Teaching Practices Guide: Improving Accessibility for Students with Learning Disabilities & ADHD: The Computer Science Principles (CSP) Course

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Each student in your computer science (CS) classroom is unique and benefits from instruction that accounts for their differing characteristics. This is particularly true for students with diagnosed learning disabilities and ADHD, here referred to as "learning differences." Sixty-six percent of U.S. students diagnosed with learning disabilities spend 80% of their school days in inclusive classrooms [1, 2].

Guide Overview: This resource highlights instructional practices particularly well-suited for students with diagnosed learning differences. You may already be using some of these strategies to differentiate in your Computer Science Principles (CSP) class. The recommended practices come from a study conducted by Outlier Research & Evaluation and Wolcott School (an independent, college-preparatory high school for students with learning differences) that is exploring ways to make the CSP course more accessible for students who learn differently. Rooted in existing research in non-CS subject areas and the experience of the Wolcott learning specialists, the recommendations below are actionable steps you can use in your CSP course to create a more inclusive classroom. The recommendations are not intended to change the content or reduce the rigor of CS lessons, or to simplify grading and testing measures. Rather, they are intended to provide students with multiple ways to access and engage with content, and demonstrate understanding.

Terminology: We use the term **"adaptation"** to refer to instructional practices you can use with your whole-class (to benefit students with learning differences, and potentially all learners in the classroom) and **"accommodation"** to refer to differentiation for individual students based on their unique learning needs beyond what the whole-class practices provide. Many of the "adaptations" are akin to Universal Design for Learning (UDL) strategies that emphasize how information is presented, how students demonstrate understanding, and how students interact and engage with materials. However, the recommendations here specifically address the needs of students with diagnosed learning differences.

We identify not only the broader diagnostic information (such as diagnoses of disorders of *reading, written expression, language, mathematics,* and *attention*) but also the basic *psychological processes* underlying the learning and attention disorders that can make certain activities common in CS and non-CS classes challenging. Note that two students may both have a disorder in reading that, due to the different underlying processes that contribute to the disorder, call for different kinds of actions to address the disorder. Therefore, it is important to remember that, like students as a whole, those with diagnosed differences are also very heterogeneous.

To learn more, find ways to collaborate with your school's Special Education personnel and school psychologist(s) to generally benefit from their expertise and perspective. These specialists may also be able to help you navigate any unfamiliar or unclear information contained in a student's [Individualized Education Program (IEP)](#) or a [504 plan](#) (legal documents that outline supports that schools and teachers must provide for students with disorders that impact their learning).

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[Instructional Strategies for the Computer Science Principles Course](#)

We have organized the instructional practices by five types of activities that are common in many CSP courses. Each type includes three whole-class recommendations (**adaptations**) and several include individual student **accommodation** options.

[1] Reading and Writing

Activities in CSP that involve reading and writing may occur as part of recurring class work, or in formative and summative assessment work. They pose challenges for some students with disorders in: *reading, written expression, language*, and *attention* as well as those who face academic challenges related to (for example) *verbal reasoning, vocabulary/semantics, oral formulation, retrieval fluency, phonological awareness*, and *working memory*. These students may find the following instructional directions to be challenging: write down ideas quickly and accurately, sketch images or symbols, read and comprehend questions, put your thoughts into words, express your thinking in a way comprehendible to others, and physically type responses.

Recommendations

Adaptations:
- Read questions aloud as a group and clarify vocabulary and phrasing by rephrasing information and referring students to a running glossary (that you or the students create for the class at the beginning of the school year and add to throughout the year).
- Circulate and assist students who are having difficulty putting their thoughts into words. Use cueing or modeling to assist students in making their written words clear to others.
- Before students respond to any free response questions, help them interpret the questions by assisting them in making a list of key points relevant to the questions. You can also direct them to a running glossary when key or novel terms are involved in the questions and required responses.

Accommodations:
- Offer students the use of text-to-speech software to read the questions.
- Provide opportunities for students to use dictation software to add their ideas to electronic documents (like student activity guides, or Microsoft Word docs).
- Allow students to use electronic features on word processing software or drawing software to sketch ideas or draw symbols.

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[2] Collaborative Work

Activities in CSP that involve collaborative work might include think-pair-share, paired programming, or partnered thinking and problem solving. These activities may pose challenges for some students with disorders in *language*, and *attention* as well as those who face academic

challenges related to (for example) *oral formulation, retrieval fluency, self-monitoring, social skills, language processing, listening comprehension,* and *sustained focus and alertness*. These students may find the following instructional directions to be challenging: use socially appropriate language in communication and collaboration, read social cues, sustain attention while classmates explain their thoughts, comprehend the language used by peers, find the correct words and phrases to articulate thoughts, and reflect and identify the reasoning behind approaches to problem solving.

Recommendations
Adaptations:
- ➢ Place students in partnerships or groups that will be supportive of learning differences (these partnerships may remain for an extended period of time, or need to be changed regularly).
- ➢ Explicitly state that students will work or problem-solve together (not just work in parallel). Review and model guidelines for students on how to work together (e.g., only one person talks at a time; everyone accepts feedback; listen actively; people can share differences of opinion) and provide feedback. Guidelines can be posted in the classroom as a visual reference and appropriate language can be modeled. *(Also recommended for Discussions)*
- ➢ Circulate and model phrasing for students who may have difficulty translating their thoughts to language and who have difficulty retrieving the words they would like to use.

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[3] Discussion

Activities in CSP that involve discussion may occur as part of a whole-class, teacher-led conversation about a topic or within smaller group conversations. Discussions may pose challenges for some students with disorders in *language* and *attention* as well as those who face academic challenges related to (for example) *language processing, cognitive reasoning, self-monitoring, social skills, oral formulation, listening comprehension, sustained focus and alertness,* and *vocabulary/semantics*. These students may find the following instructional directions to be challenging: comprehend discussion prompts, recall or retrieve information, express thoughts with the correct words and phrases to articulate them, use socially appropriate language in communication and collaboration, read social cues, sustain attention while classmates explain their thoughts, and comprehend information and gain knowledge from the teacher and classmates through discussion.

Recommendations
Adaptations:
- ➢ Check for understanding of any discussion prompts. If necessary, rephrase and restate prompts, model phrasing, and clarify vocabulary.
- ➢ Rephrase and recap student responses to emphasize essential points and to clarify information shared by students that may not be clear to their peers.
- ➢ Share teacher-created discussion notes or take group notes during discussion to a) model note-taking skills and b) allow those who have difficulty with writing to focus on the discussion.
- ➢ Review group discussion guidelines for students (e.g., only one person talks at a time; listen actively; people can share differences of opinion) and provide feedback. Guidelines can be posted in the classroom as a visual reference and appropriate language can be modeled.

[4] Exploratory or Project-Based Work

Activities in CSP that involve exploratory or project-based work may occur as part of a lesson activity, like using a new on-line widget with little explanation about how it works, or as part of a multi-day project or summative assessment. They may pose challenges for some students with disorders in *attention* and *reading* as well as those who face academic challenges related to (for example) *visual-perceptual reasoning, higher-order reasoning, cognitive flexibility, visual-pattern recognition, visual discrimination, sequential memory, planning,* and *self-monitoring*. These students may find the following instructional directions to be challenging: choose a topic, a point of focus, or program to write, find sources appropriate for the activity (reading and background level), develop a plan for work by breaking tasks into smaller components, and build knowledge while exploring new content in a systematic manner.

Recommendations
Adaptations:
- Model strategies and approaches to work (e.g., provide an exemplar, demonstrate examples, and provide steps for how one could explore options).
- Provide consistent and explicit feedback about student approaches.
- Circulate and assist students in breaking down plans into smaller steps.

Accommodations:
- Present students with potential options if they are having difficulty choosing a topic, a point of focus, or program to write.
- Provide opportunities for students to use dictation software to document their ideas and responses.

[5] Programming Activities

Activities in CSP that involve programming may occur as part of paired or individual programming. They may pose challenges for some students with disorders in *written language (spelling), reading*, and *attention* as well as those who face academic challenges related to (for example) *phonological awareness, visual memory, visual discrimination, visual pattern recognition, sustained focus and alertness, self-monitoring, cognitive flexibility*, and *procedural memory*. These students may find the following instructional directions to be challenging: use the same element ID with consistent spelling and capitalizations, identify "errors" in the way variables have been written when debugging (e.g., the difference between "Square1" and "squar1"), recall the use of each command and the type of variable that should be entered in the command, and think flexibly and systematically about command use.

Recommendations
Adaptations:
- Create a reference sheet listing new code; provide a short descriptor of the command and the type of variable that should be entered in the command.
- Instruct students to create an electronic document (Word doc, Google doc) to record the variables used in the programs; students can refer to this document to: a) compare variables side-by-side to identify errors when debugging, and b) copy the variables in

the document to paste in the program in order to ensure they always write them in the same manner.

➢ Present previously- introduced commands visually (project on a screen or slide, or provide in a handout) to refresh students' memory from previous lessons.

Accommodations:
➢ Provide explicit guidance for students who may have difficulty initiating and finishing multi-step activities (e.g., designing a complicated algorithm).

ABOUT THE OUTLIER-WOLCOTT STUDY:
The Computer Science and students with learning differences study is a two-year exploratory research-practice partnership project funded by the National Science Foundation (# 1542963). The study seeks to make the CSP course more accessible for students with specific learning disabilities and attention deficit disorders. Learn more about this work at http://outlier.uchicago.edu/accessCSP/.

References Cited
[1] Cortiella, C. & Horowitz, S. (2014). *The state of learning disabilities: Facts, trends and emerging issues.* New York: National Center for Learning Disabilities. Retrieved from https://www.ncld.org/wp-content/uploads/2014/11/2014-State-of-LD.pdf.
[2] U.S. Department of Education, Office of Special Education Programs, Data Analysis System (DANS), OMB # 1820-0517 (2010). *"Part B, Individuals with Disabilities Education Act, Implementation of FAPE Requirement,"* 2010. Data as of 8/14/2012.