Effects on skills and knowledge of a sensory teaching program for culinary students

Damsbo-svendsen, Marie; Karpantschof, Bat-El Menadeva; Stovgaard, Mikkel; Christensen, Jacob Højgaard; Frøst, Michael Bom

Published in:
International Journal of Food Design

DOI:
10.1386/ijfd_00041_1

Publication date:
2022

Document version
Publisher's PDF, also known as Version of record

Document license:
CC BY-NC

Citation for published version (APA):
MARIE DAMSBO-SVENDSEN
University of Copenhagen

BAT-EL MENADEVA KARPANTSCHOF
University of Copenhagen

MIKKEL STOVGAARD
University of Aarhus

JACOB HØJGAARD CHRISTENSEN
University of Aarhus

MICHAEL BOM FROST
University of Copenhagen

Effects on skills and knowledge of a sensory teaching program for culinary students

ABSTRACT
Culinary practitioners (chefs and healthcare cooks) need tools to systematically assess and improve the sensory quality and acceptance of the food they produce. Sensory science provides these tools to develop, revise and improve foods. However, in the culinary arts educations in Denmark teaching in sensory science is limited. We developed a teaching programme for culinary arts educations, focusing on the use of central practices of sensory science in production kitchens. The teaching
programme was tested and developed in dialogue with vocational teachers and culinary students. The material consists of five theoretical and practical teaching modules that cover topics such as the senses, sensory vocabulary development and training, fast sensory methods and factors contributing to palatability. In total, 137 culinary students participated in the teaching programme. The goal was to make culinary students master sensory evaluation techniques and improve their ability to develop food that is liked by consumers. Consequently, these practitioners can improve the sensory quality and acceptance of sustainable and healthy foods. Learning outcomes in a combined sensory knowledge (ten questions) and skills test (eight sensory tasks) were examined. Altogether 89 culinary students participated in both the baseline and follow-up test. Results demonstrate a highly significant effect in both domains. The knowledge scores were significantly higher after than before the course and the scores in the skills tests revealed a significant improvement of culinary students’ vocabulary after completing the course as measured by a higher number and quality of descriptors used to describe four different foods in an open description task. A higher number of descriptors used to describe foods by means of a check-all-that-apply (CATA) sensory descriptive methodology emphasized these findings. Integrating a course on sensory science and methods into the culinary arts educations leads to significant improvement of culinary students’ sensory vocabulary, knowledge and skills. The sensory educational programme is available in Danish with elaborate instructions for teachers through Taste for Life’s online services. Additionally, to train vocational teachers so they can teach it themselves, virtual courses on the sensory educational content were created in 2021 and are accessible online.

INTRODUCTION

We need to shift the food consumption in industrialized countries as it is formulated in the Sustainable Development Goal 12, responsible consumption and production (United Nations 2016; Willett et al. 2019). Meals must contain sustainable ingredients, which require less resources to produce (such as vegetables, algae, legumes, grains, seeds and nuts), and new ingredients (such as production side-streams or insects) (Chai et al. 2019). However, meat and meat-based products are generally considered to contribute to the deliciousness of a meal due to the taste of umami and high energy content (Mouritsen and Styrbæk 2014). Sustainable and healthy foods are not necessarily delicious due to, e.g. bitterness and lack of umami and may even evoke disgust or be socially unacceptable to eat (Rozin and Fallon 1987).

To overcome the challenge of a transition of our food consumption to the better, it is imperative to provide acceptable, sustainable and healthy meals. One of the means to do so is the application of sensory methods during the development phase (Giboreau 2017; Harrington and Ottenbacher 2013; Naes and Nyvold 2004). Consumer acceptance of foods is determined by liking, and therefore liking is essential for food choice (Mustonen et al. 2007). A structured approach to meal development and evaluation of sensory characteristics of foods which leads to increased liking of the food is therefore crucial to ensure consumer acceptance (Harrington and Ottenbacher 2013; Tuorila 2007). A recent study (Westling et al. 2021) demonstrates how a systematic recipe development approach, aptly named the culinary funnel, can be used to design novel foods and meals from a selected base ingredient, in their study grey peas.
An increasing share of the foods eaten is provisioned by the hospitality sector (Warde et al. 2007). In Denmark around 800,000 meals are served daily at schools, kindergartens, eldercare and hospitals, and approximately 225,000 meals are eaten in restaurants, cafés, fast food restaurants or consumed as takeaway meals (Stamer et al. 2017). Moreover, 25 per cent of the Danes with access to canteens at work or in their place of education eat their daily lunch in the canteen (Landbrug og Fødevarer 2016). In European countries there are 1.6 million enterprises in the food and beverage service industry (Statista 2019), and in Denmark there was 9000 enterprises in 2018 (Statista 2021). Replacing meat-based meals in the hospitality sector with more sustainable meals will therefore have a substantial impact on achieving sustainable and healthy eating habits. However, usage of sensory science expertise by culinary practitioners (trained chefs, caterers, sandwich makers and healthcare cooks) is scarce and mostly reserved for culinary practitioners working at high-end restaurants and other industries rather than being applied across the whole hospitality sector (Aguilera 2017; Harrington and Ottenbacher 2013). The particular Danish vocational context is described in the next paragraph. Recently Schifferstein et al. (2020) analysed the link between sensory science and culinary practices and emphasize that a good command of the underlying sensory principles and mechanisms can be used in the creation of menus, so hopefully more research will study how to do so, as the practice is presently very limited. In a very recent case study, Patois et al. 2021 describe an approach for collaboration between chefs and health professionals and demonstrated it to be useful for the design of meals for patients with special dietary needs.

Time constraints in the hospitality sector may be a reason for not applying sensory science in the development phase (Frøst et al. 2015), but simple sensory profiling methods exist and could beneficially be applied (Varela and Ares 2012). An additional reason probably is that teaching and training in sensory science in the culinary arts educations in Denmark is scarce. Chefs (the lesser used, but formal name for the education is Gastronom in Danish) do not have a specific course dedicated to sensory science. Yet, in the standard culinary handbook for chefs’ education, eight pages on sensory science are included (Rasmussen and Andreasen 2014). The curriculum must include around one week of teaching in sensory science, e.g. sensory analysis and preparation, and chefs should obtain a sensory vocabulary to be able to express themselves and communicate with colleagues and guests (Ministry of Education 2021). Since the time of development of this course, the curriculum has been updated. However, it does not include more sensory analysis than before (Ministry of Education 2022). In the development phase of the training programme some of the authors carried out workshops with teachers at vocational institutions, and through this learnt the effectual level of sensory education taking place, which in general amounts to around one week. In contrast, the education for healthcare cooks (Ernæringsassistent in Danish) includes a ten-day course called ‘Sensory Science and Food Quality’ (Ministry of Education 2020) and a book related to this course (Andersen 2013). Several academic works (García-Segovia et al. 2012; Naes and Nyvold 2004; Vetter 2009) have pointed to the fact that culinary professionals and product developers need practical sensory evaluation tools to ensure the meals they develop are liked by consumers. These tools must be adapted to the everyday practice of the kitchen work, to be useful in the development and the daily production of meals and foods.
Taste lessons have been developed previously with the aim of educating children in taste and the senses to improve their ability to verbalize and evaluate their own food experiences. It is called the SAPERE sensory food education, and the taste lessons have led to improved identification and verbalization of sensory experiences (Jonsson et al. 2005; Reverdy 2011; Sepp and Höijer 2016).

Including theories for sensory perception and adapted sensory methodologies for testing foods in the curriculum of culinary students would, like the SAPERE taste lessons, increase the likelihood that culinary professionals use them in their professional practice.

Therefore, we developed a five-module teaching programme for culinary students (chef and healthcare cook apprentices) with the aim of improving their skills and knowledge within sensory science and systematic testing in the development of new meals. Each module has a duration of four hours. Before and after participating in the teaching programme, we tested culinary students’ knowledge and skills through a test adjusted to the content of the classes. We hypothesized that participating in the teaching programme would improve culinary students’ sensory knowledge e.g. ability to distinguish between the different sensory modalities, vocabulary and skills in using sensory methods.

MATERIALS AND METHODS

Study design

The intervention consisted of a five-module teaching programme on the topics of sensory science, selected sensory methods and their application in meal development. The particular needs for education within sensory knowledge, methods and skills among chefs were identified in workshops with vocational teachers. The content of the teaching programme was developed based on these inputs and the format appealed to different learning styles (slide presentations, films, practical exercises in the kitchen, tastings and group discussions [Fleming and Mills 1992]). From April to June 2019 a pilot study of the teaching programme was carried out with 44 participants from three vocational schools in Denmark, all of which were partners in Smag for Livet, and teachers willing to work with us. The teachers had also taken part in initial workshops to co-create the content of the course. A final adjustment led to a within-subjects study design with a five-module teaching programme appropriate for the intervention. Damsbo-Svendsen et al. (2020) outlines the development process and the learning from the pilot tests.

The teaching materials consist of a combination of theory taught through videos and slide presentations and practice taught through tastings and exercises. It includes an introduction to the biology and function of the senses: taste, sight, smell, hearing and touch, and practical sensory methods with associated exercises, which can be carried out in a kitchen or classroom. It contains teacher guides with questions for in-class discussions and questions for the apprentices to discuss and reflect upon during the kitchen exercises. Each module centres on a topic within the framework of the senses and their function, verbalization and assessment and, most importantly, deliciousness. The final module is a development session centred on developing a dish for a particular purpose (e.g. a dish to celebrate game season in the local gastro-pub, or the vegetarian option in a workplace canteen) based on focusing on a few principles for deliciousness, evaluating the dish and the degree to which
Effects on skills and knowledge of a sensory teaching program...

it successful in using these principles, and how it fits a target group of diners. The teaching programme is designed so that it is possible to select the content that fits to a particular level in the education. Modules 1–4 take between two and four hours to complete, depending on the time spent on discussions in class, and module 5 takes between four and seven hours to complete.

**Baseline and follow-up test**

Before and after the five-module teaching programme, culinary students completed a baseline and follow-up test. The content of the tests is presented in Table 1 (see Appendix 1 for more details).

For the tasting part of the baseline and follow-up test, participants were presented with eight different samples on a plate and corresponding tasks to each of them. The first two tasks were intensity rating of curry powder and curry powder/cinnamon mix. Curry powders were prepared by mixing 150 g Sun Best Madras Curry Powder (India) with 150 g Santa Maria Curry (Sweden) consisting of *cinnamonum humatum* (Indonesian cinnamon). This mixture composed the first yellow curry powder labelled with a three-digit numerical code. From this mixture 150 g was transferred to a new container and mixed with 112.5 g Santa Maria ground cinnamon to form the yellow curry powder spiked with cinnamon also labelled with three-digit codes. Participants were instructed to sniff the curry and cinnamon/cinnamon mixes (in dark covered glasses). The intensity of cinnamon aroma was rated on fifteen-point intensity scales anchored ‘not at all’ to ‘very much’. The next two tasks were intensity rating of umami taste in cheese. Cheeses used for intensity rating of umami were Thise Ravost (a hard yellow cheese, Denmark) matured for twelve weeks (Thise Dairy 2007) and Thise Vesterhavsost (a hard cheese inspired by the Dutch cheese ‘Gouda’, Denmark) matured for 30 weeks (Thise Dairy 2008). Participants were instructed to taste the cheese (ca. 10 g of each sample served on a plate). The umami intensity was rated on fifteen-point intensity scales anchored ‘not at all’ to ‘very much’. Tasks 5 and 6 were recognition of specific sensory characteristics in two products – chocolate (Toms Ekstra Mørk 70 per cent chocolate, ca. 5 g served) and honey (Änglamark organic flower honey, ca. 15 ml served in a small beaker, and with a teaspoon). Participants were instructed to taste the products, read the list of descriptors and check-all-that-apply (CATA), hence the name CATA for this type of task. Chocolate

**Table 1: Content of the baseline and follow-up test.**

<table>
<thead>
<tr>
<th>Baseline test</th>
<th>Follow-up test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ten multiple-choice questions on sensory knowledge</td>
<td>Ten multiple-choice questions on sensory knowledge</td>
</tr>
<tr>
<td>Intensity ratings of curry powders and cheeses</td>
<td>Intensity ratings of curry powders and cheeses</td>
</tr>
<tr>
<td>Check-all-that-apply (CATA) of dark chocolate and honey</td>
<td>CATA of dark chocolate and honey</td>
</tr>
<tr>
<td>Open description of two products: Group A: olive oil and almonds</td>
<td>Open description of two products: Group A: tomato sauce and crisp bread</td>
</tr>
<tr>
<td>Group B: tomato sauce and crisp bread</td>
<td>Group B: olive oil and almonds</td>
</tr>
</tbody>
</table>
participants were presented with a list of sensory descriptors based on a vocabulary developed by De Pelsmaeker et al. (2019). For honey the descriptors were developed by the last author, Michael Bom Frøst, based on further development of existing vocabularies (González et al. 2010; Marcazzan et al. 2014; Stolzenbach et al. 2011). The final two tasks were open-ended description of two food products. Participants were asked to describe a food using their own words in one minute, including writing the words. To prevent memory effects on the use of descriptors, samples were randomized so that a participant received two products in baseline and two others in the follow-up test. The four samples were olive oil (Cucina organic extra virgin olive oil, ca. 15 ml in a small beaker); roasted almonds (Kims roasted almonds with paprika, Orkla Snack, Denmark); pizza sauce ‘Aromatizzata’ (Mutti, Italy) and crispbread with sea salt and herbs (Sigdal Bakery, Norway). In the open description participants were asked to describe the products in one minute.

**Ethics approval and General Data Protection Regulation (GDPR)**

Data handling complied with the GDPR 2016/679 (case: 514-0135/20-5000). Because it was not a health science research project, the Science Ethics Committee did not have to approve it (journal number: H-20002435). As the study was conducted in collaboration with the Danish School of Education, University of Aarhus, an agreement on shared data responsibility was drawn up with these partners. Informed consent was collected from participants before data collection.

**Participants**

The five-module teaching programme was targeted at culinary students within the culinary vocational educations in Denmark. Seven classes from three different vocational schools were recruited. This resulted in 137 culinary students participating in the programme. The teaching programme was part of the normal teaching in the vocational school, so some absences in one or more classes was expected, and not all consented to have their data used for research. Of the participants, 89 students participated both in the baseline and the follow-up test and gave consent for us to analyse their data, some of them were absent for one or more of modules 2–4.

**Data coding and analysis**

Data from the multiple-choice sensory knowledge test, CATA and open description of foods were coded before they were analysed. In the ten multiple-choice questions correct answers were assigned a score of 1 and incorrect answers a score of 0. Total scores for each participant were calculated and could range from 0 to 10 points. Scores were analysed by examining if they were significantly higher in the follow-up than in the baseline test. Data were inspected for normality through density plots (Otto and Kahle 2022) and Shapiro–Wilk normality tests. Analysis of significant differences in scores was completed using paired Wilcoxon signed rank test with continuity correction, because the Shapiro–Wilk normality tests revealed that data were non-parametric. Multiple Linear Regression by analysis of variance (ANOVA) was performed with the difference in scores between baseline and follow-up in the multiple-choice test as the dependent variable and gender, educational level, work experience, culinary education and level as independent variables.
Intensity ratings on the fifteen-point intensity scale of cinnamon in curry powders and umami in cheeses were assessed by calculating the difference between the scores of curry powders and cheeses at baseline and analysing if these were significantly different from the differences in scores in the follow-up test. Moreover, differences in scores of the same product at baseline and follow-up, respectively, were analysed to see if usage of the scale, or the intensity of flavour in the foods, changed at follow-up compared to baseline.

Data from the CATA were analysed by assigning points to the different descriptors according to how specific they were from 1 (slightly) to 3 (highly) e.g. the descriptor ‘fermented’ was assigned one point, ‘fermented fruit’ two points and ‘overripe fruit’ three points. Total scores and number of descriptors used were calculated and tested for significant difference between the baseline and follow-up test.

For the data analysis, descriptors from the open description of four different food products were inspected. Hedonic words, intensity rating descriptions (e.g. ‘very’ and ‘little’) and unspecific terms were excluded from further data analysis. The total number of descriptors generated per participant was calculated and analysed by testing if there was significant difference from baseline to follow-up. Also, descriptors were divided into categories according to which sensory modality they referred to (e.g. taste, texture, aroma and appearance). Words with similar meaning, such as ‘sour’ and ‘acidic’, were merged into a single descriptor. Descriptors were assigned points from 1 (slightly) to 3 (highly) according to how specific they were e.g. ‘aromatic’ were assigned one point, ‘herb-like’ two points and ‘rosemary’ three points. To establish a framework for determination of the number of points a given descriptor received, categorization of descriptors in two flavour wheels was used: the Coffee Taster’s Flavour Wheel and a sensory wheel and lexicon on chocolate (Bolger et al. 2017; De Pelsmaeker et al. 2019). The flavour wheels were used as concrete examples of level of specificity in the different tiers, to develop a consistent system for scoring the open descriptions. Evaluation and categorization of the descriptors was done by the authors and discussed thoroughly to ensure compliance between the categorization of the flavour wheels and the authors’ assessed categorization of the descriptors. The points for valid descriptors generated for each participant were added together to give a total score. This was carried out both in the baseline and the follow-up test, separately. Data were analysed by testing if there was a significant difference between participants’ scores in the baseline and the follow-up test using Wilcoxon signed rank test, as data were non-parametric. The number of descriptors generated was analysed using paired t-test because data were parametric. Data were collected using SurveyXact (Rambøll, Aarhus, Denmark) and analysed using Microsoft® Excel Version 16.46 and packages ‘readxl’ and ‘tidyverse’ in RStudio Version 1.3.1073.

To investigate characteristics of students at an overall level, and how the overall differences in starting points correlate with students learning outcomes, we conducted a cluster analysis (Teo 2013) on the collected baseline and follow-up data. Each cluster will differ from other clusters with regard to the same parameters (Petscher et al. 2013). The approaches that calculated the grouping was the Wards Linkage approach (Everitt et al. 2011). This is a hierarchical cluster method that initially calculates which two observations are most similar in the entire data set and groups these in the same cluster; this is carried out sequentially to create a dendrogram that shows the relationship between all respondents from most similar (nearest neighbour) to least
similar (furthest away in the dendrogram). In our analysis the dendrogram indicated a cut-off point with three clusters, which we chose to proceed with in table analyses. To examine which items in the dataset could be grouped as latent constructs we conducted an explorative factor analysis (see Table 6). Also, three main themes, ‘progression in sensory test’, ‘progression in number of words in test’ and ‘progression in quality of words in test’, were examined through a comparison of baseline and follow-up scores from the survey and sensory test and tabulated with the constructed cluster variable (see Table 7). The dataset contains 89 students in total while 64 students are included in the cluster analysis. This difference is a consequence of missing values since the cluster analysis is conducted exclusively with students from whom there are complete data regarding all items.

RESULTS AND DISCUSSION

Demographics

Of the 89 participants, 56 (63 per cent) were males, 33 (37 per cent) were females and no participants reported to be ‘other’ gender. Participants’ age ranged from 18 to 57 years, and the mean age was 26.6 years (Q1 = 22, median = 24, Q3 = 30 years). The majority of participants had a short-cycle educational background: 43 (48.3 per cent) participants had finished primary school, 29 (32.6 per cent) had finished a high school education, 9 (10.1 per cent) had finished two years of further education programme, 7 (7.9 per cent) had finished 2–4.5 years of continued education and 1 (1.1 per cent) had finished a continued education of five years duration.

Almost a third of participants (32.6 per cent) had more than four years of relevant work experience, 59.6 per cent had one to three years of experience while only 9.0 per cent had no or less than a year of experience. In Table 2, the culinary arts educations participants were enrolled in and level of the education they had reached are presented.

**Sensory knowledge test**

It was hypothesized that the more sensory teaching modules culinary students participated in, the more they learned. Consequently, they would score higher
in the follow-up test, and a larger difference between their scores at baseline compared to follow-up would be expected. Analysis of knowledge scores from the ten multiple-choice questions (the full quiz is given as Appendix 1) before and after the five-module teaching programme revealed that the knowledge scores were significantly higher after than before the course ($p = 10^{-13}$). Thus, it is evident that participants’ sensory knowledge on how the senses contribute to the perception of foods improved after the training.

Results from an ANOVA with the difference in scores between baseline and follow-up in the multiple-choice test as the dependent variable and gender, educational level, work experience, culinary education and number of sessions participated as independent variables revealed a slightly significant effect of work experience on the scores ($p = 0.031$) and a significant effect of the number of sessions participated in the five teaching modules ($p = 0.012$). However, the model only approached significance ($p = 0.073$) and only explained a slight fraction of the variance ($R^2 = 0.065$). Subsequently all the non-significant factors were eliminated, and a simpler model of only the effect of work experience and number of sessions participated was created. It showed only a significant effect of the number of sessions participated in teaching programme ($p = 0.017$). This model was significant ($p = 0.0082$) and explained 8.5 per cent of the variance ($R^2 = 0.085$).

However, data inspection revealed that culinary students reported participation in zero to five modules. Yet, to complete the baseline and the follow-up test, culinary students had to participate in modules 1 and 5 meaning that at least they participated in two modules. Report on participation is therefore subject to some uncertainty, but the results from the knowledge test did show that the participants gained knowledge during their participation in the five-module teaching programme. It was not the aim of this study to investigate differences in learning outcome due to participation, but future studies should examine if there is a significant difference in the learning outcome due to participation and how much teaching it is necessary to participate in to gain an intended learning outcome.

**Intensity ratings**

Inspecting the intensity ratings (Table 3) of cinnamon in curry powders revealed that cinnamon aroma in the curry powder spiked with cinnamon decreased slightly but not significantly in intensity ($-1.1; p = 0.0699$) from 11.6 to 10.5.

<table>
<thead>
<tr>
<th></th>
<th>Mean intensity rating baseline</th>
<th>Mean intensity rating follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curry spiked w/cinnamon</td>
<td>11.6</td>
<td>10.5</td>
</tr>
<tr>
<td>Curry</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td><strong>8.6 ($p = 10^{-13}$*)</strong></td>
<td><strong>7.3 ($p = 10^{-34}$*)</strong></td>
</tr>
<tr>
<td>Vesterhavsost matured 30 weeks</td>
<td>10.1</td>
<td>11.4</td>
</tr>
<tr>
<td>Ravost matured twelve weeks</td>
<td>8.5$^1$</td>
<td>8.7$^1$</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td><strong>1.6 ($p = 10^{-3}$*)</strong></td>
<td><strong>2.7 ($p = 10^{-9}$*)</strong></td>
</tr>
</tbody>
</table>

$^*$Significance level: $p < 0.05$.

$^1$Scores were normally distributed as measured by a Shapiro–Wilk normality test, $p$-value $= 0.0823$. 

---

*www.intellectbooks.com*
to 10.5 on a fifteen-point scale from baseline to follow-up. On the other hand, it was relatively stable (difference: +0.2, \( p = 0.33 \)) in the curry powder without added cinnamon. This indicates that the aroma concentration of cinnamon may have decreased a little, or the participants used the scale differently from baseline to follow-up. Participants clearly managed to identify the difference in cinnamon aroma between the two curry samples; at baseline the rated difference in cinnamon aroma between the two samples was 8.6 (\( p = 10^{-15} \)) on a fifteen-point scale, while it was 7.3 (\( p = 10^{-34} \)) at follow-up. A significant dissimilarity (\( p = 0.0120 \)) between the difference in rated cinnamon aroma of the two samples at baseline and at follow-up emphasizes that curries were rated differently at follow-up compared to baseline. Participants were able to detect differences in umami taste in the cheeses according to the maturation time of the two samples. At baseline the difference in umami taste within the two cheeses was 1.6 (\( p = 10^{-3} \)), whereas it increased at follow-up (2.7, \( p = 10^{-9} \)). The increased difference in umami taste between the two cheeses at baseline compared to at follow-up was significant (\( p = 0.046 \)). This indicates that the students increased their ability to rate differences in the taste of umami, or participants might have used the scale differently. Inspecting data reveals that the Vesterhavsost was rated significantly higher at follow-up compared to baseline (\( p = 0.0055 \)). This might be due to a little longer maturation of the cheese from baseline to follow-up (Toelstede and Hofmann 2008). However, an increase in the umami taste of the Ravost would thus also be expected but was not demonstrated (difference from baseline to follow-up: 0.2, \( p = 0.5944 \)).

A plausible explanation for the differences in intensity ratings of umami taste in the cheeses is thus that participants improved their ability to detect and rate the taste of umami. As a part of the training in the programme they were introduced to foods high in umami (e.g. soy sauce, marmite, Parmesan) for them to better learn this basic taste. We used the same samples of curry powder for the baseline – and follow-up test – and since the study was conducted over a time period of 1.5 months (January–March 2020), it is likely that parts of the volatile cinnamon aroma (Raghavan 2006) may have escaped the curry powder and the mix spiked with cinnamon, or it may be because we did not train them specifically on cinnamon sensory characteristics.

Thus, it appears that participants are more in agreement with each other regarding the intensity ratings at follow-up compared to baseline.

**CATA**

The average number of descriptors selected to characterize the sample of chocolate increased significantly (\( p = 0.0069 \)) by 1.1 descriptors per participant from 6.6 at baseline to 7.7 at follow-up. However, the quality of the descriptors did not improve significantly, only borderline to an effect (\( p = 0.051 \)) from baseline to follow-up. Thus, participants became more aware of how to describe the sample with more descriptors and consequently improved their ability to characterize it. However, they did not characterize the sample with more specific descriptors.

The average number of descriptors selected to characterize the honey sample also increased significantly (\( p = 0.028 \)) by 1.2 descriptors per participant from 6.4 at baseline to 7.6 at follow-up. Similar to the chocolate sample, participants became better at characterizing the honey, but did not use significantly more specific descriptors in their characterization (\( p = 0.062 \)). For both chocolate and honey there was a numerical increase in quality, but the
Effects on skills and knowledge of a sensory teaching program …

increase was a little below significant level. Table 4 provides an overview of the results from the CATA.

Through the five-module teaching programme participants were taught how to use sensory methods and trained in how to characterize foods by identifying relevant descriptors through tastings. Consequently, it would be expected that participants improved their ability to characterize foods. The results reveal that participants improved their ability to identify more descriptors significantly but did not generate significantly more specific descriptors, and hence the quality of the descriptors was not significantly different from baseline to follow-up. To be able to characterize foods, one needs to train by tasting and characterizing foods repeatedly (Lawless and Heymann 2010). The five-module teaching programme included several exercises dedicated to descriptive methods and training in sensory description of foods. This amount of training might be insufficient to make a significant change in the ability to identify very specific descriptors to characterize foods based on a CATA. More training in sensory descriptive methods would be necessary to make a difference in the ability to identify more specific descriptors based on a CATA.

Open-ended description of foods

Table 5 lists the results of the analysis of the open description of the foods. The number of descriptors generated by the participants in the open description mode increased significantly ($p = 10^{-4}$) from 7.4 at baseline to 9.0 at follow-up. Generation of a higher number of descriptors suggests that participants extended their vocabulary and became more conscious of how to describe foods in more detail. In addition, it is important to evaluate the number against the content of the descriptors: how specific are they, do they constitute sensory descriptors or are they intensity rating descriptions, hedonic words and unspecific terms? Assessing the content of the terms revealed that the

Table 4: Overview of results from the CATA of chocolate and honey.

<table>
<thead>
<tr>
<th></th>
<th>Baseline (no. of descriptors)</th>
<th>Follow-up (no. of descriptors)</th>
<th>Difference between no. of descriptors from baseline to follow-up (Wilcoxon signed rank test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate: analysis of CATA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of descriptors</td>
<td>6.6</td>
<td>7.7</td>
<td>$p = 0.0069^*$</td>
</tr>
<tr>
<td>Average quality of descriptors (points: 1 = overall category, 2 = subcategory, 3 = second subcategory)</td>
<td>15.1</td>
<td>17.1</td>
<td>$p = 0.051$</td>
</tr>
<tr>
<td>Honey: analysis of CATA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of descriptors</td>
<td>6.4</td>
<td>7.2</td>
<td>$p = 0.028^*$</td>
</tr>
<tr>
<td>Average quality of descriptors (points: 1 = overall category, 2 = subcategory, 3 = second subcategory)</td>
<td>14.5</td>
<td>17.1</td>
<td>$p = 0.062$</td>
</tr>
</tbody>
</table>

*Significance level: $p < 0.05$. 
number of intensity rating descriptions, hedonic words and unspecific terms was similar at baseline (0.55/individual) and follow-up (0.57/individual). Of these terms, 0.30 at baseline and 0.24 at follow-up were hedonic terms. Thus, there was a slight drop in the number of hedonic terms used to describe the foods, but overall, it appeared that participants did not improve their ability to discriminate actual descriptors from intensity rating descriptions and hedonic terms. Participants did, however, improve their vocabulary and ability to describe foods with more descriptors.

From baseline to follow-up the quality, measured as a score related to the specificity of the descriptors, increased very significantly \( (p = 10^{-36}) \). On average the quality of descriptors generated by the participants increased by 16.7 points from 8.0 points at baseline to 22.7 points at follow-up. This very large difference indicates a high learning outcome in this domain most likely as a consequence of the training in the five-module teaching programme.

Within the one-minute framework, which participants were given to describe each food, they generated a slightly larger number of descriptors, while at the same time they certainly became better at describing foods with specific and detailed descriptors. Participants evaluated different foods at baseline compared to follow-up, so descriptors generated in the baseline test were not suitable for reuse for characterizing the foods in the follow-up test. Participants consequently had to generate new descriptors at follow-up and the results therefore did not rely on memory from baseline but rather their learnt competencies in describing foods. Thus, the high increase in quality scores at follow-up clearly indicates improved vocabulary and skills in describing food attributes most likely due to the five-module teaching programme.

**Cluster analysis**

The explorative factor analysis indicated four latent constructs as displayed in Table 6 along with Cronbach alpha tests of reliability.

We considered the alpha values as acceptable based on general statistical quality criteria, which typically recommend values between 0.7 and 0.9, indicating that the constructed variables are reliable (Cho and Kim 2015; Streiner 2003; Tavakol and Dennick 2011).

### Table 5: Overview of results from the open description of olive oil, almonds, tomato sauce and crispbread.

<table>
<thead>
<tr>
<th>Analysis of descriptors generated (open description of products)</th>
<th>Baseline (score)</th>
<th>Follow-up (score)</th>
<th>Difference between baseline and follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of descriptors</td>
<td>7.4</td>
<td>9.0</td>
<td>( ^1p = 10^{-48} )</td>
</tr>
<tr>
<td>Average number of descriptors discarded (intensity rating descriptions, hedonic words and unspecific terms)</td>
<td>0.55</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Hedonic words</td>
<td>0.30</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Average quality of descriptors (points: 1 = overall category, 2 = subcategory, 3 = second subcategory)</td>
<td>8.0</td>
<td>22.7</td>
<td>( ^2p = 10^{-36} )</td>
</tr>
</tbody>
</table>

*Significance level: \( p < 0.05 \).

\(^1\) Wilcoxon rank test.

\(^2\) \( t \)-test.
Table 7 illustrates a table analysis containing some of the main themes investigated through survey and sensory test, which are tabulated with the constructed cluster variable. The coefficients are mean scores on a standardized scale for each theme.

The students in cluster 1 were characterized by having more sensory experience compared with the two other clusters. At the same time these students expressed the highest level of self-assessed need to improve their level of sensory proficiency. This means they were the ones that to the highest extent wanted to improve their sensory knowledge and skills. At the same time, they found the highest degree of use-value of sensory methods in their future work. They also performed best in the two sensory word tests. Paradoxically they on average progressed slightly negatively in the sensory test. A plausible explanation for this result could be that these students in general were very knowledgeable and skilful already in the baseline test and thereby it would be relatively more difficult to establish further progression in some of the test formats used in this study. The coefficients in cluster 1 illustrate characteristics of academically strong students. Even though they were experienced,

### Table 6: The four latent constructs and Cronbach alpha tests.

<table>
<thead>
<tr>
<th></th>
<th>No. of items</th>
<th>alpha</th>
<th>Baseline</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory experience</td>
<td>4</td>
<td>0.75</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Self-assessed proficiency needs</td>
<td>3</td>
<td>0.73</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Self-assessed use-value</td>
<td>2</td>
<td>0.70</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Self-assessed learning outcome</td>
<td>4</td>
<td>0.85</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

### Table 7: Student characteristic within the three clusters for the 64 students with no missing values in the data.

<table>
<thead>
<tr>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experienced, seeking more sensory skills</td>
<td>Clusters not clearly evident</td>
<td>Inexperienced, learnt much</td>
</tr>
<tr>
<td>Medium experience, disinterested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory experience</td>
<td>0.81</td>
<td>−0.70</td>
</tr>
<tr>
<td>Self-assessed proficiency needs</td>
<td>0.82</td>
<td>−0.04</td>
</tr>
<tr>
<td>Self-assessed use-value</td>
<td>0.46</td>
<td>0.40</td>
</tr>
<tr>
<td>Self-assessed learning outcome</td>
<td>0.51</td>
<td>0.37</td>
</tr>
<tr>
<td>Progression in sensory test</td>
<td>−0.11</td>
<td>0.95</td>
</tr>
<tr>
<td>Progression in number of words in test</td>
<td>0.69</td>
<td>0.49</td>
</tr>
<tr>
<td>Progression in quality of words in test</td>
<td>0.53</td>
<td>0.28</td>
</tr>
<tr>
<td>n</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>%</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>

N = 64; p = 0.001.
knowledgeable and skilful they still strived to become more proficient, which
the results show that they overall succeeded to be. In brief this cluster can be
named: experienced, seeking more sensory skills.

The students in cluster 2 were characterized by having the lowest degree
of sensory experience and compared to the other two groups, they on aver-
age had an intermediate self-assessed need to improve their level of sensory
proficiency. They assessed the use-value of sensory science high, and they had
the second highest self-assessed learning outcome and the second highest
progression in the two-word tests. This group of students also had the highest
level of progression in the sensory test. Hence this is a group of students with
learning potential, because they had little experience with sensory science but
viewed the subject as useful and worth learning about. This view correlates
positively with the students’ self-assessed learning outcome and their test-
based learning outcome results. In brief this cluster can be named: inexperi-
enced, learnt much. The students in cluster 3 are characterized by having an
intermediate level of sensory experience compared to the other two groups.
They viewed sensory science as having a low degree of use-value in their
future work, and they did not see a need to improve their sensory proficiency.
These negative views correlate with highly negative self-assessed learning
outcome and highly negative test scores. Hence this is a group of students,
which can be characterized as weak students with regards to sensory knowl-
dge and use of methods. They performed poorly in sensory tests, and they
self-assessed their sensory knowledge and skills low. In brief this cluster can
be named: medium experience, disinterested.

The members of clusters 2 and 3 share the traits that the students had
potential to learn much about sensory science, because both clusters of
students initially possessed a low or much lower degree of sensory experi-
ence compared to students in cluster 1. However, students in clusters 2 and
3 differed greatly regarding their views upon use-value and self-assessed
proficiency need. This difference indicates that if culinary students with learn-
ing potential in a sensory teaching programme are to progress, it is vital to
open their eyes to the usefulness and applicability of sensory science. For
more information about differentiated learning outcome due to the culinary
students’ engagement see Stovgaard et al. (forthcoming).

**General discussion of the results**

Across the different tasks, improvements were observed from baseline to
follow-up, albeit not significant in all domains. Outcomes from the sensory
knowledge test showed that participants became more aware of how
the senses contribute to the perception of foods as measured by signifi-
cantly higher knowledge scores after than before the five-module teach-
ing programme. But acquiring theoretical knowledge about the importance
and function of the senses in relation to foods does not necessary reflect
improved sensory skills, i.e. the ability to detect, discriminate and describe
does not necessarily follow the theoretical knowledge. Nevertheless, the
sensory skills tests also revealed significant improvements. Significant differ-
ences in intensity ratings of the curry powders (curry and curry spiked with
cinnamon, respectively) demonstrated that participants were able to detect
the dissimilarity in intensity, and to better perform a sensory intensity evalua-
tion using a scale. Similarly, participants were able to detect differences in the
taste of umami in cheeses matured for different time periods. Data from the CATA and open description task demonstrated that participants were able to identify significantly more descriptors related to the samples after completing the five-module teaching programme compared to baseline. However, the quality of the descriptors only improved significantly in the open description task and not in the CATA of chocolate and honey. This might partly be due to the structure of a CATA which contains a fixed vocabulary and does not allow descriptors to be generated freely, so the task may not be able to capture improvements in specificity of the descriptions. The outcome of the quantitative questions showed that not all students improved equally, and we identified three main clusters of student types. Some of the less proficient students experienced that the content was less relevant for their education and their outcome was lower. This demonstrates that although the five-module teaching programme was successful in improving culinary students’ sensory skills and knowledge, not all students’ interests and level of proficiency were matched.

Challenging the content of culinary arts educations has been done by other researchers in order to increase the creativity and critical thinking by culinary students (Deutsch 2018). Frøst et al. (2015) found that applying fast sensory methods in the work with culinary professionals is valuable in capturing and documenting sensory properties of foods and beverages.

Hu et al. (2016) completed a qualitative analysis of e.g. interviews, classroom observations and educators’ reflection notes combined with a consensual assessment technique (CAT) consisting of 70 items to assess students’ innovative performance after exposure to an innovative culinary competency curriculum (ICCC). They found that teaching students the ICCC significantly improved their innovative performance. By means of a similar study design and intervention Horng and Hu (2009) found that teaching culinary arts through an experimental curriculum in culinary creativity significantly improved students’ culinary creativity process and performance as measured by pre- and post-surveys. Supporting the findings of a positive learning outcome due to an intervention course targeted at chefs, Abdulsalam and Condralsky (2017) found that exposing apprentices to educational intervention lessons on protein and sodium led to improved knowledge as measured by a pre- and post-topic specific knowledge test instrument. Overall, in line with our study, results from other studies on teaching interventions within food and sensory science reveal significant effects on the learning outcome. Consequently, to improve culinary students’ sensory knowledge, skills and creativity, it is effective to include a course on sensory at the culinary arts schools.

CONCLUSION

In conclusion, integrating a five-module course on sensory science and methods into the culinary arts educations leads to significant improvement of culinary students’ sensory vocabulary, knowledge and skills. The improvement in knowledge scores due to the teaching programme was highly significant and cluster analysis revealed that the culinary students with the highest learning potential were those with relatively little sensory experience that also found it useful to learn about using your senses when cooking professionally. On the other hand, culinary students with the lowest learning potential were those who had little sensory experience and did not find sensory useful.
Very sensory-experienced culinary students had the highest learning outcome regarding sensory methods but regressed in sensory knowledge possibly because they were already knowledgeable within this field before participating in the five-module teaching programme. The improved learning outcome due to the five-module teaching programme is in line with findings in other studies on the outcome of sensory education e.g. the SAPERE sensory education (Jonsson et al. 2005; Reverdy 2011; Sepp and Höijer 2016).

Altogether, implementing a teaching programme on relevant sensory theory and methods during a culinary arts education results in good learning outcomes at a relatively low number of teaching sessions.

Future studies should investigate the outcome of execution of the teaching programme by the teachers that normally teach culinary arts. The current teaching programme was executed by specialists in sensory science and methods. It is relevant to evaluate if teaching done by less specialist culinary teachers is as effective as teaching done by experts within sensory science. Moreover, the teaching programme could beneficially be translated and adapted to culinary educations in other countries, and the learning outcome could be tested against the results found in Denmark to evaluate if the teaching programme is as effective in other countries. The teaching programme is available for free at https://www.smagforlivet.dk.

**FUNDING**

Creating the teaching materials on sensory science was supported in part by the University of Copenhagen, Department of Food Science and by the Nordea Foundation via a grant to the research and communication centre smag for Livet (Taste for Life).

**APPENDIX 1: THE TEN SENSORY KNOWLEDGE QUESTIONS AND THE MULTIPLE-CHOICE RESPONSE OPTIONS (ONLY ONE SHOULD BE INDICATED)**

<table>
<thead>
<tr>
<th>Question</th>
<th>Response options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is sensory science?</td>
<td>A. <em>The science of methods to evaluate food with the senses</em></td>
</tr>
<tr>
<td></td>
<td>B. The science of the physiology of the body</td>
</tr>
<tr>
<td></td>
<td>C. The science of kitchen techniques to improve the taste of food</td>
</tr>
<tr>
<td>2. Which combination of senses do we use both to evaluate food with?</td>
<td>A. Sense of taste/propiotation</td>
</tr>
<tr>
<td></td>
<td>B. Sense of smell/sense of balance</td>
</tr>
<tr>
<td></td>
<td>C. <em>Visual sense/sense of hearing</em></td>
</tr>
<tr>
<td>3. What is trigeminal stimulation?</td>
<td>A. That a food is experienced with three senses at the same time</td>
</tr>
<tr>
<td></td>
<td>B. <em>That something feels strong/sharp in the mouth</em></td>
</tr>
<tr>
<td></td>
<td>C. That the sight of something makes the mouth water</td>
</tr>
</tbody>
</table>

(Continued)
APPENDIX 1: (Continued)

<table>
<thead>
<tr>
<th>Question</th>
<th>Response options</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. What do ortho- and retronasal sensing relate to?</td>
<td>A. Smell</td>
</tr>
<tr>
<td></td>
<td>B. Taste</td>
</tr>
<tr>
<td></td>
<td>C. Texture</td>
</tr>
<tr>
<td>5. What does it mean that something is astringent?</td>
<td>A. That it has a sour taste</td>
</tr>
<tr>
<td></td>
<td>B. That it gives a rough and puckering mouthfeel</td>
</tr>
<tr>
<td></td>
<td>C. That it is bitter</td>
</tr>
<tr>
<td>6. Where do the different basic tastes on the tongue taste?</td>
<td>A. On the whole tongue</td>
</tr>
<tr>
<td></td>
<td>B. On certain areas of the tongue – sweet and salty in front of the tongue</td>
</tr>
<tr>
<td></td>
<td>C. On certain areas of the tongue – sour, bitter and umami in front of the tongue</td>
</tr>
<tr>
<td>7. Which of the following is basic taste</td>
<td>A. Astringent</td>
</tr>
<tr>
<td></td>
<td>B. Umami</td>
</tr>
<tr>
<td></td>
<td>C. Strong</td>
</tr>
<tr>
<td>8. What can you use a sensory vocabulary for?</td>
<td>A. Development and evaluation of dishes</td>
</tr>
<tr>
<td></td>
<td>B. Development of dishes with a focus on hygiene</td>
</tr>
<tr>
<td></td>
<td>C. Making nutrition declarations</td>
</tr>
<tr>
<td>9. In what contexts can sensory evaluation methods be used?</td>
<td>A. When making nutrition declarations</td>
</tr>
<tr>
<td></td>
<td>B. When developing dishes</td>
</tr>
<tr>
<td></td>
<td>C. When evaluating guest service</td>
</tr>
<tr>
<td>10. What can criteria, in the style of Klosse’s culinary success factors be used for in the development of a new dish?</td>
<td>A. Guidelines for a balanced menu</td>
</tr>
<tr>
<td></td>
<td>B. To make all dishes taste the same</td>
</tr>
<tr>
<td></td>
<td>C. To learn how to make a dish you have not made before</td>
</tr>
</tbody>
</table>

Each response option also included the ‘I don’t know’ option (not listed). Correct answer is in italics.

REFERENCES


Lexicon, College Station, TX: World Coffee Research and Kansas State University.


SUGGESTED CITATION

Damsbo-Svendsen, Marie, Menadeva Karpantschof, Bat-El, Stovgaard, Mikkel, Christensen, Jacob Højgaard and Frost, Michael Bom (2022), ‘Effects on skills and knowledge of a sensory teaching program for culinary students’, International Journal of Food Design, 7:2, pp. 119–41, https://doi.org/10.1386/ijfd_00041_1

CONTRIBUTOR DETAILS

Marie Damsbo-Svendsen is assistant professor in health and nutrition at University College of Copenhagen. Through her work in Smag for Livet as research assistant at the Section for Design and Consumer Behaviour, Department of Food Science at the University of Copenhagen she has been doing research on sensory science, food choice, acceptance and neophobia. Her latest research concerned if teaching sensory science at culinary arts schools lead to improvement of practitioners’ ability to taste and evaluate foods. Her current focus is on teaching sensory science, chemical and functional properties of foods and product development.

Contact: Department of Nursing and Nutrition Education, University College Copenhagen, Campus Sigurdsgade, Sigurdsgade 26, DK-2200 København N, Denmark.

E-mail: mdsv@kp.dk

https://orcid.org/0000-0002-6357-7873

Bat-El Menadeva Karpantschof is assistant professor in health and nutrition at University College Absalon. From 2015 to 2021 Bat-El worked in Smag for Livet as a research assistant and project manager at the Section for Design and Consumer Behaviour, Department of Food Science at the University of Copenhagen. She has taught and developed teaching materials on sensory science for a range of audiences, amongst others for primary schools and for university courses. Her latest research focused on the impact of teaching sensory science in the Culinary Arts programme in Denmark.
Mikkel Stovgaard is associate professor at the Danish School of Education, Aarhus University. Mikkel holds a Ph.D. within the field of general didactics and empirical school research. His research includes evidence-informed teaching, targeted teaching, taste didactics in different educational settings, motivational theory and the effectiveness of educational programmes, with a particular interest in students’ motivation, well-being and learning processes in various pedagogical practices. His research is primarily empirically based and methodologically, he focuses on the development of mixed methods research and integration processes, among others.

Contact: Danish School of Education, Aarhus University, Tuborgvej 164, DK-2400 København NV, Denmark.
E-mail: stovgaard@edu.au.dk

https://orcid.org/0000-0002-6229-2307

Jacob Højgaard Christensen holds a Ph.D. in didactics, and currently he is working as a school researcher at Aarhus University, Denmark, where he also functions as vice centre director of the Danish National Centre for School Research. His expertise is within the fields of health pedagogy, food education and well-being in primary to upper-secondary school. He has researched the effectiveness of teaching plans and didactic programmes with a view to developing and improving learning environments and teaching practices.

Contact: Danish School of Education, Aarhus University, Tuborgvej 164, DK-2400 København NV, Denmark.
E-mail: jach@edu.au.dk

https://orcid.org/0000-0002-9835-4522

Michael Bom Frøst works in the Section for Design and Consumer Behaviour, Department of Food Science at University of Copenhagen as an associate professor in Food Sensory Innovation. In his work in Smag for Livet, he has carried out research in the area of sensory acceptance, learning sensory skills, food neophobia and sensory properties of underutilized ingredients. His main research interest is how we balance sensory, functional and reflective input in our appreciation of foods. He develops and applies sensory methods to real-world settings, to empower food innovators to develop foods under constraints.

Contact: Department of Food Science, Design and Consumer Behaviour, Taste for Life, University of Copenhagen, Rolighedsvej 26, 5, DK-1958 Frederiksberg, Denmark.
E-mail: mbf@food.ku.dk
https://orcid.org/0000-0002-0854-960X

Marie Damsbo-Svendsen, Bat-El Menadeva Karpantschof, Mikkel Stovgaard, Jacob Højgaard Christensen and Michael Bom Frøst have asserted their right under the Copyright, Designs and Patents Act, 1988, to be identified as the authors of this work in the format that was submitted to Intellect Ltd.