Framing Computer Science Education Meeting Summaries

Meeting Summary #1: Advisor Meeting #1 – October 26th, 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 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 education 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 come together in person to communicate and collaborate on putting "pen to paper" to create the actual 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. Practices are the behaviors that computer scientists engage in that require both content knowledge and specific skills, and these practices will ultimately 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 concept 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 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 first in the series of meeting summaries.

Summary of Advisor Meeting #1 – October 26th, 2015

Who were the Advisors?

The following Advisors attended this meeting:

Joanna Goode, University of Oregon
Mark Guzdial, Georgia Institute of Technology
Helen Hu, Westminster College
Yasmin Kafai, University of Pennsylvania
Todd Lash, Kenwood Elementary
Irene Lee, Santa Fe Institute
Minsoo Park, Champaign School District
Shay Pokress, Project Lead the Way
Tammy Pirmann, School District of Springfield
Deborah Seehorn, former CSTA Board Chair
Ben Shapiro, University of Colorado Boulder
Alfred Thompson, Bishop Guertin High School
Bryan Twarek, San Francisco Unified School District
Aman Yadav, Michigan State University

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

Steering Committee Members:
Cameron Wilson, Code.org

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

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

Both Advisor meetings (AM1 and AM2) followed the same structure and process.

The Structure of Meetings and Guidelines for Group Discussions:

Introductions and Overview of the NGSS Framework Process: First, the whole group shared introductions and heard statements from an invited speaker, and from Jennifer Childress of Achieve, Inc. Childress spoke about the processes by which the Next Generation Science Standards (NGSS) and the National Research Council (NRC) Framework were created. She especially emphasized the benefits of maintaining a transparent process during the creation of the framework, and that using a framework as a foundation for eventual standards would help clarify potential issues with standards documents.

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."

Meeting Purpose Discussion: Next, the whole group discussed the purpose of the meeting, the intended structure of the framework, and the definitions of terms, such as practice, concept theme, and standard. The group also discussed and agreed upon a rubric to use to test whether content under consideration qualified as a "concept theme" (AM1) or a "practice" (AM2).

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.

Small Group Discussion: Advisors then split into small groups to generate their best list of concept themes (AM1) or practices (AM2). The development staff formed the groups to ensure diversity of background and expertise.

Small Groups:
Group 1: Goode, Guzdial, Pokress, Seehorn, Twarek
Group 2: Hendrickson, Lee, Park, Phillips, Reed
Group 3: Childress, Kafai, Thompson, Yadav
Group 4: Lash, Hu, Pirmann, Shapiro, Yongpradit

Report Out and Whole Group Discussion: Each small group reported their thinking to the whole group. The whole group then discussed which concept themes (or practices) should be included, and drafted a list. Lingering thoughts, ideas, and questions were collected throughout the meeting for discussion and consideration at future gatherings.

What did the Advisors decide?

Purpose of the Framework:

The first discussion of the AM1 meeting regarded the purpose of the framework. The whole group began with a Statement of Purpose, which read:

"What concepts and practices should all students learn to…
- be careful consumers of CS-related information, and informed citizens who can engage in public discussion on related topics
- develop as learners, users, and creators of CS knowledge and artifacts
- learn, perform, and express themselves in other subjects (math, science, arts) and interests
- be ready for college and career"

After some discussion, the statement was revised to say:

"What concepts and practices should all students learn in order to…
- be ~~careful~~ critical users of computing systems ~~consumers of CS-related information~~ and informed citizens who can engage in public discussion of related topics
- develop as learners, [users], and creators of CS knowledge and artifacts
- learn, perform, and express themselves in other subjects (math, science, arts) and interests
- ~~Be ready for college, career, and civic life [move to higher level discussion]"~~

Explanation: AM1 participants removed the phrase "college and career" because some thought that it would promote the misconception that CS education aims only to produce CS workers. AM1 participants also wanted to remove the word "consumers" to remove the implied passiveness of the word.

This discussion continued in the next Advisors Meeting (See Meeting Summary #2).

Decisions About the Concept Themes:

The concept themes are the big concept categories that will house all of the sub-concepts that students must learn. The primary goal of AM1 was to generate a list of concept themes.

The list of concept themes created by the Advisors was:
1. Computing/Hardware Systems
2. Data and Information
3. Networks and Communication
4. Algorithms and Programs
5. Impact and Culture

To create this list, participants were divided into small groups to discuss their concept theme ideas. The development staff formed four groups to ensure diversity of background and expertise.

Each small group presented their concept themes to the whole group, and in some cases, also proposed cross-cutting themes. Each participant was then given time to comment on each of the other group's concept themes in a Google document.

As a whole group, participants developed the following lists:

AM1 Group 1 Concept Theme List:	**AM1 Group 2 Concept Theme List:**
• Computing Systems • Communication • Data • Programming and Algorithms • Information	• Hardware and Software Systems • Networks and Communication • Computational Thinking • Algorithms and Programs • Data and Information • Impact, Society, and Habits of Mind
AM1 Group 3 Concept Theme List:	**AM1 Group 4 Concept Theme List:**
• Systems and Devices • Networks and Communication • Programming and Algorithms • Data and Information • Impact and Culture	• Hardware and Systems • Internet and Communication • Programming and Algorithms • Data and Information • Ethics, Impact, and Culture

Discussions and Decisions about Themes:

1. Computing/Hardware Systems

After discussion, the four groups had revised Concept Theme 1, "Hardware and Systems," as shown in the table below:

AM1 Group Concept Themes
Group 1. Computing Systems
Group 2. Hardware and Software Systems
Group 3. Systems and Devices
Group 4. Hardware and Systems
DRAFT Proposed Concept Theme: Hardware and Computing Devices

Upon seeing the suggestions generated by the other groups, the Advisors began their discussion by focusing on whether to refer to "hardware," "computing devices," or "computing systems" in the first concept theme. The group decided that making distinctions between these terms fell into the realm of wordsmithing, and collectively agreed to call the concept theme "Computing/Hardware Systems." However, participants of the Stakeholder meeting on November 18th, 2015, opted to rename the theme **"Hardware and Computing Devices."**

2. Data and Information

Each group included **"Data and Information,"** so the group decided to move on without discussion.

3. Networks and Communication

AM1 Group Concept Themes
Group 1. Communication
Group 2. Networks and Communication
Group 3. Networks and Communication
Group 4. Internet and Communication
DRAFT Proposed Concept Theme: Networks and Communication

The group discussed the proposed titles for the concept theme addressing networks, communication, and the internet. There was some concern that the term "internet" would become dated, but others pointed out that using the term "internet" may open funding opportunities. Still others argued that the internet is simply one type of network and that perhaps the more general term "network" should be used. The group ultimately decided on **"Networks and Communication."**

4. Algorithms and Programs

AM1 Group Concept Themes
Group 1. Programming and Algorithms
Group 2. Algorithms and Programs
Group 3. Programming and Algorithms
Group 4. Programming and Algorithms
DRAFT Proposed Concept Theme: Algorithms and Programs

Most small groups included a concept theme named "Programming and Algorithms," except for one, which termed it "Algorithms and Programs." The whole group discussed whether programming should be included as a concept theme, or whether it made more sense for it to be included as one of the practices, or if it would be covered in both dimensions. Some argued that while programming is certainly a practice that computer scientists engage in, students should also understand concepts about programming without necessarily engaging in the practice. For example, a student could learn how to read a program or understand that programs are indeed created by humans, and not an "app fairy." The group decided to distinguish the practice of programming from the concepts related to programs and programming by calling the concept theme **"Algorithms and Programs."**

5. Impact and Culture

AM1 Group Concept Themes
Group 1. (None)
Group 2. Impact, Society, and Habits of Mind
Group 3. Impact and Culture
Group 4. Ethics, Impact and Culture
DRAFT Proposed Concept Theme: Impact and Culture

The last set of proposed concept themes concerned society, culture, and impact of computer science. Some participants felt that this concept theme was out of place compared to the others. Other participants argued that since the field of computer science struggles with equal representation, issues of culture and society were of particular importance. Many felt that if this concept theme were left out of the framework, it likely would not be addressed in classrooms, while others argued that it would be difficult to assess cultural and societal concepts. The group recognized that wordsmithing would be necessary, but agreed upon **"Impact and Culture"** as a tentative name for this concept theme.

Cross-Cutting Themes:

Participants of AM1 explicitly generated lists of cross-cutting themes in their small group discussions. These were:

AM1 Group 1 Cross-Cutting Themes List:

- Structure, Behavior, and Function
- Patterns and Abstraction
- Processes
- Systems and System Models
- Culture

AM1 Group 2 Cross-Cutting Themes List:

Group 2 did not identify any cross-cutting themes.

AM1 Group 3 Cross-Cutting Theme List:

- Computational Thinking
- Abstraction

AM1 Group 4 Cross-Cutting Theme List:

- Demystifying Computing
- Abstraction

Cross-cutting themes were not discussed in detail in AM1 beyond the creation of these lists. Participants in AM2 discussed these further (See Meeting Summary #2).

Framing Computer Science Education Meeting Summaries

Meeting Summary #2: Advisor Meeting #2 – November 12th, 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 "Advisors," "Stakeholders" and "Writers" to accomplish this task.

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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 knowledge and skill. They are the skills and processes used by computer scientists that 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.

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	Practice 1	Practice 2	Practice 3
K-2	Statement 1… Statement 2…		
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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 CEMSE at the University of Chicago, observed each meeting, took notes during whole group discussions, observed at 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 second in the series of meeting summaries.

Summary of Advisor Meeting #2– November 12th, 2015

Who were the Advisors?

The following Advisors attended this meeting:

Owen Astrachan, Duke University
Josh Caldwell, Code.org
Leigh Ann DeLyser, CSNYC
Jill Denner, Education, Training, Research (ETR)
Jeff Forbes, Duke University
Diana Franklin, Center for Elementary Mathematics and Science Education, University of Chicago
Shuchi Grover, SRI International
Maya Israel, University of Illinois Urbana-Champaign
Todd Lash, Kenwood Elementary
Irene Lee, Santa Fe Institute
Don Miller, NYC Dept. of Education
Daniel Moix, Arkansas School for Mathematics, Sciences and Arts
Minsoo Park, Champaign School District
Sheena Vaidyanathan, Los Altos School District
Nicki Washington, Winthrop University
David Weintrop, Northwestern University
Uri Wilensky, Northwestern University

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

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

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

Both Advisor meetings (AM1 and AM2) followed the same structure and process.

The Structure

Introductions and Overview of the NGSS Framework Process: First, the whole group shared introductions and heard statements from an invited speaker, and from Jennifer Childress of Achieve, Inc. Childress spoke about the processes by which the Next Generation Science Standards (NGSS) and the National Research Council (NRC) Framework were created. She especially emphasized the benefits of maintaining a transparent process during the creation of the framework, and that using a framework as a foundation for eventual standards would help clarify potential issues with standards documents.

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.

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   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.**
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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.**
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Meeting Purpose Discussion: Next, the whole group discussed the purpose of the meeting, the intended structure of the framework, and the definitions of terms, such as practice, concept theme, and standard. The group also discussed and agreed upon a rubric to use to test whether content under consideration qualified as a "concept theme" (AM1) or a "practice" (AM2).

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 to 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 they be wholly unique and quintessential to computer science, or should they overlap with other disciplines so as to bring them in and involve them? 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 wide audience. Ultimately, the group agreed to use the proposed criteria above.

Small Group Discussion: Advisors then split into small groups to generate their best list of concept themes (AM1) or practices (AM2). The Development Staff formed the groups to ensure diversity of background and expertise.

Small Groups:

Group 1: Forbes, Franke, Franklin, Lee, Miller
Group 2: DeLyser, Israel, Moix, Vaidyanathan, Weintrop
Group 3: Astrachan, Childress, Denner, Nelson, Park, Yongpradit
Group 4: Caldwell, Grover, Hendrickson, Lash, Washington, Wilensky

Report Out and Whole Group Discussion: Each small group reported their thinking to the whole group. The whole group then discussed which concept themes (or practices) should be included, and drafted a list. Lingering thoughts, ideas, and questions were collected throughout the meeting for discussion and consideration at future gatherings.

What did the Advisors decide?

Purpose of the Framework:

During their discussion about the purpose of the framework, participants in the AM1 meeting decided the purpose should be to answer the following question:

What concepts and practices should all students learn in order to…

- be critical users of computing systems and informed citizens who can engage in public discussion of related topics;
- develop as learners, [users], and creators of CS knowledge and artifacts; and
- learn, perform, and express themselves in other subjects (math, science, arts) and interests.

Although the AM1 participants had removed a reference to "college and career" (see Meeting Summary #1) some AM2 participants felt strongly that the Statement of Purpose should include language about college and career, since college, and ultimately careers, are so critically important for justifying standards in education. Others in AM2 agreed that including references to both college and careers would potentially invoke Career and Technical Education (CTE), and also show that computer science is important for all students, including those not heading to college. The AM2 group agreed that these distinctions came down to wordsmithing and that they should be tabled for now.

The resulting, final statement of purpose was:

What concepts and practices should all students learn in order to…

- be critical users of computing systems and informed citizens who can engage in public discussion of related topics;
- develop as learners, [users], and creators of CS knowledge and artifacts; and
- learn, perform, and express themselves in other subjects (math, science, arts) and interests.

Identification of Practices:

Practices were defined as containing dimensions of knowledge and skill, and are different from skills in that "skill" does not necessarily imply the use of knowledge. Practices should also be those that are used by computer scientists, and that distinguish computer scientists from other professionals.

The list of practices created by the Advisors was:

1. Testing and Iterative Refinement
2. Planning/Design
3. Connecting Computing to a Range of Contexts and Cultures
4. Communicating About Computing
5. Creating Computational Artifacts
6. Collaboration

Keeping in mind the "rubric" for practices, participants split into their small groups to brainstorm lists of practices. The small groups then shared their practices lists with the whole group:

AM2 Group 1 Practices List:	AM2 Group 2 Practices List:
• Debugging/Testing/Troubleshooting • Optimization/Efficiency • Computational Design • Design with/for Others • Programming • Abstraction • Connecting to the World	• Abstracting • Communicating about Computing • Collaboration • Creating • Iterating and Considering Audience • Analyzing/Assessing Computational Artifacts • Thinking like a Computer Scientist/Computational Thinking • Creativity and Pursuing Novel Solutions
AM2 Group 3 Practices List:	**AM2 Group 4 Practices List:**
• Computational Problem Solving • Communicate and Collaborate • Analysis • Design • Critical Thinking	• Pattern Recognition • Modeling • Abstraction • Representation • Identifying Problems and Defining Solutions • Decomposition • Create Computational Artifacts (Programming) • Evaluating Solutions • Testing and Debugging • Iterative Refinement • Collaboratively Develop Computational Artifacts • Communication • Use Computing as a Form of Personal Expression • Connecting Computing to a Range of Contexts and Cultures

Note that not every proposed practice was discussed explicitly, so there are some practices listed above that are not listed in the tables below.

Discussion and Decisions about Practices:

1. Testing and Iterative Refinement

LT2 Group Practices
Group 1. Debugging/Testing/Troubleshooting
Group 2. Iterating and Considering Audience
Group 4. Testing and Debugging
Group 4. Evaluating Solutions
Group 4. Iterative Refinement
DRAFT Proposed Practice: Testing and Iterative Refinement

AM2 participants began by discussing the most popular practices first, and aimed to come to a consensus on which practices should be included. The most popular practice was "Debugging/Programming." One participant pointed out that this category addressed ways of analyzing problems and was concerned that it would be too similar to other practice categories that also addressed analysis. Another participant felt that the specific term "debugging" was too specific to programming and that this particular practice should be moved under the more general umbrella of "troubleshooting." The name "Testing and Iterative Refinement" was proposed as a replacement for this category. Some asked what would be under this category other than debugging, to which others proposed "user testing." Some pointed out that the practice of debugging code is a solitary activity that forces the individual to confront and critique their own thinking, while user testing necessarily involves others. Others countered this by saying that one could debug another's code. One participant again argued for the category name, "Testing and Iterative Refinement," since this describes the behaviors used during both debugging and user testing. Ultimately, the group decided on the category name **"Testing and Iterative Refinement."**

2. Planning/Design

LT2 Group Practices
Group 1. Computational Design
Group 1. Design with/for Others
Group 3. Design
Group 4. Modeling
Group 4. Representation
DRAFT Proposed Practice: Planning/Design

The discussion about "Testing and Iterative Refinement" led to a discussion of design in computer science, and whether design was the same as planning out a solution to a problem or issue. This then segued into a discussion about modeling, and whether groups meant modeling as in part of the design process (i.e., using a model to plan part of a program) or modeling as in modeling or simulating data. Some participants said that they were referring to the practice of modeling data, and that they included this in their list so that practitioners could see the connection between CS and other disciplines such as mathematics or science. One participant asked whether modeling should be subsumed under the category of abstraction, but another argued that abstraction has more to do with the recognition of

patterns, while modeling and simulation are more concerned with showing or understanding the interactions in a system. This led to a discussion of whether modeling and simulation was important enough to receive "top billing" as a practice category. Some argued that it should be given that status, as modeling and simulation are currently receiving a lot of attention in education. Ultimately, the group decided that naming the category "modeling" was missing the mark, that the category name should have more to do with the planning and design processes used in computer science, and that the category should be named **"Planning/Design."**

3. Connecting Computing to a Range of Contexts and Cultures

LT2 Group Practices
Group 1. Connecting to the World
Group 4. Using Computing as a Form of Personal Expressing
Group 4. Connecting Computing to a Range of Contexts and Cultures
DRAFT Proposed Practice: Connecting Computing to a Range of Contexts and Cultures

The group then moved to a discussion of the social and cultural aspects of computer science. A proposed category name was "Connecting Computing to a Range of Contexts and Cultures." One participant asked whether replacing "cultures" with "the world" would be sufficient, but another participant argued that the word "cultures" must be included because it would better speak to students currently underrepresented in computer science. Other participants agreed that highlighting this as a practice rather than a cross-cutting theme would ensure that it would be explicitly highlighted. Others argued that the practice of "design" would include designing with and for others. This was met with resistance from some participants, who argued that unless students could see themselves represented in computer science, they would never design anything for anyone else, and that this category was part of ensuring that students are able to foster an identity as computer scientists. Several participants felt strongly that this category should be given "top billing," especially given the underrepresentation of minorities in computer science both at the K12 student and professional levels. The group ultimately decided on the category name **"Connecting Computing to a Range of Contexts and Cultures."**

4. Communicating about Computing

LT2 Group Practices
Group 2. Communicating about Computing
Group 3. Communicate and Collaborate
Group 4. Communication
DRAFT Proposed Practice: Communicating about Computing

The next topics of discussion were collaboration and communication, which dovetailed with a discussion about computational artifacts. Some argued that communication and collaboration were too common among disciplines to be explicitly included. Others then asked whether the intention of these categories was communicating *with* computing, or *about*

computing. Some said that it should be *with* computing, in that students would communicate ideas and express themselves with computing and computational artifacts. Others argued that students should also be able to talk about the computational artifacts they create in meaningful ways. Others agreed that the undergraduates they currently encountered were often skilled at writing code, but were unable to describe it in natural language. Others brought up the idea of using disciplinary or "academic" language – that is, the "lingo" used by computer science professionals – and how the NGSS now addresses the use of "academic" language. One participant pointed out that if a student can explain what they're doing, they are learning. The group ultimately proposed the category name **"Communicating about Computing."**

5. Creating Computational Artifacts

LT2 Group Practices
Group 1. Programming
Group 2. Creating
Group 4. Creating Computational Artifacts
Group 4. Collaborative Create Computational Artifacts
DRAFT Proposed Practice: Creating Computational Artifacts

The next discussion concerned programming. Many participants had concerns about the level of prominence given to programming, since they were sensitive to the fact that computer science is commonly, and mistakenly, equated with programming. Some argued that the practice of programming was really the practice of creating computational artifacts. Others pointed out that some may consider a spreadsheet to be a computational artifact, and others emphatically agreed that creating a spreadsheet did not capture the intention of the proposed category. Still others wondered whether programming should be referred to explicitly as a practice simply because it is a recognizable and would be expected from a CS framework. One participant pointed out that the spirit of the category was captured by the name **"Creating Computational Artifacts,"** and that this should be the tentative name for the category.

6. Collaboration

LT2 Group Practices
Group 2. Collaboration
Group 3. Communicate and Collaborate
Group 4. Collaboratively Develop Computational Artifacts
Group 4. Using Computing as a Form of Personal Expression
DRAFT Proposed Practice: Collaboration

The group then discussed collaboration. One participant asked whether this should be included under the "Communicating about Computing" practice, but others said that this practice was meant to capture communication *with* computing as opposed to *about* computing. Then, others pointed out that communicating with computing would likely result in some artifact, and that this should then fall under the "Creating Computational Artifacts" practice. Participants agreed that collaboration was important to computer science, but

questioned whether it could be assessed, since each practice (after married to a concept) must be assessable. Others argued that observing students working could be a viable way to assess collaboration. One participant said that including collaboration would help change stereotypes about the "loner" computer scientists, and that this could help inspire teachers to change their classrooms and practice. The group decided to keep **"Collaboration"** as one of the practices.

Cross-Cutting Themes:

The participants of AM2 discussed the compiled list from AM1 (See Meeting Summary #1) reprinted below:

- Ethics
- Structure, behavior, function
- Patterns and abstraction
- Processes
- Systems and system models
- Culture
- Computational thinking
- Abstraction
- Demystifying computing

The AM2 group discussed what exactly a cross-cutting theme was, and the fact that the decision to include cross-cutting themes arose organically in the previous meeting. The understanding of a cross-cutting theme that emerged was that it was a "sense-making device" that would apply to each of the concept themes – for example, a concept like "abstraction" could be used to help understand many or all of the proposed concept themes. Cross-cutting themes were to be further addressed by the framework writers in future Writers Workshop meetings.

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.**