Motivating students by giving responsibility during lab classes

Laboratory of Food Chemistry (FCH)

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This presentation is based on the course Food Chemistry

- 2nd year Bachelor Food Technology
- This year: ~190 students
- 2 groups: ~95 students per group

- Lectures / knowledge clips
- Exercises (digital)
- Calculation cases (digital)
- Lab classes

General learning objectives for lab classes

8 groups of learning objectives (Kirschner and Meester 1988)

- Formulate hypotheses
- Solve problems
- Use knowledge and skills in unfamiliar situations
- Design simple experiments to test hypotheses
- Use laboratory skills in performing experiments
- Interpret experimental data
- Describe clearly the experiment
- Remember the idea of an experiment over a long period of time

Challenges in many laboratory classes - I

I: Students having cognitive overload

- It is often the instructional format which causes an overload

→Make instructions more implicit

37. Reducing sugars content (Nelson-Somogyi method)

Introduction

The carbonyl group of a sugar monomer (in open ring structure) can be oxidized by Cu^{2+} ions. In other words: the sugar molecule reduces the Cu^{2+} ion. Therefore such a sugar is a named a **"reducing sugar"**. All monosaccharides are reducing sugars, however disaccharides, oligosaccharides and polysaccharides also have **one reducing terminal sugar residue**. Sucrose is **not** a reducing sugar, because the monomers (glucose and fructose) are linked in a 1-2 linkage, with both sugars in closed ring conformation.

The reaction can be used to determine reducing sugars in all kind of products. The Cu_2O (solid) has a red-brown colour and can react further with arsenomolybdate reagent to soluble molybdate blue, that can be quantified in a spectrophotometer.

Method

Decide whether it is nec

1. Using the 150 µg/r

tube	ml
1	
2	
3	
4	
5	
6	

in 20 ml reaction t
2. Pipet 450 µl of ea
3. Make a series of di
diluted). Pipet 450
4. Prepare a "copper
with 1 volume par
this experiment.
5. For each test tube
6. Cover the tubes with aluminum foil and heat during 10 minutes in a 100°C water bath.
7. Let the samples cool down to room temperature. Placing them in cold tap water will help.
8. Prepare a "arseno-molybdate reagent"( ), by mixing 1 volume part of stock solution "Nelson A3" with 2 volume parts of stock solution "Nelson A4". Prepare only the amount you need for this experiment.
9. Add 450 µl arsenic molybdate reagent ( ) to each tube.
10. Add 3 ml demi water to each tube. If some precipitate is formed, then centrifuge for 5 minutes in a table top centrifuge at maximum speed.

in 20 ml reaction tubes.

2. Pipet 450 µl of each glucose concentration into a new reaction tube.
3. Make a series of dilutions of your sample (for instance 10, 100, 1000 and 10.000 times diluted). Pipet 450 µl of each dilution into a new reaction tube.
4. Prepare a "copper reagent", by mixing 4 volume parts of stock solution "Nelson A1" with 1 volume part of stock solution "Nelson A2". Prepare only the amount you need for this experiment.
5. For each test tube add 450 µl copper reagent with a pipette and mix well.
6. Cover the tubes with aluminum foil and heat during 10 minutes in a 100°C water bath.
7. Let the samples cool down to room temperature. Placing them in cold tap water will help.
8. Prepare a "arseno-molybdate reagent"( ), by mixing 1 volume part of stock solution "Nelson A3" with 2 volume parts of stock solution "Nelson A4". Prepare only the

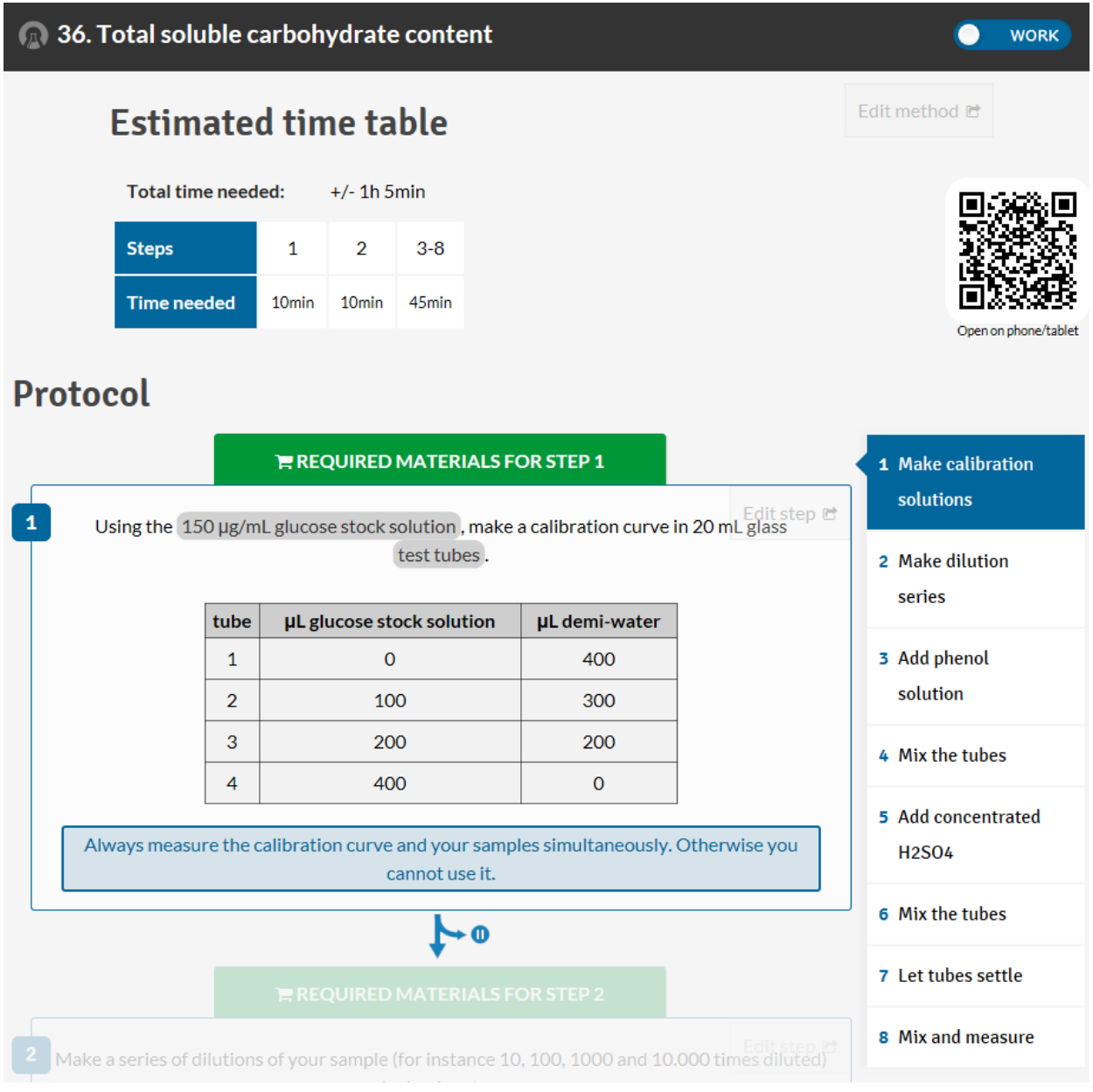
Explicit information in lab manual

3. Get a 5 ml pipette and a number of pipette tips (present on your lab bench), add 1.6 ml 2.5% phenol solution (stored in the safety cabin next to the fumehood; the bottle looks like this...; take care: phenol is toxic, so work in fumehood, wear gloves and put on safety glasses; phenol waste is collected in the phenol waste container, located in the cabin under the fumehood) to each tube by setting the volume to 1.6 ml using the centrally located rings, placing a tip on the discharge end of the pipette, ... The compounds formed in step 5 (furfural and hydroxymethylfurfural) will react with phenol to a yellow-orange coloured complex.

→ Provide implicit information

(Kolk et al, 2012)

Solution: WebLabManual



Challenges in many laboratory classes - II

I: Students having cognitive overload

- It is often the instructional format which causes an overload

II: Students are not motivated

- Students do not feel responsible

We have learned that during lab classes ...

... students who are responsible for their own planning and their own choices,

- are more **motivated**
- are more **aware** of **what** they are doing
- Are more **aware** of **why** they are doing this

Giving students responsibility

Lab classes start with a list of assignments

Assignments give students the **goals** of the experiments

- For each assignment student choose themselves which method they need to perform
- Students make their own work-flow in ExperD
- Student plan the experiments themselves
- Each student write his/her own report

Example of Assignments

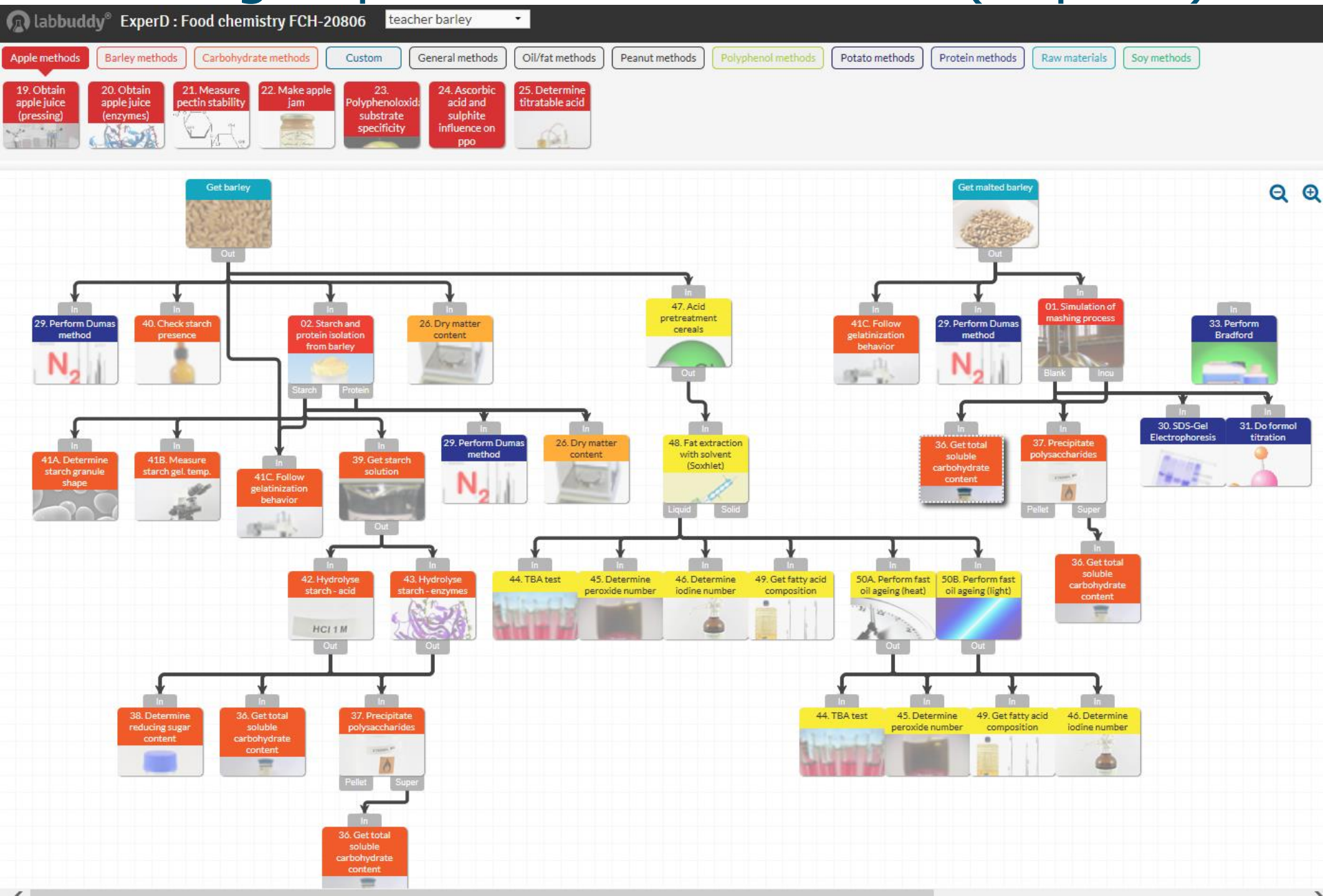
- Students work in groups of 3
- Assignments are divided over the 3 students

Assignments

All the outcomes of these assignments should be described and explained in your final report.

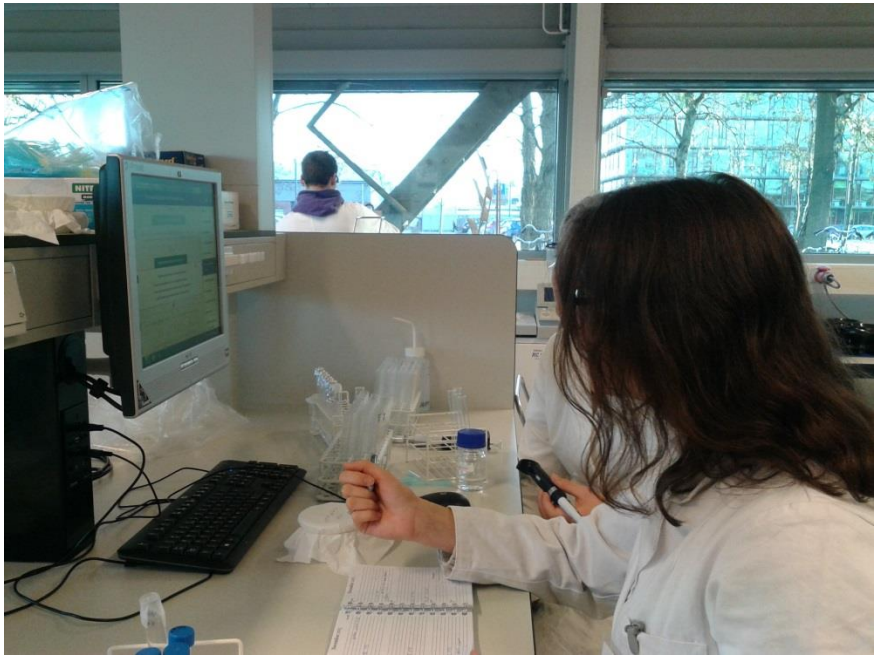
1	Demonstrate the presence of starch in barley.
2	Isolate total starch from barley and determine the yield.
3	Isolate (some) protein from barley and determine the yield and the recovery.
4	Determine the size, the shape and the location of the hilum of the isolated barley starch granules.
5	Compare the shape of the isolated barley starch granules with those of potato starch. Make drawings in your lab journal.
6	Determine the gelatinization temperature of barley starch, using different methods.
7	Compare the gelatinization temperature of barley starch with that of potato starch. (Contact the group working with potato starch).
8	Determine the effect of heating on the viscosity of suspended ground barley and suspended ground malt. Explain the differences.
9	Demonstrate the difference of two starch hydrolysis mechanisms. Determine the degree of hydrolysis and determine which part of the total carbohydrate is polysaccharide after hydrolysis.
10	Simulate the mashing process of barley and make a "protein extract" and a "carbohydrate extract" of the samples.
11	Find out whether the mashing process has gone well by determining how much polysaccharides and how much low molecular weight carbohydrates are present in the "carbohydrate extracts". Explain your results.
12	Find out whether the mashing process has gone well by investigating with two different methods what happened with the proteins of barley during the mashing process. Motivate the choice of your methods and explain your results.
13	Determine the protein content of the barley, the malt, the purified starch and the isolated protein. Where possible, compare the results with values from literature.
14	Determine the lipid content of the barley. Compare the results with values from literature. (Store the lipid)
	Since barley has only a very small amount of oil, the following assignments are performed with sunflower oil
15	Let the sunflower oil age in a fast way (= old oil) via heat AND via light. Determine quantitatively the presence of primary autoxidation products in the fresh oil and both old oils. In case you do not have enough lipid from barley, you can use sunflower oil.
	Determine qualitatively the presence of secondary autoxidation products in both old oils and

Making experimental work-flow (ExperD)



During the lab classes

- Students use ExperD:
  - Overview
  - Communication
- Student use WebLM



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Challenges in many laboratory classes - III

I: Students having cognitive overload

- It is often the instructional format which causes an overload

II: Students are not motivated

- Students do not feel responsible

III: Students start not well-prepared

- Often lack theoretical background
- Often do not know what they are doing / why

→ pre-lab activities

Preparing: Pre-lab activities

1: Making the set-up in ExperD

- Students know the assignments (goal)
- Students know why they perform the methods

2: Pre-lab questions

- Students understand the steps of the methods
  - Each method has pre-lab questions
  - Need to be answered for chosen methods
  - Some include movies of known “problems”

Pre-lab questions: prepare mode

42. Acid hydrolysis of starch

PREPARE

Edit method

Introduction

One way to degrade starch to glucose (or a mixture of glucose, maltose and oligosaccharides) is to treat it with acid at a high temperature. At those conditions the glycosidic linkage between the glucose building blocks of starch is broken down. The degree of hydrolysis of starch is usually indicated as dextrose-equivalents (DE). The DE is the reducing capacity of a starch hydrolysate, expressed as glucose and calculated as percentage of the dry substance. For this purpose, first the total carbohydrate content has to be determined and subsequently the content of reducing sugars.

Open on phone/tablet

Answer question

Estimated time table

Total time needed: +/- 1h 20min

Steps	1	2-5	6
Time needed	5min	1h 5min	10min

Set-up - schedule

Day	Activity
Thursday	Make set-up with group (ExperD)
Friday	Answer pre-lab questions (WebLM) Check set-up with supervisor (ExperD)
Monday – Friday	Experiments
Monday – Friday	Experiments Finished: Start writing
Monday – Tuesday	Writing
Wednesday	Peer-review
Friday	Review report with supervisor

Special thanks

www.labbuddy.net

(Koos van der Kolk, Kryt bv)