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Pedagogical benefits of a new student exercise

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Summary. 'Food Science and Culinary Techniques' is an MSc course offered at KU-FOOD that has faced important challenges due to both the very broad educational background of the students and practical hurdles. The course is continuously being improved and there is a great potential to strengthen various pedagogical aspects of the course. A new practical exercise within the topic 'baking' has been developed for the 2016 version of the course. From a pedagogical point of view, the new exercise will potentially improve the amount and quality of formative assessment in the course, it will contribute to student engagement and self-directed learning, it will support learning of both disciplinary and general scientific competences and it will strengthen the student's communication skills.

Introduction

The present pedagogical project is based on the MSc course (7.5 ECTS) *Food Science and Culinary Technique* (FSCT) offered at the Department of Food Science, University of Copenhagen. The course is based on a fundamental insight into food and its components but has a very practical approach. The main challenge with regard to teaching this course is the very broad educational background of the students, in particular the varying level of food chemistry and sensory science. Another challenge in the course was the decision to increase the uptake from 30 to 60, which was a last minute decision before starting the course in 2015. The 2016 version of the course is being developed to accommodate 60 students. The course is continuously being developed and many new initiatives have been taken this year to improve it.

The current project aims to identify pedagogical aspects that can be improved in the course and to develop a new student exercise within the topic 'baking' that supports pedagogical improvements of the course. The new baking exercise will substitute an existing kitchen exercise on baking. The key elements in this project are:

- Identifying pedagogical aspects that can be improved in FSCT.
- Developing a new student exercise that will substitute an existing kitchen exercise (to be implemented in the course in Sept-Nov 2016).
- Discussing how the newly developed exercise has the potential to improve several pedagogical aspects of the course.

The outcome of the project is described below with some references to the vast literature on pedagogy and student learning. At first the basic facts about FSCT in its current form are described.

Facts about the course

The course *Food Science and Culinary Technique* is offered at KU-FOOD and it is a mandatory 1st year course on the Master degree program *Food Innovation and Health* but also open to other students.

Course content

FSCT covers a range of scientific subjects centered on food and culinary techniques. It is a science-based course with a very practical approach. The main focus is on chemistry but the course also integrates topics from microbiology, sensory science and physics. The topics taught in the course are illustrated in Figure 12.1. The official course description can be found in appendix A.

The students

The course capacity was changed from the previous 30 students to 60 students in 2015 in order to accommodate the number of students wishing to attend the course. In 2015, 30 students accepted on the *Food Innovation program* plus another 20 students attended the course. Only students on MSc level are accepted for the course. The level in relevant scientific disciplines among the students accepted for the course varied considerably as

did their culinary skills and kitchen experience. Students taking the course have over the years been a mixture of our 'own' students with a BSc degree in food science, students with a bachelor in health and nutrition (*in Danish* Professionsbachelor), international student with a science background and a few others. The significant number of students coming with a professional bachelor education poses a problem since they have a low level in organic and food chemistry and in general a very weak scientific background.

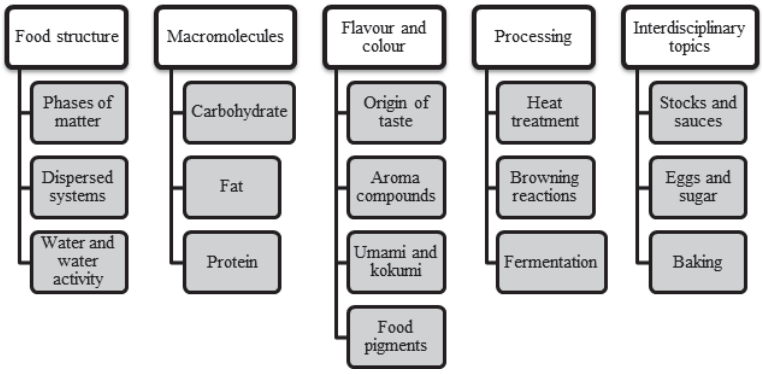

Fig. 12.1: Topics taught in the course *Food Science and Culinary Techniques*

Teaching methods

The course includes kitchen exercises, after-lab discussions and lectures. The lectures comprise traditional lecturing as well as individual/group work on study questions and minor assignments.

In 2015 the five kitchen exercises were: 1) Emulsions and foams, 2) Sous vide, 3) Stocks and sauces, 4) Baking and 5) Vegetables. Except for the first exercise on emulsions and foams, the exercises were all newly developed for 2015 edition of the course. The exercises are carried out in the 'gastro-lab', which is a research kitchen used for teaching, individual student work and research. The baking exercise was developed as a take-home exercise and carried out in groups by the students in their own kitchens. This take-home concept was new in 2015 and was well received by the students. The reason behind introducing this concept was lack of ovens for a baking exercise combined with the last minute decision to accept 60 students instead of the usual 30. We further believed that this concept had the potential to work well in FSCT and that it could open up some possibilities for further development of the course.

The exercises were all carried out in groups of 4-5 students as traditional exercises where students follow detailed instructions on the procedure. The round up on the practical exercises took place a few days later in an 'after-lab discussion', which was a lecture designed to follow up on the outcome of the exercise and the learning goals within the relevant topic in general.

Exam

In previous years the course exam consisted of a 4-hour written exam with questions based on the various topics in the course. In 2015 the exam was changed to a 24-hour take home exam. The questions were built up on a common theme but otherwise they were not much different from previous years. The big difference was of course that the students had access to the internet and could communicate with each other. The purpose of the new exam form was to make the exam reflect a real-life problem. Using the internet can to some degree be an advantage for problem solving but the students on the other hand had to be very careful selecting good sources on the internet, if using it. They also had the opportunity to discuss with peers, which is a realistic and often beneficial strategy when solving a problem.

Pedagogical aspects

In this section various pedagogical aspects of FSCT will be discussed focusing on room for improvement. The identified pedagogical issues will be used as background for the discussion on how the new baking exercise has the potential to improve the course.

Course organization

The course could benefit from better organization as well as thorough consideration of its content and level. In view of the challenges regarding students' educational background, it has not been easy to establish the course content and structure. Additionally various practical constraints like availability of teachers and kitchen facilities but also last-minute planning and last-minute changes of the course content and structure have made the course organization problematic. For the 2016 version of the course various initiatives have been taken to improve organization. These include discussions and planning of the course content in relation to the scope of the

course (see also section 12), and of how topics are presented and how they are integrated. Ideally the overlaps between topics taught by different teachers should be clear to the teachers and the overlap should be exploited. In order to do so more communication between teachers and more time for discussion and planning are necessary. Generally the effort in organizing the content better as well as having a course secretary for the first time have a great potential to improve the course.

Alignment

Alignment of the course content in relation to the course goals and in relation to the educational programme *Food Innovation and Health* are both relevant to discuss.

Food Science and Culinary Techniques covers the physical and chemical aspects of food and the relation between cooking/processing/handling of foods and the development of textures, flavours and colours in food. It also gives the students practical experience with foods and various culinary techniques. This course is the only course in the educational program covering the chemical /physical aspects of foods and culinary techniques until the final 'thematic course' and the master project.

The course could be improved by also training the students in experimental design and scientific argumentation in order to support the learning of these more general scientific competences, which are very relevant for the educational programme and for science in general (Dahl and Troelsen, 2015; Rienecker, von Müllen, Dolin, Musaeus, and Mørcke, 2015). This could easily be incorporated into the kitchen exercises that are already a part of the course. One could also argue that these generic competences ought to be part of the official course description.

When considering alignment of the course in relation to the goals of the educational programme but also in relation to the course exam (which of course ideally should reflect the course goal as well), communication skills are crucial. Knowing and understanding scientific concepts are not sufficient for solving problems beyond the frame of a university course. More individual /group assignments should be introduced allowing the students to practice their written and oral communication more. This would also increase the focus on critical thinking, self-directed learning, and increase the options for implementing formative assessment to a much higher degree in the course, which will be discussed further below. There is a great potential

in developing the teaching methods to align the course better with the goal of the course itself as well as the educational programme.

Another challenge with regard to alignment is the large differences in the students' background and in particular their insufficient competences in basic chemistry and sensory science. The issue on students' background and their low level of academic skills when entering this as well as other courses is often observed and often discussed. One reason explaining the broad background of the students in this course is the wish (and need) to make the course and the educational programme available to as many students as possible. It is particularly students with a professional bachelor education (bachelor in nutrition and health) who struggle with the basic scientific skills. These students are on the other hand often motivated, have a broader insight in food and nutrition, and not least often have some culinary experience. Practical experience with food and cooking can be very beneficial frame of reference and a great motivation factor throughout the course.

The students' varying levels in relevant scientific disciplines like food chemistry and sensory science makes both teaching and alignment more difficult, however. On the one hand the teacher needs to design the best possible course seen from an ideal perspective, giving students the competences they need for subsequent courses and as a graduate and on the other hand the teacher must face reality and accommodate students that do not have the prerequisites for obtaining the skills and competences as defined in the ideal situation. Part of the solution could be to more clearly define and communicate the expectations to the students and to increase the possibilities for self-directed learning. In planning of the course for this year the starting level in basic themes like carbohydrates, proteins, fats and sensory science has been more clearly defined and will be communicated to the students. In order to support the students with a poor scientific background (and those that just need to refresh their memory) in these topics, a so-called 'recap' lecture of one hour will be offered to the students within the topics: fat, protein and carbohydrate, respectively. Basic sensory science that will not be taught in the course is offered as e-learning before the course starts. Further, the students will get access to online material on organic chemistry that can be used as supplementary material. In the further development of the course one could include quizzes to clarify the theoretical as well as the practical competences of the students when entering the course. The purpose of such quizzes should be to clarify and to make visible the diversity

of competences among the students to the teachers as well as the students themselves.

Student engagement

As also discussed by Dahl and Troelsen, 2015 active learning and student engagement are key elements of good teaching. Since university courses traditionally have been centered around passive lectures, active learning is an issue in many courses.

Food Science and Culinary techniques is likewise an example of a course where this aspect could be improved. In the current version of the course various elements of student engagement are already implemented but the possibilities for further improvement are obvious.

One place to start could be the lectures, which ideally should contain a larger range of engaging activities. How to activate students during lectures is described in more detail by Dahl and Troelsen, 2015.

Another way to facilitate a higher engagement by the students in the course is through the kitchen exercises. The previous versions of the five exercises are built up as traditional 'step-by-step instructions. This way of teaching practical work has been criticized, since it encourages the student to put 'hands on' but 'mind off' as stated by Rienecker et al., 2015.

Project based learning (PBL) is one tool to activate students and to engage them in the learning process. PBL also facilitates a connection between theory and practice which is often a motivating factor for students (Krogh and Wiberg, 2015; Duffrin, 2003; Willard and Duffrin, 2003). It is also a goal in itself that students see the connection between the theoretical contents of the course and real-life applications and this could also facilitate a better alignment. PBL is a tool that could be implemented more as part of the lectures or in relation to the practical work in the course. However, despite the great possibilities for student engagement that comes with PBL, some concerns are also present. It is a concern that limited supervision on the student projects would result in either wrong conclusions and/or superficial learning. With 60 students and limited teaching resources it could be a challenge to ensure that the students obtain the desired disciplinary understanding of a topic.

In conclusion, written assignments, whether these are in the form of PBL or not, could greatly heighten the level of student engagement in the course. The benefits of including written assignments in the course are discussed below.

Written assignments

In the current format, the course contains no written assignments. Previous versions of FSCT contained traditional reports after each kitchen exercise but these were eliminated mainly due to the work load associated with giving feedback on the reports.

One argument for introducing written assignment to the course is to align the course with the written exam. The further argument is that written communication of scientific subjects is an important competence to acquire. Very often knowledge is useless if one is not able to communicate it to others. It was very obvious from the 2014 and 2015 exams that the students in general do not have these competences already and thus need training. In other words obtaining knowledge and understanding complex problems within the scope of the course is not sufficient. The students must acquire qualifications in how to communicate as well. Written assignments in the course are therefore necessary in order to improve the students' ability to explain a problem and a suggested solution to the problem in scientific terms.

The written assignments can be implemented as part of the lecture, in relation to the practical exercises or as independent assignments. Ideally more than one approach should be taken in order to assist the student in obtaining these competences. As also discussed by Jørgensen, 2015, a written assignment should have a clear purpose, good instructions and the requirements for the assignment must be clear.

The main obstacle in obtaining the goal of more written assignments in the course is without doubt the lack of teaching resources. The time required to rethink the course content and the teaching methods is the first obstacle and the second obstacle is the time it takes to provide the necessary feedback to the students.

In order to approach the latter, one could use peer-feedback as part of the feedback on written assignments. This could be done alongside with whole-class feedback from the teacher. Improving the amount and quality of assessment is not only relevant in relation to written assignments but is a general pedagogical issue in the course that is described in more detail below.

Formative assessment

In the current version of FSCT no formalized feedback to the student is given. Discussion during the kitchen exercises and discussion in class may

count for some formative assessment but in general feedback is minimized in view of the 'lack of teaching resources' argument. Feedback on the practical work is given as whole-class feedback and is based on a set of questions in the lab manual. Feedback on study questions is likewise given in class based on questions from the students. There is thus a great potential to improve the amount and the quality of formative assessment in the course but it has to be done within the constraints of the limited resources.

Peer feedback is one initiative that could be taken to improve the amount of formative feedback in the course with a limited amount of extra work for the teacher. Further arguments for using peer feedback are that it enhances active engagement of the students in their studies, it strengthens the students' understanding of a topic since feedback requires explanation and justification. Students also get to reflect upon what is good and why, which will support their own progress (Bloxham and West, 2004; Assessment Standards Knowledge Exchange, 2007) both within the discipline itself but also with regard to communication.

Peer feedback could be introduced as part of a classroom activity, for example individual or group work on study questions, in relation to written assignments of various kinds or in relation to the practical exercises.

Regarding the issue of minimizing the work load of the teacher when giving feedback, it is worth considering the possibly of giving elective feedback to students, meaning giving the students the choice of receiving feedback on e.g. a subset of answers to study questions or a subset of a written assignment. This will give the teacher the possibility to give some general feedback on the scientific writing with a somewhat limited effort. It further gives the teacher a qualified indication of the strengths and weaknesses of the students understanding of a problem /scientific concept and simultaneously their communication skills.

Elective feedback may also be combined with peer-feedback. An example could be to let students work on a list of study questions and hand over answers to a subset of these questions to a peer student in order for the peer to give feedback on the answers. Peer feedback could be supported by a round-up in class by the teacher to clarify selected questions.

The advantage of using elected feedback is also that the students are engaged and encouraged to take responsibility for their own learning – it encourages self-directed learning. They will need to consider 'what do I want feedback on' and 'what do I find challenging in this course' and this in itself could be useful knowledge for the teacher. Using elective feedback

has the purpose of involving the students in their own learning process and focusing the feedback from the teacher where it is most needed.

Formative feedback in the lectures of the course could also be given by the use of clickers (or similar). This gives the teacher the possibility to assess the students' knowledge which can be a tool for the teacher to plan the teaching but it is also useful for the student in testing his/her knowledge throughout the course. It is a very quick way of giving feedback to the students. Using clickers in lectures can also support curiosity of the student and make them participate actively in class.

In general, when improving feedback in the course, several parameters should be considered. As also discussed by Rienecker and Bruun, 2015 these parameters are: what to give feedback on and how much, the criteria for the feedback (the scientific content, the written communication etc.) and who should give the feedback (teacher, peer student, computer).

A new student exercise

The baking exercise that was developed for the 2015 version of the course aimed to give the student hands-on experience with the material presented in class. In addition the exercise aimed to demonstrate a systematic investigation of a hypothesis derived from the literature, although this aim was not clearly defined and apparently not obvious to the students.

In order to improve the baking exercise from 2015 and simultaneously improve various pedagogical aspects of FSCT a new baking exercise has been developed. This will be implemented in 2016. The exercise includes four steps (more detailed information can be found in Appendix C).

1. Students identify a hypothesis based on literature (to be approved by teacher).
2. Students plan a baking experiment based on the approved hypothesis:
    - A draft of experimental design is made by the group, including a short description of the underlying science
    - Peer-review on experimental design by another group
    - Experimental design is revised based on peer review
    - Shopping list is generated
3. Students carry out the baking experiment (at home)
4. Students present the experimental plan and their result in class.

The students need to submit a draft of the hypothesis prior to a 5 hour planning session, where a supervisor will be present. During the planning session the must refine their hypothesis, make a draft of the experimental plan and peer review an experimental plan from another group. They must then finalize the experimental plan and submit it prior the day of the practical exercise. A baking lecture, introducing the scientific topic, is scheduled prior to the planning session. The experiment is carried out at home, after the students have picked up the ingredients. It will also be possible for the students to borrow equipment if needed or to use the kitchen facilities at the University if a home kitchen is not available. The presentations will take place in a 2½-hour session, where each group presents their work in clusters of six groups with one teacher present. This way of finalizing the baking exercise may very well be further developed at a later stage since there is a risk that these presentation sessions become a one-way monologue without fruitful discussion.

In order to guide the students toward a realistic hypothesis and experimental setup (under the given circumstances in the course), another of the five exercises (Vegetables) in the course is built up very similarly with a hypothesis to be tested, a small experiment to be carried out at home and assessment of the outcome of the experiment. In this exercise, the hypothesis and the experimental design are predefined. This exercise will be carried out prior to the baking exercise and can thus be used a guidance for the students when planning the baking experiment. Instructions for the previous exercise can be seen in appendix B. Instructions for the new student exercise can be seen in appendix C.

Discussion

By implementing the new baking exercise as described in section 4, as a substitute for the previous exercise (Appendix B), there is a potential to improve various pedagogical aspects of the course. The new baking exercise will not by itself revolutionize the course and it is important to mention that the new baking exercise is one out of several new initiatives that have been taken to improve the course. In fact four out of the five kitchen exercises have been redesigned for 2016 to support several of the above identified pedagogical challenges, and also the lectures are being continuously developed.

Therefore, although the discussion below focuses on this one new exercise, it is important to keep in mind that this initiative is only considered one step in the right direction.

Formative assessment

Lack of formative assessment was identified as being one important issue in the course. The new baking exercise includes formative feedback on three stages.

1. Feedback on hypothesis by the teacher, which will be given as part of the preparation session. This type of feedback will allow a discussion between the group and the teacher about what a good hypothesis is and why. Students must have their hypothesis approved before they can continue the exercise.
2. Peer feedback on a draft of the experimental design. The use of peer-feedback in this situation encourages the students to reflect on the criteria for a good experimental design which is valuable in order to improve their own. A successful peer feedback session requires that the students are introduced to giving and receiving feedback and also to the purpose of using this tool. Thus simple advice on how to give and receive feedback will be given to the students prior to the exercise.
3. In-class feedback by teacher and peer students on the oral group presentations. The feedback will focus on the outcome of the exercise (hypothesis, experimental design, and presentation of results) as well as on the oral and visual communication of the outcome. The feedback will be given to the individual groups but most likely it will also result in some general feedback on common difficulties/pitfalls in the assignment. Likewise, the feedback should include highlighting well-done assignments, pointing toward their qualities.

Written assignment

There were no written assignments in the course in previous years, but the need for training the students in written communication of scientific topics is obvious. Including more written assignments in the course has the purpose of aligning the course content with the exam but also aligning the course with the general competences expected when doing a MSc. The written assignment in the baking exercise comprises an experimental design and

a hypothesis. The work is initiated in the planning session and finalized at home after having received feedback from peers. More initiatives regarding written assignments will be taken in the 2016 version of the course; these are however not described here.

According to Jørgensen, 2015, important issues to consider when designing a good written assignment are:

- What are the criteria for the solved assignment?
- What kind of assignment is necessary to reach the goal?
- Are there any study skills involved?
- Is it fixed or open?

I relation to the written assignment in the baking exercise, these issues are elaborated on below. The **criteria** for the written assignment are:

- The hypothesis is generated from the literature (preferably the curriculum, but exceptions can be made) and it is well defined and not too ambitious
- The experimental design is in accordance with the hypothesis
- The defined assessment methods are suitable considering the hypothesis and practical conditions
- The students express an understanding of the scientific topic by arguing in scientific terms
- The experiment is realistic considering the time and resources available
- The written communication/presentation is clear, concise and formulated so that a peer can understand the purpose and the content.

The written assignment is designed with the goal of supporting the students' achievements of certain competences:

- Communication of a scientific topic
- Academic thinking
- Scientific argumentation
- Giving and receiving feedback
- Self-directed learning
- Acquiring specific knowledge on a topic within the science of baking

The expected outcome of the written assignment thus comprises general academic competence, specific knowledge within the discipline as well as study skills.

The written assignment is to some degree open, meaning the students must identify and formulate their own hypothesis based on the curriculum

or at least a closely related topic. The openness of the assignment calls for a high engagement in the assignment and group discussions. At the same time the assignment is reasonably closed with regard to the format since the purpose is to make it fit into an academic communication style and to make it fit into the frame of the course.

General vs. disciplinary competences

Teaching activities in science need to facilitate learning of disciplinary as well as more general skills like practical work, presentation of data as well as scientific communication and natural scientific argumentation, as also mentioned above. With regard to the practical work it is particularly important that students connect the practical work with the theory in order to benefit fully (Rienecker et al., 2015), as also discussed in section 12.

The redesigned baking exercise, as well as the additional four new exercises that will not be described here, in general facilitate more general competences and a better connection between theory and practice. The change from very fixed exercises, where the student follow a long detailed protocol to a more open exercise that in some of the exercises requires preparation beforehand, will promote more reflection on the connection between theory and practice. The new vegetable and baking exercises also support learning of skills like natural scientific argumentation and experimental set-up. These exercises are designed as small research experiment with a hypothesis, an experimental set-up including defined experimental parameters, an evaluation method and presentation of results.

Facilitation of more general competences in the course supports alignment of the course with regard to the exam and with regard to the competences that the student should obtain as part of their MSc program.

Student engagement

The new baking exercise enforces student engagement/active learning in several ways. The students are engaged in designing their own experiment based on the curriculum, they give peer feedback on experimental design and they must present the outcome of the exercise to the rest of the class. This way of engaging the students has a potential to

- motivate the student
- support self-directed learning and the ability to evaluate one's own work

- support critical thinking
- improve skills in giving and receiving feedback
- improve team building

One challenge with regard to the initiatives toward active learning is to ensure that the students take responsibility when giving a task. Students who are not willing to take responsibility for their own learning will not gain from these initiatives.

Conclusion

The new baking exercise is designed to give students specific competences within the scientific discipline of baking as well as general scientific competences like written communication, presentation of data and scientific argumentation. The exercise will further support study skills like evaluation of their own/peers' work and self-directed learning. Finally the new exercise will support important pedagogical aspects like higher engagement of the students, formative assessment and course alignment.

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A Course description: Food Science and Culinary Techniques, 2016

Education
MSc Programme in Food Innovation and Health

Content
The course includes a series of lectures giving a scientific description of foods as a chemical and physical system. It relates to proteins, lipids, carbohydrates as well as topics within general chemistry (inorganic and organic), acid and bases, and interaction of these components.The course provides an understanding of the culinary techniques used in the production of foods and highlights the effects of food processing on the chemical and physical properties of the food product such as changes in structure and functionality.
Practical exercises in preparation of foods will be used as a stepping stone to the understanding of culinary techniques. The use of ingredients in various recipes will be evaluated and thereby demonstrate important experimental aspects of food processing and preparation. This will include after-lab discussions with reflections over culinary processes to understand how they contribute to palatability in foods.
The lectures and theoretical exercises will demonstrate how food components contributes to the functional properties in dry systems, crystalline states, emulsions, foams and other real food systems. During the practical exercises students will be trained in using various rapid sensory methods to asses foods.

Learning Outcome
Students will obtain a scientific understanding of the chemical and physical composition of foods and which changes occur when various culinary techniques are applied.
Students will obtain a theoretical and practical foundation for working at the interface of science and gastronomy.

A student who has fulfilled the aim of the course should be able to:
Knowledge

- Describe some important chemical reactions and physical changes during processing of foods.

- Identify factors of relevance for detection, perception and loss of aroma compounds in different solvents.

Skills

- Work in a gastronomic laboratory with specific culinary techniques and follow instructions to obtain a well-defined product.
- Explain the changes in foods taking place during preparation of food from a chemical and a physical point of view.
- Predict the outcome of various culinary techniques in relation to the composition of the raw material.
- Evaluate a complex food and communicate the compositional structure of the product.
- Evaluate the effect of various culinary techniques on the food structure and flavour.

Competences
Work effectively in a group with a practical exercise.

Literature
Margaret McWilliams (2014) - Foods: Experimental Perspectives, 7th Ed., Compendium, and Instructions for Practical Exercises

Teaching and learning methods
The teaching (lectures and exercises) contains introductory sessions for general understanding of food science in combination with practical exercises in a gastronomical laboratory in order to examine the effect of various processing methods on the chemical and physical properties of food. The practical exercises set the frame for group-oriented work and will be evaluated by afterlab discussions, problem-based learning, answering questions from the lecturers.

Remarks
It is recommended to follow the course on the first year of the MSc. Programme in Food Innovation and Health

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Exam

Credit	**7,5 ECTS**
Type of assessment	Written assignment, 24 hours Individual written assignment which must be completed within 24 hours on a specific topic based on the curriculum.
Exam registration requirements	Participation in afterlab discussions of practical exercises, min.80%
Aid	All aids allowed
Marking scale	7-point grading scale
Censorship form	No external censorship More than one internal examiner
Re-exam	If 10 or fewer register for the reexamination the examination form will be oral. If participation in afterlab discussions of practical exercises of min.80% have not been fulfilled, students must take the course again.
Criteria for exam assesment	
Cf. Learning outcome	

Workload

Category	Hours
Lectures	36
Theory exercises	52
Practical exercises	28
Preparation	66
Exam	24
Total	206

Course information	
Language	English
Credit	7,5 ECTS
Level	Full Degree Master
Duration	1 block
Placement	Block 1
Schedule	C Practical exercises Wednesday 13-17 and following afterlab discussions
Course capacity	30
Continuing and further education	
Study board	Study Board of Food, Human Nutrition and Sports
Contracting department	
Department of Food Science	
Course responsible	
Karsten Olsen ✉	

B Instructions for baking exercise in Food Science and Culinary Techniques, 2015

Learning outcome
After the exercise you will be able to:

- Explain the effect of the main ingredients in baking
- Discuss the functionality of gluten and its interplay with other ingredients
- Predict the effect of kitchen procedure in various baking applications

Literature
Mc Williams: Chapter 17
McGee: Chapter 10 (521-571)

Content

- Preparations of 3 breads
- Preparation of 3 cakes
- Evaluation of breads and cakes

Start by making the three yeast doughs and while they are rising you can prepare the cakes.

A take-home exercise
This exercise should be carried out at home. So each group should find a kitchen that is suitable for carrying out the exercise. Make sure you have:

- An oven (conventional or convection)
- 3 bowls for mixing dough/batters (min 1½ l)
- 3 small bowls for mixing dry ingredients in the cake recipe (any bowl/container/pot will do)
- 3 plates for keeping the dough during rising
- A hand mixer
- Weighing scale
- Measuring teaspoon
- Spoon/spatula for mixing
- Measuring cup, 100 ml
- Thermometer
- Clean tea towel

If you are missing any of the things on the equipment list, you will need to borrow it from Gastrolab. Anything you borrow must be brought back to Gastrolab clean on the following day.

On Wednesday October 7th, you need to be in Gastrolab at 8 am to get all the ingredients and to borrow equipment if you need to do so.

Bread Each group must make 3 breads as described in Table 12.1. You need to follow the basic recipe, as shown below, but each group will make three variations. Bread I is always the basic one, prepared strictly according to the basic recipe, whereas bread II and III are variations of that recipe. It is important to be precise so that the three different breads only vary by the controlled experimental factor. Make the cakes while the bread is rising.

Group	Exp. factor	No.	Variations	To do
1 & 7	Flour type	I II III	12% prot. 10% prot. 14% prot.	Make 3 breads varying the type of wheat flour.
2 & 8	Kneading time	I II III	4 min 0 min 12 min	Make 3 breads varying the kneading time (step *b*) **after** the ingredients have come together to a coherent dough.
3 & 9	Fat addition	I II III	7 g 50 g 50 g late	Make 3 breads varying the amount of butter and the time for adding the butter. Bread numbers I and II are made following all steps in the basic recipe, but in bread III you must omit the butter in step *a*. Instead knead the butter into the dough in step *d*.
4 & 10	Sugar	I II III	4.8 g 0 g 25 g	Make 3 breads varying the amount of sugar.
5	Salt	I II III	3.5 g 0 g 7 g	Make 3 breads varying the amount of salt.
6	Liquid type	I II III	Water Milk Boiled and cooled milk	Make 3 breads varying the type of liquid. It is important that the three different liquids have the same initial temperature.

Table 12.1: Bread experiemnts

Basic bread recipe

Ingredients	Amount	To do
Wheat flour	210 g	a. Mix all ingredients to coherent dough. b. Knead the dough by hand for 4 min after the dough has come together; use **a little** extra flour if necessary. c. Let the dough rise at room temperature on a plate or in a bowl covered with a clean wetted dish cloth or cling film to double size (approximately 1 hour). d. Knead the dough again for 2 min. e. Shape the bread into a round ball and place it in a labelled aluminium foil pan f. Cover again and let rise to double size (approximately 45 min), while preheating the oven to 180°C (convection oven) or 200°C (conventional) g. Bake approximately 25 min, until done. h. Cool on a rack
Water	150 ml	
Salt, fine	½ tsp* (3.5g)	
Sugar	1 tsp* (4.8g)	
Butter, soft	7 g	
Yeast	8 g	
***Measuring spoon (1 tsp = 5 ml)**		

Cake

Each group must make 3 cakes as described in Table 12.2. You need to follow the basic recipe, as seen below, but each group will make three variations. Cake I is always (except in case of group 6) the basic one, made strictly according to the basic recipe, whereas cake II and III are variations of that recipe. It is important to be precise so that the three different cakes only vary by the controlled experimental factor.

Group	Exp. factor	No.	Variations	To do
1 & 7	Flour type	I II III	12% prot. 10% prot. 14% prot.	Make 3 cakes varying the type of wheat flour
2 & 8	Stirring time	I II III	0 min 5 min 10 min	Make 3 cakes, varying the stirring time (by hand) **after** all ingredients have been combined and no flour lumps can be seen (see step *f* in the recipe below).
3 & 9	Whisking time	I II III	3+1 min 1+½ min 0+0 min	Make 3 cakes, varying the time of whisking butter and sugar (step *d*) and egg (step *e*). When doing cake III, just stir the ingredients together quickly with a spoon or fork – no whisking with hand mixer.
4 & 10	Mixing order	I II III	SBE SE A	Make 3 cakes, varying the order in which things are mixed. Cake I is done according to basic recipe (SBE), first mixing sugar (S) and butter (B) and then adding eggs (E). Cake II (SE) is made by whisking sugar (S) and eggs (E) for 3 min in step *d*. Omit step *e* but add melted butter together with additional ingredients in step *f*. Cake III is made by omitting step *d* and *e* but instead combining all (A) ingredients in step *f;* use a hand mixer if you like.
5	Baking powder	I II III	½ tsp* 0 tsp* 1 tsp*	Make 3 cakes, varying the amount of baking powder (step *c*)
6	Baking powder	I II III	½ tsp* 0 tsp* 1 tsp*	Make 3 cakes, all of them by following a slightly different procedure than described in basic recipe (SBE). You should omit the whisking in step *d* and *e* but instead combine all ingredients in step *f*, use a hand blender if you like. Vary the amount of baking powder (step *c*).

Table 12.2: Cake experiemnts

Basic cake recipe (SBE)

The basic cake recipe is based on the common procedure that involves creaming sugar (S) and butter (B) followed by addition of eggs (E) and finally addition of milk and flour - in this exercise referred to as the SBE procedure. The basic recipe also contains baking powder for leavening the batter. The cakes should ideally go into the oven immediately after combining and ideally all three at the same time to avoid the oven door to be opened when rising. So prepare well by weighing out all the ingredients beforehand, turn on the oven and then start. Do step *a* with all three cakes, then *b, c, d, e, f, g and h* (or simultaneously if you have enough hands). Group 4 and 10 must be extra careful since the three cakes must be made by following 3 different procedures!

Ingredients	Amount	To do
Butter soft	5+125 g	a. Label the aluminium foil pan with a permanent marker
Sugar	125 g	b. Butter the aluminium foil pan with 5 g butter
Egg	2	c. Mix flour and baking powder until no lumps of baking powder remain.
Baking powder	½ tsp*	d. Whisk sugar and butter using a hand mixer in another bowl, 3min.
Wheat flour	125 g	e. Add eggs to butter and sugar mixture and whisk 1 more minute using hand mixer
Aluminium foil pan		f. Combine everything and stir carefully with a spoon or spatula until just combined
***Measuring spoon (1 tsp = 5 ml)**		g. Transfer the batter into the aluminium foil pan
		h. Bake at 180 °C in a preheated convection oven (200 °C in conventional) for 30 min or until done. The centre temperature will be about 80 °C when done. You can check doneness by using a sharp knife, a cocktail stick, a skewer or a toothpick - poke it into the middle. If it comes up with some wet batter, crumbs or stickiness on it, the cake needs to bake some more.
		i. Let it cool in the tin

Evaluation of breads and cakes

When cooled, cut bread and cakes into two halves. Put one half of each in a labelled plastic bag. Store at room temperature and bring them to the after lab discussion for demonstration of effects. Evaluate the volume, texture and flavour of the other half of the breads and cakes. Can you smell any difference, can you see any difference or can you taste any difference? Discuss your results in relation to the theory. Prepare yourself to briefly explain your results, and whether the results agreed with the expected outcome at the After Lab Discussion. Enjoy the rest of the goodies while you go through the additional questions below and discuss them in the group.

After Lab Discussion

Main content:

- Each group briefly explains what they did, the observed results and whether the results agreed with the literature.

Further questions :

- What is gluten and how is it formed?
- What is the effect of kneading a dough?
- Which role does oxygen play in gluten formation?

- What happens to the starch during mixing and baking of bread and cakes?
- What happens during the various stages of baking breads/cakes?
- Which flour should be used for various baking applications and why?
- What is the effect of salt, acid, fat and sugar on gluten structure?
- Explain the various methods used for leavening a dough or batter
- Could you use baking soda instead of baking powder in this recipe, why/why not?
- What is the predicted outcome when incorporating fat into dough after kneading the dough as compared to mixing it in together with the additional ingredients?
- Which role do eggs play in cakes?
- Which role does sugar play in breads and cakes?

C Baking

C.1 Instruction for the new baking exercise in Food Science and Culinary Techniques, 2016

Learning outcome
After the exercise you will be able to:

- Plan a small experiment based on a hypothesis
- Discuss the choice of experimental parameters and evaluation method with regard to aim of experiment
- Explain a specific subject within baking and the theoretical background using scientific terms

Literature
Coultate: p. 198-208
McGee: Chapter 10 (p. 521-571)

Content
The task in this exercise is to carry your own small baking experiment that is based on hypothesis generated from the literature and to clearly describe the underlying science and present the outcome in class. The exercise involves six steps:

1. Make a draft of your hypothesis (Assignment I)

2. Plan experiment (28/9 or 5/10): Submit draft and peer review (Assignment II).
3. Finalized the experimental plan (Assignment III)
4. Carry out the experiment at home (12/10 or 26/10)
5. Evaluate outcome of experiment and prepare presentation
6. Present outcome in class (31/10)

Assignments

I. Draft hypothesis

Submit your hypothesis and a few lines describing roughly how you plan to test the hypothesis through the online assignment Baking – draft hypothesis. See details below. You will get some brief feedback on the assignment before the planning session. Deadline 26/9 or 3/10.

II. Draft experimental design (peer review)

In the planning session (28/9 or 5/10) you will proceed with development of your hypothesis and your experimental plan. You must submit a draft of your experimental plan (fill out the template) no later than 3 pm, through the online assignment Baking – draft experimental design. Then the peer review process starts which you need to finish on the same day. See details below.

III. Final experimental plan

After having received your peer feedback you need to finalize your experimental plan and submit the final plan and a shopping list (google doc) through the online Assignment Baking – final experimental plan. Deadline 9/10 or 23/10

1. Hypothesis draft

Define a hypothesis and a rough plan of how you want to test the hypothesis in a small experiment that you will carry out at home. In order to do this you need to study the baking literature and use the literature to generate your hypothesis. You need to make it simple and carefully consider how this hypothesis can be tested in an experiment at home. The baking experiment is expected to have approximately the same extent as the experiment in the Vegetable exercise, but in this case you will get to decide the content and plan everything yourself.

2. Draft of experimental design and peer review
In the planning session, from 11-17, you need to:

1. Revise your hypothesis if necessary
2. Make a draft of the experimental design, using the template provided, and submit it though the online assignment no later than 15.00.
3. Read through your peer group's experimental design. Use the peer review template to give your comments to the experimental plan. Remember to make it is your job to support your peer group to improve their experiment. Submit the comments through the online assessment. Deadline for peer review is on the same day.

When planning your experiment and evaluating another group's experimental design, keep the following criteria in mind:

- The hypothesis must be generated from the literature and should be well defined and not too ambitious (given the time constraints)
- The experimental design is in accordance with the hypothesis
- The defined evaluation methods are suitable considering the hypothesis
- The students express an understanding of the scientific topic by arguing in scientific terms
- The experiment is realistic considering the time and resources available
- The written communication/presentation is clear, concise and formulated so that a fellow student can understand the purpose and the content.

3. Finalize your experimental plan
Revise your experimental plan based on the review comments you got from your peer group. It is up to you to choose how you want to improve your plan, and you are not obliged to make all changes suggested by the peer group. The final experimental plan must be submitted through the online assignment.
Make a shopping list for your experiment, using the google document provided in online assignment. You need to specify the amounts in either gram (g), milliliter (ml) or pieces (pc) as specified in the google sheet. You also need to specify if you need to borrow anything from Gastrolab.

4. Carry out the experiment
At 11 on the day of the experiment you can come and pick up the ingredients you have ordered in GastroLab. You can also borrow the equipment you have listed. The experiment must be carried out at home.

5. Evaluate outcome and prepare presentation
After completing the experiment you need to evaluate the results and decide how you want to present the outcome. What was the rationale and science behind your hypothesis?. Did your results support the hypothesis or not? Any explanation? Did you encounter any problems? Would you suggest any improvement to the design?
You need to prepare a presentation to be given in class. Consider carefully the way you present the results and your reflections of the experiment. Use figures as much as possible.
The presentation (10-15 min) must include:

- The hypothesis
- Theoretical background (what is expected and why – explain the underlying science)
- Overview of experimental set-up, including evaluation method (use figures!)
- Results (figures rather than text, could include pictures)
- Reflections on the experimental set up
- Conclusion

6. Present your experiment in class
The presentations will take place on October 31. Each group has 10 – 15 min for the presentation. Feedback to the presentation will be given by students and teacher.

C.2 Template for planning and peer reviewing baking experiment as part of the baking exercise, 2016

Hypothesis
Formulate a clear hypothesis based on the literature. It can be generated from a problem you have encountered at home or just something you find tempting to look into. More information on how to make a hypothesis and setting up an experimental design can be found on Absalon. Make a reference to the literature that supports your hypothesis.

Theoretical background
Describe briefly the theoretical background with a reference to the literature. For example, if you work on the protein content of flour, then explain how and why that is supposed to change e.g. texture.

Parameters that will be studied:
List the experimental parameter(s) you will study such as protein content of flour, amount of fat added, kneading time etc.

Experimental set up
Describe the details of which samples will be prepared and how the samples will be prepared. Use tables/figures whenever suitable (as much as possible)

Evaluation method
Describe the ways you will evaluate the products. Consider both sensory and objective measurements (eg. measure height of bread). Of course you will be very limited in evaluating your product at home but you still need to describe precisely what you will be doing. If you for instance want to evaluate perceived texture you need to specify exactly how.

Reflections on the design
Which weaknesses does your design have?
Are their obvious limitations and/or pitfalls to be aware of?

List of equipment
List all the equipment you will need to carry out the experiment.
If there is anything on your equipment list that you do not have at home, you can borrow it from Gastrolab (if available). In case so, you must list these items in the same excel file (separate sheet) as the shopping list (Absalon, folder: Baking).

Review of assignment (by the peer-review group)
When reviewing the experimental plan you need to evaluate the content of the text provided as well as the written communication of the content. Is the text comprehensive, correct and explained in an understandable way. **Suggest improvements.**
Make your notes in the table below and upload the document including your comments through the online assessment.

Peer review comments to the baking experiment	
Comments to:	Peer review comments
Hypothesis	Is it clear and concise and supported by the literature?
Theory	Does the description support the hypothesis and does it describe the necessary theoretical frame for the experiment?
Experimental design	Is the experiment well planned and well suited to test the hypothesis?
Evaluation	Are the evaluations of the products well planned and does it seem suitable in order to test the hypothesis?
Reflections	Any comments/ suggestions?
Written communication	Is the text clear, precise and well structured? Do tables and figures support the text and communication of the content in general?

All contributions to this volume can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/improving-university-science-teaching-and-learning---pedagogical-projects-2017---volume-9-no.-1-2/