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ABSTRACT

A professor involved with the HELDS project (Higher Education for Learning Disabled Students) describes modifications in a general chemistry course. A syllabus lists program objectives for eight text chapters, evaluation components, and course rules. Two units are described in detail, with information presented on modifications made for LD students. Units focus on manipulation of data (symbols, formulas, equations, and stoichiometry) and on theories related to the quantum mechanical model of the atom. Appended is a behavioral checklist for adults with LD. (CL)

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[redacted]
ACCOMMODATING
DISABLED [redacted]

SUGGESTIONS FOR MODIFICATIONS IN THE TEACHING OF GENERAL CHEMISTRY TO ACCOMMODATE LEARNING DISABLED STUDENTS

Alternative Techniques for Teaching General Chemistry to Learning Disabled Students in the University

by
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HELDS Project
(Higher Education for
Learning Disabled Students)

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THE HELDS PROJECT AT CENTRAL WASHINGTON UNIVERSITY

The acronym HELDS stands for Higher Education for Learning Disabled Students. It represents a model program funded for three years (1980-1983) by the Fund for the Improvement of Post Secondary Education (FIPSE), a division of the Department of Education. This project was funded as a model for other colleges and universities that are preparing to provide equal academic access for the learning disabled students.

Project HELDS had three major focuses. The first was to provide such access for the learning disabled student under Section 504 of the Rehabilitation Act of 1973. This we did for learning disabled students, most of whom were admitted without modified requirements to Central Washington University. These students were not provided remedial classes. They were enrolled in classes with other college students. The help that we gave was habilitative, rather than remedial, teaching them how to compensate for their weaknesses.

The habilitative training began with identification of those who were learning disabled and included, but was not limited to, such support services as taped textbooks (provided through the services of our Handicapped Student Services Coordinator), readers, writers for tests, extended time for tests, pre-registration with advising to ensure a balanced schedule, the teaching of study skills and tutoring by tutors from the campus-wide tutoring program who were especially trained to tutor learning disabled students.

The second focus of the project was to give a core of twenty faculty teaching classes in the basic and breadth areas a sensitivity to the characteristics of students who were learning disabled so that they could modify their teaching techniques to include the use of more than one modality. This ensured an academic environment conducive to learning for the LD. The faculty members participated in monthly sessions which featured experts in the field of learning disabilities, and in the area of the law (Section 504) that deals with the handicapped student and higher education. There were several sessions in which Central Washington University graduates and currently enrolled LD students shared their viewpoints and experiences with the faculty members. As a result of this some faculty members used the students as resource people in developing curricula for their various disciplines published in this series.

The third focus of the project was to make the university community aware of the characteristics of learning disabilities and of the program at Central. It also sought to encourage other colleges and universities to initiate such programs.

WHAT IS A LEARNING DISABLED STUDENT?

People with learning disabilities have handicaps that are invisible. Their disability is made up of multiple symptoms that have been with them since childhood. Many of them have been described as "dyslexics," but if they are categorized as dyslexic, this will be only one of their many symptoms, as a sore throat is only one of the many symptoms of a cold.

Three concise descriptions of the learning disabled children are provided in Hallahan and Kauffman:

> "The National Advisory Committee on Handicapped Children (1968) proposed the following definition, which was adopted by the 91st Congress:
>
> > Children with special disabilities exhibit a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written thinking, talking, reading, writing, spelling, or arithmetic. They include conditions which have been referred to as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, developmental aphasia, etc. They do not include learning problems which are due primarily to visual, hearing, or motor handicaps, to mental retardation, emotional disturbance, or to environmental disadvantage.
>
> Task Force II of a national project (Minimal Brain Dysfunction in Children: Educational, Medical and Health Related Services, Phase Two of a Three-Phase Project, 1969) wrote the following two definitions:
>
> > Children with learning disabilities are those (1) who have educationally significant discrepancies among their sensory-motor, perceptual, cognitive, academic, or related developmental levels which interfere with the performance of educational tasks; (2) who may or may not show demonstrable deviation in central nervous system functioning; and (3) whose disabilities are not secondary to general mental retardation, sensory deprivation or serious emotional disturbance.
> >
> > Children with learning disabilities are those (1) who manifest an educationally significant discrepancy between estimated academic potential and actual level of academic potential and actual level of academic functioning as related to dysfunctioning in the learning process; (2) who may or may not show

demonstrable deviation in central nervous system functioning; and (3) whose disabilities are not secondary to general mental retardation, cultural, sensory and/or educational deprivation or environmentally produced serious emotional disturbance.[1]

Although the preceding definitions are concerned with children, the President's Committee on Employment of the Handicapped, in their booklet *Learning Disability: Not just a Problem Children Outgrow*, discusses LD adults who have the same symptoms they had as children. The Department of Education (Reference Hallahan & Kauffman) says that two to three percent of the total public school population are identified as learning disabled and that there are over fifteen million unidentified LD adults in the United States, acknowledging, of course, that people with this problem are not restricted to the United States but are found all over the world.

We know that many learning disabled persons have average or above average intelligence and we know that many of these are gifted. In their company are such famous gifted people as Nelson Rockefeller, Albert Einstein, Leonardo da Vinci, Thomas Edison, Hans Christian Anderson, Auguste Rodin, William Butler Yeats, and Gustave Flaubert.

The causes of learning disabilities are not known, but in our project each of our identified learning disabled students shows either an unusual pregnancy (trauma at birth, such as delayed delivery, prolonged or difficult delivery) or premature birth. They oftentimes have a genetic family history of similar learning disability problems.

An exerpt from my *Criterion and Behavioral Checklist for Adults With Specific Learning Disabilities* has been included as Appendix A.

/s/ MCS
6 June 1982
Ellensburg, Washington

[1]Daniel P. Hallahan and James M. Kauffman *Exceptional Children* (Englewood Cliffs, New Jersey: Prentice Hall, 1978), pp. 121-122.

I. INTRODUCTION

The program outline and modifications suggested in the following three sections refer to the first-quarter course of the three-quarter sequence in General Chemistry. The duration of the course is ten weeks, with four class periods per week. The course is the beginning Chemistry course for majors in Chemistry and other sciences, and is sometimes selected by a few well prepared students to fulfill General Education requirements.

During Fall quarter, 1981, fifty students enrolled in the class, but only thirty-four completed the course. One of the thirty-four students was identified as learning disabled (LD). The student's disability was primarily in communicating in writing and in absorbing written information. There were other problems such as a tendency to perseverate and a tendency to be easily frustrated, but the absorption and communication problems were the ones that would constitute primary obstacles to the student's satifsfactory performance in the class.

In the following pages, I have included a complete syllabus for the course, listing the general objectives and subjects treated. I have also described sections of the program, indicating how those particular topics were made accessible to the LD student.

In general, I found that the pedagogical changes I instituted to make the course accessible to the LD students also were of benefit to the class as a whole. Students with weak backgrounds, mental blocks, or other disadvantages were able to assimilate the material presented to a greater degree. The course level was not changed, yet students on the average performed in better fashion than previously. On this basis, even if taken alone, I feel that the program and course modification were worthwhile.

II. SYLLABUS

The following information was distributed to all students at the beginning of the course. The Program Learning Objectives were listed for each chapter in the text. This was an attempt to acquaint the students with the general kinds of topics that I expect them to be able to master at the level presented. These areas were referred to at the beginning of discussion of the material in each chapter of the text, with the expectation that students will look for these topics during the course of my lectures and in their reading. In particular, students were told that the topics listed and the particular skills indicated are the important ones in each chapter. Students were strongly encouraged to use the syllabus as a study guide for examinations and quizzes. The method of evaluation and the mechanical rules pertaining to the class were also included so that

students would be able to maintain a running evaluation of their performance in the class, and so that they knew and understood the ground rules for operation of the class. The syllabus in its entirety was discussed in some detail with the class during the first class period.

SYLLABUS

Chemistry 181, General Chemistry
Fall Quarter, 1981
MTWF, 9:00 a.m., Dean 355

Instructor: Dr. H.S. Habib
Office: Dean 311
SUB Student Services
Telephone: 963-3409

I. Program Learning Objectives

CHAPTER I

Some basic terminology used in describing properties of substances.
Units of measurement--the SI system.
The uncertainty in measurements and the application of rules for significant figures.
Density and Specific Gravity.
Temperature--units and interconversions.
Units of heat measurement; specific heats and their use in calculations of quantities of heat.

CHAPTER II

Symbols for the elements--memorize name and symbol for elements 1-30, 35, 38, 47, 48, 50-58, 74, 77-86, 88-94.
Empirical and molecular formulas.
Atomic weights, moles, Avogadro's number, and the relationships between them.
Molecular weights, moles, Avogadro's number, and the relationships between them.
Calculation of percent composition and derivation of formulas.
Writing and balancing simple chemical equations.
Calculations based upon balanced equations.
Solutions--concentration units, calculations based on concentration.

CHAPTER III

Stoichiometry--calculations of all types based upon balanced equations.

Calculations of yield.
Calculations based upon the use of limiting reagents.

CHAPTER IV

Sub-atomic particles, their discovery and properties.
Nuclear atoms.
Isotopes.
The Bohr atomic model--quantum numbers, ground states, excited states, energy levels.
Atomic spectra.
Quantum Mechanical Model--the Heisenberg Uncertainty Principle, probability density functions.
Quantum numbers, principal, azimuthal, magnetic, and spin.
s,p,d,f,--orbitals - orbital shapes, energy level diagrams, Hund's Rule, Pauli Exclusion.
The Aufbau process--theoretical development of the Periodic Table.
Periodic Law, structure of the Periodic Table--families and groups of elements--electronic structure and the Periodic Table.
Variation in covalent radii, ionic radii, ionization potentials, and electron affinities within groups and periods.

CHAPTER V

(a) Lewis formulas for simple compounds.
(b) Ionic bonding--nature, predictability from the Periodic Table.
(c) Writing formulas for ionic compounds.
(d) Covalent bonding--formation, Lewis formulas.
(e) Multiple covalent bonds.
(f) Electronegativity and bond polarity.
(g) Resonance, resonance formulas.
(h) Coordinate covalence.
(i) Oxidation numbers--rules for determination of oxidation numbers, writing formulas for compounds.
(j) Nomenclature system for binary and ternary compounds.

CHAPTER VI

(a) Molecular orbitals--bonding and antibonding orbital formation.
(b) Sigma and pi molecular orbitals.
(c) Energy level diagrams, the aufbau principle.
(d) Molecular orbital description of homonuclear diatomic molecules.
(e) Heteronuclear diatomics.
(f) Bond order and relationship to bond length.

CHAPTER VII

(a) Prediction of molecular structures using VSEPR.

(b) Hybridization of atomic orbitals--s-p hybrids, d-s-p hybrids
(c) Bonding in heteronuclear molecules described by hybrid orbitals.

CHAPTER VIII

(a) Definition and properties of Acids, Bases, and Salts.
(b) Strength of acids, bases.
(c) Lewis acids and bases; Bronsted--Lowry acids and bases.
(d) Electrolytes and non-electrolytes.
(e) Types of chemical reactions: addition, decomposition, metathesis, redox--examples.
(f) Acid-base reactions--protonic and Lewis.
(g) Variation of chemical properties as a function of position in the Periodic Table--metallic properties, oxidation, number.

II. Program Schedule

The syllabus handed out to students included, in this section, a day-by-day assignment indicating which chapter in the text will be under discussion, suggested questions and problems from the text that students are expected to attempt, scheduled examination days, and scheduled vacation days when class would not meet.

III. Evaluation:

(a) Four hour Exams @ 100 points/exam =	400 points
(b) Final exam =	150 points
(c) Quizzes--average adjusted to:	50 points
Total:	600 points

Final grades will be determined using a combination of a % distribution curve and the following *guidelines* (which means that they're not absolute--a little variation in either direction may occur):

Average	Grade
90 - 100%	A
82 - 89%	B
65 - 81%	C
60 - 65%	D
0 - 59%	E

IV. Rules

(a) Make-up quizzes will not be given

(b) Make-up exams will be given only if *proven* extenuating circumstances made it absolutely impossible to take the exam. I *must* be notified *prior* to the exam.

(c) Exams, including the Final, will *not* be given at an earlier date or time from that already scheduled.

(d) "Incomplete" grades are given *only* if you have completed most of the quarter and were physically unable to complete the course.

(e) "Extra credit" work will not be given. Do it right the first time.

(f) Your withdrawal from the class, beyond Sept. 30, is at *my* discretion, not *yours*. Please do *not* assume that you can withdraw simply by making the request. (After November 30, even I cannot withdraw you from class). I will allow withdrawal from the class if extenuating circumstances justify the action.

III. SAMPLE UNITS

I have chosen two units to describe in more detail. One unit involved primarily manipulations of data and calculations; the other unit was primarily theoretical and descriptive. I have chosen these two types of units to illustrate the different problems learning disabled students experience especially on tests and quizzes.

Sample Unit I.

The unit is covered in Chapter II of the text and deals with Symbols, Formulas, Equations, and simple Stoichiometry. The program learning objectives are listed in the syllabus, and I refer to this frequently during the course of the lectures on this unit.

The main modifications I made relative to this unit are listed below. While the modifications made the unit accessible to the LD students, they were also of significant help to all the students in the class.

(i) All major points were spoken *and* written. For example, I wrote all definitions on the blackboard *and* read them to the students. All steps involved in the solution of stoichiometry problems were listed on the blackboard *and* read to the students. This provides two modalities for the LD student (and the other students) to absorb the material.

(ii) Visual aids, in terms of drawings on the blackboard and demonstrations, were used liberally. For example, in dealing with Avogadro's number and the concept of the mole, it was helpful to *show* the students actual molar quantities of various substances, and discuss the relationship between molar mass, Avogadro's number, and molecular mass. Again, the provision of visual and auditory modalities was of great benefit to the LD student and to all the other students.

(iii) For most students and especially for LD students, multiple repetitions are needed to cement a principle in their minds. I therefore make it a point to define a term, then use it (and remind them of the definition) at every opportunity. An excellent example of this is the definition of Molarity. In every case when I am illustrating various molarity problems, I either re-state the definition or ask the students to do so. This is extremely important since, if the students do not understand or know the definition of molarity, they certainly will not be able to use the concept in problem solving.

(iv) At the end of the unit, I listed *on the blackboard* and read to the students the *specific* objectives the students should be able to achieve.

For example:

(a) Distinguish between molecular and empirical formulas

(b) Be able to determine the molar mass of a compound

(c) Be able to to determine the number of moles of a compound given the mass

(d) Be able to determine the number of atoms or molecules in a given mass of substance

(e) Be able to determine the % composition of each element in a compound.

(v) All students learn more efficiently when topics are presented in an orderly, logical sequence. Learning disabled students are particularly sensitive to order and logic in their efforts to assimilate sophisticated material. In many cases, I have found that a logical development of a topic was far more accessible to all the students than the standard historical development. For example, in developing the definitions of and relationships between atomic or molecular mass, Avogadro's Number, and molar mass, I followed the following format:

(a) I presented an analogy for a Mass Spectrometer as a person standing on a bridge on a windy day and dropping balls of various masses (e.g., styrofoam, ping-pong, cork, steel, etc.) vertically. The wind sweeps the balls on trajectories that make them drop into the water at various distances from each other depending upon their respective masses.

(b) I then presented a short description of a Mass Spectrometer.

(c) I then proceeded to conceptually run a carbon sample through the Mass Spectrometer and indicated the distribution of carbon species (isotopes), the abundances, and the respective actual atomic masses in grams based upon machine data and trajectory.

(d) We then defined the atomic mass unit and thereby obtained the masses of single atoms of each isotope of carbon in amu.

(e) We then obtained the average mass of a carbon atom based upon isotope abundance and isotopic mass in amu.

(f) I then proceeded to show that, for any given mass of carbon, we could determine the number of atoms in that mass.

(g) Then, choosing a mass of carbon in grams equal in magnitude to the atomic mass in amu, we determined Avogadro's Number and defined the mole.

(h) We then extended the same process to various other elements.

(i) Finally, the same process was applied to molecular compounds.

(vi) The examination of this unit consisted of definitions and problems. The one LD student in the class was asked to sit in the front row so that I could *read* the questions to her if she experienced difficulty in reading or understanding the question. The problems seemed to present little difficulty to her once the question became accessible to her in this manner.

The definition questions were a different matter. Here the problems were two-fold—understanding the written question *and* communicating the answer in written form. I solved the problem by asking the student to answer the questions as well as she could during the examination, which she took with the rest of the class. After the examination period, in my office, I read the definition questions to the student, and in some instances, paraphrased the question; she responded orally and was graded accordingly. The difference between her written and oral responses was astounding. She had the knowledge, but simply could not communicate her knowledge in the written form.

Sample Unit II

This unit is covered in Chapter IV in the text. Specifically, the section dealing with the Quantum Mechanical model of the atom is of prime con-

cern, since the topic cannot be treated in any mathematical detail, but must be treated on a purely abstract, conceptual basis. While all steps listed in Sample Unit I were followed, significantly higher emphasis had to be placed on audio-visual materials and models. Models of atomic orbitals (s,p,d) can be made quite easily from styrofoam balls and sheets. Transparencies of figures of probability density distributions were used. An excellent film to show is the Chem Studies Series film "The Hydrogen Atom as Viewed by Quantum Mechanics." Prior to showing the film, however, it is imperative that the students be told what they are about to see; then after the film is shown, the material presented in the film should be reviewed and reiterated by the instructor.

Here again I have found that presenting the material in the traditional manner was not conducive to efficient learning by all students, especially learning disabled students. Most textbooks follow a historical exposition of the factors that led to the modern view of atomic structure starting with Cathode rays and the discovery of the electron, canal rays and the discovery of the proton, Rutherford's experiments, Moseley's experiments, etc. This presents a formidable array of seemingly disjointed material to the students, making it very difficult for the LD student to organize the material into a cohesive whole leading to a rational picture of an atom. I have found that the following set of topics, presented in logical order, makes atomic structure understandable and accessible to the LD student and thus to all the students in the class:

(a) I presented electrons, protons, and neutrons as fundamental building blocks of all atoms except Hydrogen. The mass and charge of each particle were described.

(b) I presented the nature of natural radioactivity and described the properties of alpha, beta, and gamma radiation. Then Rutherford's experiment leading to the nuclear atom model was described.

(c) Atomic number, Mass number, and isotopes were discussed.

(d) The problems with Rutherford's model were discussed. Some of these problems were resolved by Bohr based upon information generated from Atomic Spectra and the quantization of energy.

(e) The nature of electromagnetic radiation, the terms wavelength, frequency, and wavenumber were discussed. Continuous spectra and the hydrogen line spectra were discussed, the latter in terms of the Rydberg formula.

(f) Bohr's theory was presented, and its use in generating the Balmer series of lines illustrated. Bohr structures for simple atoms were presented.

(g) The problems that were left unsolved by Bohr's theory, wave-

particle duality, and the Heisenberg Uncertainty Principle, were discussed.

(h) I then introduced the students to wave mechanics, probability density, the four quantum numbers. We used the Pauli Exclusion Principle and Hund's Rule to write electronic structures. We used the Aufbau process in developing the electronic structure of the elements in sequence in the Periodic Table.

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APPENDIX

APPENDIX

Criterion and Behavioral Checklist for Adults with Specific Learning Disabilities

1. Short attention span.
2. Restlessness.
3. Distractability. (The student seems especially sensitive to sounds or visual stimuli and has difficulty ignoring them while studying.).
4. Poor motor coordination. (This may be seen as clumsiness.)
5. Impulsivity. (Responding without thinking.)
6. Perseveration. (The student tends to do or say things over and over. Mechanism that says "finished" does not work well.)
7. Handwriting is poor. (Letters will not be well formed, spacing between words and letters will be inconsistent, writing will have an extreme up or down slant on unlined page.)
8. Spelling is consistently inconsistent.
9. Inaccurate copying. (The student has difficulty copying things from the chalkboard and from textbooks; for instance, math problems may be off by one or two numbers that have been copied incorrectly or out of sequence.)
10. Can express self well orally but fails badly when doing so in writing. In a few cases the reverse is true.
11. Frequently misunderstands what someone is saying. (For instance, a student may say, "What?", and then may or may not answer appropriately before someone has a chance to repeat what was said previously.)
12. Marked discrepancy between what student is able to understand when listening or reading.
13. Has trouble with variant word meanings and figurative language.
14. Has problems structuring (organizing) time -- The person is frequently late to class and appointments; seems to have no "sense of how long a "few minutes" is opposed to an hour; has trouble pacing self during tests.

15. Has problems structuring (organizing) space -- The student may have difficulty concentrating on work when in a large, open area -- even when it's quiet; may over or under-reach when trying to put something on a shelf (depth perception).

16. Has difficulty spacing an assignment on a page, e.g., math problems are crowded together.

17. Thoughts -- ideas wander and/or are incomplete in spoken and written language. Student may also have difficulty sequencing ideas.

18. Sounds -- A student's hearing acuity may be excellent, but when his brain processes the sounds used in words, the sequence of sounds may be out of order: e.g., the student hears "aminal" instead of "animal" and may say and/or write the "aminal."

19. Visual selectively; May have 20/20 vision but when brain processes visual information, e.g., pictures, graphs, words, numbers, student may be unable to focus visual attention selectively - in other words, everything from a flyspeck to a key word in a title has equal claim on attention.

20. Word retrieval problems -- the student has difficulty recalling words that have been learned.

21. Misunderstands non-verbal information, such as facial expressions or gestures.

22. Very slow worker -- but may be extremely accurate.

23. Very fast worker -- but makes many errors and tends to leave out items.

24. Visual images -- Has 20/20 vision but may see things out of sequence, e.g., "frist" for "first," "961" for "691." Or, a student may see words or letters as if they are turned around or upside down: e.g., "cug" for "cup," or "dub" for "bud," or "9" for "L" for "7," etc.

25. Makes literal interpretations. You will have to have them give you feedback on verbal directions, etc.

26. Judges books by their thickness because of frustration when learning to read.

27. Has mixed dominance: e.g., student may be right handed and left eyed.

28. Moodiness -- Quick tempered, frustration.

29. Cannot look people in the eyes and feels uncomfortable when talking to others.

30. Has trouble answering yes or no to questions.

Students with specific learning disabilities which affect their performance in math generally fall into two groups:

1. Those students whose language processing (input and output) and/or reading abilities are impaired. These students will have great difficulty doing word problems; however, if the problems are read to them, they will be able to do them.

2. Those students whose abilities necessary to do quantitative thinking are impaired. These students often have one or more problems such as the following:

A. Difficulty in visual-spatial organization and in integrating nonverbal material. For example, a student with this kind of problem will have trouble estimating distances, distinguishing differences in amounts, sizes, shapes, and lengths. Student may also have trouble looking at groups of objects and telling what contains the greater amount. This student frequently has trouble organizing and sequencing material meaningfully on a page.

B. Difficulty in integrating kinesthetic processes. For example, a student will be inaccurate in copying problems from a textbook or chalkboard onto a piece of paper. The numbers may be out of sequence or the wrong numbers (e.g., copying "6" for "5"). Problems may be out of alignment on the paper. Graph paper is a must for them.

C. Difficulty in visually processing information. Numbers will be misperceived: "6" and "9," "3" and "8" and "9" are often confused. The student may also have trouble revisualizing, i.e., calling up the visual memory of what a number looks like or how a problem should be laid out on a page.

D. Poor sense of time and direction. Usually, students in the second group have the auditory and/or kinesethic as their strongest learning channels. They need to use manipulative materials accompanied by oral explanations from the instructor. They often need to have many experiences with concrete materials before they can move on successfully to the abstract and symbolic level of numbers.

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