

## Methods for Individualizing Instruction

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October, 2005

### Introduction

Since joining the teaching profession in 1973 I have learned about many different models of instruction. The ideas that most interest me are individualization, promotion of self-learning and ways to give the students the course evaluation tools as part of the learning package.

Self-learning is encouraged by keeping the students active. All of my assignments and exercises are fully or partially individualized and the students also have practice quizzes to study.

I give numerous quizzes, all of which exist in multiple versions. The production of the required materials is time consuming. Over the years I have adopted and adapted methods learned from other teachers. Some methods I have developed myself.

This document summarizes most of the methods that I use for individualization and for production of multiple versions of quizzes. Copies of four articles I have had published on these topics are available on request. They are cited in the appropriate sections below.

### *Why Individualize Exercises and Assignments?*

Individualization of exercises and assignments is employed to encourage students to be as active as possible in their own learning.

Individualization is relatively easy to do for numerical questions. It can also be achieved for non-numerical questions, as the examples provided later will show. If topics or question items are in short supply, it is possible to produce a pseudo-individualized assignment as if it were multiple versions of a quiz (see later).

### *Why Produce Multiple Versions of Quizzes?*

Producing multiple versions of quizzes is employed for several reasons:

- Several versions may be used in a crowded classroom to provide a measure of security;
- Additional versions remain available for those who miss writing at the required time;
- Additional versions remain available for those who did not succeed at first;
- It allows for students to become self-pacing;
- It improves year-to-year security, since new versions are available for successive years.

## Methods of Individualization

### *A. Numerical Questions - Pre- and Post-Laboratory Questions; Assignments; Quizzes.*

1. Individualized numbers for each student may be generated by the use of the well known **UVWXYZ** method, usually using the individual student's ID number. Numerical answers to the individual questions for marking may be generated by the use of spreadsheet operations.

Publication of the questions is usually by a common manual or a common handout.

Examples of this type are given in **Appendix 1** and **Appendix 2 (Question 1)**.

2. Individualized random numbers for each student may be generated by the use of spreadsheet operations. Numerical answers to the individual questions for marking may be generated by the use of spreadsheet operations.

Publication of the questions may be done individually using a merge operation.

Instructions for this method may be found in **Reference 1** (copy available on request). This method is elegant, but requires more work than **Method 1**, and has no real advantages.

### *B. Non-Numerical Questions*

1. **Pre- or Post-Laboratory Exercises or Questions**

Short lists of topics are created, usually 5 or 10 topics per exercise. Assignment of the topics to the students is made by the **UVWXYZ** method.

Publication is usually by a manual.

An example of this type is given in **Appendix 2 (Question 2)**.

2. **Report Assignments**

A large list of assignment topics is created (enough for all students). A common set of instructions and a mark scheme is published by a manual or a handout. Each student has a number which determines her/his topic.

An example of this type is given in **Appendix 3**.

In cases where there are insufficient topics so that duplication is necessary, publication of topics may be made by a merge operation.

**This Topic Continues on the Next Page**

***Non-Numerical Questions (Cont.)*****3. Non-Numerical Assignments or Quizzes**

Short lists of questions are created. The questions are combined in all possible combinations in a spread sheet or in a table format. Multiple versions of the assignment or quiz are thus created and published by a merge operation.

Instructions for this method and examples may be found in **References 2 and 3**.  
(copies available on request).

**4. Matching Exercises**

Multiple versions of the exercises are created using a spread sheet or a table to scramble the matches and published by a merge operation.

Instructions for this method and examples may be found in **Reference 4**.  
(copy available on request).

**References**

1. D. N. Cash, "Individualized Assignments by Mail Merge", **CRUCIBLE**, Volume 25.1, March 1994, pages 24-25.
2. David N. Cash, "A pseudo-individualized assignment for VSEPR theory", **CHEM 13 NEWS**, Number 289, December 2000, pages 4-6.
3. David N. Cash, "Multiple versions of an organic naming quiz using mail merge", **CHEM 13 NEWS**, Number 314, October 2003, pages 8-9.
4. Dr. David Cash, "Multiple Versions of Matching Exercises by Merge Operation of a Word Processor", **CRUCIBLE**, Volume 36.2, November 2004, pages 11-13.

## Appendix 1

This Example is a Pre-Laboratory Exercise taken from Experiment 4 of the Laboratory Course for CHEM CH117 - General Chemistry for the Process Automation Degree Program.

Each student determines the values of the numbers to be used in calculation based on her or his student ID taken as **UVWXYZ**.

1. **Calculate** the value of the equilibrium vapour pressure of water at **2Z.YX °C (Box 5)**. **Report** your answer to **4 significant figures**.
2. A sample of hydrogen gas was collected over water at the temperature of **Question 1** above.

The gas sample was equalized to atmospheric pressure (**101.W kPa**), when the volume was found to be **3W.V mL**. **Tabulate** the values of your given data and calculated results as shown:

**Calculate:**

- a. The partial pressure of the collected hydrogen gas (**kPa units**);
- b. The amount of the hydrogen gas collected (**mol units**).

**Report** your final answer to **3 significant figures**.

<b>Table: Given and Required Values</b>	
<b>Property</b>	<b>Value</b>
Temperature	<b>2Z.YX °C</b>
Vapour pressure of water (kPa) (Calculated value from Question 1.)	
Atmospheric pressure	<b>101.W kPa</b>
Sample volume	<b>3W.V mL</b>
Partial pressure of hydrogen gas (kPa) (Calculated value)	
Amount of hydrogen gas collected (mol) (Calculated value)	

## Appendix 2

This Example is a Pre-Laboratory Exercise taken from Experiment 9 of the Laboratory Course for CHEM CH602 - Organic Chemistry 3 for the Chemical Engineering Technology Diploma Program.

Each student determines the numbers to be used in calculation or for choice of topic based on her or his student ID taken as **UVWXYZ**.

- An amount  $0.8\text{XY}7$  g of **ethylene glycol** ( $\text{MW} = 62.07$ ) is to be reacted with an **equimolar** amount (mol ratio 1:1) of **phthalic anhydride** ( $\text{MW} = 148.12$ ). Your Mohawk College ID is ---**XYZ**. Calculate the mass of phthalic anhydride required. Show all calculations required.
- You are assigned the **dioic acid** in **Table 1** below having the same number as the **third last digit X** in your Mohawk College ID, and the **diamine** or **diol** in **Table 2** having the same number as the **second-last digit Y** in your Mohawk College ID.

Draw by hand or using a draw program the structural formula of a **tetramer** (four monomers linked together) formed from your two monomers.

- Identify **your polymer substance** in Question 2 as a **polyester** or a **polyamide**, and locate on the structure the **characteristic bond** of the polymer.
  - Indicate on the structure **one smallest repeat segment or unit** of your polymer.

**Table 1: Some Dioic Acids**

X	Dioic Acid
0, 5	propanedioic acid
1, 6	butanedioic acid
2, 7	pentanedioic acid
3, 8	hexanedioic acid
4, 9	heptanedioic acid

**Table 2: Some Diamines and Diols**

Y	Diamines	Y	Diols
9	1,3-diaminopropane	4	propane-1,3-diol
8	1,4-diaminobutane	3	butane-1,4-diol
7	1,5-diaminopentane	2	pentane-1,5-diol
6	1,6-diaminohexane	1	hexane-1,6-diol
5	1,7-diaminoheptane	0	heptane-1,7-diol

### Appendix 3

This Example is an Assignment for Occupational Health and Safety taken from CHEM CH602 - Organic Chemistry 3 for the Chemical Engineering Technology Diploma Program.

Each student determines his or her topic from their number on a class list.

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#### CHEM CH602 Assignment 2 List of Substances

	Monomers		Solvents
1	vinyl chloride	19	1,4-dioxane
2	epichlorohydrin	20	2-ethoxyethanol aka ethylene glycol monoethyl ether or cellosolve®
3	chloroprene	21	tetralin
4	isoprene	22	decalin
5	1,3-butadiene	23	diethyl ether
6	isobutylene	24	ethyl acetate
7	divinylbenzene	25	carbon disulfide
8	styrene	26	pyridine
9	phenol	27	sulfolane
10	ethylene oxide	28	N-methyl-2-pyrrolidone (NMP)
11	vinylidene dichloride	29	dimethylformamide (DMF)
12	methyl 2-cyanoacrylate (methyl a-cyanoacrylate)	30	methyl ethyl ketone (MEK)
13	formaldehyde	31	tetrahydrofuran (THF)
14	ethylene glycol	32	dimethylacetamide (DMA)
15	methyl methacrylate	33	dimethyl sulfoxide (DMSO)
16	toluene diisocyanate	34	methyl isobutyl ketone (MIBK)
17	vinyl acetate		
18	acrylonitrile		

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**Appendix 3 (Cont.)****CHEM CH602****Mark Scheme for Assignment 2****Full Marks = 80 points**

<b>Topic</b>	<b>Marks</b>
<b>Information (60 points)</b>	
<b>name, full structural formula</b> (drawn <b>yourself</b> by hand or by drawing software) and physical properties of the substance	<b>/5</b>
<b>industrial synthesis</b> method, including structural equations, catalysts and conditions, or source and extraction or purification method if naturally occurring	<b>/10</b>
<b>industrial uses</b> or other uses	<b>/5</b>
<b>toxicity and hazard</b> , acute and chronic effects, TLV, STEL, LD <sub>50</sub> , regulatory limits, etc.	<b>/7</b>
<b>OHS collection method(s)</b> and instrumental analytical procedure(s), including type of equipment, and principles of both the collection method and the analysis method	<b>/20</b>
<b>controls and safe handling</b> procedures	<b>/8</b>
<b>economic data of interest (Bonus)</b>	<b>/5</b>
<b>references</b> all sources correctly referenced	<b>/5</b>
<b>Format, Use of Language and Graphical Impression (20 points)</b>	
<b>Format</b> one-sided, standard paper size, one inch margins; course code, name, date, topic title; <b>2.0 pages</b> optimum, 3.0 pages maximum.	<b>/10</b>
<b>Use of Language</b> spelling; grammar; evidence of care and proof-reading; simple and consistent style.	<b>/5</b>
<b>Graphical Impression</b> organization; <b>headings and sub-headings</b> ; clear print or hand printing; use of tables; equations; illustrations or charts; <b>general impression</b> .	<b>/5</b>
<b>Total =</b>	<b>/80</b>