Teacher's Manual

Chapter 2: Introduction to Universal Design for Learning

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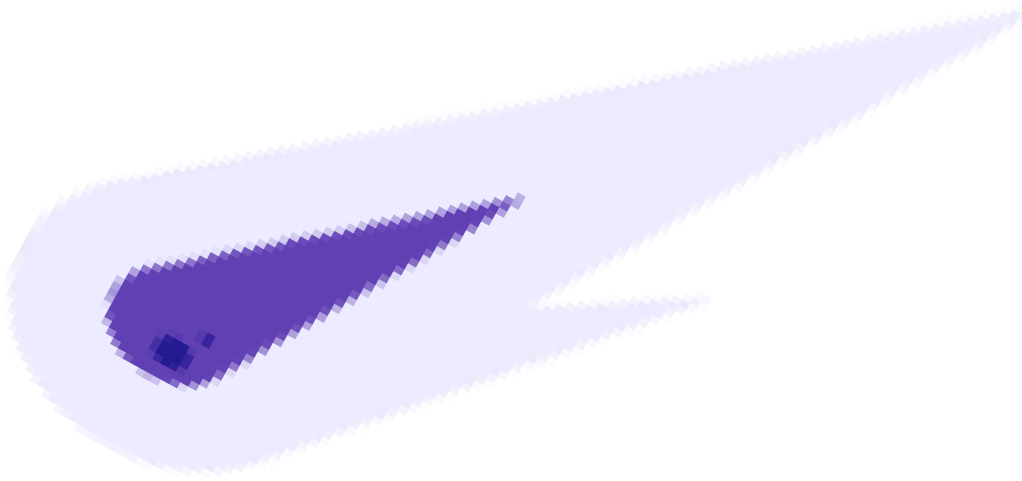
Work Package 3
StAnD Academy



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2.1 What is Universal Design for Learning?

Universal Design for Learning, or **UDL**, is a design framework that focuses on supporting the success of *all* students, acknowledging their diverse learning and life needs. It is not intended only for students with exceptional abilities or those who require special assistance. The core idea behind UDL is to reduce barriers or impediments within learning environments and increase access, thereby providing all students with greater opportunities to succeed.
The concept of Universal Design for Learning originates from the architectural and physical design principle of universal design. Universal design involves creating products, buildings, or environments so they can be readily used by the widest possible range of users. In architectural design, making an environment accessible for individuals "on the margins," such as by adding a ramp in front of a building, often ends up reducing barriers for everyone. Universal design is well-established in fields like architecture but is relatively new to education.

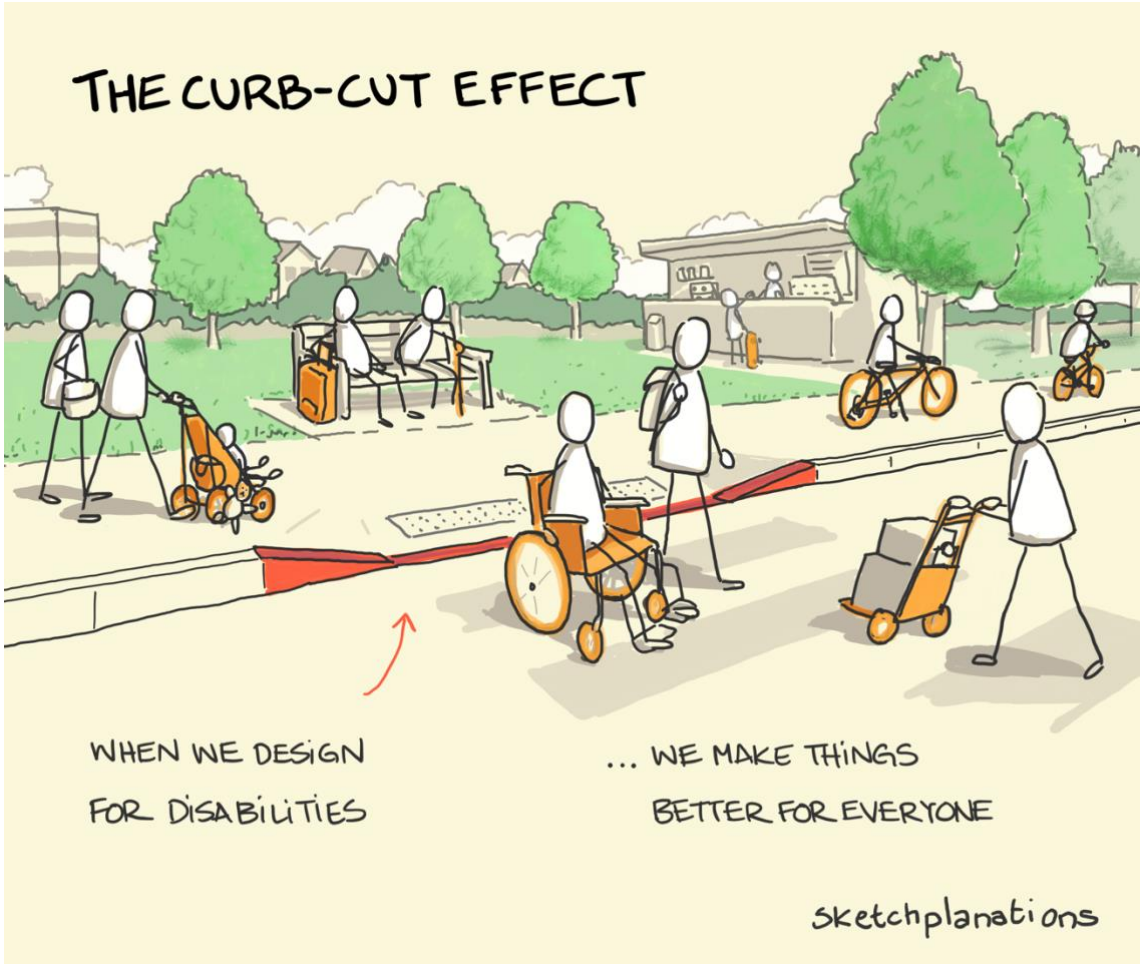

Figure 2.1.1. The curb-cut effect is an example of Universal Desgign hat illustrates how designs that benefit disadvantaged or vulnerable groups helpins society as a whole.
Credit: Jono Hey (https://sketchplanations.com/the-curb-cut-effect)

When transfering the idea of universal design from the built environment to the learning environment, its principles and techniques are adapted to reflect the differences between these contexts. UDL is specifically focused on learning environments, which are created not just to transmit information or provide shelter, but to support and promote changes in knowledge and skills. Therefore, UDL requires the design of accessible pedagogy, not merely accessible information. Pedagogy, in this context, refers to the science of teaching and learning, encompassing the educational methods used by skilled educators to highlight critical features, emphasize big ideas, clarify relationships, provide scaffolds for practice, model expert performance, and guide students.

The framework for UDL is grounded in findings from cognitive neuroscience that inform us about the needs of individual learners. It embeds accessible pedagogy into three central considerations for teaching: the means of representing information, the means for students to express knowledge, and the means of engagement in learning.

It is important to note that UDL strategies aim to reduce the need for *some* accommodations for students with certain disabilities but do not eliminate the need for all accommodations. Rather than focusing on a disability model, UDL centers on a social justice model to support diverse learning needs. The goal of UDL is to foster **learner agency**, which is described as being purposeful and reflective, resourceful and authentic, and strategic and action-oriented. UDL provides a structure for rethinking how to design effective learning experiences. The principles of UDL should be viewed as tools or guidelines for educators, not as a rigid set of definitive rules. Like UDL itself, applying it is often a work in progress, not a final destination.

2.2 The Three Principles of UDL

The UDL framework is built upon three core principles:

1. **Multiple Means of Representation**
2. **Multiple Means of Action and Expression**
3. **Multiple Means of Engagement**

These principles are based on neurocognitive networks in the brain. Providing multiple means of representation activates the **"WHAT"** networks, which are involved in recognition and processing content. Providing multiple means of action and expression activates the **"HOW"** networks, related to strategic and motor skills, enabling students to demonstrate what they know. Providing multiple means of engagement activates the **"WHY"** networks, connecting to affective mental networks that address motivation and relevance.

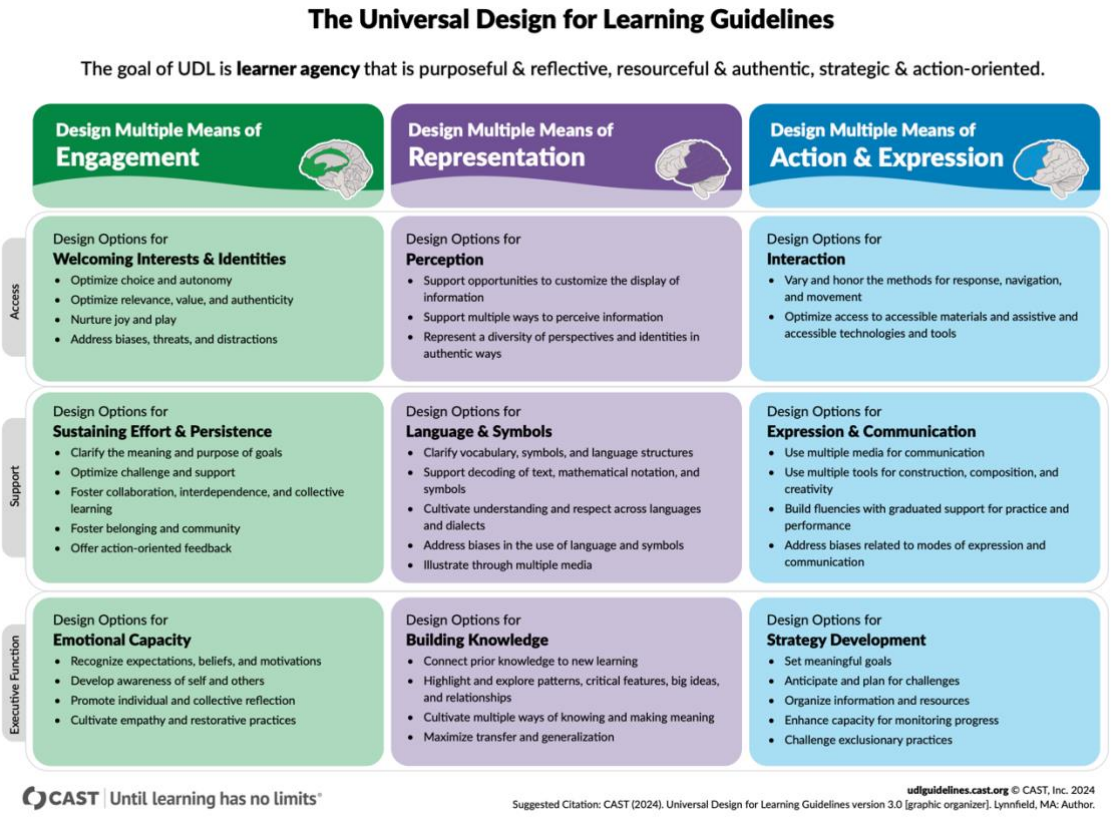

Figure 2.2.1. Universal Design for Learning Guidelines (https://www.cast.org/)

Let's explore each principle in more detail:

- **Principle One: Multiple Means of Representation** Students differ in the ways they perceive and access information. There is no single method of presenting information that is optimal for all learners. This principle highlights the need to offer information and resources using a variety of presentation formats and techniques. This includes presenting information in diverse formats such as text, visuals, and sounds, integrating readings, videos, visuals, infographics, and lectures. It also involves helping students develop important vocabulary by providing glossaries or links to resources. Strategies can include using concept maps, annotating texts, or providing short videos to illustrate connections between ideas or highlight structural elements. Chunking information into smaller, manageable segments or units can also help students process content more effectively. Providing text or spoken equivalents of visual material can support non-proficient readers or students that are not native speakers. Offering content with hyperlinked information or footnotes can assist students with cognitive impairments. The application of this principle also extends to the methods of teaching, ensuring that techniques for highlighting critical features, emphasizing big ideas, connecting new information to background knowledge, and modeling inquiry are accessible to all students. The goal is not just providing access to information, but teaching students how to find, create, use, and organize it.

- **Principle Two: Multiple Means of Action and Expression** Students vary in how they can navigate a learning environment and express what they know. They do not all have the same capacities for action or expression across different domains. Therefore, there is no single means of expression or type of support that is optimal for all students. Assessment techniques, which require students to demonstrate and express what they know, are heavily influenced by this principle. UDL encourages providing multiple means for students to express their knowledge and apply what they have learned. This can involve allowing students to communicate their understanding in a variety of formats, not just traditional ones like papers. Depending on the course, this could include using text, images, sound, video, or web-based formats. Even within a specific format like writing, varying the length, purpose, and intended audience can be beneficial. Providing checklists or guides for note-taking, or offering lecture outlines, can help students develop this skill. Showing different ways to solve problems, with real-life and academic examples, can also help students act on their knowledge. Using online discussion tools alongside or instead of face-to-face discussions can support students who might face barriers in oral communication. Offering flexibility and choice in how students demonstrate learning outcomes is key.

- **Principle Three: Multiple Means of Engagement** Students differ significantly in what engages and motivates them to learn. There is an important affective component to achieving any learning goal. This principle focuses on providing various ways to engage and motivate learning that are accessible to all students. Strategies include offering opportunities for both group and individual work, designing chances for discussion both online and face-to-face, and allowing students to choose topics within assignment parameters based on their interests. Building learning activities with real-world purposes or audiences, or asking students to ground new ideas in familiar contexts, can make content more relevant. Collecting regular feedback on how students perceive activities relates to learning outcomes can inform instruction and prompt students to connect their effort to goals. Varying the order of activities in terms of required effort and building linked tasks with varying difficulty towards a common outcome can help maintain engagement. Providing prompt and frequent feedback, encouranging the use of rubrics to clarify expectations, can also enhance engagement. Other engagement strategies include optimizing choice and autonomy, optimizing relevance, value, and authenticity, nurturing joy and play, and addressing biases, threats, and distractions.

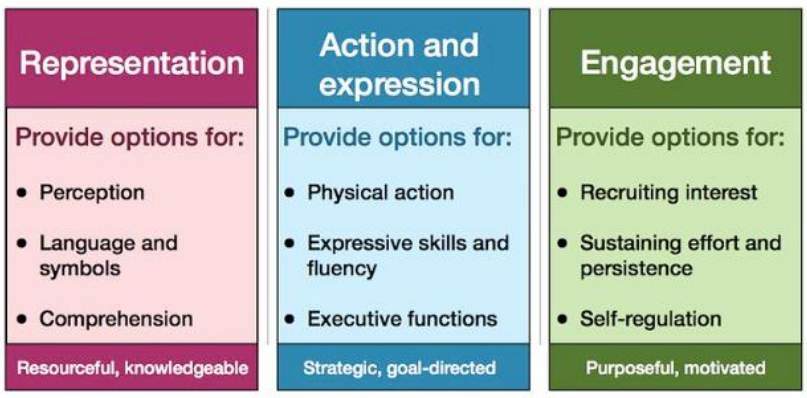

Figure 2.2.2. Universal Design for Learning Principles (Don Glass, modified by Chrissie Butler)

2.3 Universal Design for Learning in the StAnD Project

The StAnD project explicitly incorporates Universal Design for Learning principles as a fundamental part of its approach, particularly in the training and support provided to teachers. Inclusion is a top priority for StAnD, and the project leverages the experience of consortium members with UDL and IDEA (inclusion, diversity, equity, and accessibility) principles. The UDL principles are seen as fostering equity, inclusion, gender balance, and the mindset that diversity is richness to be promoted and accommodated.

The StAnD Teacher's Manual itself is designed following the main guidelines of Universal Design for Learning. The manual introduces key principles for instructional design, guided by UDL, to help teachers adapt the resources from the StAnD Toolkit to their classroom practices and curriculum delivery, incorporating concepts like inclusion, diversity, and equity.

StAnD aims to bring innovation into the classroom by integrating digital tools and resources and involving students in state-of-the-art experiments. The differentiation and personalization of students' experiences, guaranteed by applying UDL, ensures that the specific needs of participants are accounted for.

Digital tools play a significant role in StAnD, complementing physical activities and enhancing teaching and learning, which aligns well with UDL principles. The project utilizes online platforms for the MOOC, specific software for astronomical observations, data analysis, and meteor detection, a central project website and social media for communication and resource sharing. Project materials are made available in an Open Educational Resources (OER) format, allowing them to be freely adapted and adopted by teachers. The project activities themselves, such as installing and operating meteor cameras, collecting micrometeorite samples, and analyzing robotic telescopes' data, are designed to stimulate active participation and civic engagement.

Figure 2.3.1. Student analyzing robotic telescope images (Mila Mitra)

2.4 Applying UDL to StAnD Topics

StAnD focuses on bringing the exciting subject of asteroids, comets, meteors, and meteorites, and their connection to planetary defence, into schools. Teachers applying UDL principles can make these topics accessible and engaging for all students, taking advantage of specific activities and resources provided by the project.

2.4.1 Solar System Overview

Teaching about the Solar System can be enhanced by applying these UDL principles:

- **Representation:** To explain the different objects (Sun, planets, moons, dwarf planets, minor bodies), teachers can provide information through text descriptions, diagrams, images, videos, and even interactive simulations or scale models. Using software like Stellarium can help visualize orbits and positions, serving as an alternate epresentation of complex concepts. Vocabulary like "minor bodies" can be clarified using visual aids or a glossary.
- **Action and Expression:** Students can demonstrate their understanding of the Solar System in various ways. Instead of just writing reports or taking exams, they could create presentations, build physical or digital models of the solar system or specific objects, draw diagrams, or create short videos explaining a concept. They could use online quizzes (e.g., Kahoot, Mentimeter) to test their knowledge.
- **Engagement:** Teachers can connect the study of Solar System objects to current events in space exploration (e.g., missions to Mars, Jupiter) or topics like finding life elsewhere, leveraging students' natural curiosity. Allowing students to choose a specific planet, moon, or other body to research in more detail can increase motivation. Discussing the origins of the Solar System and planetary formation can also engage students' "WHY" networks.

2.4.2 Asteroids and Comets

Teaching about asteroids and comets and regions like the Main Asteroid Belt, Kuiper Belt, and Oort Cloud can be made more accessible and engaging with UDL.

- **Representation:** Information about these minor bodies and their locations can be presented using diagrams, 3D models, videos, and data visualizations from real observations. Connecting them to planetary formation through visual timelines or narratives can aid understanding. Teachers can provide access to real data from robotic telescopes used in the project as an authentic information source. Vocabulary related to orbits and composition can be supported with visuals.
- **Action and Expression:** A key activity in StAnD is participating in asteroid search campaigns and follow-up observations using robotic telescopes. This is a powerful example of action and expression, where students directly apply skills and

demonstrate knowledge by potentially discovering new objects or studying known ones. Students can also express their learning by analyzing the telescopic data, writing reports on their findings, creating presentations about specific asteroids or comets, or even creating public outreach materials about the search process.

- **Engagement:** Highlighting the project's connection to planetary defence can significantly engage students by presenting a real-world challenge and relevance. The possibility of making original scientific discoveries provides strong motivation. Offering choice in which observation project to join or which asteroid/comet to study can further boost engagement. Discussing careers in space science and astronomy related to these topics can also be motivating.

2.4.3 Meteors

Applying UDL to teaching about meteors can leverage the active nature of the StAnD project's meteor activities.

- **Representation:** Explaining concepts like meteoroids, meteors, fireballs, and meteor showers can be done using videos of atmospheric entry, animations showing meteoroid paths, diagrams illustrating the relationship between meteoroids and their parent bodies, and charts showing meteor shower timings and radiant points. Using data from the meteor detection cameras provides real-world examples.

- **Action and Expression:** Students can actively participate by installing and operating meteor detection camera systems in their schools. Analyzing the images captured by these cameras is a direct way for students to apply skills and express understanding of meteor phenomena. They can then report their findings, create visual logs of observed meteors, or present data analysis results. Online discussion forums can allow students to share observations and discuss events with peers.

- **Engagement:** The hands-on operation of the meteor cameras and the possibility of detecting real meteors create a highly engaging experience. Connecting meteor showers to observable celestial events that students might see themselves can also increase relevance. Framing the activity around contributing data to a larger scientific effort provides authenticity and purpose.

2.4.4 Meteorites

Teaching about meteorites, their formation, differentiation, and distinction from Earth rocks is central to the micrometeorite collection activities in StAnD.

- **Representation:** Presenting information about different types of meteorites, their composition, and formation processes can involve showing images of samples, diagrams of planetary formation and differentiation processes, and explanations of how to identify them. Providing clear visuals and descriptions of the differences between Earth and space rocks is crucial.

- **Action and Expression:** The StAnD micrometeorite toolkit is a primary example of supporting action and expression. Students engage in the practical procedure of washing material, using a magnet, and examining collected samples on a flat surface. They apply skills to identify candidate micrometeorites. They can express their findings through lab reports, visual logs of collected samples, presentations about their search process, or by documenting the properties of potential micrometeorites, including their differences from Earth rocks. Allowing different formats for these reports (e.g., text, photos, videos) aligns with UDL's second principle.

- **Engagement:** The hands-on, "treasure hunt" aspect of searching for micrometeorites is highly engaging. The idea of finding actual microscopic particles from space makes the learning tangible and exciting. Connecting the study of meteorites to understanding the early solar system and planetary formation provides a larger scientific context. Offering feedback on their collection and identification efforts can sustain motivation.