The Icing on the Communication: 
Text or Video?

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Abstract

Learning is lifelong, life-wide and life-deep (Tal & Dierking, 2014) and whilst science is everywhere, opportunities for scientific learning are missed every day. However, when it comes to learning, the learner must be intrinsically motivated and interested in the subject matter to result in information gain. The present thesis focuses on learning through the typical home activity of baking. Participants were randomly assigned a recipe for either chocolate brownies or chocolate chip cookies and the recipe was either displayed in a typical written format or a video format. Related science knowledge and concepts were incorporated throughout the recipes, explaining the ingredients and the baking process. A sample of 100 participants from a North American population were tested on recall of science facts presented within the recipes and answered 28 Likert-style questions to determine engagement with the given media format. The results indicated that following baking instructions from a science baking recipe in video format was beneficial to science knowledge gain. For engagement scores, however, the results revealed no significant effect of media format. These findings imply that video formatting of an instructional home activity may be more beneficial for science knowledge transfer than a written text format.
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Humans learn best when they are presented with words, pictures and commentary used simultaneously. Also, food is an engaging and relatable way to learn science concepts. The present research thesis sought to identify which is a more engaging format of presenting science concepts through baking: learning relevant science information through written text or video formatting.

The creative part of this thesis project has taken past research about learning and engagement with science concepts, as well as design and media findings to create an interactive and immersive eBook titled Sweet Science. Books involve multimedia in the combined form of words, video and sound to afford optimal learning opportunities.

The eBook is classified as a recipe book presenting 10 original baking recipes. Each recipe has an accompanying story with an interesting written narrative associated with the history of each baked good, as well as short, easy-to-follow videos of the recipes being baked. Each recipe also has small sections of science interspersed without it, to support the instructions. A printed PDF version of the eBook is accompanying this printed thesis and follows after the appendices.

The science involved in the baking has been researched and will be of value to readers in that they will understand baking practices and methods more thoroughly, resulting in better baking products for themselves. Learning the science behind what happens in the kitchen during baking is interesting to home bakers and will expand their own science knowledge in a field that they are assumedly already interested in. Any way in which science can be subtly and positively incorporated into daily activities presents an opportunity for long term science knowledge retention.
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1. Introduction

1.1 Learning

Learning is life-long, life-wide, and life-deep (Bell, Tzou, Bricker, & Baines., 2012; Hodson, 2014; Livingstone, 1999; Tal & Dierking, 2014). Humans are constantly learning, from the day we are born until old age, and across a vast range of social situations and settings. In the non-empirical domain, we can acquire information through spiritual or moral belief systems, learning concepts based on what we value and believe (Bell et al., 2012). However, scientific knowledge is especially useful for solving everyday problems and is thought to contribute to an individual’s well-being in many different aspects of life (Tal & Dierking, 2014). It is essential that comprehensive science and math knowledge be given to both children and adults to encourage problem-solving and communication skills. For adults, learning science is crucial for decision-making and it has been found that these skills shape multiple worldviews, for example political attitudes (Miller, 2010).

1.1.1 Science Learning

As humans, we have a natural curiosity about the world around us, especially as children. We use scientific methods and ideas (science knowledge) to gain information about our surrounding environment and all that it contains. Science is now seen as more than just specific knowledge or its own segregated topic. It is a part of daily life across all societies, regardless of age, history, or socioeconomic background or status; it is incorporated into culture, people and their everyday activities and experiences (Cheng, Claessens, Gascoigne, Metcalfe, Schiele, & Shi, 2008; Livingstone, 1999; National Research Council, 2009; Ziman, 1991).

As Linn and Eylon (2011) discuss, knowledge integration occurs when a collection of science ideas is gathered then linked together and built upon, resulting in a coherent understanding of science. These activities transpire when the different experiences and environments to which people are exposed present them with an array of scientific
information and the corresponding ideas and skills; however, the individual is not necessarily aware of this learning process. As Zimmerman (2012) notes, getting a first pet, such as a hamster, may originally begin as just that; however, over time the everyday experience of owning a pet will ultimately teach the pet owner scientific concepts about hamster food, health and care.

Other studies have shown that, through valued cultural activities such as playing basketball in North America, intellectual ideas are developed, giving way to better understanding of mathematical concepts (Nasir, 2002). Although many everyday experiences do not provide obvious opportunities for explicit science learning, basic science skills, such as measuring distance or weight, are often implicit. Such experiences may also provide the learner with more relatable contexts for making sense of difficult science concepts.

Context, as noted by influential education researchers Brown, Collins and Duguid (1989), as well as Hodson (2014), is vital to understanding a concept. That is how we understand and learn, by applying foreign concepts to what we have already learnt and applying this information to diverse situations. According to Bell et al. (2012), “Learning happens in relation to the social and material circumstances of particular places or locations” (p. 276). When science concepts cannot be identified in day-to-day life or only rigid scientific facts are given, interest in science is commonly lost and the individual is typically not engaged (George, 2006). Rather, to successfully gain lasting and generative scientific knowledge, a learner must attach personal meaning to the information through positive experiences. Solomon (1993, p. 111) points out that, “There are more and less subtle ways of offering science to the public.” Indeed, it has been considered an “art” to achieve the ideal balance between the amount and/or depth of information being communicated and the relatability of that information for the particular audience at hand (Mason, 2004). The casual, gradual interactions between an individual and science helps to cultivate a positive experience and increased scientific knowledge (Tal & Dierking, 2014).

1.1.2 Informal Learning
Scientific knowledge transcends boundaries of classrooms, museums and textbooks and can be gained in the informal learning environment of the home. The home structure as a learning environment has been researched for over two decades and is considered an especially viable setting for learning, given the range of experiences and activities that can enhance scientific thinking and the skills readily acquired in comfortable, informal settings (Goldman, Pea, Barron, & Derry, 2007; Solomon, 2003; Tizard & Hughes, 1984).

Informal learning has been defined by Livingstone (1999) as “any activity involving the pursuit of understanding, knowledge, or skill which occurs outside the curricula of educational institutions, or the courses or workshops offered by educational or social agencies” (p. 2). Learning is, of course, a cognitive process, not just an outcome. Thus, examining how people learn can provide insight into how different learning experiences might be made more efficient and effective (Rennie, Feher, Dierking, & Falk, 2003). People learn differently in informal environments such as the home. The learner must be self-motivated and have a pre-existing interest in the subject to enhance their desire to learn the material (Rennie et al., 2003). With a positive attitude towards the subject and its accompanying concepts, experiences with that topic are bound to be positive, and the amount of learning about that subject will increase in both formal and informal environments, spreading to surrounding people such as friends (Mager, 1968).

In analysing the results of previous studies, The Committee on Learning Science in Informal Environments identified that informal learning settings tend to be more inclusive and engaging for all learners. Adult learners, especially, had improved capacity to recall past experiences, use cognitive reasoning methods, and interpret new information by applying scientific knowledge learnt in their past informal learning experiences (National Research Council, 2009). Adults and children alike engage with new concepts when their learning environment is accepting, open to questioning, and takes into consideration their needs (National Research Council, 2009). Measuring the effectiveness of informal learning environments is a controversial issue, however, primarily because learning outcomes are typically measured very ineffectively. Many past studies have used the same measures for informal environments that are used for measuring academic achievement outcomes in formal school environments. Critics have argued that this approach is problematic, as it is difficult to properly measure the potential educational content of informal environments (Livingstone, 1999; National Research Council, 2009).
A large over-the-phone survey conducted by The National Research Network on New Approaches to Lifelong Learning (NALL) in Canada addressed adult learning mechanisms with a focus on explicit informal learning (Livingstone, 1999). They found that, on average, Canadians spent 15 hours per week in informal learning activities. Four different areas of informal learning were identified in the survey, including employment, volunteer work, household work and other general interests. Of particular relevance for present purposes is the category of informal learning involving household work. Activities in this category included such things as home cooking, home maintenance, grocery shopping and gardening among many other home activities. Of 1562 participants sampled for this survey, around 80% of the respondents said they had learned informally through household work, with an average of 5 hours a week, per person, spent engaging in knowledge-based activities in this context. Almost 60% of the respondents identified home cooking as part of their informal learning experience.

1.1.3 Hands-on Learning

Some researchers believe that participating directly in activities is the most effective way to learn (Hodson, 2014; Schank, Berman, & Macpherson, 1999). In a study of middle-school aged students learning about climate change, two thirds of the participants claimed they preferred to learn with dynamic and interactive experiments rather than by reading a textbook or through their teacher or classmates (Corliss & Spitalnik, 2008). In 2012, the American Institute of Baking (AIB) International restructured its educational resource framework with a focus on more hands-on, physical educational experiences (Munyon, 2012). AIB International is an organisation committed to sourcing and providing information regarding baking, nutrition and food safety with the goal of improving the global food industry. Students participating in coursework through the AIB have experienced changes in the core curriculum as the teaching methods employed by the AIB have had to adjust to technological innovations in line with empirical evidence. Altering the structure of courses, more kinaesthetic methods were utilised. Students began their coursework with theory-based material taught in a lecture setting, which they could then apply outside of class (i.e., a home environment), which solidified their understanding.
Alongside this, they increased digital and distance-learning opportunities for students and customers (Munyon, 2012). This change in curriculum encouraged active learning.

1.1.4 Active Learning

For learning to be considered “active” or deep, learners have engaged with concepts more effectively by thinking through concepts (usually with the interaction of peers or teachers) (Gamson, 1991). Useful for active learning is the incorporation of interactive activities (such as baking or working with food) as they facilitate skill acquisition while giving a sense of concrete evidence to foreign concepts. This dynamic enhances the learning experience and ensures that concepts are understood and made more memorable while also transferring the relevant information (McCarthy & Anderson, 2000). In a study by Dickie (2006), for example, students who participated in classroom experiments for an economics course had higher Test of Understanding in College Economics (TUCE) scores compared to those who took the same class without the experimental components. Student attitudes towards economics were also improved and some evidence for knowledge retention of the concepts involved in the experiments was also found. Lecture-style learning lacks these experimental components and involves passive “absorption” of the information that later will be “regurgitated” out when tested at a later time, discouraging comprehensive learning of a topic (Marton & Saljo, 1976).

1.1.5 Case-based Reasoning

From an evolutionary perspective, it is unsurprising that human memory does not support recall from textbooks, lectures, or other standard forms of direct informational transfer. Rather, memory retrieval involves drawing upon salient information that has been indexed or stored from our past experiences, and this information is in turn activated by related scenarios for problem-solving purposes. Cognitive psychologist Roger Schank coined the formal term case-based reasoning (CBR) in the early 1980s to refer to the process by which people use memories from their prior experiences to solve current problems.

Schank et al. (1999) argue that CBR is used in situations such as baking. The first time one bakes a recipe, for example, they will learn new methods, ingredient mixtures and
processes of going about that singular exercise, all of which converge to produce a specific baked good. Depending on whether or not that first baked product was determined to be successful, they would recall the experiences the next time they approached the activity, and potentially alter the way in which they baked. For example, if the final baked product was perceived to be too tough because it appeared that too much flour had been added into the recipe, returning to the experience a second time would likely evoke memories of that failed original product, with the baker changing his method (in this case, adding less flour into the mixture). Similar to the CBR concept is “elaborative processing,” a phrase coined by Najjar (1998, p. 313) to describe when a concept is related back to prior knowledge in a more complex cognitive way. Hands-on learning, is beneficial to learners because of CBR or elaborative processing. Across a large body of studies in this area, researchers have found that when learners undertook instructions for an interactive activity, they were both more positive towards learning the concepts and learned them more quickly, with interactive video also being a more cost-effective option than other instructional activities (Bosco, 1986; Fletcher 1989, 1990). However, it should be noted that the information gained in an interactive activity is not usually retained in the long term (Fletcher, 1989).

As previously mentioned, people must be intrinsically motivated to learn, typically by the desire to reach a goal, or memories are unlikely to be retained (Najjar, 1998). Formal education has developed a pattern in which ideas are taught with the end goal being a one-off situation (e.g., answering a homework question or sitting an examination), whereby the information is learnt and retained for an unnatural retraction point. This style of learning frequently results in the loss of information, as there is no intrinsic motivation to learn (Hodson, 2014). As Garner (1990) discusses, to learn efficiently, cognitive strategies are used. Strategies like re-reading text, taking notes and quizzing oneself on a topic are all strategies utilised for the goal of obtaining and retaining specific information. Repetition of an idea and the meaning behind it across spaced intervals of time is important for long-term retention of information (Dempster, 1996, Najjar, 1998). Without intrinsic motivation individuals are likely to find learning goals too unobtainable and therefore unlikely to invest time or energy on complex learning strategies.

1.2 Learning Tools
Using food in learning involves the use of food tools. As Brown and colleagues (1989) point out, “People who use tools actively rather than just acquire them, by contrast, build an increasingly rich implicit understanding of the world in which they use the tools and of the tools themselves” (Brown, Collins & Duguid, 1989, p. 33). The use of tools or other forms of manual activity appears to facilitate the acquisition of science knowledge and to engage an audience. Artefacts or topic-related objects, even kitchen equipment when baking for example, have been shown to be an important component in the learning process, whether in an informal or formal environment. For instance, they can aid in creating dialogue and subsequently in forming solutions for problems (Goldman et al. 2007; Miles and Bachman, 2009). Likewise, in an informal museum setting, visitors often engage with the informational exhibitions through physical activities, tools and conversation with others. According to the National Research Council (2009, p. 37) tools are considered “foundational resources” and support science learning. In discussing hobbies, Azevedo (2004) uses the examples of hobbyist astronomy and model rocketry. Sometimes, the objects utilized within these domains are not obvious science tools (e.g., a telescope), but instead are materials that support the learning of science material such as visual demonstrations of scientific data. Nevertheless, these tools are believed to aid others in learning challenging science concepts. Baking involves many tools (e.g., an oven, mixing equipment, measuring cups, and so on) to facilitate the hands-on process and enhance learning.

1.2.1 Food as a Learning Tool

In the foregoing vein, food – and in particular baking – was the focus of the current thesis and can be conceptualized as a tool used to convey dietary science, as well as scientific principles in related domains (e.g., physics and temperature). Every person has a meaningful connection as well as a variety of experiences with food, making it a viable, and potentially powerful, science-learning tool (Barkman, 1996). As a “naturally captivating” subject that “inspire[s] enthusiasm rather than dread,” food is full of science concepts that are often looked over (Simek and Pruitt, 1979, p. 230). In one telling study, parents were surveyed about whether or not they were willing to help their children with homework; while most said they would provide such support, when the subject was identified as “science,” this percentage dropped significantly. However, when the homework activity was identified as “an activity in the kitchen,” the percentage rebounded (Solomon, 1993).
Because food is so relatable, multiple research programs and universities have attempted to engage students with science through food (Calder, Brawley, & Bagley, 2003; Barkman, 1996; Duffrin, Cuson, Phillips, & Graham, 2005; Francek & Winstanley, 2004). University and elementary aged students from Ohio and North Carolina were involved in the FoodMASTER (Food, Math and Science Teaching Enhancement Resource) program (Duffrin et al., 2005.) The students were put into small groups and asked to create a food product together. The simple activity involved three hours of product discussion, design and development followed by three hours in a test kitchen making their preconceived product. Children in this study reported memorable experiences of working with food, improved chemistry knowledge and greater understanding of science concepts such as molecular change and the processes involved in heat reaction; likewise, the teachers of these children noted higher engagement and interaction levels with the lesson compared to regular in-class textbook lessons (Duffrin et al., 2005).

In another paper by Calder et al. (2003), the authors review the National Science Foundation (NSF) Graduate Teaching Program in central Maine. The program involved high-achieving graduate Teaching Fellows in the science, engineering, maths and technology (SMET) fields hosting an “inquiry-based” food program involving experiments in the classroom of high school students (Calder et al., 2003, p. 58). The aim of the program was to enhance the communication skills of the Fellows while promoting SMET education and interest. They found skills such as cell knowledge and scientific reasoning were transmitted by the hands-on activities. For example, students were asked to use liquorice and gumdrops to mimic DNA strands, or to work with gelatine to understand cell structure. The researchers found that these immersive teaching methods used were more effective for communicating science than standard classes. Teachers also noted an increased use of scientific language by their students (Calder et al., 2003).

In a food science program directly aimed to “get students excited about science” (Barkman, 1996, p.4) students were asked to participate in a series of food experiments. One experiment involved making ice cream in three different ways replacing the fat and sugar contributions; these activities were followed up with reflection and discussion. Barkman found that students became more engaged with science via the ice cream making activities compared to regular in-class activities. They also displayed knowledge of career paths in the
field of food science of which they were previously unaware. Also, those who were already interested in science expressed surprise at learning how integral science was in relation to food (Barkman, 1996). Several university courses have used food to teach a variety of different subjects, including earth science and chemistry, due to the relatability and relevance of food to the lives of their students (Francek & Winstanley, 2004).

1.3 Video as a Learning Tool

This use of video in general education can be extremely effective. The ever-increasing use of media (e.g., television, film, the Internet and social media) correlates with an increasing availability of science information as Najjar (1998) has argued, empirical evidence supports the use of multimedia (items involving a range of presentation factors such as video, text, sound and graphics) as beneficial for knowledge acquisition (McDonald, 2016). As media access becomes more affordable, technological innovations emerge, and the ease of using such technology grows, multimedia teaching practices will increase (Najjar, 1998).

Research by Clark (1982) compared previous studies where achievement and enjoyment were the two measured factors. It was concluded that students have higher enjoyment levels when using learning methods that utilise the least amount of effort and therefore offer the least in terms of achievement and learning. Alternative research by Clark and Craig (1992) compiled previous research on interactive multimedia and video use for instructional use. They concluded that when knowledge gain occurred in an multimedia instructional activity, it was the interactive nature of the task which accounted for that knowledge gain, not the multimedia itself. Varied multimedia, including video, generally had no impact on learning.

1.3.1 Integration of Visual and Verbal Mediums

Visual mediums in particular, such as films, animations, and television shows, are powerful science communication tools because they can explain and show aspects of science that are otherwise difficult to explain satisfactorily (Enger, 1976; Harwood & McMahon, 1997; National Research Council, 2009). They take away the audience’s need to imagine the
material being communicated (as is required through reading), instead providing graphic
illustrations or enactments of a difficult concept or process. This is believed to help learners
break down and comprehend challenging ideas, relating foreign concepts and ideas to that
individual’s own experiences and knowledge base (Harwood & McMahon, 1997).

Adults and older children are the most likely to benefit from informational
multimedia. However, some multimedia modes will work more effectively for knowledge
spread than others (Najjar, 1998). Multiple studies have found that, in contrast to simply
reading text, teaching is improved when visual pedagogical techniques, such as videos, are
used in conjunction with verbal techniques to explain science concepts (Baggett &
Ehrenfeucht, 1983; Menne & Menne, 1972; Najjar, 1998). With regards to short-term recall,
a study by Murdock (1968) showed learners found an auditory medium, or sound, to be
more effective than reading text when tasked with the activity of having to recite 10 items
from a list. By contrast, for long-term knowledge retention, some studies have found the
opposite to be true, whereby text is more effective than sound mediums when
communicating a variety of things (e.g., including items on a list, library information)
especially if accompanied by entertaining images (Severin, 1967; Sewell & Moore, 1980).
Importantly, when the same information has been presented via written text and video, one
study showed no differences in participants’ recall immediately afterwards (Nugent, 1982).
A study by Baggett (1979), however, found improved recall of a story that had been told via
pictures compared to a story told by written text, a week later. As Salomon (1981) reported,
less effort is put in by students when watching televised or video content compared to when
that same content is displayed in a written format and therefore has to be read.

Multiple studies have found that when informative videos are accompanied by a
synchronised and supportive narration, they are more effective for learning ideas compared
to when the narration came before or after the video content (Baggett & Ehrenfeucht, 1983;
Baggett, 1984; Mayer & Anderson, 1991; Robinson, 2004). Furthermore, narrating in a
casual way, with major informational points emphasised, is more beneficial for learning than
on-screen text (Robinson, 2004).
1.3.2 Successful Use of Video in Learning

Visuals such as animations and pictures incorporated into multimedia or interactive programs are also found to be more appealing, especially when showcased in aesthetically pleasing ways with regards to layout and colour (Jacques, Preece, and Carey, 1995; Lingaard, Fernandes, Dudek, & Brown, 2006; Shenkman & Jonsson, 2000; Mayer & Anderson, 1991). In an Israeli study (Barak et al., 2011), young children watched at least one animated video per week as part of their basic science class. The short videos used two main characters to present a scientific question and explain the answer using animation. Researchers found that the students were using three modes of learning during this process: auditory, visual and kinaesthetic. For instance, the animations themselves engaged the auditory and visual learning with written text and the use of visible characters. After viewing the animations, students engaged in discussion and small assignments including puzzles, using kinaesthetic learning styles. The author argued that using multiple senses when learning makes for a more worthwhile experience, as critical thinking skills are used, at least for children. Barak et al., (2011) encouraged the formal use of animations for learning in students of all ages, as it seems to meaningfully increase both engagement with science and the motivation to learn.

Other successful use of video media for learning was observed in a study by Croker, Andersson, Lush, Prince, and Gomez (2010). Croker et al. (2010) used digital video guides as part of a laboratory experiment with results showing increased inquiry-based or active learning and independent, self-sufficient learners. Short videos ranging from two to four minutes were constructed inexpensively by the researchers themselves and showcased one of four experimental activities (e.g. measuring lung function or measuring blood pressure). Students were advised to follow the instructional videos to complete the activity, devoid of written notes, but encouraged to make their own. Feedback from both students and laboratory demonstrators affirmed the video guides as effective learning tools. Reducing the amount of demonstrator support was beneficial to the students as they became in control of the pace of their learning, with 90% of the students reporting a preference for the videos over written instruction and 70% expressing a preference for the videos over an in-person demonstrator. When instructions are given in a written format, it can be difficult to accurately translate these instructions to a physical act and studies have shown students
being in control of an experiment themselves become more engaged and develop more advanced reasoning skills compared with another cohort of students following written instructions (Lord & Orkwiszewski, 2006). Ultimately, visual images should be accompanied by written text for a deeper understanding of concepts, and this understanding can further deepen when learners have control over the media they are interacting with (Robinson, 2004).

1.3.3 Learning Chemistry Through Video

Although food science is made up of many intertwined disciplines, such as microbiology, biology, nutrition and health, arguably one of the core subjects is chemistry (Calder et al., 2003; Harwood & McMahon, 1997). As a complex subject, chemistry is proven to be difficult to teach, especially without the use of analogies, models and experiments (Gabel, 1999). However, chemistry knowledge is seen to be crucial to 21st century science education requirements and therefore needs to be taught in some way (Tro, 2004). Many inaccuracies in chemistry knowledge can emerge from difficult concepts and the vast amount that needs to be understood. The use of experiments, however, aid with this. Both experimental activities and videos have been well-utilised in chemistry classes. In one survey, 70% of the high-school aged respondents stated laboratory activities were their favourite part of chemistry class (Gabel, 1993).

A study by Harwood and McMahon (1997) looked into how student achievement and attitude was impacted by employing video media to teach high school chemistry via the World of Chemistry video series. The series was created to introduce chemistry to those with little science knowledge in an engaging way. The treatment group involved teachers incorporating at least eight videos into their lessons over a one-year period, while the control group consisted of teachers not using any video technology within their chemistry lessons over the same time period. Those in the treatment group scored significantly higher in both achievement (as judged by results from the High School Subjects Test: Chemistry) and attitude towards science (as judged by results from the High School Chemistry Student Opinion Survey). Student opinions towards the videos were positive, with many students noting their novelty and how they appreciated and learnt from the videos (Croker et al., 2010). High school chemistry pupils following video-format instructional experiments had
much higher achievement scores than their counterparts who were not using the videos (Harwood & McMahon, 1997).

1.3.4 YouTube as a Learning Tool

As discussed, several studies have shown an increase in student engagement with science material and increased achievement after using instructional video content within their school environment (Savenye & Strand, 1989). With newer video content platforms such as YouTube, this will only be growing, and likely within the home environment too.

YouTube began in February 2005, and quickly became the most popular and efficient video sharing platform, with over 100 million videos watched daily by 2006, and since then a rapidly growing popularity (Burke & Snyder, 2008). Fortunately, many people have discovered educational benefits from YouTube. Multiple studies have examined YouTube as an educational tool in the health sector and found it could be a useful way for patients to view health information through high-quality, informative videos, provided specific videos are sourced (Giminez-Perez, Robert-Vila, & Tome-Guerrero, 2018; Wong, Doong, Trang, Joo, & Chien, 2017).

Croker et al. (2010) predicted that with platforms such as YouTubeEdu, hosting educational video content would become increasingly respected as a legitimate form of knowledge delivery. The audience for such prospective video platforms can be grouped into four: students, teachers, professionals and the life-long learners. The last category consists of adults looking to enrich their lives with more knowledge (Gilroy, 2009). In research by Spangenberg (1973), video content was superior when trying to address dynamic concepts but less effective when the concepts are too complex or do not require video media to support the idea.

1.4. Chapter Summary

As computer and internet usage increases in homes, the number of visitors to science museums, audience numbers of science TV shows, and readers of science magazines has decreased. Learning spaces need to be redefined to involve the internet (Miller, 2010).
Settings which were once considered the ultimate site for science education, such as museums, are now the starting point for science knowledge, with learners then turning to the Internet to further enhance their understanding of concepts. Using the Internet to access video content where interactive, instructional science videos are supplied is a common-sense approach that could be beneficial to informal environment learners.

A task that anyone can complete regardless of background or skill set, baking is a home activity that increases confidence and provides an engaging challenge with a satisfying end product (Haley & McKay, 2004). Barkman (1996) noted that food scientists working within the commercial food industry need a basic understanding of science concepts, including the chemical, physical and structural components of food, to enable them to create quality products. The same logic should therefore apply to home bakers. As the use of food as a learning tool has been shown to serve as a useful and efficient means for communicating science, the present thesis sought to determine whether different formatting of baking exercises could enhance science learning in the home environment.

1.5. The Present Study

The current research investigated the role of baking as a science learning process in the informal learning environment of the home. I predicted that video formatting of a recipe infused with science concepts would be more engaging to viewers and result in better short-term recall of science concepts than the same recipe in written text format.
2. Methods

2.1 Research Question

The overarching goal of this thesis project was to distinguish if typical recipes baked in the home kitchen could incorporate science concepts to aid people’s understanding of basic food science. The aim was to increase basic science knowledge, with an applied effect of improved baking (in terms of satisfying baking results). This would cultivate individual creativity in the home kitchen and turn a typical experience into an opportunity for learning. I was primarily interested in the empirical question of whether home-bakers who watch instructional videos learn science concepts and engage more with the activity than do those who follow a traditional written recipe. My prediction, based on previous studies on the benefits of multimedia engagement, was that this would indeed be the case.

2.2. Survey Overview

Participants recruited through Amazon Turk Prime undertook a 37-item survey created through Qualtrics. Participants were required to read an Information Sheet, a Consent form, and a “Kitchen Hazards and Warnings” page and then confirm they had read this information before advancing to the survey. Three demographic data questions were first asked involving age, gender and the degree of education. The second block of questions asked about the participants baking background and their thoughts about the importance of baking and separately, the importance of science. In these questions, 11 Likert-style answers were offered to participants, as more options have been shown to increase construct sensitivity and capture participants’ feelings more accurately (Peterson, 1994; Leung, 2011).

In the next block, participants were randomly assigned to one of four conditions, presented with: a video recipe of cookies; a video recipe of brownies; a written text recipe of cookies, or; a written text recipe of brownies. They were then asked to follow along with the recipe, baking it in their own home kitchen. The page would not allow participants to advance through the survey until 15 minutes had passed. This was enforced in the survey as one method of checking full participant engagement in the experiment. Both the brownie
and cookie recipes would have taken longer than 15 minutes to finish therefore this method was used in the hope of discouraging those participants not undertaking the experiment properly

It was also in this stage of the survey where participants were asked to take a photo, either of their baking set up, or midway through their baking task. This was the major check of whether or not a participant fully partook in the experiment as legitimate photos were easily identified. Once the participant progressed, they were given an attention check question in which they were asked to identify which ingredient they did not use in their baking activity as a third method to identify whether or not the participant actually undertook the baking task. This was followed by inserting a link to the image they took earlier in the survey.

The next block of 28 questions were formulated by O’Brien and Toms (2008) as part of their User Engagement Scale (UES) for the purpose of testing engagement in the baking activity (discussed in further detail below). These 28 questions were randomly split into five groups, each containing 5-7 individual questions. Splitting the 28 questions across five pages of the survey aimed to lessen any test fatigue experienced by the participants when answering.

The final block of questions involved 10 open answer questions that required short, several word answers. The questions were all answerable with information given within the recipe and this part of the survey was used to test recall. Participants were given two minutes to answer all questions; if they did not know the answer, they were required to enter “unsure” into the text box. Participants were not pre-warned of the quiz as not to encourage purposeful retention of the knowledge. All questions in the Qualtrics survey were forced response to encourage full data compilation.

2.2.1 Testing Engagement

Engagement is a “positive, fulfilling and work-related state of mind that is characterised by vigour, dedication, and absorption” (Schaufeli, Martinez, Pinto, Salanova, and Bakker, 2002, p. 465).
O’Brien and Toms have taken a conceptual approach to studying engagement by attempting to measure the engagement of subjects as they perform a task using a computer-based instrument (Wiebe, Lamb, Hardy, and Sharek, 2014). The User Engagement Scale (UES) was created by O’Brien and Toms (2010) as a survey tool used to measure engagement of software users by self-reporting. Measures to determine engagement have been formulated in past research; however, they have not been tried and tested across a range of situations and disciplines. To identify how engaged someone is in something and what constitutes engagement is difficult. Because of the complexity of the term ‘engagement’, the measure of engagement needed to be sensitive enough to capture this construct. O’Brien and Toms (2010) drew upon past research carried out across different disciplines to identify key components of engagement.

Originally having 49 questions placed into six subscale categories, later research by Wiebe et al. (2014), used exploratory factor analysis (EFA) to compact the User Engagement Scale into 28 questions across four factors of engagement (focused attention, perceived usability, aesthetics and satisfaction). All aspects of engagement could be catered for by these four factors. This refined the UES survey questions down from 31 to 28. This was the final set of questions analysed in the current study. Other studies assessing the UES also encouraged fewer factors.

All seven questions within the perceived usability subscale were reverse-coded to encourage active answering from participants and then reverse-coded in SPSS when analysing results. A five-point Likert-scale was provided with possible answers ranging from strongly disagree to strongly agree, as this provided the participant with possible answers and made for straightforward data accumulation. The UES has been statistically verified and is beneficial because of its simple execution and potential to be applied to a variety of multimedia design applications (O’Brien & Toms, 2010).

When interacting with a computer program, the engagement of the user is both a process and a product. It can be altered depending on a variety of factors including the users’ needs or emotions and the way in which the program is presented to the user. The UES is specifically a survey tool as researchers determined survey the most efficient way to obtain
participant thoughts on their own engagement. As stated by Wiebe et al. (2014), a Cronbach’s alpha value of 0.92 indicated the scales reliability was acceptable.

2.2.1.1 Changes to the UES

Minor alterations were made to the 28 survey questions to appropriately apply the instrument to the current study. The subject of the tasks used in former studies was altered to focus on the baking context instead (e.g., “I was absorbed in my shopping task” was modified to “I was absorbed in my baking task.”).

2.2.2 Testing Recall and Retention

Using a 10-item questionnaire, participants were given two minutes within the Qualtrics survey to answer simple quiz questions relating to the science information given throughout the recipe (regardless of condition). For example, “why is butter called a shortner in baking?” and “what family of proteins is formed when water and flour mix?”. Quizzing is found to enhance learning, and the recall and retention of information with short-answer style questions chosen for their ability to produce better answers in comparison to multiple-choice style questions (Klionsky, 2008). This was a time and cost-effective option as opposed to a follow-up survey to test retention.

2.2.3 Value Scores

Participants were asked to determine their feelings about baking and science from four Likert-style questions looking at interest, fun, knowledge and importance. For example, “I find science interesting” or “I am knowledgeable about baking”. Their mean score for each baking and science was calculated and attributed the baking or science “value score”. The scores were then divided into four groups representing high value, moderate value, low value and no value.

2.2.4 Pretesting
A small unofficial pre-test of three family members/friends indicated two statements in the UES were difficult to interpret and encouraged slight rewording. Two further statements, however, perceived as confusing and too dependent on interpretation in the unofficial pre-test were altered more substantially. “I lost myself in this [baking experience]” was changed to “I was completely immersed in this baking experience” and “during this [baking] task, I let myself go” was changed to “During this baking task, I felt completely uninhibited.”

An official paid pre-test was undertaken by eight individuals thorough Amazon Mechanical Turk. Each participant was paid USD$1.50 as gratitude for their participation. This pre-test confirmed prior concerns that the baking activity would not be fully participated in and therefore modifications were made to the survey through Qualtrics.

2.2.5 Participants

Participants were from a North American population and recruited through Amazon Mechanical Turk, an online crowdsourcing platform, extremely viable for online surveys (Behrend et al., 2011). This online-testing technique increased the study pool for the interactive survey. Also, as noted by (Humble, 2010) home-baking holds great significance in [North] American society, therefore making it a suitable participant pool.

Given that participation in the study was time and resource-consuming for participants, participant numbers were kept low (N = 100) with relatively high payment (USD$1.50).

2.2.6 Study Environment: Laboratory vs Home

To ensure participation, the present study would have been done in a controlled laboratory setting; however, the nature of the activity made the logistics of this approach formidable (Garner, 1990). Moreover, In lab environments, feelings of anxiety and wariness tend to occur (Ceci & Bronfenbrenner, 1985). Compared to an experimental laboratory kitchen setup, keeping the activity as home-based and “normal” (i.e., ecologically valid) as
possible was deemed more reflective of the aims of the research question driving the present work.

2.2.7 Recruiting Participants

With added features and the ability to remove bots from the respondent pool, Amazon Turk Prime was utilised as the recruitment platform for this study. The survey was released in batches of 20-40 at a time with time spans on average around seven days, allowing for participants to complete the survey activity.

Through Qualtrics, Amazon Mechanical Turk and TurkPrime, a total of 855 responses were recorded. After removing those who did not provide an appropriate image to prove their participation in the experiment (i.e., uploading a photo of their brownies or cookies), those who incorrectly answered the attention-check question, and those whose science answers were copied from an external source, the final sample was 100 people (N=100).

2.3 Statistical Analysis

All results were analysed with IBM SPSS statistics viewer. Table 2.1 below displays the analyses undertaken for each research question.
<table>
<thead>
<tr>
<th>Research Question</th>
<th>Dependent Measures</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do different formatting options for baking recipes influence the amount of science learned?</td>
<td>10 short-answer science questions with two minutes to answer.</td>
<td>Marked according to pre-set marking schedule and given 1 point for correct answer. Graded as a %.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mann-Whitney U-Test (for two independent groups)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-parametric Kruskal-Wallis test (for more than two independent groups)</td>
</tr>
<tr>
<td>2. Do different formatting options for baking recipes influence the engagement?</td>
<td>28 Likert-style questions from the User Engagement Scale (O’Brien and Toms, 2010)</td>
<td>Calculated by summing the mean of each individual subscale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mann-Whitney U-Test (for two independent groups)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-parametric Kruskal-Wallis test (for more than two independent groups)</td>
</tr>
</tbody>
</table>

*Table 2.1. Table displaying each research question and the statistical analysis used to answer them.*
3. Results

A total of 100 adult North American participants (70 females, 28 males, 2 other; \(M_{\text{age}} = 33.5 \text{ years}, \ SD = 9.1599\)) were used in this experiment. The overwhelming majority of participants (91%) had at least some college education. For both baking and science, 95% of participants expressed high to moderate value scores with well over half (64%) of the participants having high value of science and similarly, 62% of participants having high value of baking.

3.1 Science Knowledge Results

To determine the amount of science knowledge recall, in the final part of the survey participants were given two minutes to answer 10 short-answer style questions relating to functions of ingredients and processes involved in the baking task. All answers to the questions were provided in the baking recipe and all participants received identical questions regardless of format or recipe being baked. The answers were marked on a two-point scale with answers either identified as correct or incorrect based on an answer schedule created before the survey was distributed. As mentioned previously, those participants who provided obviously copy and pasted answers were excluded from the participant pool. The percentage of correct answers was calculated with the average science score for each condition plotted as shown below (Figure 3.1.) In the text condition (\(n=51\)), the mean science question score was 43.92 while in the video condition (\(n=49\)), the mean score was 44.49. When tested using a Mann-Whitney U-test, there was no evidence for a statistically significant difference between the two media conditions (\(U = 1275.5, p = 0.857\)).
3.1.2 Science Knowledge Results Between All Four Conditions

For the science question scores when broken down into individual condition groups (brownie/video n=27, brownie/text n=25, cookies/video n=22, cookies/text n=26), separating the baking conditions, the brownie/video condition mean was 43.33, the brownie/text mean was the lowest at 31.60, the cookie/video mean was 45.91 with the highest mean science question score of 55.77 for the cookie/text condition. A non-parametric Kruskal-Wallis test was carried out to determine whether the difference between the average science question score for each of the four conditions was significant (t=10.738, p<0.05). The results showed evidence for a strong difference in the means between at least one group comparison. Upon further post-hoc testing using the Dunn’s pairwise tests and the Bonferroni adjustment, one of the six pairings showed strong evidence of a statistically significant difference. This pairing was between the brownie/text condition and the cookie/text condition (t=-26.148, p<0.01) with mean rank of 36.66 for brownie/text and 62.81 for cookie/text. In other words, those participants who were in the cookie/text condition could recall more correct answers to the science quiz questions on average compared to those participants in the brownie/text condition. Based on this finding, the null
hypothesis - that the distribution of science scores not differ across condition groups - could be rejected.

Figure 3.2. Simple bar chart showing mean science score for the four individual conditions; brownie/video, brownie/text, cookie/video, cookie/text.

Asterisks indicate which condition pairing showed a significant difference.
3.2 Engagement Results

To determine the level of engagement with the activity formatting, participants were asked to determine their feelings across a range of Likert-style questions addressing six different aspects of the formatting (focused attention (FA), perceived usability (PU), aesthetic appeal (AE), endurability (EN), novelty (NO), felt involvement (FI)). The mean engagement score was calculated and plotted as shown below (Figure 3.3). A Shapiro-Wilk normality test showed non-normal distribution (p=0.56). For participants in the text condition, the mean overall engagement score was 48.4785 while the mean overall engagement score for participants in the video condition was 48.1845. When tested using a Mann-Whitney U-test, there was no evidence for statistically significant differences between the two media conditions (U=1142, p=0.459).

Figure 3.3. Simple bar chart showing mean overall engagement score for the combined text condition and the combined video condition.
3.2.1 Engagement Results Across All Four Conditions

The mean overall engagement was 48.0261 for the brownie/video condition, 49.1799 for the brownie/text condition, 48.3791 for the cookie/video condition and 47.8041 for the cookie/text condition. A non-parametric Kruskal-Wallis test was carried out to determine whether the difference between the mean engagement score for each of the four conditions was significant. The difference was found to be not statistically significant (t=5.769, p=0.123).

![Simple bar chart showing mean science score for the four individual conditions; brownie/video, brownie/text, cookie/video, cookie/text.](image)

3.2.2 Engagement Subscale Scores

The engagement overall score was a sum of four subscale results. Here the means for each of the four engagement subscales (perceived usability, satisfaction, aesthetics and focused attention) across each condition are shown. With very little difference between all of the means, the highest mean was observed in the text condition for focused attention at 12.3309 while the lowest mean was observed in the video condition for satisfaction at 11.7988. Non-parametric Mann-Whitney U-tests were performed to identify any significant
differences in the means of each subscale measure across either the text or video media condition but none of the four tests showed statistically significant results. PU (p=0.235), FA (p=0.177), AE (p=0.220) and SA (p=0.643).

3.3 Baking Value Score

As shown in Figure 3.6, across both media conditions, the highest average science scores in each condition (text and video) were associated with the groups of high baking value (a mean science score of 52.50 for the text condition and a mean of 51.33 for the video condition). Subsequently the moderate value groups had the second highest mean science scores, followed by the low value groups for both conditions. A Kruskal-Wallis test for significance indicated there was evidence for a statistically significant difference in distribution of science scores across the categories of media condition and baking values (t=17.775, p<0.01). That is, participants who valued baking had higher average science scores compared to those with lower baking value scores.
Post-hoc testing including Dunn’s pairwise tests and the Bonferroni adjustment were undertaken, showing evidence for statistically significant differences between text/low and text/high (t=46.656, p<0.05), text/moderate and text/high (t=22.759, p<0.01), text/low and video/high groups (t=46.083, p<0.05) and video/moderate and text/high (t=17.812, p=0.043) with mean rank of 59.41 for text/high, 36.65 for text/moderate, 12.75 for text/low, 58.83 for video/high and 41.59 for video/moderate. Together, this pattern of results indicated that the higher the value placed on baking, the higher the science score, regardless of condition. Based on these findings, the null hypothesis - that the distribution of engagement scores would not differ across condition groups when science value scores are a covariate - could be rejected.

When comparing average engagement scores for both conditions with baking value scores as a covariate (see Figure 3.7), there were only minor differences in engagement scores across all groups. The highest average engagement score was seen in the video/no value condition with mean engagement score of 49.68 while the lowest mean engagement score of 47.36 observed in the video/low condition. A Kruskal-Wallis test for significance showed no statistically significant results between any of the groups (p=0.125) and therefore the null hypothesis - that the distribution of average engagement scores across the media and value conditions was the same - could not be rejected.

Figure 3.6. Simple bar chart showing mean science scores for each overall media condition, divided into groups based on baking value score.

Matching symbols indicate which condition pairings showed a significant difference.
When average overall engagement score was plotted against media condition with the addition of the science value score as a covariate, similar patterns emerged. The low science value groups for both the text and the video conditions had the highest average engagement scores. For the text condition, the low science value average engagement score was 50.5661 and the video condition low science value average engagement score was 48.70. In both conditions these were followed by the moderate science value groups with the high science value groups in each condition having the lowest average engagement scores. The lowest overall engagement score across all conditions was in the text condition for high science value with an average engagement score of 48.064. When a Kruskal-Wallis test was run, no evidence was found for statistically significant differences across the groups (t=5.193, p=0.393). Therefore, the null hypothesis – that the distribution of average engagement scores is the same across the media and science value groups - could not be rejected.

3.4 Science Value Score

Figure 3.7. Simple bar chart showing mean engagement scores for each overall media condition, divided into groups based on baking value score.
When comparing the average science scores between media conditions when the science value covariate was also involved, no obvious patterns emerged. In the text condition, the highest average science score was found in the low science value group (55) while in the video condition, the highest average science score was found in the high science value group (49.33). The lowest average science score was observed in the low science value video condition, at 23.33. The data was tested for significance using a Kruskal-Wallis test for statistical significance however no evidence was found for statistically significant results. The null hypothesis – that the distribution of average science scores across the science value text and video conditions remain the same – therefore cannot be rejected.

![Figure 3.8. Simple bar chart showing mean engagement scores for each overall media condition, divided into groups based on science value score.](chart.png)
Figure 3.9. Simple bar chart showing mean science scores for each overall media condition, divided into groups based on science value score.
4. Discussion

4.1 General Discussion

Participants within the present study were exposed to simple food science ideas in an appropriate context of their home kitchens while baking a recipe. They used interactive tools in a hands-on activity and could relate any foreign science concepts to the baking activity they were partaking in. Although we cannot conclusively say if participants were “actively” learning, as we did not test for how participants were thinking through ideas, participants were supplied with key factors that have been proven to encourage active learning (Gamson, 1991).

The results, although not supporting our proposed hypothesis, support the conclusions of some past studies (Clark & Craig, 1992). The media condition (video or text) in the present study did not appear to have a strong impact on either science score or engagement. It is possible that like Clark and Craig (1992) concluded, the interactive nature of an instructional activity has more impact on the knowledge gain than the differing types of multimedia used to provide those instructions. However, because all four groups participated in an equally interactive task, we cannot conclusively determine whether this same conclusion can be made with our data.

4.2 Science Score

Based on previous studies findings (Enger, 1976; Harwood & McMahon, 1997), we expected to see high science knowledge scores in the video conditions due to the power of video to break down foreign concepts into digestible and comprehensible ideas as the viewer can visibly see show what written text can only describe. Although overall the video condition did have higher mean engagement scores, the result was not significant.

With 95% of participants attributing high or moderate value to both baking and science in general, the science scores, interestingly, were varied across conditions. Overall, the collective video media condition (for both cookies and brownies) had a higher mean science score of 44.49 (44.5%). As suggested by previous studies (Murdock, 1968) this result may be observed because in short-term recall situations, knowledge tends to be more effectively gained when an auditory medium is used, as observed in the baking videos.
However, although this result trended in the predicted direction, it was not a significant finding.

Compared to the Harwood and McMahon (1997) study, in which students who were shown chemistry videos throughout the year achieved much higher chemistry test scores than their peers who did not watch the videos, the results from the present study are weaker. We expected to see a similar result, however, the text condition overall had higher science scores. The individual condition with the overall highest mean science score was the cookie/text condition with an average science score of 55.7 and the individual condition with the overall lowest mean science score was the brownie/text condition with an average science score of 31.6.

Due to the nature of the way in which participants were chosen for this study, their experience with baking, in terms of prior baking knowledge, may have attributed to the inconsistent findings of the present study when compared to that of Harwood and McMahon (1997).

The survey method of the present study required participants to be highly interactive and at their own expense, both time-wise and financially. It was expected that people with little interest in baking would not voluntarily opt in to such an extensive baking exercise. This was shown in the results with over half (62%) of the participants attributing high value to the task of baking. In the Harwood and McMahon (1997) study however, the participants were inexperienced chemistry pupils, unlikely to be hobbyist chemists.

When one participant group has a solid prior interest in the task, offering the same information in different formats may have little impact on their engagement or knowledge retention. The group may find the activity interesting and engaging regardless of how the task, and the associated information, is presented. This may be the case for the present study participant pool. However, when a second pool of participants, such as those in the Harwood and McMahon (1997) study, has little prior experience with or knowledge of an activity, offering that activity via alternative methods may result in higher level of engagement with one medium compared to another. These participants with little prior knowledge may be more easily engaged in the task through more visual and novel mediums like video (Barak et al., 2011; Harwood and McMahon, 1997).
The results of the present study were closer to the Nugent (1982) study. In the Nugent (1982) study, where the same information was presented in video format and written text format, no differences were found in participant recall of the information immediately afterwards, while our present study only found a slight difference.

The cause of this difference is unclear, and unfortunately the current study does not allow me to ascertain why this effect arose. These face-value results may be down to this particular sample population. Subsequently, more research would be required to ultimately determine the reasoning of why the cookie condition had a higher science score than the brownie condition. Speculatively, this difference could simply indicate a preference for cookies over brownies more generally. However, interestingly, the randomly selected cookie/text condition sample only consisted of participants with high and moderate value scores of baking (a chance distribution). It is possible that those already interested in baking and who had attributed a high value to baking, already had the science knowledge which was tested in the survey, prior to participation in this experiment. As previous research has determined, learning is a continual process of ideas repetitively being linked together and different ideas coming together (Linn & Eylon, 2011; Tal & Dierking, 2014; Zimmerman, 2012). For some participants, perhaps more of those in the text condition than in the video condition, this may not have been the first time these science concepts were put to them and therefore they were actively building upon existing knowledge, allowing them to answer more science survey questions correctly.

Alternatively, as Rennie et al. (2003) noted, learning occurs when the person involved is already interested and curious in the subject matter. Therefore, as there were higher value scores for baking observed within the cookie/text condition, this could explain the higher mean science scores as participants within the cookie/text condition already expressed interest in baking. However, as mentioned, more research would be needed to accurately define why these results occurred.

Text formatting of a baking recipe is the standard format of a recipe as viewed in a tangible recipe book. The text condition participants may have felt more comfortable with this standard way of following a recipe and were therefore able to retain and recall more science concepts, than those participants in the video condition.
4.3 Engagement

There were no meaningful differences in engagement scores across the four conditions, nor when the two media condition groups were combined.

Possible participant fatigue from the extent of the engagement questions on top of an already time and resource-intensive baking activity may have influenced the insignificant engagement results. Participants may have rushed or given less thought to their responses after the baking activity, providing inaccurate answers (or those that did not reflect their attitudes or beliefs). Such general issues are a common problem with electronic surveys (Patents, 2016). Also, the sample population was disproportionately interested in baking. This may have influenced the results in that the overwhelming majority (95%) of participants valued baking and therefore were engaged regardless of which media format they viewed their recipe. Moreover, with a relatively small sample size, the potential effect size was limited.

Based on previous research (Croker et al., 2010, Savenye et al., 1989), my expected results would have revealed differences between video and text conditions, with higher engagement scores for those participants within the video groups. Again, videos have been found to increase engagement, interest and ease explanation of concepts (Gabel, 1993; Najjar, 1998). Video content also requires less effort to view compared to the required effort needed to read a written piece, an important factor when enjoyment and engagement are being measured (Salomon, 1981). All participants in the present research were undergoing an interactive task which required identical effort, regardless of which condition they were assigned. The effort required was also large as participants had to be physically active and bake, use their own resources and obviously their time. It is possible that because the task was so intensive, our results differed from those previously obtained in past studies.

As noted by George (2006), typically, engagement is lost when the science information lacks context. As all participants in the present study were receiving the same food science information within a suitable context of their home kitchens while baking a recipe, this could be one reason why little difference in the engagement scores across conditions was observed. The participants could all relate to the task in some way as the information was given in a suitable context.
Active learning and engagement with ideas is the result of learners thinking through concepts, a process that often involves other people, such as teachers or peers (Gamson, 1991). Potentially, the lack of peer involvement in the experiment and the decreased ability to discuss and digest ideas limited the amount of engagement participants had with the activity. Also, the timeframe participants had to complete the baking activity may have caused participants to feel rushed, reducing their time to reflect deeply about and engage with the activity.

4.4 Limitations

4.4.1 Study Design Limitations

Over the course of undertaking this research, limitations of the study became apparent. To begin with, given the absence of direct comparisons in the field of science communication, the current design was a hybrid of existing studies. Studies which were referenced and used as influences for the current study came from a variety of disciplines, including computer science, food and health education, adult learning and education, chemistry and psychology. These studies also had a broad range of different empirical objectives, many of them examining learning and information gain with children and adolescents in classroom environments, whereas the current study focused on adult learning in the home.

4.4.2 Survey Limitations & Directions for Future Research

4.4.2.1 Study Demand Limitations

Due to the demanding nature of the study and home environment requirements (e.g., a kitchen with a working oven), the sample was limited to 100 due to the high cost of recruitment. Participants had to use at least 30 minutes of their time and their own ingredients and kitchen space, utensils and power in the experiment, hence the relatively
high gratitude payment for participation as well as low recruitment rate. This small sample means that the data may not be representative of an entire population.

The high intensity of the activity with obvious crucial focus on baking as the main activity of the survey would have impacted the sample population. Keen home-bakers would have been naturally more inclined, as well as more likely to have the necessary baking supplies, to partake in the survey. This was reflected in the results, with 95% of the sample having high and moderate value scores with regard to baking. They therefore may have had some influence in the very similar mean engagement scores across conditions. If most of the participants already had an interest in baking, they likely would be engaged with the whole activity regardless of the format to which they were randomly assigned. At the very least, it is unlikely that such a high percentage of the North American population places a high value on baking, suggesting we view the present data with caution due to a likely sampling bias.

4.4.2.2 Self-reporting Limitations

To measure the psychological aspects of engagement, self-report methods are favoured (Wiebe et al., 2014). Self-reporting was the chosen method for this study for convenience and ease of information collection (O’Brien & Toms, 2010). The validity and reliability of self-report measures make them a favoured choice of data collection. A limitation of self-reporting, however, is the lack of objectivity.

Self-reported data introduces bias potentially in the way of exaggeration, in which participants may have been prone to over-emphasise their responses. Self-reporting also has the potential for error due to the personal nature of the survey-taking, answer fatigue, and the potential for questions to be misinterpreted. Although it is unclear if any of the foregoing factors influenced the results in the present study, it is possible that participants may have overstated their opinions on baking and science and therefore may have contributed to higher value scores for each. The same self-report bias could also have occurred when participants answered the questions on engagement.

4.4.3 Statistical Test Limitations
With regards to the dataset, upon testing for normality, the results indicated the data were non-normal and therefore nonparametric tests (Kruskal-Wallis and Mann-Whitney U-Test) were used. Due to the nature of these tests and the loss of original information when swapped out for rank measures, the nonparametric tests are less powerful than a parametric ANOVA test and therefore may have missed opportunities for statistically significant results.

4.4.4 Science Score Limitations

The lack of a pre-test to gauge whether participants already knew the answers to the science questions was another limitation of this study. By not wanting to familiarise the participants with the questions before the answers were offered within the recipes and therefore pre-empting responses and active information retention, it is impossible to identify whether participants actively learnt the answers to the questions by doing the baking activity or were already known by the participants.

4.4.5 Engagement Score Limitations

The User Engagement Scale was created by O'Brien and Toms (2010) to quantify “engagement” of an audience, a notoriously challenging construct to operationalise. Having only been applied to situations such as video games and websites, the User Engagement Scale has not been applied to anything like a baking task. This altered the way in which the original User Engagement Scale Likert-style questions were asked from their original format, adjustments that may have affected the pattern of results in the present study.

4.4.6 Directions for Future Research

In the present research, although we expected to see that participants in the video conditions would have both higher science scores and overall engagement scores, the results of the present study neither confirmed nor denied our assumptions. The data did however demonstrate that science knowledge recall could potentially be influenced by the subject matter of the activity at hand, as well as prior interest in the subject before participation in the task. More research is needed to determine why the results of the present study were
found, as well as broader research of incorporating science into hobbies and everyday home tasks. Specifically, asking open-ended questions and obtaining qualitative data, allowing participants to divulge their opinions and enabling researchers to uncover more of the reasoning behind participants responses.

A follow-up survey is also encouraged in further research to ascertain whether the participants had retained the science information from the baking recipes. This would involve modifying the primary measure from a short-term recall test to a long-term retention test. In the present case, time and budget were both limiting factors for such a dual approach.
5. Conclusion

Home learning environments are highly relevant to people’s everyday experiences, and science communication in such casual contexts offers considerable promise for both researchers and applied practitioners. Identifying the most viable options to utilise when trying to communicate science through activities such as experiments at home or casual hobbies is important. Without knowing how to integrate science knowledge into different topics and through different mediums, there will be missed opportunities for obvious science communication and chances to engage a wider audience through activities and topics for which people already have an intrinsic interest. And there are incentives through such learning as well. For instance, should a home baker’s knowledge science knowledge increase, their actual baked goods should also improve.

As shown by the review of prior studies and available literature, the science communication field has not yet adequately explored the applied practice of how to effectively communicate science to adults through everyday activities in the home. However, with an ever-increasing focus on technology and consistent updates and changes within the technological world, video has been an increasingly popular and viable multimedia formatting option. As such, most scholars in this area have considered it to be a highly effective learning tool. Therefore, research identifying which media formats can be most effective for learning is important, especially in this rapidly changing world of technological developments.

Even though science learning in the home is difficult to assess, with improved methods, more time and a larger budget, the research into science learning in the home through everyday tasks, such as baking, has the potential to grow. The future of research within this field need not be limited to only baking, but other potential hobby activities in which science can be incorporated (e.g., sports, gardening, etc) and as the current research was limited by sample size, any future research would need to be repeated with a larger population size.

As one of very few studies, that we are aware of, to explicitly link multiple fields including food science, media technology and in-home learning together, this research has
presented an original idea and methodology on learning science in the home. By utilising pre-existing tools, like food, to communicate science as well as determining the most effective formatting method to do so, we can learn how to enhance in-home science learning, and therefore maximise the spread of valuable science knowledge.
References


Appendices

Appendix I: Baking Recipes

CHOCOLATE BROWNIE RECIPE (TEXT CONDITION)

You’re going to need:
150g diced butter
1 cup of dark chocolate pieces
1/2 cup + 1/8 cup white sugar
1/2 cup + 1/8 cup brown sugar
3 eggs, room temperature
2 tsp vanilla extract
1/2 tsp salt
1 cup all-purpose flour
1/4 cup of Dutch-process cocoa
1/2 cup milk, optional
1 cup mixed chocolate pieces

Start by preheating the oven to 165°C / 330°F and line a brownie pan with baking paper.

Grab a large mixing bowl and add the diced butter and 1 cup of chocolate chips.
Butter is made up of around 80% fat plus some milk solids and water. This high-fat content means butter is called a shortener as the fat coats the flour that we’ll be adding in later and "shortens" chains of gluten being formed, helping keep our product soft.
Place in the microwave for 1 min and then mix.

Microwave it for another 30 seconds until completely melted.
Chocolate comes from cacao beans. Cacao beans undergo a series of processes which results in two products we find in the chocolate we eat; cocoa mass and cocoa butter. The cocoa mass in the dark chocolate we are using provides that extra rich chocolatey taste while the cocoa butter adds more fat into the mixture, helping to achieve that soft, chewy texture we want.

Mix in both of the sugars with a whisk until it's all combined.
Sugar is called a liquefier in baking. This means the sugar granules melt when they're baked to become a liquid, helping to tenderise the brownie. Light brown sugar actually consists of white sugar and around 10% molasses, giving it that golden brown hue. The additional molasses actually adds moisture helping to make the brownies chewier.

Now add the eggs.
Eggs have important roles in brownies. Under heat, proteins in the egg unravel creating a solid structure from liquid, giving the brownies structure and volume. Egg yolks contain the emulsifier lecithin. This means they can make ingredients which normally don't like to associate, like fats and water come together.
Add the vanilla.
Vanilla extract adds flavour to the recipe but also helps to enhance other flavours such as the chocolate.

Beat in with a low-medium setting on an electric beater until the mixture is smooth and silky.
That crispy, crackable top you find on a brownie is actually a meringue formed by beating the egg whites and sugars together.

Sift together the salt, the flour and cocoa and mix together with a wooden spoon or spatula until just combined.
Flour is the ultimate baking stabiliser, meaning it thickens the mixture. When it mixes with water, flour forms gluten, which is a family of proteins. Gluten acts like glue, binding the other ingredients together. It's the fat in the butter and chocolate we mentioned before as well as not over-mixing that helps to prevent too much gluten forming, preventing the brownie from becoming too cakey and tough.

Cocoa also gives the brownie some structure but mostly it adds the chocolate flavour to our brownie and obviously that deep brown colour. This is Dutch-processed cocoa. Natural cocoa is actually acidic, giving it a more sour, fruity taste whereas Dutch-processing neutralises the natural acidity of cocoa leaving it with a more bittersweet taste.

Salt is important for flavour as it absorbs water, preventing the dilution of other flavours.

If the mixture is quite stiff, add the milk.
As a liquefier, it will help tenderise the mixture.

Gently mix in the chocolate pieces.

Pour the mixture into the pan and place it in the oven for 30-35 minutes until it's still slightly gooey when a knife is inserted.

Let the brownie cool for 30 mins before slicing and serving.

Bon appétit!

**CHOCOLATE BROWNIE RECIPE (VIDEO CONDITION)**

Please watch the following video with the sound on AND follow the recipe along in real time to make brownies. It is fine to pause the video and go back if you need to.

The survey will only proceed once the baking task has begun. While the brownies are baking in the oven, you are welcome to continue with the survey but please ensure you have
watched the video in its entirety before advancing to the next page. You will not be able to go back once you have proceeded.

Please remember to **take a photo** on any available device **during** this baking activity. The photo **must** show the mixing bowl.
CHOCOLATE CHIP COOKIE RECIPE (TEXT CONDITION)

You're going to need:
150g softened butter
1 1/2 tbsp peanut butter
1/2 cup white sugar
1/2 cup brown sugar
1 egg
1 tsp vanilla
2 cups flour
1/2 tsp baking soda
1/2 tsp salt
1 cup mixed choc chips

Start by preheating the oven to 175°C / 350°F and line a large baking tray with baking paper.

Grab a large mixing bowl and begin by melting the butter and peanut butter together in a microwave.
Start with 45 seconds, mix, then put in for another 30 seconds.
Butter is made up of around 80% fat plus some milk solids and water. This high-fat content means butter is called a shortener as the fat coats the flour that we'll be adding in later and shortens the chains of gluten being formed helping to keep our product soft. Butter and peanut butter both add flavour and more moisture to the cookies.

Incorporate both the white and brown sugars into the mixture with a wooden spoon.
Sugar is called a liquefier in baking. This means the sugar granules melt when they're baked to become a liquid, helping to tenderise the cookies. Sugar also gives cookies those crispy outer edges and obviously also adds sweet flavour. Light brown sugar actually consists of white sugar plus around 10% molasses, giving it that golden brown hue. The additional molasses actually adds moisture helping to make the cookies chewier.

Now add the vanilla and egg and mix until combined.
Vanilla extract is used to add flavour to the recipe.

In cookies, eggs are especially important. Under heat, proteins in the egg unravel, creating a solid structure from liquid, helping to give the cookies some structure and volume. Egg yolks contain the emulsifier, lecithin, this means they can make ingredients which normally don't like to associate, like fats and water, come together.

Now add the flour, baking soda and salt.
Flour is the ultimate baking stabiliser, meaning it thickens the mixture. When it mixes with water, flour forms gluten, which is a family of proteins. Gluten acts like a glue, binding the other ingredients together giving structure and helping to create a thick, doughy cookie.

Baking soda is needed for the cookie to rise. It does this by reacting with the molasses in the brown sugar, a form of chemical leavening.
Salt is important for flavour as it absorbs water, preventing the dilution of other flavours.

**Mix until the dough comes together and it isn't overly sticky.**
Then add the chocolate chips.
Chocolate chips don't melt all throughout cookies for two reasons. Firstly, they are slightly insulated from the heat of the oven by the batter they are in. Secondly, chocolate chips are made with less cocoa butter so that they can hold their shape when heated to the point of melting and then re-solidify back into their original shape.

**Continue mixing until the chocolate chips are combined.**

**Now put the mixture in the fridge for 20-30 mins.**
This re-solidifies the fat in the butter and eggs in the dough. When the dough then is rolled and put into the oven, it takes longer for the fats to re-melt, therefore keeping the cookies thick and raised. The refrigeration also dries out the dough, concentrating the sugar, making the cookies taste sweeter and have a crispier texture.

Remove the dough from the fridge and using a tablespoon, scoop out spoonfuls of mixture and roll into evenly sized balls.

Place the balls on the tray, equal distance apart and bake for 10 to 15 minutes or until lightly browned and still slightly soft.
The hotter the oven, the less the cookies will thin and widen out across the tray.

Remove cookies from the oven and leave to rest until firm.

Bon appétit!

**CHOCOLATE CHIP COOKIE RECIPE (VIDEO CONDITION)**
Please watch the following video with the sound on AND follow the recipe along in real time to make cookies. It is fine to pause the video and go back if you need to.

The survey will only proceed once the baking task has begun. While the cookies are baking in the oven, you are welcome to continue with the survey but please ensure you have watched the video in its entirety before advancing to the next page.
You will not be able to go back once you have proceeded.

Please remember to take a photo on any available device during this baking activity. The photo must show the mixing bowl.
Appendix II: Qualtrics Survey

RECIPES AS SCIENCE COMMUNICATION TOOLS
INFORMATION SHEET FOR PARTICIPANTS

What is the aim of the project?
The aim of this research project is to investigate how different formatting of recipes could be used as effective tools for communicating food science to home-bakers. This project is being undertaken as part of the requirements for Bailey Kench's Masters in Science Communication degree.

What type of participants are being sought?
We are seeking 100 participants over the age of 18 from North America with access to a home kitchen and the following ingredients and appliances readily available: Butter, Chocolate pieces, Eggs, Vanilla Essence, White Sugar, Brown Sugar, Plain flour, Cocoa powder (Dutch-process), Salt, Peanut Butter, Baking Soda, Oven, Microwave, Fridge, Electric Mixer, Camera phone or any available photo-taking device, Pen and paper.
If you do not have these ingredients available but do wish to complete the study at a later date, please return to the study when possible.

What will participants be asked to do?
Should you agree to take part in this project you will be asked to: Read and electronically sign a consent form, Bake a dessert recipe following supplied instructions in either written or video form and take a progress photo, Answer a short survey and 10 short-answer questions, Upload a link to the photo taken during the baking exercise.
Please allow at least 50 minutes for the baking and 10 minutes for the survey questions.

KITCHENS CAN BE HAZARDOUS AND WE ADVISE THERE IS RISK INVOLVED WHEN BAKING.
Please be aware that you may decide at any time not to take part in the project without any disadvantage to yourself of any kind.

What data or Information will be collected and what use will be made of it?
The raw data to be collected as part of this study includes: Age and gender, Your survey responses.
The only people with access to this information will be the project supervisor and the student researcher working on the project. Should you wish to withdraw from the study at any point, you may simply close the window and your responses will be instantly deleted.

Once you press the "submit" button at the end of the survey, your results will be recorded and cannot be altered or retrieved after this point.

The data collected will be securely stored in such a way that only those mentioned below
will be able to gain access to it. Data obtained as a result of the research will be retained for at least 5 years in secure storage. Any personal information held on the participants may be destroyed at the completion of the research even though the data derived from the research will, in most cases, be kept for much longer or possibly indefinitely.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

**Can participants change their mind and withdraw from the project?**
You may withdraw from participation in the project at any time and without disadvantage to yourself of any kind. Should you wish to withdraw from the study at any point, you may simply close the window and your responses will be instantly deleted.

**What if the participants have any questions?**
If you have any questions about our project, either now or in the future, please feel free to contact either:

Associate Professor Jesse Bering or Bailey Kench
Department of Science Communication
+64 34716147 +64 34716147
jesse.bering@otago.ac.nz kenba071@student.otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

☐ I have read the Participant Information Sheet
RECIPE AS SCIENCE COMMUNICATION TOOLS
CONSENT FORM FOR PARTICIPANTS

I have read the information sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-
My participation in the project is entirely voluntary;
I am free to withdraw from the project at any time without disadvantage;
Personal identifying information (age, gender) will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;
I may be at risk baking and working in a kitchen;
Participants will receive a small reimbursement as thanks for participating in this study of USD$1.50

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph+643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

☐ I consent
☐ I do not consent

KITCHEN HAZARDS AND WARNINGS
Please be aware that the kitchen can be a hazardous place.
Ensure you are keeping yourself and others safe at all times.

**Hygiene:**
Clean up the area of food preparation and handling both before and after the activity has taken place
Please keep your hands clean and any long hair or loose clothing is secure
Keep the floors clean and free from slippery products

**Utensils:**
Appropriate knives should be used for the task
When not in use, knives need to be put away securely

**Burns:**
Be aware of your surroundings and make use of oven mitts or tea towels when handling hot items

**Ovens:**
Never leave food cooking on a stovetop unattended
Remember to turn the oven off when it is no longer in use

**Electrics:**
Keep all electronic appliances far away from water

☐ I have read the Kitchen Warnings and Hazards

Please enter your date of birth
_____ Day
_____ Month
_____ Year

Please select your gender
☐ Male
☐ Female
☐ Other
What is the extent of your education?

- Less than high school
- High school graduate
- Some college
- 2 year degree
- 4 year degree
- Master's or equivalent
- Ph.D. or equivalent

How often do you bake at home?

- Daily
- 2-6 times a week
- Once a week
- 1-3 times a month
- Less than once a month
- Never

Please select the ingredient you DID NOT use in the recipe

- Butter
- Cinnamon
- Peanut Butter
- Flour
Please select the ingredient you DID NOT use in the recipe

- [ ] Eggs
- [ ] Flour
- [ ] Walnuts
- [ ] Chocolate pieces
Please select an option for each idea on baking

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<tr>
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<th>Extremely Agree</th>
<th>Highly Agree</th>
<th>Moderately Agree</th>
<th>Slightly Agree</th>
<th>Neither Agree nor Disagree</th>
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<th>Disagree</th>
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<td>I find baking interesting</td>
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<td>I am knowledgeable about baking</td>
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<td>I think knowing how to bake is important</td>
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Please select an option for each idea on science

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<th>Moderately Agree</th>
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<td>I am knowledgeable about science</td>
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<td>I think science is important</td>
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BAKING ACTIVITY AS IDENTIFIED IN APPENDIX I.

Please now insert a URL/ link to the image you took of your baking activity. We recommend using one of the following platforms: Dropbox, Google Drive, Imgur, TinyPic.

Please indicate on the scale how you feel about each given statement.

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<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<td>I was immersed in this baking experience</td>
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<td>I felt annoyed while following this baking recipe</td>
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<td>I felt interested in my baking task</td>
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<td>During this baking task, I felt completely uninhibited</td>
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Please indicate on the scale how you feel about each given statement.

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<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<td>I felt discouraged while following this baking recipe</td>
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<td>I was really drawn into my baking task</td>
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<td>Baking this recipe was worthwhile</td>
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<td>I was so involved in my baking task that I lost track of time</td>
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<td>This baking recipe format was aesthetically appealing</td>
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<td>When I was baking, I lost track of the world around me</td>
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<td>This baking experience did not work out the way I had planned</td>
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<tr>
<td>I blocked out things around me when I was following this baking recipe</td>
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Please indicate on the scale how you feel about each given statement.

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On the next page, you will be asked 10 questions.

Most of the questions only require a one or two-word answer.

Please answer the questions to the best of your ability (without the aid of search engines) and if you do not know the answer, please enter "unsure" into the box.

You will have 2 minutes to answer the questions before the page will advance.
What happens to the proteins in eggs under heat?

________________________________________________________________

What is the name given for the role of sugar in baking?

________________________________________________________________

What approximate percentage of butter is fat?

________________________________________________________________

What is the name of the emulsifier found in egg yolks?

________________________________________________________________

What main function does vanilla essence have in baking?

________________________________________________________________

Why is butter called a shortener in baking?

________________________________________________________________

What is the name given for the role of flour in baking?

________________________________________________________________

What approximate percentage of molasses is found in brown sugar?

________________________________________________________________
What family of proteins is formed when flour and water mix?

__________________________________________

What does salt do in baking to enhance other flavours?

__________________________________________
Appendix III: Ethics Approval Form

21 June 2018

Assoc. Prof. J Bering
Centre for Science Communication
133 Union St East

Dear Assoc. Prof. Bering,

I am writing to let you know that, at its recent meeting, the Ethics Committee considered your proposal entitled “Recipes as Science Communication Tools”.

As a result of that consideration, the current status of your proposal is: Approved

For your future reference, the Ethics Committee’s reference code for this project is: 18/100. Approval is for up to three years from the date of this letter. If this project has not been completed within three years from the date of this letter, re-approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

Upon approval, it is expected that all members of the research team are made aware of what the standard conditions of ethical approval covers. This includes the date ethical approval expires, as well as the process regarding applying for amendments to the research.

The Human Ethics Committee asks for a Final Report to be provided upon completion of the study. The Final Report template can be found on the Human Ethics Web Page
http://www.otago.ac.nz/council/committees/committees/HumanEthicsCommittees.html
Creative Component – eBook PDF
Hi,

Welcome to Sweet Science, my little slice of compiled baking knowledge, facts, and some delish recipes.

As a keen home-baker from a pretty young age, I always loved that a few separate ingredients stashed away at the back of the cupboard could come together to make something delicious. I also enjoyed having dessert each night - it doesn’t help I possibly have the worlds largest sweet tooth!

This book was written for the purpose of supporting home-bakers. To show why we do what we get told to do in recipes, to make sense of our baked goods. To inspire others to make their own recipes because you now understand the science, and you can! Read about what happens in the minutes between that runny batter going into the oven and that dense, gooey chocolatey brownie coming out. Follow along with the videos to see what your mixes, batters, and doughs should look like at what stage. See why almost every baked recipe involves the same ingredients. Read about the history of your favourite baked good.

All photos, videos and graphics were created by myself, for the reader. They belong to me but I am more than happy to share if asked, and only when credit is given. The science information supplied has been compiled by intelligent food historians, researchers and fellow home-bakers, with a reference list supplied at the back for those interested.

A day without dessert is not a complete day, I say. So go forth, get reading, get baking, get creating and get eating!

Bailey
CHAPTER 1

SCIENCE FUN - WHAT HAPPENS IN THE OVEN?
1. FATS MELT

At 30°C-55°C, butter begins to melt, releasing air + water which contribute to making baked goods rise. The sooner fats melt, the better a tenderiser they make, as they get more time to coat structure builders (like flour) + prevent them from doing their structure-building.

2. GASES EXPAND

Oven heat evaporates water into steam, helps to generate carbon dioxide (CO2) faster during fermentation + dissolves baking powders, activating the CO2 within them. These newly formed gases move around to fill all of the little air pockets made during mixing + then as the heat increases even more, the gases expand, pushing cell walls out, causing the product to rise.

3. MICROORGANISMS DIE

With all food comes living things - mould, bacteria, yeast, viruses. However, when oven temperatures reach 55°C-60°C the heat can actually kill most of these little guys. This is beneficial as some microorganisms, like the bacterium salmonella (which is mostly found in raw animal products e.g eggs), can cause illness.

4. SUGAR DISSOLVES

When raw baking mixtures are high in moisture, most sugar is dissolved before it even reaches the oven. However, when the ratio of sugar to liquid is higher, the sugar won't have completely dissolved before the oven. Once these sugar crystals are heated, they steal water from other sources in the batter, like proteins or starches, making the batter more runny + dissolving the sugar.
5. PROTEINS DENTAURE + COAGULATE

Before they are heated, egg proteins are big, coiled, entwined molecules surrounded by water. When heated, these proteins unravel (denature), then bond together in their new forms + harden (coagulate) to form a network which holds water + surrounds air cells in the mixture. When those air cells expand, they eventually burst, leaving a solid, porous structure. This is a vital step in the structure forming of baked goods. Gluten proteins also coagulate.

6. STARCHES GELATINISE

When heated to around 50℃-60℃, small starch molecules (which make up starch granules) begin to absorb water + trap it, swelling up and softening. The water comes from any source the starch molecules have access to including proteins + gluten. At around 95℃ + only if more water is available, starch molecules move out of the granules, the granules therefore collapse + starch is released into the mixture causing it to thicken + become gel-like in texture.

7. GASES EVAPORATE

Many liquids in baking mixtures will evaporate to gases that will contribute to leavening + making the baked good rise. Some gases are lost early on in the baking process while temperatures are slowly increasing due to soft cell walls but the largest amount of gases are released when hardened cell walls burst. This big release results in a hard crust on the surface of goods as well as a loss in volume. It is this point in the process when the scent of fresh baking fills a room.

8. BROWNING OCCURS

Caramelisation is one of 2 processes that results in browning + involves sugars breaking down resulting in browning + delicious aromas. Maillard browning is the second + needs both sugars AND proteins. It can contribute a variety of flavours to a baked good. Both of these processes occur when the surface temperature of the batter or dough heats up to over 150℃, once surface evaporation has stopped. The intense heat is what causes the sugars + proteins to break down.
CHAPTER 2
WHAT TO USE? - KEY INGREDIENTS
FLOUR

The product of when wheat kernels are milled or repeatedly ground down + sifted.

Wheat kernels are made up of the endosperm, the germ + the bran but the milling process removes the latter 2 -the most nutritional parts.

The endosperm is left, high in starch + gluten-forming proteins.

Flour is a very important structure builder, if not, the most important.

When flour + water meet, gluten (a cohesive network of hydrated + swollen gliadin + glutenin proteins) forms.

Glutenin is responsible for: dough strength + elasticity.

Gliadin is responsible for: dough stretchiness.

The more a batter or dough is mixed or kneaded, the more chance flour +water molecules get to meet + form gluten.

Flour is also really good at:

• Absorbing liquids due to the high starch + protein content, helping ingredients bind together
• Providing volume to baked goods

Use high grade flour for bread products or products using yeast. The hard wheat used has high protein + therefore strong gluten-forming capabilities.

Use standard grade flour for everything else e.g. pastries, cakes, cookies. The softer wheat grain has low protein content + therefore gluten production will be weaker.
When we think of sugar, it's likely we think of the grainy white stuff in the pantry we scoop into baked goods, sucrose. But we often hear about lactose, glucose, fructose, maltose + more, all of which are sugars too.

All sugars consist of carbon, hydrogen + oxygen (O2) atoms but its the arrangement of these atoms that determines which sugar results.

Being hygroscopic, sugar pulls water away from other sources like gluten, eggs + starches causing a light syrup to form. The result is the thinning of batters + softening of the product.

Sugar is also really good at:

• Acting as a preservative by limiting microorganism growth
• Giving baked goods that beautiful brown, caramelised surface
• Providing sweet, sweet flavour - With that sweet flavour comes high calories + energy.

SUGAR

Simple carbohydrates which are broken down quickly by the body for energy.
Across the timespan of 1 day, a yolk is released from the ovary of the hen and waits to be fertilised by a rooster. If that doesn’t happen, the egg white forms around the egg, followed by the shell membranes. The shell, colour + coating then takes the longest to form (19 hours) before the egg is laid.

Emulsifiers are molecules with the ability to unite water + oil. They do this because 1 part of the molecule loves water (hydrophilic) while the other end loves fats + oils (lipophilic).

Eggs are both an emulsifier + an emulsion themselves (because fat droplets are held within egg yolks).

**Lecithin** is the most well-known emulsifier within egg yolks (makes up 10% of the yolk).

**Egg white, or albumen**, consists of around 90% water + 10% protein with tiny amounts of glucose.

**Egg yolks** consist of 50% moisture + 50% yolk solids (proteins, fats, emulsifiers, mineral ash, yellow-orange carotenoids).

The more eggs are heated, the more egg proteins group together forming a rigid, tight coagulated protein network. If over-coagulation occurs, the proteins will curdle + shrink up, squeezing all the liquid out, producing a rubbery, dry baked good. Slowing down coagulation is therefore beneficial to achieving a soft, tender baked good.

Eggs are also really good at:

- **Structure building.** Egg whites can be whipped up to 8x their original volume + create a stable foam allowing spaces for air to move in to.
- **Creating glossy brown surfaces on goods when used as an egg wash.**
When milk or cream is churned or shaken, the walls of milk fat globs are broken apart. When this happens, the released fat globs join together, forming a solid product, butter.

This process is actually changing an oil-in-water (milk) emulsion into a water-in-oil emulsion (butter) = requires a whole lot of energy e.g. intense churning.

Butter mostly consists of 80-82% butterfat, with 18% water, some milk solids + sometimes some added salt.

Butter is really good at:

• Providing unrivaled mouthfeel + flavour because it has the same melting temperature as the human body, 37°C.

• Giving moisture + tenderness to goods like cakes but flakiness to pastry by coating gluten, starches + egg proteins preventing them from hydrating + structure-building.

• Providing proteins + lactose which contribute to Maillard Browning reactions.
LEAVENERS

The products which cause baked goods to rise, resulting in voluminous, tender goods that are easily digestible.

3 main leavening gases:
  - steam
  - air
  - carbon dioxide (CO₂)

3 types of leavening:
  - physical (steam, air)
  - biological (yeast)
  - chemical (baking powder/soda)

AIR: ALL baked goods need air to leaven, no ifs, no buts. Air gets incorporated into batters by physical leavening (whipping, creaming, kneading, folding). It gets broken down into small air cells which are evenly dispersed throughout the batter then later get filled with steam + CO₂ to fill + expand within.

STEAM: ALL baked goods also need steam to leaven. Steam is just the gaseous form of water + because all baked goods contain water or liquid of some sort, it’s a factor in all baking. The temperature of the oven has to be high enough for evaporation of liquids to occur to cause steam. But when it happens, steam can be super advantageous to leavening, occupying up to 1600x more space than water.

CARBON DIOXIDE: There are 2 sources of CO₂ for leavening; yeast fermentation + chemical leaveners (baking soda or baking powder). The liquids in batters + doughs generally dissolve CO₂ when it is first created but when enough air is created + warmed in the oven, CO₂ will move into air cells + cause them to expand.

BAKING POWDER: A chemical powder formed of baking soda + acid salts + starch. When mixed with liquid, the acid salts release the acid, reacting with the baking soda + producing carbon dioxide.

BAKING SODA: A chemical compound formed of salt that decomposes in the presence of moisture + acids. When it breaks down, it results in carbon dioxide + water + salt residue.
CHAPTER 3
WHAT TO EAT? - 10 RECIPES
RECIPIES

SPICED APPLE MAPLE CAKE

VANILLA BABYCAKES

CHUNKY CHOC CHIP COOKIES

ULTIMATE CINNAMON SCROLLS

DOUGHNUTS

MINI MACARONS

COCONUT MARSHMALLOW

GOOEY CHOCOLATE BROWNIES

SWEET SHORTCRUST TARTS

NEW YORK CHEESECAKES
SPICED APPLE MAPLE CAKE

Cake:
2 apples, peeled, cored, diced
1 tbsp lemon juice
1 tbsp brown sugar
125g butter, diced, softened
100g white sugar
100g brown sugar
2 eggs
1 tsp golden syrup
2 tsp vanilla
½ cup oil
½ cup milk
200g standard flour
2 tsp baking powder
1 tsp salt
1 tsp cinnamon
1 tsp nutmeg
½ tsp allspice
1 cup chopped walnuts

Prepare a cake tin with a light brush of butter or baking paper and preheat oven to 180°C.

Place apples in a small bowl and drizzle with lemon juice and 1 tbsp of brown sugar. Put aside.

Used as a defence mechanism against insects, many plants contain an enzyme called polyphenol oxidase. The enzyme is released when the plant is damaged, it then comes into contact with oxygen (O2) in the air and turns the plant brown, this result acting as a deterrent to bugs and animals and allowing the plant to heal.

Lemon juice however, is packed with vitamin C (AKA ascorbic acid) and its this ascorbic acid which reacts with oxygen before the polyphenol oxidase gets a chance to. This postpones the process of the apples turning brown.

In a large mixing bowl, cream together the butter and both sugars with an electric mixer on medium speed until pale in colour and fluffy in consistency.

Mix in both eggs, golden syrup, vanilla, oil and milk with electric mixer until combined and smooth.

The oil here is used as a tenderiser, helping to keep the cake nice and moist. In a cake, we don’t want full gluten formation like we do when making breads, or else the cake would be chewy. Urgh. This is why cake recipes generally contain a decent amount of liquids. The water dilutes proteins in gluten, breaking it down, and a liquid very good at doing just that is oil.

Add the flour, baking powder, salt and spices and mix with a wooden spoon until the mixture is smooth. Quickly beat the mixture with an electric mixer to remove lumps.

All spices contain high amounts of volatile oils (essencial oils) oils which easily evaporate. Spices have different flavours based on different concentrations of volatile oils and contribute the beautiful aromas and flavours to the goods they are in.

Add in the apple pieces and walnuts and combine gently.
The best apples for baking (especially for pies in particular) are thought to be Granny Smith due to the sour taste, strong scents and rigid structures.

Fun fact: Apples consist of lots of small, tightly-packed and water-filled cells. When your teeth bust through these cells, that water is released so quickly that vibrations go through the air, creating that crisp sound.

Pour into the prepared pan and bake for 50 minutes or until springy when touched.

If cake batter is under-mixed, not enough air is whipped into the batter, resulting in a coarse cake crumb and a cake low in volume. Gases that get a chance to form will move into the little amount of air cells available, expanding them greatly and making them prone to collapse.

If cake batter is over-mixed, too much air will be whipped into the batter, making the walls of the air cells too thin and overstretched and therefore, weak. When baked in the oven, the cells will expand even more and eventually collapse.

Remove from oven and leave to completely cool before icing.

To make the icing, sift the icing sugar and cinnamon into a small bowl.

Add just a touch of water until the icing begins to form.

Slowly add the maple syrup and consistently mix until combined and consistency is smooth.

Pour the icing across the cake, using a spatula to spread across, allowing the icing to drip down the sides before serving.

Enjoy!
VANILLA BABYCAKES

Cupcakes:
- 150g unsalted butter, softened
- 1 cup caster sugar
- 2 eggs
- 1 cup milk
- 2 tsp lemon juice
- 1 tsp vanilla extract
- 1 tsp vanilla bean paste
- 1 cup all-purpose flour
- ½ cup almond meal
- 1 ½ tsp baking powder
- ½ tsp salt
- 1 cup desired filling

Prepare a cupcake pan with a light brush of butter and preheat oven to 180°C.

In a small bowl, combine the milk and the lemon juice and set aside for 10 minutes until thick and curdled. This will become the buttermilk.

Milk is made of mostly water (88%), a scoop of proteins (3.3%), a dash of sugar (lactose), and some vitamins & minerals, milk fat and emulsifiers. That small percentage of proteins found in milk are actually really important. Casein proteins easily coagulate and group together when they interact with an acid (like lemon juice) or certain enzymes, helping to thicken a mixture and create a substance like buttermilk.

In a large mixing bowl, cream together the butter and sugar with an electric beater on a medium speed until pale in colour and fluffy in consistency.

Creaming blends sugar and fat together and is a mechanical leavening method to incorporate air into the mixture by creating air cells.

Add the egg and both vanillas and beat together with the electric mixer until all combined.

When extracts are made, flavour agents (e.g. vanilla beans) are soaked in alcohol for weeks at a time. Alcohol is used because of its superior ability to dissolve and suck out all of the flavour molecules when compared to water.

Essences however are imitation flavourings and are generally much more cost effective made from synthetic chemicals imitating a vanilla flavour.

Vanilla bean paste is authentic like the extract but a thicker mix (hence the term “paste”). Its full of tiny little vanilla seeds which really add aesthetics to the baked good and make them look super boutique-y.

Gently mix in the buttermilk with a wooden spoon until combined.

Add the flour, almond meal, baking powder and salt, mixing with a wooden spoon until combined then beating with the electric mixer until smooth.

Icing:
- 1 cup icing sugar
- ½ cup butter, softened
- 1 tsp vanilla essence
- ½ cup desired filling
- ½ tsp food colouring, if desired
Spoon even amounts of the mixture into the prepared cupcake pan and place in oven for 20 minutes or until springy when touched and completely cooked through.

Remove cupcakes from oven and leave to cool for 20 minutes before transferring to a wire rack.

Ensure cupcakes are completely cool before flipping cupcakes over and cutting small 1cm diameter holes into the middle of each cupcake.

Using a teaspoon, gently fill each cupcake hole with desired filling.

In a small bowl, add all icing ingredients together and beat with an electric mixer until all ingredients are combined and the consistency is thick but still liquid.

Using a tablespoon, drizzle the icing over each cupcake, allowing the icing to run down the sides before serving.

Enjoy!
150g unsalted butter, diced
1 ½ tbsp peanut butter
½ cup brown sugar
½ cup white sugar
1 tsp vanilla extract
1 egg
2 cups all-purpose flour
½ tsp baking soda
½ tsp salt
1 cup mixed chocolate chips

Preheat oven to 175°C and prepare a large baking tray with either baking paper or non-stick oil spray.

In a large mixing bowl, melt together the butter and peanut butter in the microwave for 1-2 minutes.

Many cookie recipes call for the creaming of the butter and sugar which incorporates air into the mixture, helping to lift the cookies when baking. This recipe however uses melted butter as the resulting cookies will be chewier.

Using a wooden spoon, mix the butter and peanut butter until combined then add both sugars.

Brown sugar is just normal white sucrose sugar with added molasses. The molasses contributes to the brown colouring, flavour and moisture, and make cookies chewier.

Add the egg and the vanilla, mixing until combined.

Next add the flour, baking soda and salt, mixing the dough together until all combined. If the dough is too sticky, add a sprinkle of flour.

Baking soda in cookies does a whole lot of things. Firstly, it increases the pH which actually increases the spread of cookies when they are baked by weakening the gluten structure.

You’ll find salt in every recipe and although used in small quantities, it has a big role in baked goods. Salt modifies flavour as it absorbs excess water, preventing the dilution of flavours. It also helps to increase the crust colour of goods.

Gently mix in the chocolate chips.

Place the mixture, covered, in the fridge for at least 30 minutes and up to 1 hour if time permits.

To prevent the cookies from excessively spreading when in the oven, the 1 hour refrigeration time helps solidify the butter again. It also gives the cookies a coarser crumb, encouraging cookies to dry and crisp faster, as well as increases the rate of browning.
Remove the cookie dough from the fridge and scoop out small handfuls of dough, rolling into small balls. Place on tray, evenly spaced apart.

Bake for 8-10 minutes until very lightly browned.

The sugar in the cookies will draw water from proteins & starches and will slow down protein coagulation (grouping) and encourage the spreading of cookies as there is more moisture in the dough. However, when proteins do coagulate once the suitable temperature is reached, cookies will stop spreading.

Leave to rest until the cookies are firm.

Enjoy!
Dough:
1 cup milk
2 ¼ tsp active dry yeast
½ cup white sugar
⅓ cup butter, melted
1 egg
3 ¾ cups high grade flour + ¼ cup for hands/dusting bench
1 tsp salt

Filling:
¾ cup softened butter
1 cup brown sugar
3 tbsp cinnamon
½ cup raisins (optional)

Icing:
1 cup icing sugar
½ cup cream cheese
2 tbsp milk (or water)

Preheat oven to 50°C and once reached, turn the oven off.

In a large mixing bowl, heat the milk in the microwave until hot to the touch then gently mix the yeast into the milk and leave to rest for 10 minutes until bubbly and frothy on the top.

Many old, old bread recipes call for scalding the milk. This was common practice due to different milk processing processes back in the day where some bacteria and enzymes remained in milk and would affect baked goods. Today however, scalding is not necessary, but having warmed milk helps to dissolve the yeast and break down other ingredients.

When the yeast mixture is frothy, add the white sugar, butter, egg, salt and flour and mix until a soft dough forms. Remove the dough from the bowl with floured hands and knead on a floured surface for 10 minutes.

Grease the large mixing bowl with a drizzle of oil and return the kneaded dough to the bowl. Cover the bowl with a damp tea towel and place into the warm oven. Leave for 1 hour until dough has doubled in size.

The first time dough is left to rise is called bulk fermentation or primary fermentation. During kneading, the dough becomes more extendible and all the CO₂ forming expands that gluten network causing the dough to rise.

Prepare a large baking tray with baking paper.

After 1 hour, remove the dough from the oven and roll out on a floured surface until 1cm thick.

Rub the softened butter across the dough leaving a 2cm border around the edge clean.

In a small bowl, mix the brown sugar and cinnamon together with a fork. Sprinkle the sugar mix evenly across the butter followed by the raisins.

When spices like cinnamon, are added directly to bread dough, the tiny particles interfere with the structure of gluten by making it shorter and weaker. The cinnamon therefore is not added directly to the dough but added on top of the dough, later.
Ultimate Cinnamon Scrolls

Raisins are dried grapes that have been left in the sun for several weeks to darken and dry out. Among contributing flavour, sweetness and colour to baked goods, raisins also extend the shelf life due to their hygroscopic nature, drawing moisture into the product. Small amounts of antimicrobial agents within raisins also help prevent mould growth.

Begin rolling the dough from the short edge tucking the dough tightly while being rolled. When the length of the dough is completely rolled, smooth the edge down into the other side with fingers or a fork, ensuring the dough won’t come unstuck. With a sharp knife, slice the log of dough into equally-sized rolls around 3cm thick. Place the rolls on the tray and leave to rise for another 30 minutes.

The second resting period is called final proofing/second proofing/secondary fermentation. After shaping the dough, the gluten strands need to readjust to this new shape they are now in.

Bread doughs need these resting periods to allow the yeast to do its thing + ferment properly, for gluten to develop + so the dough can mature and be its best self.

While waiting for the second proofing, preheat the oven to 200°C.

After 30 minutes, place the scrolls in the oven for 20 minutes or until lightly browned.

When cool, prepare the icing.

In a small mixing bowl, soften the cream cheese in the microwave.

Add the icing sugar and beat with an electric mixer on a low speed until incorporated.

Add the milk (or water) and beat until combined and the desired consistency and with a teaspoon, drizzle over the scrolls.

Enjoy!
Preheat oven to 50°C and once reached, turn the oven off.

In a large mixing bowl, heat the milk in the microwave until hot to the touch then gently mix the yeast into the milk and leave to rest for 10 minutes until bubbly and frothy on the top.

When the yeast mixture is frothy, add the sugar, butter, egg, vinegar and vanilla mix gently until combined.

Add the flour, cornstarch and salt gradually while continuously mixing until a dough forms. If the dough is too sticky, continue adding small amounts of flour until the dough becomes a unit.

When dough is over-mixed, too much gluten can form. This would change the resulting product from soft, breakable, and fluffy to dense and stretchy. When too much gluten forms, the already-established gluten network gets so overworked it begins to break down. Gases or liquids can not be held within the network and the product is very likely to collapse.

Remove the dough from the bowl with floured hands and knead on a floured surface for 10 minutes or until the dough is slightly sticky but can hold its shape.

In bready-y baked goods, the dough needs to be kneaded. Kneading encourages extensive gluten formation and therefore a strong network capable of trapping gases like oxygen (O₂). Oxygen in turn encourages the strength of gluten and helps to evenly distribute ingredients and particles throughout the dough. What also aids in keeping the dough uniform is turning the bread 90 degrees every so often while kneading. It helps to get all the flour particles interacting with liquid. Gluten formation can be seen in the dough as it is worked and becomes smoother and drier.

Grease the large mixing bowl with a drizzle of oil and return the kneaded dough to the bowl. Cover the bowl with a damp tea towel and place into the warm oven. Leave for 1 hour until dough has doubled in size.
After 1 hour, remove the dough from the oven and roll out on a floured surface until 2cm thick.

Cut out circular rounds from the dough as big or small as desired and leave to rest for 30 minutes.

Pour oil into a large saucepan, and heat on medium heat using a food thermometer to measure the oil temperature. When the oil reaches 180°C drop the rounds of dough in 2 or 3 at the time and wait until they are nicely browned on one side before flipping over with tongs.

Use tongs to remove doughnuts from when nicely browned all over and have puffed up evenly. Drain doughnuts in a sieve over a bowl before transferring to a paper towel when cool to further drain oil.

When completely cooled, make a hole in each doughnut with the end of a wooden spoon. Use a piping bag or tool to insert desired filling into doughnuts and sprinkle with icing sugar before serving immediately.

Enjoy!

Fermentation is the process where organisms (like yeast) convert sugars into CO₂ + alcohol + some energy for the purpose of growth, reproduction, survival.

Little single-celled organisms like yeast are especially useful in baked goods like breads for their ability to produce carbon dioxide CO₂, an agent used to make the dough rise + be light, fluffy + delish.

Yeast + sugar --> CO₂ + alcohol + energy (+ flavour molecules)

During fermentation, an enzyme, called amylase, works to break down sugars (in the form of starch) into smaller units. This sugar is then used as yeast food to continue the process. The alcohol produced by the reaction is important in early baking as it evaporates, causing that first, fast rise of the bread when baking.

Ideal temperatures for yeast fermentation fall between 25 and 38°C. If temps are too hot, fermentation will occur too quickly + appropriate flavours won’t have time to develop. However, if the dough is left too long + too much fermentation occurs, the gluten network will begin to weaken.

Generally speaking, the more yeast, the faster the fermentation, however too much yeast will alter the flavour of the dough as well as exhaust it.
MINI MACARONS

1 cup almond meal
1 ⅓ cup icing sugar
⅛ tsp salt
3 egg whites, aged
½ cup white sugar
⅜ tsp vanilla bean paste
2-5 drops gel food colouring (any colour)

Prepare a large baking tray with baking paper or prepare a macaron tray and preheat the oven to 160°C.

In a large mixing bowl, sift together the almond meal, icing sugar and salt, discarding the remaining almond meal. Set aside.

When sucrose (classic white sugar) gets ground down very finely, and a tiny bit of cornstarch is added, the result is icing sugar. The cornstarch prevents the icing sugar from glugging together but it also helps when icing sugar is used in icing to help the icing set like a glaze.

In a medium mixing bowl, beat the egg whites until frothy.

When making macarons, if volume is more important than stability, room temperature and aged egg whites should be used.

Fats and oils prevent egg proteins from unfolding and aggregating and then take up valuable space on the foam bubble surface, preventing a well-structured network from forming. Therefore, it is not wise to use a plastic mixing bowl when making meringues as plastic absorbs fats and oils which may alter the desired result of the meringue.

Slowly add in the sugar, consistently beating until the mixture thickens and becomes white.

When meringue is made and the sugar is added, it actually slows the whipping process and actually decreases the foam volume ever-so-slightly, so to help retain as much of that volume as possible, the sugar must be added slowly. This prevents the foam from being weighed down as the crystals get sufficient time to dissolve. Adding the sugar slowly is also important as it gives time for the egg proteins to unfold completely which would result in soft meringues.

When sugar dissolves during whipping, it forms a thick syrup which coats air bubbles protecting them from collapse.

Add the colouring and continue beating until the mixture has stiff peaks and can hold its shape.

When eggs get whipped, a whole lot of air is incorporated into the liquid causing egg proteins to denature and unfold. Once unfolded, the proteins move to the surface of air bubbles, quickly bonding with neighbouring proteins around the air bubbles. This creates a flexible network where bubbles already trapped are unlikely to collapse yet more bubbles can be incorporated with further whipping. The proteins responsible for this process include ovalbumin, conalbumin, globulin, ovumucin and lysozyme. They unite and together provide a huge amount of foaming power and stability to a baked good when sufficiently whipped.

Over-whipping egg whites denatures and aggregates proteins too aggressively so the flexible network gets overstretched and rigid, eventually collapsing.

Under-whipping egg whites will result in proteins that aren’t fully aggregated.
Gently fold the egg mixture into the almond mixture with a spatula until the consistency reaches a point where a “figure 8” can be created when letting the mixture drip off the spatula, without breaking.

Spoon the mixture into a piping tool and squeeze out 2 cm diameter rounds, spacing them around 4-5 cm apart across the tray.

**Tap the tray** hard 5 times on the edge of the bench and rotate the tray, repeating the taps on each side.

This helps to pop the large air bubbles in the macaron batter, ensuring they will be of a smooth consistency when baked.

Sprinkle any desired toppings on the wet macarons before leaving in a non-humid area until the surface of the macarons is dry to touch.

Place macarons in the oven for 7 minutes until meringue has risen but not cracked.

Remove tray from oven and leave to cool.

Make desired filling.

Pipe filling onto the middle of one macaron shell then gently twist the other shell on, spreading the filling evenly between the two shells.

Store the macarons in a container and refrigerate overnight before serving.

Enjoy!
Prepare a large baking tray with baking paper. Sprinkle coconut across tray and grill in oven at 200°C for 3 minutes or until nicely browned. Remove coconut from oven and set aside.

Prepare square pan or with baking paper and sprinkle only half of both the cornstarch and icing sugar evenly across the bottom and sides.

Pour ½ cup water into a small bowl and sprinkle the gelatin over the waters surface. Put aside for 5 minutes until mixture is thick.

Gelatin, the substance made from large animal protein molecules, is an extremely effective thickening and gelling agent. Taken from pig skin or cow bones and hides, gelatin melts at a temperature lower than body temperature (around 37°C) so generally contributes to a soft, pleasant mouthfeel. Gelatin requires blooming to ensure it doesn't clump when subsequently used in a recipe. To bloom gelatin is to hydrate gelatin, by adding it to cold liquid and allowing it to swell and the mixture to thicken.

Add the remaining water, glucose syrup, sugar and salt to a small saucepan and bring up to 116°C, no higher, until the mixture has thinned.

Glucose syrups results from starches undergoing a process called hydrolysis. Starches, like cornstarch for example, are made up of many, many glucose molecules all bonded together. In hydrolysis, a process taking place in the presence of water, the big starch molecules break up into smaller units, creating a syrup. This syrup is then refined and filtered through a series of steps removing the colour and flavour. The resulting syrup is extremely thick and colourless and extremely useful for softening the texture of goods as well as adding extensive volume to products, making in perfect for marshmallow.

Transfer the bloomed gelatin into a very large mixing bowl and beat with an electric mixer on low speed until slightly frothy.

Slowly add the sugar syrup, continuously beating.

When all of the sugar syrup has been incorporated, increase the mixing speed, beating on a medium to high speed until the mixture is slightly thickened and white in colour.
Add the vanilla and continue beating on medium-high speed until very thick and white.

Pour into the prepared pan, sprinkle the remaining cornstarch and icing sugar over the top as well as the coconut and leave to cool before placing in the fridge to set overnight.

Once set, remove the marshmallow from the pan and, using a hot knife, slice into evenly sized squares before serving.

Enjoy!
GOOEY CHOCOLATE BROWNIES

150g butter, diced
1 cup dark chocolate pieces
⅔ cup white sugar
⅔ cup brown sugar
2 tsp vanilla extract
3 eggs
1 cup all-purpose flour
¼ cup Dutch-process cocoa
1 tsp salt
1 cup chocolate pieces (any)

Preheat oven to 165°C and prepare a brownie pan with either baking paper or non-stick oil spray.

In a large mixing bowl, melt together the butter and the dark chocolate pieces in a microwave by heating for 30 seconds at a time, mixing in between.

Chocolate, obviously very important in gooey chocolate brownies, is the product of cocoa beans. Grown in hot, humid, equatorial regions, cocoa trees produce cocoa fruit bearing the cocoa seeds or beans which are processed to produce a variety of products, the most popular being chocolate.

Once the beans have been processed (crushed, roasted and ground), chocolate liquor, a paste-like substance is the result. When chocolate liquor is further processed (separated by hydraulic pressing), cocoa butter melts out and a presscake is left. This presscake is then ground down forming naturally acidic, natural cocoa powder. When sugar is added to cocoa, we call that hot chocolate mix.

Adding melted dark chocolate to the brownie contributes not only to colour and flavour but also mouthfeel. The proteins and carbohydrates within cocoa solids are also good for absorbing excess liquid.

Whisk in both sugars until combined.

Using an electric mixer, beat in the vanilla and the eggs, individually, until mixture is smooth and silky.

Beating the eggs for a decent amount of time actually helps to create a crispy surface on the brownie when its cooked as the sugar and eggs beat to form a meringue!

Sift the flour, cocoa and salt together and incorporate into the wet mixture with a wooden spoon.

Dutch-process cocoa is treated with a mild alkali before the cocoa beans are even ground. The result is smoother, with a less bitter taste than natural cocoa and produces darker colour, ideal for a rich brownie.

Gently mix in the chocolate pieces.

Bittersweet dark chocolate usually involves chocolate liquor, sugar, cocoa butter, emulsifiers, flavours and sometimes a dash of dairy. These ingredients are continuously refined using a melangeur (chocolate grinding machine) then pressed and rolled some more, releasing fat particles and making the chocolate flow nicely when its melted. A conche (chocolate polisher) is then used to ensure cocoa butter is evenly dispersed amongst the mixture. The chocolate is then tempered (controlled heating) to control the crystal sizes in the cocoa butter so that when the chocolate is subsequently molded and cooled, the consistency will be even with the signature, smooth chocolate mouthfeel.
Milk chocolate has less cocoa solids than dark chocolate but still undergoes the same processes - refining, conching, tempering and molding. The result however is a sweeter chocolate more mellow in flavour, and softer in texture due to the smaller amount of cocoa solids and added dairy. Milk and dark chocolate cannot be used interchangeably because of this difference in cocoa solids.

White chocolate technically isn’t really chocolate based on the fact it doesn’t contain any cocoa solids at all. Sugar, cocoa butter, milk solids, and flavourings contribute to the especially sweet “chocolate”.

Pour mixture into the prepared pan and place in oven for 40-50 minutes until still slightly gooey when a knife is inserted.

Let the brownie cool before slicing and serving.

Enjoy!
In a large mixing bowl, sift the flour and salt together.

To keep shortcrust pastry tender and flaky, the flour needs to not become fully hydrated. Full hydration will occur when moisture from the butter is released if it begins to melt, hence the trick to preventing the flour from hydrating is to keep the dough as cold as possible, even halting the processes mid-way to re-refrigerate the dough.

Add the butter and rub into flour with fingertips until the consistency of fine breadcrumbs. If the butter starts becoming too soft and the mixture is warming, place the bowl in the fridge for 10-15 minutes.

The more fat (butter) is worked into the flour before water is added, the more tender the pastry will be.

Mix in the icing sugar until evenly dispersed.

In a separate bowl, mix together the egg yolk and water with a fork.

Egg yolk is used in pastry as egg yolk proteins don’t coagulate as fast as egg white proteins, producing a more tender product.

Slowly add the egg mixture to the dry mixture, bringing it together with a knife until the dough comes together, some egg mixture should remain.

Combine the dough into one solid form before covering with cling film and refrigerating for at least 1 hour.

The pastry dough must be given time to relax in the fridge as this gives the water molecules within the dough time to disperse evenly throughout the mixture. This will stop the pastry having uneven consistency with some parts soggy and some parts crumbly.

Preheat the oven to 180°C and prepare tart cases or a mini muffin pan with a light covering of softened butter.

After 1 hour, remove the pastry dough from the fridge and gently roll out with a floured rolling pin onto a floured surface until 5mm thick.
Cut out circles from the dough with a cutter and gently insert the rounds into the prepared pans.

Pierce holes into the pastry cases with a fork and blind bake in the oven for 15 minutes.

Remove pastry cases from the oven and remove blind baking tools.

Brush the bases with remaining beaten egg mix and place back in oven for a further 10 to 15 minutes until cases are browned and completely dried out.

Remove tart cases from the oven and cool before adding the desired filling.

Enjoy!
NEW YORK CHEESECAKES

Base:
250g superwine biscuits
150g butter
1 tbsp golden syrup

Cheesecake:
500g cream cheese
125g sour cream
⅔ cup caster sugar
2 eggs
2 tbsp condensed milk
1 tsp vanilla bean paste
¼ tsp cinnamon
¼ tsp nutmeg
½ tsp salt

Prepare a cupcake pan by lightly greasing just the bottom of each hole with butter.

Place biscuits into a ziplock bags being careful not to overfill and use a rolling pin to crush biscuits until fine consistency. Transfer biscuit crumbs to a small bowl.

Add melted butter and golden syrup to the biscuit and mix until combined.

Golden syrup is one form of invert sugar syrup made from normal cane sugar (sucrose). When sugar cane is refined and pressed, sugar cane juice is produced. When this juice is boiled and concentrated, sucrose is broken down into fructose and glucose and the result is golden syrup. The syrup is hygroscopic meaning it draws water in so when golden syrup is used in baking, it can add a lot of moisture.

Add a small handful of base mixture into each cupcake hole, pressing down firmly with clean hands. Refrigerate for at least 1 hour.

Preheat oven to 160℃.

A lower oven temperature is needed to prevent the egg proteins from recoiling too tightly and resulting in a curdled texture.

In a large mixing bowl, add the cream cheese, sour cream and caster sugar, lightly beating with electric mixer until just combined.

Add eggs, condensed milk, vanilla, spices and salt, mixing on medium speed electric mixer until smooth, combined and creamy.

Eggs are pretty important to cheesecakes when no starch is used. The emulsifiers within eggs contribute to the silky smooth texture while egg proteins in general unravel and rejoin under heat, thickening the mixture.

Sweetened condensed milk is created when milk is evaporated and sugar is added. When milk is evaporated, heat is quickly applied and that heat energy breaks apart the water molecules within the milk, turning the water from a liquid to a gas. The reduced water content results in a thickened milk product. Sugar is then added making the product denser and sweeter.

The light golden hue and caramel flavour of sweetened condensed milk comes from the Maillard Browning reaction when heat was applied. Maillard Browning is a chemical reaction between sugars and proteins occurring in the presence of heat. Many different chemical products result from Maillard browning causing a huge array of different flavours from sweet caramels, to nutty grain-like flavours.
Using a tablespoon, scoop even amounts of cheesecake filling into cupcakes cases, almost completely filling the cups.

Place in oven for 15-20 mins until the very centres of the cheesecakes still slightly wobble.

Let cool before sprinkling with cinnamon and serving.

Enjoy!
# Fillings

## Chocolate Ganache

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 tsp instant coffee</td>
<td></td>
</tr>
<tr>
<td>3 tbsp boiling water</td>
<td></td>
</tr>
<tr>
<td>1 ½ cup dark choc drops</td>
<td></td>
</tr>
<tr>
<td>¼ cup cream</td>
<td></td>
</tr>
<tr>
<td>2 tbsp butter</td>
<td></td>
</tr>
<tr>
<td>¼ cup icing sugar</td>
<td></td>
</tr>
<tr>
<td>½ tsp salt</td>
<td></td>
</tr>
<tr>
<td>Pinch of salt</td>
<td></td>
</tr>
</tbody>
</table>

In a small bowl, combine coffee and water. Set aside.

In a small saucepan, over low-medium heat, combine cream and butter. Do not allow to boil. Add coffee mixture and mix.

Remove from heat.

In a large bowl, pour cream mixture over chocolate chips and whisk until completely combined, and smooth.

Leave to cool slightly before putting in fridge to solidify for 30 mins.

Remove from fridge and beat in icing sugar until combined.

Return to fridge until desired consistency is reached.

## Berry Filling

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cup mixed frozen berries</td>
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</tr>
<tr>
<td>¼ cup water</td>
<td></td>
</tr>
<tr>
<td>¼ cup sugar</td>
<td></td>
</tr>
<tr>
<td>1 tbsp cornstarch</td>
<td></td>
</tr>
<tr>
<td>½ tsp vanilla bean paste</td>
<td></td>
</tr>
<tr>
<td>¼ tsp salt</td>
<td></td>
</tr>
</tbody>
</table>

In a small saucepan over low-medium heat, combine all ingredients.

Mix with a whisk and continue whisking as mixture begins to thicken and bubble.

Remove from heat when filling is of a smooth consistency and thick.

Leave to cool.

## Caramel Filling

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 tsp cornstarch</td>
<td></td>
</tr>
<tr>
<td>½ cup milk</td>
<td></td>
</tr>
<tr>
<td>1 tbsp golden syrup</td>
<td></td>
</tr>
<tr>
<td>2 tbsp condensed milk</td>
<td></td>
</tr>
<tr>
<td>50g butter</td>
<td></td>
</tr>
<tr>
<td>½ tsp salt</td>
<td></td>
</tr>
<tr>
<td>½ cup brown sugar</td>
<td></td>
</tr>
<tr>
<td>2 tsp vanilla bean paste</td>
<td></td>
</tr>
</tbody>
</table>

In a small saucepan, combine all ingredients.

Mix with a whisk and continue whisking as mixture begins to thicken and bubble.

Remove from heat when filling is of a smooth consistency and thick.

Leave to cool.
CHAPTER 4
A LITTLE BIT MORE - HISTORY OF THE BAKED GOODS
The term ‘cake’ encompasses an entire history of delicious flavours, textures, layers, designs, icings, ganaches... the list in infinite. So how did cakes come about and why are we so passionate about having our cake and eating it too?

Cake actually has some common ancestors in bread, porridge and pancakes. Archaeologists recently found evidence for bread dating back over 14,000 years to the Stone Age, thought to be a part of a religious ceremony. The bread found at the Shubayqa 1 site in northeast Jordan, also host to stone buildings and tool artifacts, was thought to have existed 3500 years before agriculture. At that time, food was likely to have been eaten purely for nutritional value. However, the energy gained from the bread made of wild cereal would not have been enough to outweigh the energy lost from preparing the item. This implies potentially a social or ideological reasoning for the making of the bread. Perhaps for a feast commemorating the dead, or a religious display? Other archaeological deposits of bread loaves once thought to be the earliest forms of cake were found at Neolithic lake sites in Switzerland. The Neolithic period was the final stage of the “Stone Age,” a time period that began and ended around 12,000 years ago. These “cakes” consisted of crushed grain including linseed, wheat, and millet, moistened and shaped into flat round discs.

Both the Greeks and the Romans had names for cakes; ‘plakous’ for the former and ‘placenta’ by the latter. Cakes have always seemed to be rounded lumps of food and, much like they are today, cakes were made to be the centerpiece of a feast. Large, sweet and round, they were the perfect decorative addition to a table of food at religious celebrations.

During the Italian Renaissance, cakes got a makeover. Towards the end of the 17th century, cake hoops were invented. Cake hoops gave cakes solid supported walls during the baking process, much like a modern day cake tin. Kitchen spaces with ovens were also becoming more popular. More importantly, however, was the discovery of using beaten eggs to raise a cake, replacing the use of yeast as a raising agent. It sometimes took up to an hour of hand-beating the eggs to provide enough lift for the cake.

The discovery of other potential raising agents occurred in the 18th century, particularly with the creation of a substance called pearl ash. Pearl ash, also known as potassium carbonate, was the white powder remaining after potash (salt minerals containing potassium) were heated in a kiln at extreme temperatures. It was used in America at the same time as baking soda but it wasn’t until the mid 19th century when one of the most commonly used raising agents today, baking powder, (made of baking soda, acid salts and starch) was created.

When World War II started in 1939, the rationing of food meant limited ingredients available for cake making. Cakes had been symbolised for the past century as a joy-inducing, celebratory item, which wealthy women would dress up in their best attire for every afternoon. Inventive food writers of the war era made cake recipes using whatever ingredients were available as a way to lift spirits, reminding the populace of happier times when women would get dressed up for the daily afternoon tea and cake. One such recipe consisted only of sugar, hot water, lard, cheap spices and raisins. In fact, it wasn’t until the 1970s when the wholemeal food buzz saw a return of the quality cake.

Whether used in religious ceremonies, as centerpieces of a feast or as an afternoon treat, cakes have always had some sort of sentimental value to us.
BABYCAKES

Were cupcakes named for the fact they took a cup of butter, a cup of sugar and a cup of flour to make? Or were they named because, at some point in time, the mixture was placed in small cups and baked in the oven? Unknown. What is known is that miniature versions of our favorited baked good, cake, are very well-liked and seem to have cropped up in the foodie market after WWI. Some food historians recognise Queen Cakes - small fruity cakes baked in individual portions - which were pretty well-liked in the 18th century - as perhaps the original cupcakes.

The growth of the cupcake was thanks to foodie and felon, Martha Stewart. Before her five-month stint in jail for insider trading, Stewart's 1982 cookbook set up picturesque scenes that your average housewife could only dream of living up to, yet the ideals were beautiful and inspiring. Cupcakes were something that only the most put-together ladies could conjure up. However, they became much more accessible to the average Joe in the 1990s, thanks to Magnolia Bakery in New York. As the story goes, one day a small amount of leftover cake batter called for an emergency trip to the store for paper cupcake cases, and the rest is history. The lines at Magnolia would wrap around the building and the cupcake craze was only fueled by the appearance of the bakery on the TV show, Sex and the City.

Co-owners of Magnolia, and friends at the time, Jennifer Appel and Allysia Torey had to limit customer orders to 12 cupcakes to meet the demand. In a city like New York, with the constant flow of people and action, a cupcake was perfect. It was small and portable, not to mention cute and photo-worthy. Like cake, cupcakes also could recreate those feelings of happiness along with childhood nostalgia and, as some have put it, motherly vibes, phenomenal aspects you'd be hard-pressed to find so readily in the middle of New York City. When differences about the growth of the bakery split the two friends apart, Jennifer went on to create her own rival cupcake shop across the street. The cupcake craze had begun and it hasn’t stopped since.
We all love a good cookie. And there are endless kinds. Sugar, peanut butter, chocolate chip, oatmeal, even just raw cookie dough, forget waiting for them to bake. But where on earth did these delicious little nuggets of chewiness come from?

Cookies are thought to have originated in 7th century AD Persia after the cultivation of sugarcane. Sugarcane encompasses a group of tall grass species found in temperate regions. Analysis of plant matter ultimately highlighted Papua New Guinea as being the site of domestication or where wild sugarcane species were first grown as crops, based on traits for artificial selection. From here, Pacific Island voyagers transported sugar cane around the islands, eventually reaching South-East Asia and India, where today a huge proportion of the world's sugar stems from and the first rough version of sugar was produced over 2000 years ago. This was about the time that sugar cane found its way to Persia.

Sugar is produced from sugar cane thanks to photosynthesis. The excess sugar produced from photosynthesizing (turning sunlight into energy) moves from the green leaves where it is produced to other parts of the plant like the stem and is stored as sucrose. When it comes time to harvest, sugar cane crops are sometimes burnt as a way of efficiently stripping the outer leaves from the stalk before being cut down either by hand or mechanically. The cane is then crushed, forcing a sweet juice out so it can be boiled, re-boiled and then (nowadays) centrifugally spun producing two products: raw sugar and molasses.

So the first ‘cookies’, the term stemming from the Dutch word ‘koekje’ meaning little cake, began with this sugar cultivation. But if we’re looking at chocolate chip cookies, they were thought to come about accidentally in 1937 by a lady called Ruth Wakefield. Ruth Wakefield and her husband Kenneth ran The Toll House Restaurant and Inn, opening it in 1930. So the story goes, upon returning from a trip to Egypt, Ruth was inspired to put a spin on her classic “butter drop do” cookies, which were typically served on the side of ice-cream. To do this, Wakefield decided to add bakers chocolate to her original recipe. However, given that there was no bakers chocolate left in her cupboard, she had to use a Nestle semi-sweet bar, which was all she had available. She was also in a hurry, so without time to melt it, Ruth is said to have used an icepick to break apart the chocolate, then drop it into the cookie dough. To Ruth’s surprise, when they came out of the oven, the chocolate hadn’t melted all throughout the cookies, remaining intact and creating delicious cookies.

Little did Ruth know she’d just created history. The recipe was published in her 1938 cookbook Toll House Tried and True Recipes, then popularised on the Betty Crocker radio show. After reaching out to Nestle herself, Ruth Wakefield’s recipe was printed on the back of Nestle semi-sweet chocolate bars, for which she allegedly was only paid $1. However, according to legend, she did receive a lifetime’s supply of chocolate to use in her baking.

The original Toll House Restaurant and Inn burnt down in 1984, seven years after Ruth Wakefield died. A once eloquent, cottage-like accommodation, the spot now plays host to a Wendy’s fast food joint and a Walgreens pharmacy. But the legacy of that plot of land lives on… that was where chocolate chip cookies were so accidentally made many moons ago.
When it comes to the origins of baked goods, the cinnamon sroll is a bit of a cultural hybrid. Although we commonly associate the scroll with Sweden, many scroll predecessors and spinoffs are found around the world. In fact, rather surprisingly, history doesn’t explicitly state that Sweden was the creator of this scrumptious treat. In any event, now a common breakfast staple in North America, cinnamon scrolls have certainly had a long history.

Rich and fatty yeast doughs appeared in the 1700s in the north of Europe but it was the French who got creative and began shaping these doughs. The British created the Chelsea bun in the 18th century, a rolled yeasty dough topped with sugar, butter and a sprinkling of currents. In Germany, dough rolled into spirals - that classic cinnamon bun style - are called ‘schnecken’, which translated into English means ‘snails’. Covered with a syrup as well as a cinnamon filling and icing, these sticky and puffy treats were reserved for Saturday mornings.

When English and German immigrants relocated to Pennsylvania, specifically Philadelphia, in the 1800s, they bought with them their secrets of the delicious sugary, doughy treat. Here, the Pennsylvania Dutch sticky bun recipe was born. With the dough recipe from the British and the toppings similar to a schnecken, these new doughy delights had chopped nuts, brown sugar or honey drizzled on the top. But it was the Swedes who added that delightful cinnamon, and we can’t talk about cinnamon scrolls without taking a closer look at cinnamon.

Originally found in Sri Lanka, cinnamon comes from a whole range of evergreen trees. The outer, rough layer of bark is scraped off revealing the second layer of bark, the cinnamon layer, which also gets shaved off. These shavings naturally dry up into cinnamon quills and the quills frequently get ground down into a powder, the way it is used in cinnamon scrolls. Cinnamon spread around Europe during Medieval times along the Silk Road, a series of trade routes linking Europe, Asia and Africa. It was commonly used to flavour wine and incense.

For a long time, over 90% of those in Scandinavia belonged to small farming populations distributed widely across the nations. Home cooking and baking was obviously vital, with young girls required to master seven cookie and cake recipes before she could be married. Cinnamon had been a popular spice in Sweden for centuries, and paired with the Scandinavian minimalist ethos of simple high quality, the Swedish cinnamon scroll was born.

During World War I, restrictions on importing and trading goods including butter, sugar and eggs were implemented. When the war ended in 1918, importing resumed. This caused a wave of cafes to sell cinnamon scrolls and the baked good became wildly popular. Today, cinnamon scrolls are often paired with coffee and enjoyed during fika, a daily rest time for a “cuppa” and a sweet accompaniment. In 2010, the average Swede ate 316 cinnamon scrolls, many of which would have been consumed on the 4th of October – international kanelbullens dag (cinnamon scroll day). While it may have been created with inspiration from a myriad of other cultures, then, the classic cinnamon scroll is Swedish through and through.
Doughnuts have been quite the food phenomenon over the past few years. Filled doughnuts, bakery doughnuts, boutique doughnuts, inject-your-own-filling doughnuts, mini doughnuts, doughnut holes, you name it, the doughnut craze has seen it and these little oil-fried balls of yeasty goodness have actually existed for a decently long time.

Although the Ancient Romans were known to fry sweet-tasting doughs in oil, and some ties point to Middle Eastern influence, it was the Medieval time period in northern Europe when yeast-risen dough cakes, subsequently getting fried in hot oil became a thing. During the Dutch Christmas season, *Olie Koeken*, or oil cakes, are made in celebration. Whether the recipes were shared with their Pilgrim visitors, or they set sail to America with the Dutch migrants themselves, doughnut recipes were exchanged in the early 17th century. By 1808, doughnut recipes were being shared in American cookbooks. And by 1845, doughnut recipes were just as much of a staple as bread or cake, and oil frying was replaced with lard.

Lard, the fat from a pig, was preferred for its ready availability and left the doughnuts greaseless and with a much more tender finish. The use of lard came to a crashing halt, however, about a century ago, when Upton Sinclair’s novel *The Jungle* was published. Exposing the appalling working conditions of factory workers and the inhumane treatment of animals in the meatpacking industry, Sinclair’s fictional narrative inspired increased sanitation and conditions of livestock and a new industry of vegetable shortenings. The high amount of saturated fat in lard also caused alarm with scientists and health professionals, with lard being almost entirely replaced with vegetable alternatives by the 1960s.

Not only did our way of frying doughnuts change, two other major changes affected how doughnuts became the treats we know and adore today. First, the leavening methods were altered. The chemical leavener of baking powder was opted out and a biological leavener—yeast—took its place. Second, doughnut cutters, a sharp cutter with a hole insert, were invented, selling widely and making the process faster. And with a more uniform final product.

We’ve held doughnuts in quite high regard for many years, but “Doughnut Day,” celebrated on the 2nd of June, has much more importance than you might think. Doughnuts actually held a paramount role in World War I. During the hard wartime period, something nostalgic, delicious and homely was needed – and it came in the form of doughnuts. “Doughnut lassies” from the Salvation Army were put in the role of serving doughnuts to embattled American soldiers stationed in France. Doughnut Day officially began on the first Friday of June in 1938, when paper doughnuts were sold as fundraising goods and also to acknowledge those who gave their time, effort and resourceful baking skills to those men fighting. As written about in her memoir, doughnut lassie Signa Leona Saunders chronicles her experiences of baking the treats. Baking them upon stoves, and sometimes even using the helmets of soldiers, inside the small, smokey tents, Saunders writes about wearing gas masks when baking and even crying onto the doughnuts as the smoke affected her eyes. Nevertheless, the doughnuts were very popular with the troops, and they frequently ran out.
An experiment of flavour and colour combinations, and art, macarons have cropped up in many a café or boutique food store in recent years. The delicate little treats are commonly associated with French pastry chefs, and in particular, world-famous Pierre Herme. However, despite their modern relevance, macarons surprisingly date all the way back to 8th century Venice, where they were said to have been made in monasteries. Interestingly, they were nicknamed priests belly buttons, in reference to their spherical shape. The likely link between transporting the macaron recipe from Italy to France lies with Catherine de’ Medici and her personal team of pastry chefs. The Italian noblewoman became French royalty at 14 when she married the King of France, Henry II.

The word macaron is actually the French version of the Italian maccheroni (macaroni), which means paste. This refers to either the simple flour, water and egg paste that makes up pasta or the crushed almond paste used in a macaron. Ground almonds are one of the most crucial ingredients involved in macarons. The ingredient stems from the Middle East, where places such as Syria commonly exported almonds. Sweet foods like marzipan were one of the original treats made from ground almonds, using sugar or honey and the almonds. Adding egg whites to this mix and heating moderately for a set amount of time produced macarons.

Original macarons consisted of just one spherical disc and, village by village, became increasingly popular around France. The Les Soeurs Macarons (The Macaron Sisters) were two nuns, Sister Marguerite Galliot and Sister Marie-Elisabeth Morlot, who baked macarons and sold them on the streets of Nancy to pay for their boarding during the French Revolution.

It wasn’t until the early 1900s that Pierre Desfontaines, the grandson of famous baker Louis-Ernest Ladurée, had the clever idea to use some form of icing or cream to sandwich two shells together. The result has been an ever-increasing smorgasbord of shell and filling flavour combinations ranging from simple chocolate and vanilla to olive oil or even Red Bull.

MACAROON VS MACARON?

A common question but nevertheless confusing too. For an item which consists of two almond meringue shells sandwiching a decent spread of sweet icing or ganache, the name can actually be interchangeable. The original creations in Italy were called macarons, but now that the sweet treat has been claimed and consistently attributed to France and its ever-creative pastry chefs, macarons would be the only name you would hear there.

Macaroons now mostly refer to chocolate dipped or coated shredded coconut nibbles. With an abundance of coconut being used in baking during the 1800s, a trend starting in India, some think macaroons were a reinvention of the original macaron.
If we want to talk about marshmallows, we should probably first appreciate the fact that a plant called marsh-mallow also exists. Growing in damp, marshy areas, marsh-mallow plants host relatively attractive pale pink and white flowers encompassing a tube of multiple, collected stamen. Dating back to 2000 BC in Egypt, marsh-mallow root was used in conjunction with sugar and honey as a gift to the gods or to royalty. The medicinal properties also gathered attention and the root was incorporated into wine for purposes such as easing a sore throat, and some even think a topical medicine for the pectoral area of the body. That is, an ointment for your chest. Other parts like the sap and even the pith, which had spongey characteristics, and was boiled in sugar syrup, have also been mentioned to be of use.

Yet, interesting as it may be, marsh-mallow – whether it be the sap, root or pith – no longer has anything at all to do with the marshmallow of today. By the 20th century, the sticky root had been replaced with either egg whites or gelatin when being used in edible confectionary. Nowadays, gelatin is the most common emulsifying (combining) and aerating (inflating) agent in marshmallow. An extremely high-protein ingredient, gelatin comes from collagen, the protein found in animal bones, skin and cartilage. When whipped into marshmallow, gelatin is responsible for maintaining a solid yet fluffy shape. The air is incorporated by intensive beating as the gelatin sets, with the material inside hardening around those air bubbles and creating an intricately porous structure.

However, with the introduction of the starch mogul system in 1899, marshmallows were being sold as penny candies (AKA cheap candies). The starch mogul system was incredibly basic but much faster than before. Trays of starch were indented with mould shapes. Candy syrups and mixes could be poured into the moulds and over time, with the starch absorbing any excess water. The candies would dry and could be removed easily from the moulds.

However, the process was about to get much faster. Marshmallow giant company Doumak was founded by candy-maker James Doumak of Greece and co-owned with his son Alexander Doumakes. It was Alex who created a new extrusion process for marshmallow creation, with a one-day manufacturing time becoming one hour. Marshmallow was quickly pushed down a chute and evenly cut into the preferred size, meaning mass marshmallow production was now possible. The Doumakes family went down in history. With over 90 million pounds of marshmallows eaten every year in the USA, the Doumakes are probably still doing pretty well. Marshmallows may be so popular today due to the strong nostalgia and childhood memories they evoke… or maybe simply just because they taste great.

The first recipe for s’mores (marshmallows and melted chocolate sandwiched between two biscuits or graham crackers) appeared in a Girl Scout Hand-guide in 1927.

Whether they make you think of a cosy winters night as they bob half-submerged along the top of a hot chocolate, or take you back to sitting around a campfire toasting them on the ends of sticks while waiting for the edges to get that charcoal tinge, marshmallows are hugely symbolic. They may no longer hold any relation to their original plant namesake, but they’ve certainly made a name for themselves.
Chocolate brownies are a real classic treat and we have a lady called Fannie Farmer to thank for them. Growing up in Massachusetts, USA, and the oldest daughter of four, Fannie Merritt Farmer was expected by her working-class parents to receive a formal education. Although she was passionate and boasted a good work ethic, those innocent intentions from her parents were foiled when Farmer faced what some sources say was a paralytic stroke and what others think was polio during her teenage years. Whichever of these medical crises Farmer endured, though, she was left bedridden, which meant that she was unable to attend formal school.

Nevertheless, Farmer prevailed. Still by the time she was in her 20s, she was rehabilitated enough, albeit with a limp, to begin working for a family called the Shaws. It was here that she developed what would be a lifelong and historically-significant passion for cooking. It wasn’t until she was in her 30’s, when both her employers and family encouraged her to receive that education she had missed out on earlier, that Farmer enrolled at Boston Cooking School. This was at a time when ‘domestic science’ was taking off, reflected in the way that the cooking school taught its pupils. Obviously, students were taught the methods of cooking but supplementary classes of food chemistry, marketing and human anatomy, to name a few academic disciplines, provided an intellectually changing and immersive experience. This scholarly approach to cooking school clearly inspired Farmer.

She excelled at her studies, and when Farmer graduated in 1889, was offered the role of Assistant Director of the school. Over the next few years, her passion for food and its impact on diet and health blossomed, and in 1891 she was named the Director. Farmer also attended Harvard Medical School, enrolling in a summer course and then becoming one of the first women to lecture at the prestigious institution.

Her passionate talks about the relationship between diet and health were popular and motivating, especially for other women.

Farmer was one of the first people to work in and enhance the small field of domestic science or home economics, and with her authoritative knowledge and passion for science within cooking, she wrote her recipes simply and effectively. As the “mother of level measurements”, she has been credited with determining the sizes of the simple cups-and-spoons measuring system still widely used today. Yet the publisher house Little, Brown & Company was initially apprehensive to print her book, fearing it wouldn’t do very well. Farmer, by now a clever businesswoman, retained the rights to her book while successfully convincing the publishers to print 3,000 original copies. The Boston Cooking School Cookbook was wildly popular and the 13th edition is still being sold today. In total, over 3 million copies of Fannie Farmer’s original book, although slightly revised, have been sold. Her recipes changed the way in which people were cooking, using science and simple, exact measurements to make a successful and delicious meal. Explaining the chemical processes happening when cooking and baking was part of her cookbook’s charm. It was in this cookbook of hers all those years ago what is known to be the first recipe for brownies. The recipe was similar to what we would call “blondies” today.

The simple, pragmatic approach that Fannie Farmer applied to her recipes made the task of cooking and baking accessible for everyone. She had a knack of making the difficult seem easy. In fact, her passion for teaching resulted in Farmer opening her own school, Miss Farmers School of Cookery, in 1902. Having faced her own health struggles, the purpose of her school was to teach the sick or physically disabled as well as housewives to cook, not to just train up teachers. Farmer continued lecturing and spreading her knowledge, wisdom and passion for 13 more years. Suffering from a second stroke, Farmer continued her lecturing engagements up until her death in 1915 at age 57.
Danishes with a light and flaky puff pastry encapsulating berries or apples, filo pastry wrapping up some warm feta cheese and spinach, choux pastry filled with the sweet surprise of cream and smothered in dark chocolate, or – favourite – sweet shortcrust pastry housing a thick, creamy, vanilla custard, my favourite. There are so many kinds of pastry existing in the culinary world today, each with its own careful rules and instructions, that can easily be prepared incorrectly. In fact, even though I adore it, pastry is probably my own biggest weakness when it comes to baked goods.

Pastry has been around a very long time as is obvious by the fact the ingredients are so simple. In ancient civilisations such as Egypt, Rome and Greece, filo pastry was one of the first pastries, using just flour and oil. The Romans then used the pastry dough to cover meat, with no intention for this pastry to be eaten, only to contain the flavors and aromas.

It was during Medieval times when pastry began to more closely resemble what we make today: a thick, crumbly pastry shell. Although thoughts of pastry likely make us think of France, it was in fact Britain where the close ancestor of shortcrust pastry was created. This was the hot-water raised crust. If you imagine someone shaping a pot out of damp clay on a kiln, moulding the walls of the item with their hands, that is similarly how chefs would mould this pastry crust, which was used to contain meat (most commonly pork). The Forme of Cury, a cookbook written at the very end of the 14th century, and the first known cookbook to be written in English, made mention of tart cases and baked pies.

The revolutionary change in the pastry game, however, came in the form of a Frenchman named Marie-Antoine Careme. Born in Paris only a few years before the turbulent French Revolution began, Careme had a difficult upbringing as one of many – by some estimates, a whopping 25! – children born to poor parents. By the time he was 10, the story goes, Careme was abandoned by his family and forced to get a job in the midst of the Revolution. Fortunately, he was taken in by a restaurant owner, under whose tutelage he worked as a kitchen aid before undergoing culinary training while learning the art of design. Careme went on to train within the culinary world and cook for King George IV among other high-profile foodies. He became famous for his extraordinary and luxurious pastry creations, some several feet high, a feat stemming from his integration of architecture into his food. Careme is now referred to as the first celebrity chef: the king of chefs and chef of kings.

Although Careme created edible architecture out of sugar and pastry, pastry is commonly more of a vessel, containing and accompanying the flavours and aromas of other fresh ingredients. The recipes and methods of pastry-making remain basically unchanged from the originals of those like Careme. After all, you can’t fix what isn’t broken!
Not actually a cake, but a tart, most cheesecakes would be summed up by the following description: a pastry shell with a cream cheese filling. Now as a rich and creamy dessert, cheesecakes have some interesting distant food relatives. Precursors to modern cheesecake include libum, placenta and savillum: all ‘cakes’ involving cheese and sweeteners. Recipes for both libum and placenta were written by Cato the Elder, who served as a Roman senator and soldier, among many other capacities. Passionate about conserving Roman culture, Cato wrote a manual and in it were the recipes for these cheesecake-like goods. Libum was essentially unleavened bread filled with cheese and sweetened with honey, whereas placenta (not to be confused with the biological product of the same name) was a sacrificial meal of layered dough interspersed with cheese and honey, then baked. Finally, savillum contained cheese, flour, egg, and honey. As honey, dates and figs were really the only sweet flavours in their cuisine; Romans utilised these flavours in their dessert or secunda mensa (“second plate” meals).

The first actual recipe for cheesecake seems to have shown up in the 14th century. From there, the cheesecake had many lineages all throughout Europe, with the English, the French and the Germans all creating their own recipes over the 17th century. Cheesecakes started to branch out into regionally classified varieties in the 18th century. It was during the course of the 19th century, however, when cheesecake recipes were common amongst cookbooks.

In those recipes, the first step was usually curdling milk with rennet. Rennet, a group of enzymes found in the stomachs of grass-grazing mammals, helps to curdle milk. The main enzyme in rennet, accounting for up to 90% of its contents, is chymosin, which reacts with the protein casein, found in milk. Rennet helps the young of such animals to digest their mothers’ milk and it is commonly extracted from the stomach (the fourth one to be exact) of newborn calves.

However, it wasn’t long before cream cheese would be first mass-produced. This happened in 1872, with the goal of making Neufchatel cheese, a soft, camembert-like French favourite. In the process, a man by the name of William Lawrence ended up creating cream cheese. As an experiment during the Neufchatel-making process, he added a touch of cream out of curiosity and lo and behold, cream cheese became a factory-produced product.

Noted for its denseness and creaminess, the popularity and appearance of New York cheesecake coincidentally bloomed around the same time as cream cheese production. The most important part of a cheesecake is the creaminess and classic NY cheesecake really aces it. Nowadays, other cheeses like ricotta (made from coagulating or solidifying the leftover whey product from cheese making) or mascarpone (made when cows milk is curdled by adding citric or acetic acid), both Italian in origin, are sometimes used.


