networks and the Internet: Bell*, Lageman[+], Owen, Washington, Hendrickson[#]
Data and Analysis: Babb[+], DeLyser*, Frost
Algorithms and Programming: Kick*, Twarek,[+] Franklin, Moix
Impact and Culture: Booker-Dwyer[+], Jones*, Speed*, Dooley, Weintrop
Practices: Blackwell[#], Childress[#], Lash, Park*, Parker[#], Pokress[+], Israel, Reese, Gruwell

Descriptive Materials Writing Groups: Prior to the writing workshop in July (see Meeting Summary 10), Writers ranked their interest for the descriptive materials. The Development Team assigned Writers based on preference as well as asked for volunteers to be Lead Writers (*) for each group. The Development Team also participated in the descriptive materials writing groups. These groups are described below.

Descriptive Materials Groups:
Examples/Elaborations: Bell, Gruwell, Pokress, Yongpradit*
Interdisciplinary Connections: Babb*, Booker-Dwyer, Hendrickson, Jones, Kick, Owen, Park
Crosscutting Concepts and Connections: Childress, Frost, Lyman, Phillips, Ray*
Curriculum Examples: DeLyser*, Lageman, Moix, Reese, Speed

Chapter Writing Groups: Writers volunteered to participate in writing additional chapters that will be included as part of the final Framework document. The Development Team also participated in the chapter writing groups. Additionally, some Writers participated as Reviewers with an eye toward specific concepts across the chapters. These groups are described below, and Lead Writers/Reviewers are designated with an asterisk (*).

Chapter Groups:
Equity: Babb, Pokress
Implementation Guidance: DeLyser*, Hendrickson, Israel, Yongpradit
Overviews: O'Grady-Cunniff, Speed, Twarek
Feedback/Revisions: Lageman, Jones, Alano, Hendrickson*
PreK Chapter: Blackwell*, Dooley, Franklin, Israel, Parker, Twarek
Reviewing Chapters: Bell, Israel, Moix, Owen, Washington
Research Chapter: Parker*, Israel, DeLyser

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[3] As described in the Writers Workshop #1 Summary, the development team designated one person from each small group as a facilitator ([+]) and one as a lead writer (*). Facilitators were responsible for scheduling, organizing, and task management, while lead writers were responsible for editing. Members from the Development Team and Process Advisors ([#]) also joined the small groups to help facilitate and streamline the final revision process.

Day 1:

The first day began with an introduction by Brenda Wilkerson, Chicago Public Schools' (CPS) CS4All and IT Programs Cluster Manager. She described the landscape of computer science in CPS and the district's mission to democratize CS by making it a high school graduation requirement. Wilkerson thanked the Writers for taking the time to create the Framework and explained how the Framework will inform the district's ongoing CS4All effort.

Hendrickson then reviewed the Day 1 agenda as well as updated the Writers on what had happened since the July meeting, namely: 1) Development Team member Yongpradit, along with Writers Heather Lageman and Dianne O'Grady-Cunniff, worked on making the Framework have consistent language and tone; 2) Descriptive Material Lead Writers completed drafts for the elaboration/examples, crosscutting concepts, curriculum examples, and interdisciplinary connections descriptive materials; and 3) Chapter Lead Writers completed drafts for their designated chapters.

Next, Hendrickson and Yongpradit described the process for confirming Concept statements, explaining that each Concept writing group should review all of their statements (ignoring descriptive materials for the moment), resolve any remaining issues, and finalize statements. They emphasized using the group norm "75% rule," explaining that no one will be 100% on board with everything, but as long as everyone is 75% okay with the statements, then the writing groups should finalize them.

While the Concept writing groups met to review and confirm their statements, the Practices group met separately to discuss potential changes to the structure of their section. Prior to the workshop, Yongpradit and Process Advisor Jennifer Childress, along with several Framework Advisors, reviewed Practices statements and identified two main issues: 1) Some statements did not accurately reflect the level of rigor expected by the end of grade 12; and 2) Some progression narratives lacked specificity and did not outline progressions for each statement included in the specific Practice.

To begin addressing this issue, the Practices Writers and Development Team held a conference call prior to the August Writing Workshop and came up with two potential solutions:

> **Option 1:** Revise the Practices statements to ensure all of them consistently reflect what students should know by the end of grade 12; or

> **Option 2:** Revise the Practices statements to make them more general to focus on the "essential idea" of the statement and then provide a K-12 progression narrative for each statement.

The Practices Writers who were a part of this call completed an anonymous survey to decide which option to pursue, and the second option received a slight majority of votes.

However, because not all of the Practices Writers were on the conference call, the two options were brought up for discussion at the in-person August Writing Workshop to confirm the decision with all Practices group members. The Writers also tried revising one of the Practices using Option 2, and through this process, they realized that the K-12 narrative progression did not always specify what early, middle, and high school students should be able to do with respect to each of the goal

statements. After in-depth discussions, the group decided to have the additional members who were not on the conference call complete the survey, and with these additional Writers, the results favored Option 1. The Writers discussed the change in results and moved forward with a hybrid approach where all statements would be revised to reflect end of grade 12 goals and then each statement would include a K-12 narrative progression.

At the end of the day, Writers reviewed all Concept statements individually and completed an online survey to identify any statements they felt still required revisions. Hendrickson then provided a short wrap up and review of Day 1, and after the Writers left, the Development Team aggregated the survey results to prepare for a whole group discussion on the morning of Day 2.

Day 2:

Hendrickson provided an overview of the day's activities, and then she and Yongpradit led a discussion on the results from the Concept statement survey (detailed below). The Development Team identified five Concept statements that three or more Writers identified on the survey as needing revisions, and brought up each statement in turn for the whole group to discuss. Hendrickson also presented qualitative feedback in the form of quotes that Writers had included in their survey responses to provide the whole group with a better understanding of what the main concerns were for each statement. Additional comments were left in the actual framework draft that are not represented in the table below.

Concept Statement	Abridged Examples of Writers' Feedback
Computing Systems, Devices, 6-8 (5 people)	● "Too vague" ● "The two sentences need to be better integrated."
Networks and the Internet, Network Connections/ Communication, 3-5 (5 people)	● "The level of detail specified here is not appropriate."
Networks and the Internet, Cybersecurity, 3-5 (4 people)	● "Needs examples of physical and digital"
Impacts of Computing, Culture, all* (3 people)	● [No comments provided]
Data and Analysis, Storage, K-2, 3-5, and 6-8 (3 people)	● K-2: "This is too abstract." ● 3-5: "Data is not information." ● 6-8: "Data is not stored as characters."

*Note. The survey had "K-2" listed for all grade band levels for the Culture subconcept statement, so the group reviewed all grade band levels.

After the full group discussion, Writers met in their Concept groups to discuss the survey feedback and make any final revisions. The Practices group met separately throughout Day 2 to continue making revisions with the new format they decided on through Day 1 discussions (see Day 1 description above).

Next, the Descriptive Materials groups met to work on their respective parts of the Framework, after which the Writers came together as a whole group and a representative from three of the four groups described their process for developing the materials (described below). The Examples/ Elaborations materials were discussed on Day 3.

> Interdisciplinary Connections: Derek Babb reviewed the interdisciplinary connections materials, and described the format the group used: an overview statement for how the

Concept applied to other content areas and then three examples. He also described how the overview statement would appear directly after the Concept statement overview to help make the connections highly visible for non-CS teachers.

Crosscutting Concepts: Julie Alano explained how the group reviewed all of the Crosscuttting Concepts to ensure each one should be included and that no Crosscutting Concepts were missing. She also described how the group reviewed the definitions for each of the Crosscutting Concepts and aligned them to specific concept statements across the entire Framework.

Curricular Examples: Leigh Ann DeLyser reviewed the curriculum examples, noting that the group intentionally did not mention or link to specific curricula to avoid inadvertently promoting one curriculum over another. She also asked Writers to pay special attention as they reviewed the examples to places where the examples sounded exclusionary.

The Writers then gathered in their Concept writing groups to review the descriptive materials for their Concept sections. Several writers brought up concerns with the Interdisciplinary Connections and the Curriculum Examples. After a discussion among the Lead Writers of these descriptive material sections and the Development Team, it was decided to remove these two descriptive materials sections from the Framework at this time, and to include them later in a different form. At the end of the day, Hendrickson touched base with each Concept writing group to get a sense of their progress on reviewing the descriptive materials. She then provided a wrap up of the day's activities and reviewed Day 3's agenda.

Day 3:

The third day began with an overview of the agenda by Hendrickson. The goals for the day included confirming the elaboration/examples for all concept statements, finalizing overviews and the glossary, working on additional chapters, and reviewing the Practice statements. In general, the theme for Day 3 was bringing coherency to the Framework, and Yongpradit provided an example and explained that coherency could be achieved by connecting subconcept statements within each grade band. He explained that by calling out the connections between statements, the Framework would allow curriculum developers and teachers to cover the Concepts at the same time, as well as create a richer experience for students.

Hendrickson then explained the process for finalizing the Concept and subconcept statement overviews, reminding Writers of the content and format that each overview should take. Concept overviews should start with a sentence about the context (i.e., why is the Concept important?) and include 1-2 sentences summarizing each subconcept, while subconcept overviews should start with a 1-sentence description and 1-2 sentences describing the progression. Yongpradit reminded the Writers that the overviews should summarize the big ideas of the Concepts and subconcepts, and Hendrickson noted that Writers might benefit from reviewing feedback from the third public review period (overarching feedback described below) when revising and finalizing the overviews. Writers had access to two documents: one with the raw feedback from the review period, and another with themes based on the raw feedback. Writers were tasked with identifying the main ideas for each overview. A smaller team of Writers would then finish writing all of the overviews with a consistent voice.

The Writers then got together in their Concept writing groups to work on confirming the elaborations and examples within their Concept statements, revising and finalizing Concept and subconcept overviews, and working on summarizing the revisions and feedback they have made throughout the entire Framework development process. The Practices team met separately to finalize the Practice statements, and continued to do so for the rest of the day.

Next, the Concept Writers reviewed the glossary terms used in their statements and descriptive materials to make sure that the definition in the glossary aligned with their intended meaning of the term. If the definition did not align, Writers provided suggestions on how to revise the definitions. They also reviewed the materials to identify whether any terms had been left out of the glossary, and if so, they added the term and suggested definition to the glossary. After reviewing the glossary, the Writers (except for those in the Practices group) got together in their Chapter working groups to continue writing these additional Framework materials. One team worked on writing overview statements for Concepts and subconcepts

At the end of the day, the whole group came together, and Shay Pokress of the Practices group described the revision process the group had undertaken over the last several days. She explained how the previous version of the Practices section had inconsistencies in the end of 12th grade statements as well as disjointed K-12 progression narratives, where some included clear descriptions for how a statement appears in elementary, middle, and high school, while others were less clearly defined. To alleviate these issues, Pokress explained how the Practices group revised the statements to make them all consistent with what students should be able to do by the end of grade 12 and created K-12 progression narratives for each statement instead of just one general narrative for all statements within a given Practice. The Concept Writers then reviewed all of the revised Practice statements and progressions and completed an online survey to provide feedback, which was discussed as a whole group at the end of Day 3. Hendrickson ended with a debrief of the day's activities and then previewed the Day 4 agenda.

Day 4:

Hendrickson began by reviewing the day's agenda, and then led a discussion of "Framework Talking Points" with Yongpradit. The goal of the discussion was to provide the Writers with clear and consistent language to use when communicating about the Framework to others in the CS field and the general public. As part of this discussion, Yongpradit reviewed how the Framework initially evolved, noting how in early 2015, state policy leaders stopped asking why CS was important and started asking what K-12 CS actually is, what the progression looks like, and what children should be

doing in kindergarten all the way through high school when it comes to computer science. He explained that the Framework initially started as a mini project within Code.org, until they realized it needed to be a much larger effort. He described how the initiative started as a project to provide states with "benchmarks," which evolved to "guidelines" and eventually to the "framework," at which point the Writers were brought in to help with the initiative and the Steering Committee was formed. Yongpradit acknowledged the vagueness that remained even when the Writers were brought on board, but also noted the clarity that the Framework Development Team had by that time with regard to state policymakers not ready to take on CS standards yet. Thus, the Development Team decided on a higher conceptual level of understanding K-12 CS by creating a framework that could then be used to inform future state standards.

As Yongpradit reviewed the Framework development process, a discussion ensued regarding the current context of CS education and how the Framework would fit in with the handful of states that currently have CS standards. Cameron Wilson, COO and VP of Government Relations for Code.org and the Code.org representative on the Framework Steering Committee, also provided insight on the potential impact of the Framework based on his experience in state and federal government policy. He emphasized how the Framework provides a big opportunity to emphasize the importance of CS education and accelerate the effort to get CS to every student. Hendrickson then clarified Framework naming conventions to ensure clarity and consistency when describing and presenting the Framework, and the Writers spent the remainder of the day working in their chapter writing groups. The Practices team spent the rest of the day reviewing the results of the survey about Practices, considering the comments from the other Writers, and making edits to each Practice statement overview, goals, and progression.

What did the Writers decide?

Interdisciplinary Connections: The original intent of the interdisciplinary connections descriptive materials was to help communicate how CS connects to other subject areas. However, through the writing process, the interdisciplinary connections team realized it would better if the connections were made by content area, not CS Concept statement, so that a math teacher, for example, could just look at all the ways CS connects with math. **The group decided to create one-pagers by content area, which will be released after the initial release of the Framework.**

Curricular Examples: The Curricular Examples group started by linking the Framework to existing curricula, but this created issues of inadvertently promoting certain curricula over others. To avoid this, they wrote descriptions of lesson activities but it became too difficult to separate Concepts from Practices. They also felt that the examples were no longer adding additional information to the existing descriptive materials. **The group decided to remove the curricular examples.**

Practices: Feedback from Reviewers, Advisors, and the Development Team revealed inconsistencies in the Practice statements and progressions. **The Writers decided to revise all statements to reflect end of grade 12 goals and to make K-12 progression narratives for each statement instead of one general narrative for each Practice.**

Next Steps: The Practices Writers will finish revising the Practices statements based on feedback from surveys, and Lead Writers will complete their additional chapters, which will be available for the other Writers to review. The Development Team will finalize the editing and formatting of the Framework, which will be released in late September.