Teaching Argumentation and Inquiry through Culinary Claims

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Introduction
The present chapter is an adapted version of a previously published article (Fooladi, 2013a) and places itself in the field of science- and cross-curricular education research, also including culinary education. A research-based teaching approach has been developed, tested and refined over a five-year period in tertiary education in a mixed group of 20–35 undergraduate students (each year) from science teacher and home economics courses. Taking its departure from perspectives in molecular gastronomy, it has sought and met some major challenges in (science and cross-curricular) education. These challenges include argumentation skills, inquiry in scientific and everyday contexts, and source awareness and critical thinking. This is predominantly framed in theoretical and empirical perspectives from science education research. Thus, it is sought to draw benefits from both science education research, a field where culinary practices are not visibly present, and molecular gastronomy, where educational research has thus far not been strongly present.

Background
Argumentation, Inquiry and Socio-Scientific Issues in Education
Within the international science education community and among policy makers, the development of quality teaching methods to promote scientific literacy, focusing not only on what we know but also on how we know and why we do so, has been defined as a major challenge (e.g., Driver et al., 2000; Osborne and Millar, 1998; Roccard et al., 2007). Consequently, recent years have seen an increasing amount of research and educational material/resources focusing on the promotion of various cognitive skills in science education, such as talking, reading and writing science (Fang et al., 2010; Wellington and Osborne, 2001) as well as the development of students’ competencies in reasoning and argumentation (Driver et al., 2000; Duschl and Osborne, 2002; Erduran and Jiménez-Alexandere, 2008; Osborne et al., 2004). Science content knowledge, argumentation and inquiry do not exist in a vacuum but are inherent parts of society. Thus, science teaching that takes into consideration science as a societal phenomenon has been promoted for achieving an education that can be experienced as relevant to learners’ own lives (Sadler, 2009; Aikenhead, 2006). Consequently, we need some rationalization for how science relates to society, and one model was described by Roberts and Gott (2010), as illustrated in Figure 95.1. The model consists of three segments: design and conduct of experiments, or second-hand inquiry into findings by others, to produce evidence (left-hand side); argumentation to generate a claim based on this evidence (middle); and the claim as a factor in a socio-scientific issue or decision to be made in an everyday situation (right-hand side).

According to the same authors, one might envision that a researcher would mainly work from left to right in this model, “looking forwards”, whereas the perspective of a scientifically literate person/citizen would be to work from right to left (“looking back”), to retrace the evidence for a given claim related to a societal or “everyday” issue. In the work described herein, this model is employed to demonstrate that starting from claims/specifications about cooking (culinary claims; see later), one may deal with all these three aspects of science in society in a context that is close to learners’ everyday lives (on the issue of “context” in science education, see e.g. Gilbert et al., 2011). Herein, this context is given through relevant content from culinary practices, namely, claims and specifications about cooking. Culinary practices can be seen to draw their knowledge, procedures and ways of thinking from two different spheres: on the one hand, natural sciences (e.g., food science, health and nutrition) and on the other hand, the practical craftsmanship of cooking, which is characterized by experiential knowledge communicated orally or through written recipes (Sutton, 2006). As a result, and as will be demonstrated below, culinary practices may offer fruitful contexts for teaching, concerning not only declarative content knowledge (a subject’s “facts”) but also scientific methods and ways of thinking.

Toulmin’s Argumentation Pattern (TAP) and Education
Throughout the last three to four decades, science education researchers have seen the importance of discourse in science learning, and there appears to be consensus that argumentation is a form of discourse that needs to be taught explicitly through suitable instruction (Erduran et al., 2004). Simply observing or being part of a discussion is not sufficient, and the learner...
needs to be engaged in a meta-discussion about argumentative practices for such instruction to be effective. Consequently, researchers have sought heuristics and tools to deal with these issues. In educational research, Toulmin’s argumentation pattern (“TAP”) developed by the British philosopher Stephen Toulmin as a tool/heuristic within informal reasoning (Toulmin, 1958/2003), has gained a foothold as an analytical tool for researchers studying argumentative discourse among learners (Erduran et al., 2004; Jimenez-Aleixandre et al., 2000; Zohar and Nemet, 2002). The essential parts of an argument according to Toulmin are often displayed schematically, as in Figure 95.2, and are:

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<tr>
<th>Description</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Claim</td>
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<tr>
<td>Data/facts</td>
<td>D</td>
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<td>Warrant</td>
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<td>Qualifier</td>
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<td>Rebuttal</td>
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Revisiting Figure 95.1 (middle part), it is seen that this is exactly what is used as the link between the left-hand and right-hand sides in the model by Roberts and Gott (2010). TAP can form a bridge between, on the one hand, science content knowledge and experiment, and on the other hand, a socio-scientific issue.

In some cases, TAP has also been used in the explicit teaching of argumentation, as a tool for teachers to gain an increased understanding of discourse in their own classroom (Osborne et al., 2004) and the epistemic nature of their own discipline (Simon et al., 2006). It has also been introduced directly to 12–13-year-old school pupils as part of nature-of-science and science literacy topics (Simon et al., 2006). In Osborne and coworkers’ words: “the use of these features of TAP offers teachers a richer metalanguage for talking about science and for understanding the nature of their own discipline” (Osborne et al., 2004). Here, the authors refer to the detailed elements of Toulmin’s pattern (see Figure 95.2) as opposed to the more general/less specific terms “ideas” (claims) and “evidence” (data, warrants, etc.). Hence, TAP allows the instruction of argumentation in a way that explicates the rhetorical elements of an argument as it is commonly used in natural settings (Driver et al., 2000; Toulmin, 1958/2003).
Teaching Argumentation and Inquiry

The “Kitchen Stories” Project

In 2009, a project was started at Volda University College to approach inquiry and argumentation in a more explicit manner than previously for undergraduate pre-service teacher students in science and home economics. The project, named “Kitchen stories”, drew inspiration from molecular gastronomy and used what This (2005) has termed “culinary precisions” as an approach to teaching argumentation and inquiry. Such culinary precisions can, in the context of informal reasoning, be considered as claims, and thus, the term “culinary claims” is used herein. Culinary claims can be defined as “the technical or procedural information present in a recipe (oral or written), which provides added value in terms of improved quality and greater chance of a successful product” (Fooladi and Hopia, 2013, 2). Examples are:

- You can’t make jelly containing fresh kiwi because then the jelly will not set.
- Cucumbers decay/rot more quickly if stored together with tomatoes.
- Leavened bakery will rise more if baked at high (flow) tide compared with ebb tide.

The research design of the project draws inspiration from design-based research in which a research-based teaching sequence is designed, implemented and analysed (Cobb, 2001; Edelson, 2002; Juuti and Lavonen, 2006). Throughout the process, data is collected by various means such as observation, interview, student text analysis and tests/questionnaires. The teaching sequence is then revised (re-designed), another cycle is conducted, and so forth. In the process, data is also collected to shed light on selected educational issues, thus at the same time producing research-based knowledge about teaching and learning.

Practical Approach in the “Kitchen Stories” Project

The concrete approach to culinary claims used in teaching pre-service teacher students in this project is as follows:

First phase (2–3 weeks’ duration, part-time)

Step 1 – Collect and document culinary claims

The students can find culinary claims by interviewing family, professionals (e.g. chef, supermarket employee, artisan, etc.) or others; they can search in literature and cookbooks, food pages on the internet and so forth. The source of each culinary claim must be documented and situated in space and time: where it was found, when it was published or stated. Each student must collect at least four culinary claims. The students must also decide whether it would be possible to test the claim through experiment.

Step 2 – Analyse and construct plausible arguments for a few selected claims

The group selects one claim for each group member for closer analysis: What is the actual claim? What subject matter or evidence is hidden behind this claim? Are there facts and justifications that support, weaken or contradict the claim? Here, TAP is introduced for explicit teaching of argumentation, and students are required to apply it when structuring their argument. The constructed argument need not be true per se, but it should be coherent and plausible when placing oneself in the shoes of the source of the claim. Indeed, retracing someone’s argument to uncover erroneous facts would be to uncover a myth, and in those cases, students would be asked to give a colour code to the element in the TAP that was (expectedly) not correct.

Second phase (2–3 weeks’ duration, part-time)

Step 3 – Test/experiment analysed claims

Each group selects one or two of the analysed claims for experimental testing. Based on their prior analysis, the experiment must be designed in detail and carried out accordingly.

Step 4 – Record and publish results, documentation of cultural heritage

The students must record and publish the culinary claims, analyses and experimental results, thus disseminating knowledge of scientific and/or food cultural nature. A culinary claim handed down orally can in some cases be experiential knowledge that would otherwise have been lost unless the students had collected it. This was done by publication in a wiki.

Case Example: You Can’t Make Jelly Containing Fresh Kiwi

Below follows a description of how a group of four pre-service science teacher students carried out part of their project based on the structure given in the previous section. The sample is taken from the first design cycle, which was carried out in 2009. Note that this might be adapted to different educational levels as long as modifications are made to suit age group, availability of equipment and so forth, one example being Vartiainen et al. (2011), who have described the use of culinary claims as an approach to inquiry in lower secondary school.

First phase (3 weeks)

Step 1 – Collection and documentation: The group collected 18 culinary claims from various sources. The claims were listed in a document together with their respective sources. Among these, four were selected as promising candidates for close analysis (claims that are difficult to test due to methodological obstacles or lack of resources are usually ruled out, such as health claims, traditional rules for slaughtering animals, time-of-year-dependent claims and so forth).

Step 2 – Analysis: The students attended lectures about argumentation, including an introduction to Toulmin’s argumentation pattern. The students had to collect data/facts, warrants/reasons, rebuttals, etc. and construct a complete and plausible, though not necessarily correct, argument; see Figure 95.3.

Second phase (3 weeks)

Step 3 – Experiment: Through the data collection process and argumentation, the students decided that the claim about kiwi in jelly was also suitable for experimental testing. The hypothesis was: the jelly does not set because protease enzymes in fresh kiwi
break down the gelatine proteins in jelly. Since enzymes lose their functionality when heated, blanching the kiwi might render the protease enzymes inactive, and hence, the jelly would set properly. Furthermore, there were at the time two sorts of jelly available in grocery shops: standard jelly based on gelatine (a protein) and “fast-setting jelly” based on locust bean gum (a carbohydrate). If the problem is due to proteases in kiwi, which are specific for degrading proteins, the jelly should set properly when using the carbohydrate-based jelly. Figure 95.4 elegantly demonstrates how the different parallel experiments shed light upon this argument.

**Results and Discussion**

**Research Questions, Observations, Preliminary Results and Discussion**

Some research questions from this educational project have been:

- To what extent is it possible to consider culinary claims as parts of formal arguments, seen from an epistemic or argumentation theoretical perspective?
- Can culinary claims be used as an approach to teaching about argumentation?
- To what extent is TAP a suitable tool in dealing with culinary claims, be it educational or as a heuristic in structuring kitchen stories as arguments?
- In what sense can culinary claims be used to promote inquiry activities in science and culinary contexts (herein, the school subject home economics)?
- Which other relevant topics, if any, appear in the process of collecting and exploring culinary claims?

Initial results and the accompanying discussion are based on systematic observations, evaluation of student assignments, and field notes during design, implementation and revision of the teaching sequences.

**Culinary Claims, TAP and Argumentation Instruction**

Through the project, it is evident that it is possible to use TAP in the exploration of culinary claims, consequently supporting the hypothesis that it is possible to construct formal arguments...
based on culinary claims. Although the students reported it to be intellectually demanding, they were able to use this tool for structuring arguments, and all groups were ultimately successful in producing coherent arguments, even though TAP is said to be difficult to apply in analysis of real-life verbal data (Erduran et al., 2004). However, as opposed to verbal data, “Kitchen stories” deals with arguments of a different kind and might thus be an arena where TAP is easier to apply, with a positive contribution to argument analysis. In the study of existing verbal data, TAP is used to deconstruct an argument (Erduran et al., 2004), whereas the role of TAP in “Kitchen stories” is to structure or construct an argument. The student groups involved in this project have been mixed groups with respect to subject as well as academic achievement levels. However, all groups were able to construct TAPs, but lower-achieving students required more guidance than high-achieving students (groups received one or two sessions of supervision for each phase). A challenge arising in this context is that one single culinary claim might have different sets of facts, warrants, rebuttals and so forth. Consequently, to dig deep into a culinary claim, one might either build several TAPs or produce one rather complex TAP.

Promoting Minds-On as Well as Hands-On Practical Work

Often, practical work (e.g. lab work) is carried out simply to confirm textbook content rather than inquire into authentic questions. Furthermore, a common problem is lack of coherence between, on the one hand, the practical work/experiments and, on the other hand, content knowledge, scientific methods and scientific ways of thinking (Abrahams and Millar, 2008). However, achieving high-quality minds-on practical instruction is not straightforward. In the “Kitchen stories” project, the traditional pattern is turned upside down, because the students spend a lot of time asking questions, discussing, searching and conducting second-hand inquiry (Palincsar and Magnusson, 2001) before the actual experiment is planned and conducted. Hence, the occurrence of genuine “minds-on experimenting” seems to be predominant. No group (a total of 26 groups throughout four implementations) had problems finding researchable questions among the culinary claims they collected. This may be a result of the requirement for each group to collect a large number of culinary claims to select from in later stages.

Using TAP seems to scaffold the students’ inquiry in a positive manner, and they apparently adopt a shared lexicon and structure of argumentative reasoning, which was one of the main aims of the project. Notably, when students were offered the hypothetico-deductive method as alternative support, they reported that TAP and the IMRaD structure combined was a sufficient scaffold to carry out their project. (The hypothetico-deductive method, HDM, is a model much used to display the process of scientific inquiry, occasionally described as “the scientific method”. It is also commonly used to scaffold inquiry teaching.) The products of the students’ work, as assessed by the lecturer, support this notion.

Epistemic Status: Source Awareness, Sourcing Skills and Critical Thinking

In the last decades, awareness and evaluation skills related to trustworthiness and credibility of information sources have become increasingly important among both experts and the non-expert members of society (e.g. Brätén et al., 2011; Norris and Phillips, 1994; Wellington and Osborne, 2001). We are constantly bombarded with large amounts of information and statements, often of competing nature, which standard textbooks seldom provide help in dealing with. In the “Kitchen stories” project, the students naturally used a broad selection of information sources in addition to course textbooks. After the first round of implementation, it became evident that source awareness was an important matter to consider, and this was one of two major revisions in the design between the first and second cycles. Hence, a source credibility step was introduced, in which the students were to rate every source they used on one of two scales (Fooladi, 2013b).

If the students considered a source to be of scientific nature, they were to rate it on a six-point scale between 1 (lowest, e.g. “internet with no other references”, “otherwise undocumented old wives’ tale”) and 6 (highest, e.g. “scientific literature on international level”). However, the source could also be a (more or less experienced) crafts person, in which case rating on a scale of scientific credibility might not be appropriate. These sources were rated on a scale from A (lowest, no relevant experience) to F (highest, e.g. an expert chef or artisan); see Figure 95.5.

In evaluating the sources, the students themselves had to choose whether a source should be rated on the scientific or the craftsmanship scale, or both. The students also had to rate their own experiments on one of these scales, since their experimental results often constituted a part of the final argument. Hence, a byproduct of the “Kitchen stories” project has been not only an increased focus on a wider selection of information sources, but also a strong emphasis on epistemic status of information, an increasingly important topic in education in recent decades. The context afforded by cooking is unique in this respect, since it represents a meeting point between science and craftsmanship. As students were asked to rate their own experiments, self-monitoring and self-evaluation became a natural part of the project, which is considered a high-hanging goal in education (for a seminal article, see Sadler, 1989).

Kitchen Stories and Declarative Knowledge

One potential problem in this project is that the teacher has limited control over which declarative knowledge (factual/textbook-type knowledge) is covered, at least if the students select freely among the collected claims. However, Vartiainen et al. (2011) have shown that relevant chemistry topics do arise naturally in the process, as was also observed in this project. Hence, “Kitchen stories” affords ample opportunities for teaching declarative knowledge in addition to the mentioned procedural knowledge and reasoning, albeit less control over the actual content covered. If high control over declarative knowledge is required, working from predefined claims or delimiting the areas from which
claims may be collected (e.g., only claims about meat or proteins allowed) would be options to consider.

**Conclusions**

Reconsidering Roberts and Gott’s (2010) model of science in society (Figure 95.1), in “Kitchen stories”, the participants start out by looking back (from the societal perspective), retracing, or “unpicking”, possible arguments for a certain claim, taking the role of an inquisitive cook or food professional. The students must then assume the role of the researcher and start “looking forward”: based on their constructed argument, they must draw up an experimental design, carry out the experiment and move all the way to the right-hand side through a coherent argument, ending up with a publication related to the societal issue at hand (Figure 95.6).
Through this process, the students have encountered real-world questions, dealt with argumentation in an explicit manner, designed and carried out one or more experiments, documented results based on evidence from their own experiment as well as second-hand sources in an argumentative manner, and finally conveyed their findings to the public. Furthermore, the students are part of a project in which data is collected for the common good of society by documenting culinary knowledge/heritage; in a sense, they assume the role of true researchers and not only students.

**Outlook**

One matter that would benefit from further studies is the epistemic aspects of this multidisciplinary setting. The possible tension between, and the possibilities afforded by, scientific knowledge and methods, on the one hand, and the epistemic characteristics and values of experience-based food and cooking (craftsmanship), on the other hand, represents a highly relevant issue when seen in the context of science in society. The fact that science is in constant change and development is often overlooked in school science (Abd-El-Khalick and Lederman, 2000; Vesterinen et al., 2009). In dealing with culinary claims, science does not always have the one true answer or may not yet have investigated all relevant issues. Thus, the “Kitchen stories” approach, or more generally using culinary claims at various educational levels as well as in informal contexts, is one avenue to approach this. Other examples of efforts to use culinary claims for learning and development exist, from compulsory education to lifelong learning in non-formal contexts, such as in France (This, 2019), in Finland (Vartiainen et al., 2011) and in Finland/Norway (Fooladi and Hopia, 2014). However, educational research on the matter is still scarce. Furthermore, it would be no exaggeration to say that culinary claims constitute a promising arena for the interaction between science and society (Fooladi and Hopia, 2013), and future efforts should be welcomed.

**REFERENCES**


