Universal Design for Learning is a set of principles for curriculum development that give all individuals equal opportunities to learn. This document provides science teachers illustrative examples of the UDL guidelines with a science focus. Please keep in mind this is not a checklist, just a selection of examples and web tools to support most of the guidelines. Links to the CAST website and more support are offered in the table.

UDL Guidelines	Illustrative Examples	Science Specific Examples and Web 2.0 Tools
I. Provide Multiple Means of Representation:	**In Your Classroom, embedded through out your lessons**	
1. Provide options for perception		
1.1 Offer ways of customizing the display of information	• **The size of text, images, graphs, tables, or other visual content** • **The contrast between background and text or image** • **The color used for information or emphasis** • **The volume or rate of speech or sound** • **The speed or timing of video, animation, sound, simulations, etc.** • **The layout of visual or other elements** • **The font used for print materials**	**Variety of symbolic representation: periodic table style (words, symbols, images)** **Provide a variety of options for required tables or data.** **Prezi: http://prezi.com/** **SMART Board Notebook presentations**
1.2 Offer alternatives for auditory information	• **Use text equivalents in the form of captions or automated speech-to-text (voice recognition) for spoken language** • **Provide visual diagrams, charts, notations of music or sound** • **Provide written transcripts for videos or auditory clips** • **Provide American Sign Language (ASL) for spoken English** • **Use visual analogues to represent emphasis and prosody (e.g., emoticons, symbols, or images)** • **Provide visual or tactile (e.g., vibrations) equivalents for sound effects or alerts** • **Provide visual and/or emotional description for musical interpretation**	**Options for video playback with audio or text support from Discovery Education at http://www.discoveryeducation.com/** **Animoto - visual representation: http://animoto.com/** **3D Toad: data bank of images that can be rotated 360 degrees. 3D Toad**

1.3 Offer alternatives for visual information	• Subtitles on video • Provide descriptions (text or spoken) for all images, graphics, video, or animations • Use touch equivalents (tactile graphics or objects of reference) for key visuals that represent concepts • Provide physical objects and spatial models to convey perspective or interaction • Provide auditory cues for key concepts and transitions in visual information	Offer tactile options for key science concepts: laboratory experience, role play, use of play-dough, field experience, science games, manipulatives, science models etc. http://www.chemeddl.org/resources/ptl/ Periodic Table Live Soundclips: Gallery of free mp3 sounds to share, listen and download - can embed directly into Notebook software: http://soundcli.ps/
2. Provide options for language, mathematical expressions, and symbols		
2.1 Clarify vocabulary and symbols	• Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge • Provide graphic symbols with alternative text descriptions • Highlight how complex terms, expressions, or equations are composed of simpler words or symbols • Embed support for vocabulary and symbols within the text (e.g., hyperlinks or footnotes to definitions, explanations, illustrations, previous coverage, translations) • Embed support for unfamiliar references within the text (e.g., domain specific notation, lesser known properties and theorems, idioms, academic language, figurative language, mathematical language, jargon, archaic language, colloquialism, and dialect)	Demonstrate that Latin and Greek languages are the origin for many scientific words - clarifying the meaning of those words: example - symbiosis (sym = together, bio = life, osis = process), macrophage (macro = large, phage = eater), hydrophilic (hydro = water, philic = lover) Science Word Map: http://www.sagepub.com/upm-data/18274_Tate_EtBGraphOrg_MSSc_Pages_18_20.pdf
2.2 Clarify syntax and structure	• Clarify unfamiliar syntax (in language or in math formulas) or underlying structure (in diagrams, graphs, illustrations, extended expositions or narratives) through alternatives that: • Highlight structural relations or make them more explicit • Make connections to previously learned structures • Make relationships between elements explicit (e.g., highlighting the transition words in an essay, links between ideas in a concept map, etc.)	http://www.visuwords.com/ Online Graphical Dictionary Snapify extension for Google Chrome Browser. Snapify enables contextual web browsing through image markers and word highlights. All you need to do is highlight a word or click an image marker and 'Snap It'.

2.3 Support decoding of text, and mathematical notation, and symbols	• Allow the use of Text-to-Speech • Use automatic voicing with digital mathematical notation (Math ML) • Use digital text with an accompanying human voice recording (e.g., Daisy Talking Books) • Allow for flexibility and easy access to multiple representations of notation where appropriate (e.g., formulas, word problems, graphs) • Offer clarification of notation through lists of key terms	Use online resources to provide multiple representation of scientific terms and notation. Sixty Science symbols video: http://www.sixtysymbols.com/videos/summation.htm
2.4 Promote understanding across language	• Make all key information in the dominant language (e.g., English) also available in first languages (e.g., Spanish) for learners with limited-English proficiency and in ASL for learners who are deaf • Link key vocabulary words to definitions and pronunciations in both dominant and heritage languages • Define domain-specific vocabulary (e.g., "map key" in social studies) using both domain-specific and common terms • Provide electronic translation tools or links to multilingual glossaries on the web • Embed visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc)	Use secondary literacy resources to develop vocabulary development Marzano's 5 step process, http://www.marzanoresearch.com/site/ Vocab Twister: http://jc-schools.net/tutorials/vocab/TWISTER.html WORDO: http://jc-schools.net/tutorials/vocab/wordo.html
2.5 Illustrate through multiple media	• Present key concepts in one form of symbolic representation (e.g., an expository text or a math equation) with an alternative form (e.g., an illustration, dance/movement, diagram, table, model, video, comic strip, storyboard, photograph, animation, physical or virtual manipulative) • Make explicit links between information provided in texts and any accompanying representation of that information in illustrations, equations, charts, or diagrams	http://phet.colorado.edu/ Great science simulations Offer tactile options for key science concepts: laboratory experience, role play, use of play-dough, field experience, science games, manipulatives, science models etc.

3. Provide options for comprehension		
3.1 Activate or supply background knowledge	• **Anchor instruction by linking to and activating relevant prior knowledge (e.g., using visual imagery, concept anchoring, or concept mastery routines)** • **Use advanced organizers (e.g., KWL methods, concept maps)** • **Pre-teach critical prerequisite concepts through demonstration or models** • **Bridge concepts with relevant analogies and metaphors** • **Make explicit cross-curricular connections (e.g., teaching literacy strategies in the social studies classroom)**	**Generating Interest:** http://www.chemcases.com/ **Teaching Science Through Literature:** http://intranet.cshgreenwich.org/heartNet/childrensLitAndScience.asp?websitemasterID=439&webpageDetailID=2818 **Windows to the Universe** http://www.windows2universe.org/ **Science in the news:** http://whyfiles.org/
3.2 Highlight patterns, critical features, big ideas, and relationships	• **Highlight or emphasize key elements in text, graphics, diagrams, formulas** • **Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships** • **Use multiple examples and non-examples to emphasize critical features** • **Use cues and prompts to draw attention to critical features** • **Highlight previously learned skills that can be used to solve unfamiliar problems**	**Graphic Organizers:** http://my.hrw.com/nsmedia/intgos/html/igo.htm

3.3 Guide information processing, visualization, and manipulation	• Give explicit prompts for each step in a sequential process • Provide options for organizational methods and approaches (tables and algorithms for processing mathematical operations) • Provide interactive models that guide exploration and new understandings • Introduce graduated scaffolds that support information processing strategies • Provide multiple entry points to a lesson and optional pathways through content (e.g., exploring big ideas through dramatic works, arts and literature, film and media) • "Chunk" information into smaller elements • Progressively release information (e.g., sequential highlighting) • Remove unnecessary distractions unless they are essential to the instructional goal	CAST Science Writer: http://sciencewriter.cast.org/welcome;jsessionid=1CB950D8E88546F71CE372D5C31B425B
3.4 Maximize transfer and generalization	• Provide checklists, organizers, sticky notes, electronic reminders • Prompt the use of mnemonic strategies and devices (e.g., visual imagery, paraphrasing strategies, method of loci, etc.) • Incorporate explicit opportunities for review and practice • Provide templates, graphic organizers, concept maps to support note-taking • Provide scaffolds that connect new information to prior knowledge (e.g., word webs, half-full concept maps) • Embed new ideas in familiar ideas and contexts (e.g., use of analogy, metaphor, drama, music, film, etc.) • Provide explicit, supported opportunities to generalize learning to new situations (e.g., different types of problems that can be solved with linear equations, using physics principles to build a playground) • Offer opportunities over time to revisit key ideas and linkages between ideas	Cast Science Writer: http://sciencewriter.cast.org/welcome;jsessionid=1CB950D8E88546F71CE372D5C31B425B Offer tactile options for key science concepts: laboratory experience, role play, use of play-dough, field experience, science games, manipulatives, science models etc. Source Material Data Base: http://www.archive.org/ Science Review Games: http://sciencereviewgames.com/srg/ Science Links Tools and Lessons: http://sciencenetlinks.com/
II. Provide Multiple Means for Action and Expression:		
4 Provide options for physical action		
4.1 Vary the methods for response and navigation	• Provide alternatives in the requirements for rate, timing, speed, and range of motor action required to interact with instructional materials, physical manipulatives, and technologies	AIM Navigator: http://aim.cast.org/experience/decision-making_tools/aim_navigator

	• Provide alternatives for physically responding or indicating selections (e.g., alternatives to marking with pen and pencil, alternatives to mouse control) • Provide alternatives for physically interacting with materials by hand, voice, single switch, joystick, keyboard, or adapted keyboard	Answer Garden: http://answergarden.ch/
4.2 Optimize access to tools and assistive technologies	• Provide alternate keyboard commands for mouse action • Build switch and scanning options for increased independent access and keyboard alternatives • Provide access to alternative keyboards • Customize overlays for touch screens and keyboards • Select software that works seamlessly with keyboard alternatives and alt keys	Provide multiple options for navigating websites such as the use of laptops, netbooks, iPads, iPods, SMART Boards
5. Provide options for expression and communication		
5.1 Use multiple media for communication	• Compose in multiple media such as text, speech, drawing, illustration, design, film, music, dance/movement, visual art, sculpture or video • Use physical manipulatives (e.g., blocks, 3D models, base-ten blocks) • Use social media and interactive web tools (e.g., discussion forums, chats, web design, annotation tools, storyboards, comic strips, animation presentations) • Compose in multiple media such as text, speech, drawing, illustration, comics, storyboards, design, film, music, visual art, sculpture, or video • Solve problems using a variety of strategies	XtraNormal animation: http://www.xtranormal.com/ Create your own newspaper: http://www.crayon.net/ Offer tactile options for key science concepts: laboratory experience, role play, use of play-dough, field experience, science games, manipulatives, science models etc Science Links tools and lessons: http://sciencenetlinks.com/
• 5.2 Use multiple tools for construction and composition	• Provide spellcheckers, grammar checkers, word prediction software • Provide Text-To-Speech software (voice recognition), human dictation, recording • Provide calculators, graphing calculators, geometric sketchpads, or pre-formatted graph paper • Provide sentence starters or sentence strips • Use story webs, outlining tools, or concept mapping tools • Provide Computer-Aided-Design (CAD), music notation (writing) software, or mathematical notation software • Provide virtual or concrete mathematics manipulatives (e.g., base-10 blocks, algebra blocks) • Use web applications (e.g., wikis, animation, presentation)	Cast Science Writer:http://sciencewriter.cast.org/welcome;jsessionid=1CB950D8E88546F71CE372D5C31B425B Text to Speech: http://audiopal.com/ Brain Pop: http://www.brainpop.com/

5.3 Build fluencies with graduated labels of support for practice and performance	• Provide differentiated models to emulate (i.e. models that demonstrate the same outcomes but use differing approaches, strategies, skills, etc.) • Provide differentiated mentors (i.e., teachers/tutors who use different approaches to motivate, guide, feedback or inform) • Provide scaffolds that can be gradually released with increasing independence and skills (e.g., embedded into digital reading and writing software) • Provide differentiated feedback (e.g., feedback that is accessible because it can be customized to individual learners) • Provide multiple examples of novel solutions to authentic problems	Google Docs (documents and presentations) provide a wonderful opportunity for students to collaborate with other students and allow teachers to include formative practice on assignments before students hand it in. Create classroom blogs for teachers and students to comment outside of class time to guide and motivate. Use Blogger at www.blogger.com/or Edublog at http://edublogs.org/ Use Skype in the Classroom at http://education.skype.com/ to offer conversations with other classes and to facilitate conversations with scientists in the field.
6. Provide options for executive functions		
6.1 Guide appropriate goal setting	• Provide prompts and scaffolds to estimate effort, resources, and difficulty • Provide models or examples of the process and product of goal-setting • Provide guides and checklists for scaffolding goal-setting • Post goals, objectives, and schedules in an obvious place	Goal setting should be directly related to the program of studies where students reflect regularly as to their level of competency.
6.2 Support planning and strategy development	• Embed prompts to “stop and think” before acting as well as adequate space • Embed prompts to “show and explain your work” (e.g., portfolio review, art critiques) • Provide checklists and project planning templates for understanding the problem, setting up prioritization, sequences, and schedules of steps • Embed coaches or mentors that model think-alouds of the process • Provide guides for breaking long-term goals into reachable short-term objectives	CAST Strategy Tutor: http://cst.cast.org/cst/auth-log in
6.3 Facilitate managing information and resources	• Provide graphic organizers and templates for data collection and organizing information • Embed prompts for categorizing and systematizing • Provide checklists and guides for note-taking	Graphic Organizers: http://my.hrw.com/nsmedia/int gos/html/igo.htm

6.4 Enhance capacity for monitoring progress	• **Ask questions to guide self-monitoring and reflection** • **Show representations of progress (e.g., before and after photos, graphs and charts showing progress over time, process portfolios)** • **Prompt learners to identify the type of feedback or advice that they are seeking** • **Use templates that guide self-reflection on quality and completeness** • **Provide differentiated models of self-assessment strategies (e.g., role-playing, video reviews, peer feedback)** • **Use of assessment checklists, scoring rubrics, and multiple examples of annotated student work/performance examples**	**The understanding by design framework is ideal for monitoring progress. There is considerable work completed to assist with differentiation, assessment etc. The work can be found at https://sites.google.com/a/share.epsb.ca/science/Home/science---division-4/science-10-understanding-by-design?pli=1**
III. Provide Multiple Means for Engagement:		
7. Provide options for recruiting interest		
7.1 Optimize individual choice and autonomy	• **Provide learners with as much discretion and autonomy as possible by providing choices in such things as:** • **The level of perceived challenge** • **The type of rewards or recognition available** • **The context or content used for practicing and assessing skills** • **The tools used for information gathering or production** • **The color, design, or graphics of layouts, etc.** • **The sequence or timing for completion of subcomponents of tasks**	**XtraNormal animation: http://www.xtranormal.com/** **Create your own newspaper: http://www.crayon.net/** **Storyboarding: http://www.kerpoof.com/** **Create your own comic strips: http://www.bitstrips.com/** **Create your own graphic novel: http://www.comicmaster.org.uk/**
7.2 Optimize relevance, value, and authenticity	• **Vary activities and sources of information so that they can be:** • **Personalized and contextualized to learners' lives** • **Culturally relevant and responsive** • **Socially relevant** • **Age and ability appropriate** • **Appropriate for different racial, cultural, ethnic, and gender groups**	**Science behind the news: http://whyfiles.org/**
7.3 Minimize threats and distractions	• **Create an accepting and supportive**	

	classroom climate
	• Vary the level of novelty or risk
	  ○ Charts, calendars, schedules, visible timers, cues, etc. that can increase the predictability of daily activities and transitions
	  ○ Creation of class routines
	  ○ Alerts and previews that can help learners anticipate and prepare for changes in activities, schedules, and novel events
	  ○ Options that can, in contrast to the above, maximize the unexpected, surprising, or novel in highly routinized activities
	• Vary the level of sensory stimulation
	  ○ Variation in the presence of background noise or visual stimulation, noise buffers, number of features or items presented at a time
	  ○ Variation in pace of work, length of work sessions, availability of breaks or time-outs, or timing or sequence of activities
	• Vary the social demands required for learning or performance, the perceived level of support and protection and the requirements for public display and evaluation
	• Involve all participants in whole class discussions	

8. Provide options for sustaining effort and persistence		
8.1 Heighten salience of goals and objectives	• Prompt or require learners to explicitly formulate or restate goal • Display the goal in multiple ways • Encourage division of long-term goals into short-term objectives • Demonstrate the use of hand-held or computer-based scheduling tools • Use prompts or scaffolds for visualizing desired outcome • Engage learners in assessment discussions of what constitutes excellence and generate relevant examples that connect to their cultural background and interests	Rubric Maker: http://rubistar.4teachers.org/ Rubrics need to be created with student input. The Alberta Assessment Consortium has great resources on creating rubrics. The user name is *EdmontonPublic* and the password is *evaluation*

8.2 Vary demands and resources to optimize challenge	• Differentiate the degree of difficulty or complexity within which core activities can be completed • Provide alternatives in the permissible tools and scaffolds • Vary the degrees of freedom for acceptable performance • Emphasize process, effort, improvement in meeting standards as alternatives to external evaluation and competition	
8.3 Foster collaboration and community	• Create cooperative learning groups with clear goals, roles, and responsibilities • Create school-wide programs of positive behavior support with differentiated objectives and supports • Provide prompts that guide learners in when and how to ask peers and/or teachers for help • Encourage and support opportunities for peer interactions and supports (e.g., peer-tutors) • Construct communities of learners engaged in common interests or activities • Create expectations for group work (e.g., rubrics, norms, etc.)	Google Docs (documents and presentations) provide a wonderful opportunity for students to collaborate with other students and allow teachers to include formative practice on assignments before students hand it in. Rubrics need to be created with student input. The Alberta Assessment Consortium has great resources on creating rubrics. The user name is *EdmontonPublic* and the password is *evaluation*
8.4 Increase mastery-oriented feedback	• Provide feedback that encourages perseverance, focuses on development of efficacy and self-awareness, and encourages the use of specific supports and strategies in the face of challenge • Provide feedback that emphasizes effort, improvement, and achieving a standard rather than on relative performance • Provide feedback that is frequent, timely, and specific • Provide feedback that is substantive and informative rather than comparative or competitive • Provide feedback that models how to incorporate evaluation, including identifying patterns of errors and wrong answers, into positive strategies for future success	Google Docs (documents and presentations) provide a wonderful opportunity for students to collaborate with other students and allow teachers to include formative practice on assignments before students hand it in.
9. Provide options for self-regulation		
9.1 Promote expectations and beliefs that optimize motivation	• Provide prompts, reminders, guides, rubrics, checklists that focus on: ○ Self-regulatory goals like reducing the frequency of aggressive outbursts in response	Assignment Calculator: http://www.lib.umn.edu/help/calculator/

	to frustration ○ Increasing the length of on-task orientation in the face of distractions ○ Elevating the frequency of self-reflection and self-reinforcements • Provide coaches, mentors, or agents that model the process of setting personally appropriate goals that take into account both strengths and weaknesses • Support activities that encourage self-reflection and identification of personal goals	
9.2 Facilitate personal coping skills and strategies	• Provide differentiated models, scaffolds and feedback for: • Managing frustration • Seeking external emotional support • Developing internal controls and coping skills • Appropriately handling subject specific phobias and judgments of "natural" aptitude (e.g., "how can I improve on the areas I am struggling in?" rather than "I am not good at math") • Use real life situations or simulations to demonstrate coping skills	Providing a safe, supportive environment in which students feel able to take risks without the fear of failure is critical when students are involved in developing science inquiry skills.
9.3 Develop self-assessment and reflection	• Offer devices, aids, or charts to assist individuals in learning to collect, chart and display data from their own behavior for the purpose of monitoring changes in those behaviors • Use activities that include a means by which learners get feedback and have access to alternative scaffolds (e.g., charts, templates, feedback displays) that support understanding progress in a manner that is understandable and timely	