

# Arizona Draft Computer Science Standards Technical Review Document

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## Introduction Section

As you conduct your review of the introduction, please consider the following questions.

- A. Does the introduction provide sufficient information and guidance on how to read the standards?,
- B. Does the introduction provide sufficient information on how the standards are structured?
- C. Is there anything missing that should be included in the introduction?

**Please provide feedback on the Introduction section. Include strengths and well as suggestions for refinements.**

NOTE: In addition to my notes below, I used track changes to comment and suggest edits throughout the draft standards document.

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Generally, the introduction is clearly written in terms of how the standards are structured and in its guidance on how to read the standards.

However, I found the Vision Statement section of the introduction to be overly broad. By broad, I mean that one could replace the term “computer science” with some other subject area (math or ed tech, for example) and the vision statement would be essentially the same. I would suggest connecting the Vision Statement more directly to computer science and computational thinking. The Nevada standards provide a good example by specifically mentioning computational thinking and the creation of computational artifacts. Another option might be to use the first paragraph of the Introduction section as the Vision Statement.

The opening section of the Introduction provides a specific and clear description of the goals for the CS standards.

In the Introduction section, I found the section on how the CS standards will integrate computer literacy, ed tech, digital citizenship, etc. to be somewhat confusing. I think for a typical teacher, it would be more valuable to distinguish CS standards from existing areas, rather than essentially say that CS standards are the same thing as existing standards. One edit could be to cut the paragraph on page 7 starting with “The Arizona Computer Science Standards integrate...”. This paragraph in some ways contradicts the paragraph starting “Computer science builds upon the concepts...”

The descriptions of the essential 5 concepts are clear and easy to understand. The concepts themselves are sensible and appropriate for K12 CS education.

The sentence “Networking and the Internet must also consider Cybersecurity” is oddly worded (the Internet can’t consider something).

Figure 1 (page 10) showing the concepts and related subconcepts includes a number of terms that have not been defined before the figure appears (and that are defined only in the glossary). It would help readers if the subconcepts were briefly defined in this section of the standards.

In the introduction to the CS Practices (pg. 11), it would be useful to more clearly explain how these practices relate to the standards overall, and to the specific concepts/subconcepts included in the standards. As currently written, there is no indication that these will be specified within the standards.

The term “computationally literate” (pg. 11) should be changed to “computer science literate” throughout the document, to prevent confusion over CS literacy vs. computational literacy.

Generally, I think the introduction section underplays computational thinking as a key component of CS literacy. The paragraph on computational thinking gets lost coming at the end of the introduction. One solution would be to give the computational thinking paragraph a Header to call it out more clearly.

The section on reading the standards is well-written and easy to understand. However, it isn’t clear what the number following the listed practice in each subconcept section means. It would benefit readers to have introduced and defined the subconcepts prior to this section.

## Standards Section by Grade Level

As you conduct your review of the grade level and High School standards, please consider these questions.

- A. Does the introductory information for the grade band and for each grade level provide enough context to understand how the standards connect within the grade and between grades within each band?
- B. Does each standard clearly state what students should know and be able to do?
- C. Can the standard be measured?
- D. Are there any ambiguous or unclear words/phrases?
- E. Do the standards in each section have appropriate **breadth**?
- F. Do the standards in each section have appropriate **depth of content and rigor** for the grade level?
- G. Is there meaningful alignment and development of skills/knowledge within each grade and from one grade band/grade level to the next?

Overall comments:

The level of clarity of the standards by grade level depends on how the document is read. Viewing the standards overall, there are problems with consistency of voice, structure, and grammar across the year-to-year standards. Looking across all grade levels, although the standards are broken down by grade, they derive from source material in which standards were defined by grade bands (K-2, 3-5, 6-8). It isn't clear if teachers are supposed to understand that the grade-by-grade standards represent specific grade bands. If so, the document should include clear information to help teachers understand this. Not surprisingly, each of the grade bands includes a large amount of repetition and overlap. In many cases, the language for a given subconcept is identical across grades in a given band...particularly for the elementary grade standards. Because the grade-by-grade standards are not always clearly delineated from year-to-year, some of the objectives and activities for a given year seem a mismatch for the developmental stage of students in some grades. This is most prevalent in the kindergarten and 1<sup>st</sup> grade standards.

At the same time, each of the bands feature a different 'voice' and language format, likely indicating different authors. For example, some sections include clear example activities for students to complete, while others do not. Some sections use future tense for the subconcept objectives, while others use present tense. Some use first person, i.e. "Discuss basic hardware problems...", while others use 3<sup>rd</sup> person, i.e. "students discuss...". While it would be beneficial to more fully align the overall document in terms of voice, language, grammar, etc., it is likely that in practice a given teacher will only read the standards associated with her/his grade(s). In this case, overall consistency across grades is less important.

More critically, the subconcept sections are inconsistent in including language about what students should know and do. Many simply describe the subconcept without including information on what students might do to learn the concept and/or demonstrate mastery of it.

### 1. Please provide feedback on Kindergarten:

- a. Does the introductory information for the grade band and for each grade level provide enough context to understand how the standards connect within the grade and between grades within each band?
- b. Does each standard clearly state what students should know and be able to do?
- c. Can the standard be measured?
- d. Are there any ambiguous or unclear words/phrases?
- e. Do the standards in each section have appropriate **breadth**?
- f. Do the standards in each section have appropriate **depth of content and rigor** for the grade level?
- g. Is there meaningful alignment and development of skills/knowledge within each grade and from one grade band/grade level to the next?

The kindergarten introduction is generally clear. The introduction sections for Kindergarten through Grade 2 all use future tense, later introduction sections use present tense.

The standards do not make any mention of grade bands, so it is unlikely that teachers will have enough context to understand how standards can/should connect from year to year within a given band. The biggest issue with the kindergarten standards is that, because they are part of a 3-grade band, but have not been fully differentiated by grade level, some of the subconcept objectives show a mismatch for the literacy level of kindergarteners (or many 1<sup>st</sup> graders). For example, the Cybersecurity subconcept asks that students make use of passwords and usernames. But kindergarteners generally can't read and are just beginning to learn to write. Similarly, under the Data and Analysis concept, students are expected to create surveys...again something that would be a challenge to students at the pre- or beginning literacy stage of development. There are many other examples that could be a problem: creating planning documents, blogs, and coding journals; calculating averages; and discussing life in a pre-computer world.

These issues could be addressed by providing grade-specific examples of how students can learn and demonstrate understanding of a given subconcept, rather than including identical language for each grade within the K-2 band.

Speaking more generally, the breadth of the standards for kindergarten seem appropriate. The depth of some sections is likely too 'deep', given the literacy level of the students at this development stage. Further differentiation of the subconcept descriptions and/or suggested activities would help address this issue.

## 2. Please provide feedback on Grade 1:

The Grade 1 introduction is clear and builds well on the introduction for Kindergarten. The wording of objectives for many of the Grade 1 subconcepts and example student activities are identical, or nearly identical, to those for kindergarten. This may not be a problem, given that a given teacher is likely to focus on her/his specific grade level. However, it could be useful to identify what is new/added in a given year more clearly. For example, a 'grade band' table showing all subconcepts and highlighting changes/additions per subconcept by grade would be a useful tool. Indeed, in reviewing the draft standards, I viewed multiple copies of the document side by side in order to better understand how the standards relate and differ by grade.

As with the kindergarten standards, some objectives and suggested activities seem a mismatch for the literacy level many 1<sup>st</sup> graders (creating blogs and planning documents, calculating averages, etc.)

These issues could be addressed by providing grade-specific examples of how students can learn and demonstrate understanding of a given concept, rather than including identical language for each grade within the K-2 band.

Under the Troubleshooting subconcept, it seems odd to include an objective with a description that says "These are, however, not specified in the standard..." If troubleshooting is not specified in the standards for this grade, it should not be included in the standards document.

The password topic seems more appropriate at this level than at the kindergarten level.

The Algorithms and Programming and Impacts of Computing Grade 1 standards and suggested activities are identical to those for Kindergarten. For an individual teacher, this may not be an issue, but could present challenges to collaborating cross-grade teachers trying to coordinate what to cover in a given year.

### 3. Please provide feedback on Grade 2:

The Grade 2 introduction builds well on the introduction for Grade 1, with an emphasis on students conducting skills practiced with teacher support in Grade 1 more independently in Grade 2. Here too, the wording of objectives for many of the Grade 2 subconcepts and example student activities are identical, or nearly identical, to those listed in the kindergarten and Grade 1 standards, which could cause problems with cross-grade teacher groups coordinating CS lessons.

The example student activities that require basic literacy are a good fit for grade 2 but may not work well in kindergarten and Grade 1. For example, Grade 2 is probably the earliest students can be expected to create a blog or planning document.

Under the Troubleshooting subconcept, it seems odd to include an objective with a description that says “These are, however, not specified in the standard...” If troubleshooting is not specified in the standards for this grade, it should not be included.

The Culture subconcept, as written, seems relatively narrow compared to other subconcepts. Discussing life pre-computers is interesting, but it is not clear to me (a) if that is a valuable activity for kindergarteners or first graders, and (b) if it needs to be repeated across grades.

### 4. Please provide feedback on Grade 3:

The language and content of the goals described in the Grade 3 introduction are noticeably different from the K-2 Introduction, reflecting a distinct grade band for Grades 3-5. Given the clustering of standards, goals, and activities for Grades 3-5, it might be useful to include some kind of “band introduction” to let teachers know that such a grade band underlies the yearly standards.

The subconcept objectives for Grade 3 are generally clear, specific, measurable, and appropriate for the grade level. However, the content and descriptions **across** subconcepts are not consistent. For example, in most subconcept descriptions, wording such as “students should...” is included, but in some cases, no such directive information is included. Further, in some subconcept descriptions example activities are suggested, i.e. “for example, discussion topics could be based on...” but in other cases no example activities are mentioned.

The sentence “Data points can be clustered by a number of commonalities”, included in the Data and Analysis/Collection, Visualization, and Transformation section, is vague.

The description of the Storage subconcept's "Recognize different file extensions" doesn't match the objective (pg 36). The description discusses file storage requirements, while the objective covers file extension names.

#### 5. Please provide feedback on Grade 4:

The introduction section for the Grade 4 standards (and for subsequent grades) is written in present tense (all prior grades were written in future tense). For consistency, it would be good to pick one or the other for the entire document.

The Grade 4 standards demonstrate a good connection to, and differentiation from, the Grade 3 standards, with an emphasis on moving from guided application of skills and knowledge to more independent application. The K-2 band of standards should include more of this kind of transition from guided to independent student work.

As with the K-2 grade band, it might be useful for readers to include a Grades 3-5 standards table, showing differences in subconcept objectives and descriptions across grades. Such a table would make it easier for teachers in a given district or school to plan out multi-grade CS curriculum.

The breadth and depth of the standards seem appropriate and measurable. Although it is probably beyond the scope of a standards document, my personal preference would be to indicate that students in 4<sup>th</sup> grade can move toward writing lines of code (and away from block-based programming).

Some of the subconcept descriptions include suggested/example activities for students. Others do not. It would be good to include sample activities for each subconcept.

The Troubleshooting objective doesn't make sense (maybe a typo?): "Develop a model with teacher guidance common troubleshooting strategies..."

As with Grade 3, the File Extensions subconcept objective doesn't really match with the description provided.

Some of the subconcept objectives and descriptions for the Grade 4 Algorithms/Programming and Impacts of Computing sections are identical to those presented in the Grade 3 standards. It would be useful to highlight additions/changes to these subconcepts across grades.

#### 6. Please provide feedback on Grade 5:

The Grade 5 introduction and standards demonstrate a good connection to, and differentiation from, the Grade 4 standards, with an emphasis on moving from guided application of skills and knowledge to more independent application.

Some of the subconcept descriptions for Grade 5 do not include sample student activities, or statements about what a student might do to demonstrate proficiency in a given area (e.g. "Students might..."). For consistency with other grades in the Standards, and to help teachers, it would be useful to include examples for all subconcepts.

Some of the subconcept descriptions start with “Explanation:”. For consistency, I’d suggest deleting this.

Some of the subconcept objectives and descriptions for the Grade 5 Algorithms/Programming and Impacts of Computing sections are identical to those presented in the Grade 3 and Grade 4 standards. It would be useful to include and highlight additions/changes to these subconcepts across grades.

### 7. Please provide feedback on Grade 6:

The shift in tone, content, and verb tense in the Grade 6 introduction and subconcepts demonstrates that its source material was organized in a Grade 6-8 grade band. I’d suggest highlighting that the standards, although broken down by grade, are grouped into grade bands...and that Grade 6 is the first Grade in a middle school grade band.

Some of the wording in the Grade 6 introduction is a bit confusing and/or grammatically incorrect (see my comments in the draft document).

Some of the subconcept descriptions for Grade 6 do not include sample student activities or statements about what a student might do to demonstrate proficiency in a given area (e.g. “Students might...”). For consistency with other grades in the Standards, and to help teachers, it would be useful to include examples for all subconcepts.

Some of the subconcept descriptions start with “Explanation:”. For consistency, I’d suggest deleting this.

The Modularity subconcept description simply repeats the subconcept objective. It would be more useful to explain the subconcept more fully, suggest tasks student should be able to perform, and include 1 or more possible activities related to the subconcept.

The breadth and depth of the standards seem appropriate and measurable.

### 8. Please provide feedback on Grade 7:

The content of the Grade 7 overall objectives is appropriate and builds well on the Grade 6 objectives. The shift toward evaluation, analysis, and implementation is good for this age group.

Verb tense in the Introduction sections in the standards draft is not consistent from year to year. Grade 7 shifts again to mostly present tense (Grade 6 used future tense). For consistency, the Introduction sections should all use the same tense.

Generally, the content of the subconcepts for Grade 7 connect to, and build upon, those in Grade 6. As with the Introduction section, the Grade 7 subconcept objectives and descriptions focus on analysis and implementation of CS skills and knowledge. Where the Grade 6 subconcepts introduced topics (such as HCI), Grade 7 has students applying their skills in various areas.



Many of the subconcept objectives and descriptions in the Program Development section are exact repeats of their Grade 6 counterparts.

### 9. Please provide feedback on Grade 8:

As with the Grade 7 objectives, the content of the Grade 8 overall objectives is appropriate and builds well on the Grade 7 objectives. The objectives demonstrate a continuing shift toward evaluation, analysis, and implementation, as is appropriate for this age group.

Generally, the content of the subconcepts for Grade 8 connect to, and build upon, those in Grade 7. Grade 8 subconcept objectives and descriptions focus on analysis, revision, and implementation of CS skills and knowledge. Many of the subconcepts cover the same areas as Grade 7, but with more detail and depth (appropriately).

The subconcept objectives show appropriate levels of breadth and depth, and are (mostly) measurable. Some of the subconcept descriptions (e.g. Safety, Law, and Ethics) do not include any specific tasks or measurable objectives.

Some of the subconcept descriptions start with “Explanation:”. For consistency, I’d suggest deleting this.

### 10. Please provide feedback on High School:

Since the high school standards are combined into a single band, the objectives are correspondingly more extensive. The overall objectives are appropriate for this level, but the ‘leap’ in complexity from the 8<sup>th</sup> Grade standards seems somewhat large. Computational thinking and problem-solving appear, as they should, in the High School Introduction. It is worrisome that these key elements only appear twice (in 3<sup>rd</sup> and 4<sup>th</sup> grade) in the earlier Introduction sections as part of the core objectives. Further, computational thinking appears **nowhere** in specific standard concepts or subconcepts.

The subconcept objectives and descriptions are generally clear and appropriate for high school level. The lack of a grade-by-grade differentiation will make it difficult for high school teachers to design curricula that works across grades. Some of the concepts may be quite challenging for a 9<sup>th</sup> grade student, while others may be too basic for a senior (assuming that student has studied CS throughout high school).

While some of the subconcept descriptions offer suggested student tasks/activities, others do not. For consistency, it would be good include examples for every subconcept.

## Standards Section organized by Essential Concept, Subconcept and learning progression

You have also been provided with each standard organized by essential concept to review and provide feedback on the development of the learning progression for each essential concept. As you conduct your review of the progression, please consider the following questions.



- A. Does the standard address meaningful content within each essential concept?
- B. Do the standards within each progression, including subconcepts have appropriate **depth of content and rigor**?
- C. Is there meaningful alignment and development of skills/knowledge within each grade and from one grade level to the next for each progression?

**1. Please provide feedback on the Essential Concept Computing Systems:**

There is a good progression through the grades. I wonder if troubleshooting is important enough to have so prominent a place in the standards across all years.

**2. Please provide feedback on the Essential Concept Networking and the Internet:**

The K-2 standards are essentially identical in this area, as are the 3-5 standards, which may cause problems. For example, I think the password topic may be too difficult for kindergarten (and possibly first grade), given that most kindergarteners do not read or write, and first graders are just beginning to do so. The high school Networking standards show a fairly large leap in complexity from the Grade 8 standards. If a given student starts studying CS in high school, as a 9<sup>th</sup> grader, these standards may be too complex.

**3. Please provide feedback on the Essential Concept Data and Analysis:**

The K-2 standard descriptions for this area are essentially identical, although the subconcept goals show a progression from teacher-led to independent activities. Some of the suggested student tasks require a level of literacy that is beyond most kindergarteners and many First graders. Otherwise, the standards in this area show a solid and logical progression across grades.

**4. Please provide feedback on the Essential Concept Algorithms and Programming:**

The descriptions of most subconcepts for Grades K-2 are identical in this area, and the 6-8 subconcept descriptions are quite similar to each other. The subconcept objectives in this area do demonstrate show a logical progression across grades.

**5. Please provide feedback on the Essential Concept Impacts of Computing:**

The descriptions of most subconcepts for Grades K-2 are identical in this area, and the 6-8 subconcept descriptions are quite similar to each other. The subconcept objectives in this area show a logical progression across grades.

## Glossary and Additional Resources

**Please provide any additional comments related to the Glossary and Additional Resources section that you would like the working group to consider.**

The glossary is generally solid, but I recommend changes to a few of the definitions (see my embedded comments in the draft document).

## Additional Feedback

**Please provide any additional comments about this draft that you want the revision working group to consider. Also use this an opportunity to summarize the strengths of the draft standards.**

Overall, the standards are quite good. The content, breadth, and depth are generally appropriate and measurable.

I think it would benefit teachers to more clearly explain that the standards, while broken down by grade level, are divided into bands (K-2, 3-5, 6-8, high school), and that the standards from year to year within a given band connect to and build on standards from the previous year. Further, it would be useful to include tables by grade band (or across all grades), that highlight changes in objectives from year to year.

I think computational thinking is underplayed in the document. It appears only briefly in the introduction, and in only 3 of the grade level introductions.

The standards show a logical progression of detail and complexity for each of the essential concept areas across grades. Paradoxically, I worry that the progression is so strong, that a high school student who has NOT studied CS in K8 may struggle with the content and skills defined in the high school standards.

Finally, the draft would benefit from a thorough copy edit to unify the 'voice' and tone of the document, as well as cleanup verb tense and other grammatical issues.