A Primer on Creating Inclusive High School CS Classrooms: Improving Accessibility for Students with Learning Disabilities and ADHD

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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 "students who learn differently." A recent report suggests that one in five children in the U.S. has learning and attention issues, although only a small portion of those students are formally identified with a disorder in school [1]. Sixty-six percent of U.S. students who have been diagnosed with learning disabilities spend 80% of their school days in inclusive classrooms [2, 3].

Guide Overview: This resource highlights instructional practices particularly well-suited for students with learning and attention disorders. You may already be using some of these strategies to differentiate in your CS 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 Computer Science Principles (CSP) course more accessible for students who learn differently. Rooted in existing research in non-CS subject areas and the experience of Wolcott learning specialists, the recommendations below are actionable steps you can use in any CS 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 who learn differently as well as other students) 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 and attention disorders.

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 some 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 lead to the disorder, call for different kinds of actions to address the disorder. A student with a learning difference may also have an interference with more than one psychological process. Therefore, it is important to remember that, like students as a whole, those with diagnosed disorders 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, in addition to the recommendations we provide).

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Instructional Strategies for High School CS Classes

We have organized the instructional practices by six types of activities that are common in high school CS courses. Each includes whole-class recommendations (**adaptations**) and several include individual student **accommodation** options.

[1] Reading

Activities in CS that involve reading may occur as part of the student activity guide work, or formative and summative assessment. They pose challenges for some students with disorders in: reading, language, and attention as well as those who face academic challenges related to (for example) vocabulary/semantics, verbal reasoning, language processing, retrieval fluency, phonological awareness, visual discrimination, visual-auditory learning, and working memory. These students may find the following instructional directions to be challenging: read and comprehend activity directions, questions, and new vocabulary, read dense and/or complex text, and scan and review work.

Recommendations

Adaptations:

➢ Project activity instructions on a screen and read any particularly challenging directions aloud as a group; provide several examples.

➢ Provide sufficient examples of work process and products to ensure students understand required work steps to move projects forward (e.g., share an exemplar, demonstrate additional examples, and suggest ways to break down work into smaller steps).

➢ 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 (that you, or the students create) when key or novel terms are involved in the questions and the required responses.

➢ Read assessment 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 course).

➢ Review any practice or real performance task overviews, planning guides and rubrics as a class. Read the material aloud to the class and check for understanding.

➢ Prior to lessons that require online research and reading, identify websites/ sources for students to use based on clarity, simplicity, and readability. As necessary, guide students to sites that match their skill levels.

Accommodations:

➢ For students who need assistance with reading the material, read it aloud and check for understanding.

➢ Offer students the use of text-to-speech software to read and reread articles, questions, and explanations.

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[2] Writing

Activities in CS that involve writing may occur as part of the student activity guide work, or formative and summative assessment. They pose challenges for some students with disorders in: written expression, language, and attention as well as those who face academic challenges related to (for example) verbal reasoning, vocabulary/semantics, retrieval fluency, phonological awareness, fine motor, planning, and self-monitoring. These students may find the following instructional directions to be challenging: write down ideas and assessment responses quickly and accurately,

sketch images or symbols, express your thoughts/ideas in writing in a way comprehensible to others, write code and other programming elements (e.g., using correct spelling, capitalization, and syntax), and physically type or hand-write responses.

Recommendations
Adaptations:
➢ Offer students the use of a graphic organizer to assist them with organizing their thoughts and learnings, and to provide a visual aid to facilitate learning.
➢ Provide sentence starter templates (verbally, or in writing) to help students formulate their thoughts and express them in writing.

Accommodations:
➢ Assist students who are having difficulty putting their thoughts into words. Use cueing or modeling to assist students in making their written work clear.
➢ Provide opportunities for students to use dictation software to add their ideas to electronic documents (like Word or Google documents) or to write assessment responses. Set aside space in a secluded corner of the room, hallway, or somewhere else outside of the general classroom for students to use dictation software if needed.
➢ Offer students the use of text-to-speech software to listen to and edit their own written responses.
➢ Allow students to use electronic features on word processing software or drawing software to sketch ideas or draw symbols. Or assist students by sketching for them, based on their input.

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[3]   Collaborative Work

Activities in CS 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 groups that will be supportive of learning differences and minimize difficulties that could arise because of social skills or other factors. Consider the following characteristics: ability to follow directions, work speed, and attitude. (These partnerships may remain for an extended period of time, or need to be changed regularly).
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> ➢ Explicitly state that students will work together and problem-solve together. Provide guidelines for how students should work together and provide feedback as they work. Possible guidelines may include: one person speaking at a time; everyone accepts feedback; everyone actively listens, etc. Guidelines can be posted in the classroom as a visual reference and appropriate language can be modeled.
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> ➢ Circulate and model phrasing for students who may have difficulty connecting their thoughts to language and who have difficulty retrieving the words they would like use.

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[4] Discussion

Activities in CS 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:

> ➢ 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.

- Check for understanding of discussion prompts; clarify and rephrase when needed and define terminology. Throughout, help students by modeling phrasing for both content and social appropriateness.
- Project key points and terminology from this lesson on a screen as well as the key points raised by students, or alternatively, write this information on a white board or poster notes for students to view throughout discussion.
- Allow enough wait time before calling on students to give them adequate time to think about their responses.
- 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.

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[5] Exploratory or Project-Based Work

Activities in CS 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:
- Display the key components of project work on a discussion slide, white board, or poster for students to reference as they identify areas where they need additional instruction/support.
- Circulate and assist students in breaking down plans into smaller steps.
- Provide consistent and explicit feedback about student approaches.
- Model strategies and approaches to work (e.g., provide an exemplar, demonstrate examples, and provide steps for how one could explore options).

Accommodations:

> ➢ Provide students with additional time for assignments, projects, and tests, where needed. In particular, provide more time for reviewing vocabulary and concepts as students begin longer-term projects.
> ➢ Present students with potential options if they are having difficulty choosing a topic, a point of focus, or program to write. Where needed, select a topic for students who struggle to select on their own, or know where to start.
> ➢ Support students who may be having significant difficulty initiating or making progress because of the independent nature of a project. Where needed, assist students in identifying project work steps and sustaining the appropriate pace to complete work on schedule.
> ➢ Provide opportunities for students to use dictation software to document their ideas and responses. Set aside space in a secluded corner of the room, hallway, or somewhere else outside of the general classroom for students to use dictation software if needed.

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[6] Programming Activities

Activities in CS that involve programming may occur as part of paired or individual work. 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:

> ➢ Circulate and assist students in debugging for errors by modeling necessary steps and providing example approaches (which may also be posted on the wall for continued reference).
> ➢ Project key mathematical terms and operators on a presentation slide or white board so they are accessible as students work.

- 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. Encourage students to keep this reference handy while working.
- Present previously-introduced commands visually (project on a screen or slide, or provide in a handout) to refresh students' memory from previous lessons. Check for understanding and clarify and rephrase when necessary.
- Create a reference sheet that lists possible "errors" that cause bugs and ways to rectify the issues as a starting point for those who may have difficulty with debugging.
- Assist students in creating 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.

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

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References Cited
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