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The use of sensory evaluation techniques in food product development at key stages 3 & 4 of design & technology

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Abstract
The use of a range of technical, symbolic and other means of representation for sensory evaluation contributes to high quality product development in the Food industry. Use of sensory evaluation techniques adapted from industrial practice would contribute to pupils' achievement of higher levels of attainment particularly in Attainment target 3: Planning & Making. Existing educational resources for such techniques are reviewed in the context of recent industrial developments in sensory evaluation. The author's resource pack, based on recent industrial developments, is described. Trialling with two teacher groups of the resource pack will be reported on in the Autumn of 1994.

This paper identifies:
- the use of a range of technical, symbolic and other means of representation for sensory evaluation which contribute to high quality product development in the Food industry;
- surveys existing resources for school based Food work which use such a range of representation for sensory evaluation;
- and reports on the initial development of a resource pack to support the use of sensory evaluation in schools.

The expectation on all teachers to ensure that what they teach of their subject is progressively more intellectually challenging for their pupils is now, however critical one may be of the format, codified within Statutory Orders.

For teachers of Design & Technology this requirement has also been linked to the need to use contexts for their teaching which may extend well beyond their own personal or educational experiences, particularly experience in business and industry.

Examples of higher levels from the Statutory Orders relevant to this paper for Attainment target 3 Planning & Making are:

Level 7c) use a range of technical, symbolic and other means of representation to assist in planning, organising, making and incorporating necessary modifications.

Level 10b) review the design proposal during planning and making and show resourcefulness and adaptability in modifying the design in the light of constraints to make a high quality product.

The rapidity of implementation of D&T has left little opportunity for teachers to agree on what `range of technical, symbolic and other means of representation' may be drawn on by pupils in the making of `a high quality product' in their specialist material. The resources and in–service development needed for such work has also been limited as has the opportunity to explore recent developments in the industries associated with teachers' specialist materials.

A good example of the resulting problems in relation to food is the SAT's task for key stage 3 Food DFE which showed restricted, indeed inappropriate, assessment criteria using a range of representation, scale drawing. Assessment Criteria Te2: Generating a Design. A scale drawing of a food product will not contribute to ensuring 'high–quality' unless scale drawings is one of the range of representations regarded as relevant within the food industry.

Sensory evaluation is highly relevant to the food industry.

Product development in the Food Industry
Within the UK, as in all industrialised societies, food companies need to ensure that they develop products that are appropriate for increasingly sophisticated consumer markets to whom the flavour of food and drink is important. Sensory evaluation is used in a number of ways to ensure that a company's products maintain or increase their market or, if new, will be acceptable to that market.

The use of Sensory Evaluation in the Food Industry
Sensory evaluation, as it is used with consumers, depends upon the human ability to assess a product.
both through the physiological stimuli made to the senses and the psychological stimuli of the individual's sociocultural context.

It is rare that a product, particularly food and drink, stimulates only one sense. Assessment of food and drink depends mainly on responses to taste, smell and pain (trigeminal nerve response), triggered by chemical receptor cells in the mouth and nasal cavity. These combined responses, referred to as flavour, are triggered by sight, sound and touch; and are affected by both the mouth– feel and afferent response of food and drink.

Sensory evaluation techniques have changed considerably in the 50 years in which they have been used and are now based on BS5929\(^3\). McBride & MacFie \(^4\) provide a good overview of these developments.

The range of technical tests used in Sensory Evaluation

A whole range of technical tests on foodstuffs are laboratory based and depend upon the objective assessment of physical units such as pH levels or total solids and are used for monitoring shelf–life, flavour stability, grade standards, etc. However technical tests have yet to be developed which can replace the specialist assessor, eg. of wine or tea. Such individuals combine a sensitive palate with long experience in their field and can thus pick–up the subtleties of sensory characteristics which combine to give flavour.

Unlike the specialist taster most individuals responses to a product are highly subjective and based on what they as an individual like. Market research is therefore about consumer reaction to a product rather than the actual product itself. Traditionally tests to identify acceptability of a product or preference for one of a range of products are used. Scaling (hedonic) tests to express the degree of like/dislike increase the opportunities for identifying why products are acceptable/preferred. Descriptive language, unless provided for tasters, is not relied on as it is both variable between individuals and skewed in favour of negative comments. What we like we are not inclined to describe with any degree of precision!

Most recently, product profiling has developed which enables consumers' preferences to be identified at much earlier stages of product formulation. Now technical product evaluations and consumer response to products are integrated in order to identify the characteristics of the product to be developed. Much of this type of work is done via consumer focus groups.

Survey of existing Resources for school based Sensory work

At secondary school level the theory of nutrition and the science of ingredient interaction have always underpinned the practically based food work, but the sensory qualities of food were rarely referred to beyond the immediate response to actual food presentation.

Certainly the forms of representation inherent in sensory evaluation, or supporting the study of the physiology of the senses was rarely evident.

The link between the physiology of the senses and taste of food is evident in more detail at primary level, Barrett \(^5\) than in secondary resources. Most recently Parker \(^6\) provides for pupils at Key Stage 2 more detailed information on the physiology of the senses and the link to food than is given in recent publications for D&T Food at secondary level.

In resources for secondary level where reference has been made to the senses it is usually to the four primary tastes: sweet, salt, sour and bitter. The information given is simple, far simpler than Parker \(^6\) gives, and can be seen in texts of very different dates. Hagequist et. al. \(^7\) in 1982 and Ridgewell \(^8\) in 1993 give quite detailed tongue maps as a means of relating physiology to sensory evaluation. Tests for sensitivity to primary tastes are used in industry to select specialist taste panel members by eliminating those individuals not able, physiologically, to distinguish sufficiently finely between the four tastes.

Physiological sensitivity, nor indeed the normal inability of younger children to distinguish between primary tastes, is not mentioned in school resources and yet quite detailed investigations of primary tastes are sometimes given, BSI \(^9\) and most recently Ridgewell \(^8\). Generally reference to physiological–sensory links in secondary school food resources are limited in number and inadequate in detail to ensure real understanding is developed. What is evident, in school resources from the early '60s on, is a tradition of tasting samples of a specific food. The usual example, varieties of cheeses, were selected for their distinctiveness and little was done to use responders' results to formulate the characteristics of a 'most liked' cheese something which might well be the purpose of such sampling in industry.

Wynn \(^10\) included a results chart for cheese tasting which is one of the few examples of a text which does identify sensory characteristics. These are linked in the table with the earlier tradition of such work of looking at origin and cost of the food.
Reynolds and Wallis (11) follow a similar and familiar format of comparing different means of providing a food product: tinned, packaged or home–made soup; or bread mix, frozen or home–made bread but they offer no sensory characteristics for comparison.

These resources overlap in time with Riddell et. al. (12) who devote a whole chapter to the discussion of, and testing for, sensory characteristics of food. Whilst it is clear from this chapter that information has been drawn from the food industry the idea that food products are developed, in part, by such methods is not made clear.

Tull (13) under `Designing food' briefly outlines what food manufacturers do including sensory evaluation. This resource is one of the first to make the real shift away from the long tradition of looking at food as a home–produced commodity. The book does not however provide any detail of how sensory evaluation is undertaken in industry or how it might be implemented in schools. The Tesco pack (14) and Ridgwell (8) both provide richer resourcing which include examples of sensory techniques for use with pupils. Neither text sufficiently informs teachers about the principles of sensory evaluation as used in industry so that they can progressively develop pupil awareness of principles and skill in the use of techniques.

With the exception of BSI (9), the concept of rating and ranking scales fundamental to sensory evaluation, was not evident in resources until Tull (13) gave a simple scoring technique based on individuals' opinions of food characteristics.

Until the Tesco (14) and Ridgwell (8) resources, the only educational resource available specifically for Sensory Evaluation was produced by the Education Section of BSI in conjunction with J Sainsbury PLC in 1983 (9). It was designed for teachers of Food and trainees in the Food Industry. This is now dated because of developments in sensory evaluation techniques but it did illustrate both the range and types of tests used and related these to the industrial/marketing context. It was however difficult to use and was rarely seen in schools except for A–level work.

The great merit of the BSI pack compared with all the others is that it both provides rigorous procedures and identifies why such procedures should be used. Such an approach contributes to ensuring that pupils achieve quality outcomes of increasing sophistication within a real world context.

Development of a Resource Pack for Sensory Evaluation

A pack designed to enable teachers to develop pupil understanding of quality assessment and control and to provide specific techniques for sensory evaluation has been developed and the first draft made available to two groups of teachers for trialling and comment.

The pack draws on procedures for sensory evaluation developed for the assessment of food, drink and domestic products and should enable pupils to:

- understand principles of quantitative and qualitative evaluation behind sound Food product development;
- recognise how these principles apply to all work within D&T;
- experience using both qualitative and quantitative procedures in evaluating food products;
- be able to apply these procedures to their own product development.

The pack provides background information and photocopiable teacher resource sheets based on techniques developed for use in the food industry. It is designed to progressively develop pupils' experience of:

- sensory characteristics of food;
- simple one–sense tests;
- a range of statistical tests;
- techniques for product evaluation and development.

Whilst it is anticipated that the pack would be most useful at Key Stages 3 & 4, early trialling indicated that initial sections may be appropriate for use at Key Stage 2 whilst the later sections would be of use with pupils on vocational courses.

The four sections of the pack cover:

Section 1 The physiological and psychological basis of sensory evaluation
Section 2 The use of sensory evaluation techniques
Section 3 The use of statistical techniques
Section 4 Product evaluation and development

Section 1

The physiological and psychological basis of sensory evaluation provides background material which outlines both the biological basis of sensory responses and the impact that sociocultural factors...
have on our sensory responses. There are rich sources of sociocultural and sensory responses to food and drink in art, film, literature and history as well as in books about food and drink. These, sadly, never appear to be referred to in resources for the teaching of food.

Section 2
The use of sensory evaluation techniques begins with simple one–sense tests and then looks at how these combine with mouth–feel and aftertaste to give flavour.

Section 3
Statistical tests are only used in the food industry in contexts where sufficient control can be exercised over the range of physical, psychological and social variables which normally shape individuals' sensory responses. Setting up a controlled environment and training sensory assessors, even at a simple level, is difficult within schools but worth while. It introduces pupils to the concepts fundamental to testing:

- selection of the appropriate statistical test;
- control of test conditions;
- consistent administration of the test;
- determining the confidence level of the test;
- interpretation of the test results.

This enables pupils to justify their product development and evaluation with some rigour rather than vague generalisations.

Section 4
Product evaluation occurs not only at the end of product development but in order to identify the characteristics of a product as it is being developed, the product profile. Consumer responses to products inform technical product evaluations through requiring consumers both to describe their preference and explain why it is preferred. Product profiling sheets, of which there are many in–house company versions, are used to record and collate consumer responses. Much of this type of work is done in consumer focus groups.

It is essential before beginning product profiling with pupils that they understand which sensory characteristics it might be appropriate to profile for a product. Presenting consumer focus groups of pupils with a product likely to be unfamiliar but reasonably acceptable, eg. Pumpernickel, is a useful way to enable them to consider how to setup evaluations for their own product development.

Provision of a range of techniques for recording a product profile and the statistical tests for recording consumer acceptability will enable pupils to use an appropriate ‘range of technical, symbolic and other means of representation’ DES (1) to support their development of a quality food product.

Initial use of the resource pack with teachers
Teachers of Food in D&T from 25 schools in two local authorities have agreed to use the resource pack after an initial ‘twilight’ 2 hour workshop introduction to it.

They completed a questionnaire to identify both their own personal/educational experience of Food product development and the opportunities they had had for in–service development or development of resources.

An evaluation of this questionnaire and a survey of the use of the draft resource pack will be undertaken in the autumn of 1994.

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