Healthy Living – Teaching Socioscientific Issues (SSI)

A Teacher's Guide

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Abstract

This project-based dissertation explores how socioscientific issues (SSI) can help improve the teaching of the Year 8 Healthy Living topic which is part of the Maltese Science Learning Outcomes Framework (2018). The written part of the dissertation explains how SSI-based learning supports scientific literacy together with critical thinking, and evidence-based decision-making. It also describes how ideas from the literature, together with curriculum requirements and classroom realities in Malta, shaped the design of the project through a practice-based and pragmatic approach.

The second part of the dissertation presents the teacher's guide, Healthy Living – Teaching Socioscientific Issues (SSI): A Teachers' Guide. This guide includes full lesson guides based on debatable questions, and also all the complementary resources that help teachers move from teaching scientific content to guiding thoughtful discussion. The lessons give students chances to understand scientific ideas while also giving them the opportunity to analyse real evidence and discuss issues that affect their everyday lives. Overall, the project aims to offer a practical and easy-to-use resource that helps Maltese science teachers build students' scientific literacy and support them in making informed health decisions.

Keywords: socioscientific issues, argumentation, Healthy Living, Integrated Science, teacher's guide

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List of Abbreviations

DQSE	Directorate for Quality and Standards in Education
EDR	Educational Design Research
LOF	Learning Outcomes Framework
LOs	Learning Outcomes
MEDE	Ministry of Education and Employment
MEEF	Ministry of Education, Employment and the Family
MEYR	Ministry for Education, Sport, Youth, Research and Innovation
NCF	National Curriculum Framework
OECD	Organisation for Economic Co-operation and Development
PBR	Practice-Based Research
PISA	Programme for International Student Assessment
SEC	Secondary Education Certificate
SSI / SSIs	Socioscientific Issue(s)

Chapter 1: Introduction

1.1 Rationale for the Study

When I first came across the idea of using debates and socioscientific issues (SSIs) in the science classroom, I was unsure whether such an approach could be effective in Malta's strongly exam-focused school culture. Many of the science lessons I observed during teaching practice were centred almost entirely on content delivery and test preparation. his This prepares students for their examinations which are an important aspect of students' education. However, it ends up leaving little room for them to be curious and   to think and discuss on a deeper lever. From my teaching practice and also from my experience as a student, I often sensed that students viewed science as a subject to be memorised rather than a way of understanding the world around them. This contrasts greatly with the aims for science education outlined in the PISA 2025 Science Framework (OECD, 2023). These aims emphasise the importance of developingscientific literacy in students to enable them to reason things out and be able to use scientific information to make responsible decisions.

My perspective on using SSI as a teaching method began to change when I started to read more about it as a pedagogical approach and the research findings that suggest that it helps to promote engagement with science by making it more meaningful (Zeidler & Nichols, 2009; Zeidler et al., 2019). The approach felt refreshing since I noticed that it creates an opportunity to bring science closer to students' lived experiences as SSIs help link science to real issues such as health and climate. I became even more interested when I saw how SSIs centred on ethical, personal, and social dimensions could invite students into the conversation in ways that traditional lessons often fail to do.

During my second year of teaching practice, I decided to take a risk and integrate SSI-based teaching into the Year 10 Biology topic Human Impact on Natural Resources. I split the topic into sub-topics and introduced a debatable question for each sub-topic. Students then had to explore scientific information and analyse evidence to carry out a debate. Although some students were hesitant at first, I was moved by the way many of them especially some quiet or disengaged students began to participate in the discussions. They shared opinions, listened to one another, and demonstrated reasoning skills they rarely showed in more conventional lessons. What stood out most was how the atmosphere shifted in the classroom since students were not simply learning science, but they were using science to make sense of real-world problems.

This experience led me to believe that SSIs can really help students develop not only scientific understanding but also a stronger sense of identity and agency, and also moral reasoning. These are essential skills for cultivating a responsible and reflective society for tomorrow as envisioned in today's science education. It was this insight I got from both my personal experience and the literature I read that inspired me to develop this project, which applies SSI and debate to the Year 8 Healthy Living topic in Integrated Science.

1.2 Aim of the Project

The aim of this project was to develop a resource guide that could support science teachers in bringing SSI-based learning into the Year 8 Integrated Science classroom in a practical and meaningful way. Through the creation of a structured teacher's guide, the project aims to provide lesson plans that model how socioscientific discussion can be embedded within scientific content. By using the guide, teachers can move beyond rote learning and develop lessons that enable students to interpret information, analyse evidence, and participate in respectful debate. Ultimately, the aim is to encourage a culture in science classrooms where argumentation, critical thinking, and open discussion are natural way of science learning.

1.3 The Project

The final outcome of this dissertation is a teacher's guide entitled Healthy Living – Teaching Socioscientific Issues (SSI): A Teachers' Guide. Each lesson in the guide is built around a central debatable question, which acts as the starting point and focus of the learning process. The scientific content is taught through this question, allowing students to explore scientific ideas while examining real-life health issues, evaluating evidence, and forming reasoned arguments.

The guide includes clear step by step lesson plans including debates, activities to teach scientific content, evidence-analysis tools, worksheets, and resources. These are all designed to support teachers in applying an SSI approach in a confident way and to use it consistently. The project aims to help teachers create lessons that are relevant, engaging, and supportive of scientific literacy by integrating the science content that needs to be learnt directly within meaningful socioscientific contexts.

1.4 Structure of the Dissertation

This project-based dissertation includes the actual Teacher's Guide as well as a written report. The written report starts with this introductory chapter that provides a rationale for the project and an overview of the main aims and the project. Following this initial introduction, Chapter 2 provides an review of the literature both from an international perspective as well as a local Maltese perspective. The review of the international literature starts with the main aims of science education and the move towards encouraging the development of scientific literacy which prepares students for using science knowledge in their daily lives. It then looks at the new theories of learning that encourage the development meaningful learning through real life contexts and collaboration. Drawing on these initial readings, the chapter then reviews literature on using socioscientific issues and argumentation as a teaching appoach that leads to scientific literacy. The chapter also includes a review of the local literature that focuses on the aims of science education in Malta, the introdcution of the LOF and changes in assessment practices in Maltese science classrooms.

Chapter 3 and Chapter 4 look at the methodological framework and the process that was followed in the development of the Teacher's Guide. Chapter 3 provides the conceptual framework for the development of the guide, drawing on a pragmatic and practice-based approach to research that emphasises the importance of developing a tangible product that can actually be used by teachers. Chapter 4 then delves into the choices and decisions that were taken when developing the Teacher's Guide. This Chapter includes the decisions that were taken when it came to selecting the topic, structuring the lessons, designing resources, and ensuring coherence with curriculum requirements. It also describes the thought that went into the choice of style, presentation, and finally printing of the guide. Chapter 5 includes the concluding reflections which include what the project contributes, its limitations, and what was learned through the process. The completed teacher's guide and full set of resources are included in the appendices, with a physical copy submitted alongside the dissertation.

Chapter 2: Literature Review

2.1 The Aims of Science Education

The National Research Council (2017) describes science as “a body of knowledge that represents current understanding of natural systems and the process whereby the body of knowledge has been established and is being continually extended, refined and revised” (p. 26). In this definition science is both a body of knowledge of content and facts, as well as process through which scientific theories are analysed, developed and understood through critical thinking and argumentation. In today’s world every individual should have some knowledge of science, and learning science has therefore become an integral part of modern curricula (National Research Council, 2017). Harlen (2010) argues that science in schools should enable students “to develop and sustain learners’ curiosity about the world, enjoyment of scientific activity and understanding of how natural phenomena can be explained” (p. 6).

While this is a generic aim that can be applied to all students learning science in schools, the development of science curricula in schools faces what Osborne (2007), describes as a fundamental tension between two main aims. In fact, the National Research Council (2017) describes the aims of the teaching of science in schools as being:

> to produce individuals capable of understanding and evaluating information that is, or purports to be, scientific in nature and of making decisions that incorporate that information appropriately, and furthermore, to produce a sufficient number and diversity of skilled and motivated future scientists, engineers, and other science-based professionals (p. 34).

These two aims of science are often placed at different ends of a continuum with the preparation of future scientists emphasising the content and learning of scientific facts and learning science for decision making focusing more on relevance to everyday life (Osborne, 2007).

In other research, Osbourne & Dillon (2008) argue that traditionally in schools, more emphasis has been placed on preparing a minority of students for careers in science. They point out preparing future scientists focuses on rigorous content knowledge often taught as facts. This has resulted in disengagement with science for the majority of students who do not wish to pursue a career in science. This has led to a push in many countries for science education in secondary schools to focus more on the pursuit of scientific literacy and science lessons related to everyday life (Harlen, 2010). As argued by Harlen (2010), “the goal of science education is not a body of facts and theories but a progression towards key ideas which enable understanding of events and phenomena of relevance to students’ lives” (p. 2). This has led to a shift in science education with a greater focus on what is described as developing ‘scientific literacy’ (OECD, 2023). As described by Osbourne (2023), “scientific literacy is the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen” (p. 787). Furthermore, using the PISA 2025 framework, Osbourne (2023) describes a scientifically educated person as having the competencies to:

1. Explain phenomena scientifically.
2. Construct and evaluate designs for scientific enquiry and interpret scientific data and evidence critically.
3. Research, evaluate and use scientific information for decision making (p. 787).

These skills and competencies are described in the PISA 2025 framework for Science Education (2023) as being essential for navigating complex 21st century challenges which can be personal, local or national and global such as issues of health, environment, climate change and technological advances. Rather than focus on the acquisition of knowledge, the emphasis is on the devlopement of attitudes, values and a science identity. This hopefully allows individuals to engage confidently with scientific information and make informed decisions for a sustainable future.

2.2 Using Socioscientific Issues (SSI) in teaching and learning Science

In the science classroom scientific literacy which has been described by Osborne (2023) and in the PISA 2025 Science Framework, as the ability to engage with science to take responsible decisions as citizens, can be developed using several pedagogical approaches. These include inquiry-based learning, group discussions, experimentation and dilemmas related to socioscientific issues (SSIs) (Badeo et al., 2024). Sadler (2024) describes SSIs as real-world problems which are usually controversial that are able to connect science, technology and the societal factors with examples being climate change, genetically modified food, vaccination, reproductive technologies, and environmental sustainability. The socioscientific issue should mirror real-life scenarios such as social controversial issues (Sætra, 2020; Zeidler et al., 2019). According to Sadler (2024), through such contexts students can connect scientific content knowledge to human aspects which go beyond the content such as the ethical, moral and social aspects which ultimately aids students in connecting scientific concepts to meaningful contexts.

Zeidler and Sadler (2023) describe SSI as having the following characteristics:

1. Utilize personally relevant, controversial, and ill-structured problems that require scientific, evidence-based reasoning to inform descisions about such topics.
2. Employ the use of scientific topics with social ramifications that require students to engage in dialogue, discussion, debate, and argumentation.
3. Integrate implicit and/or explicit ethical components that require some degree of moral reasoning.
4. Emphasise the formation of virtue and character as long-range pedagogical goals (p. 900).

Teaching through SSIs is particularly important in the science classroom because it requires students to critically evaluate information, analyse multiple perspectives, and make evidence-based decisions in situations where clear-cut answers are not always possible (Zeidler et al., 2005). In this sense, SSIs provide a natural context for the development of argumentation skills, as they encourage students to be able to build their own claims while also providing justifications, and also be able to evaluate other claims which do not necessarily match their own (Sadler & Zeidler, 2009; Zeidler & Nichols, 2009).

Another key contribution of SSI-based teaching is the development of students' scientific identity where students are able to gain skills which go beyond scientific knowledge including the gaining of certain moral values and attitudes while also learning about the true nature of science (Osborne, 2023). Thus, through the students' engagement with SSIs, they are being encouraged to reflect on their own beliefs and values in relation to scientific evidence and also societal concerns. Research (Zeidler & Kahn, 2014; Zeidler et al., 2019) shows that such engagement helps to foster empathy, moral reasoning, and a sense of responsibility. According to Zeidler et al. (2019), these values are an asset for students to be informed and active citizens and in this way, SSIs serve as a platform for students to construct a personal and social identity that includes a sense of agency in dealing with complex scientific challenges. Through this contextualisation of science students not only become more motivated to learn, but it also helps students who do not wish to pursue scientific careers to still appreciate how science shapes society and how it is important for citizens to make informed decisions (Sadler, 2011).

2.2.1 A Model for the Development and Implementation of SSI in the science classroom

The development and implementation of science lessons that include SSI may seem a bit challenging for teachers. Presley et al. (2013) identify three core aspects that are essential for SSI teaching and learning. These include design elements, learner experiences and teacher attributes which are the core attributes together with the classroom environment and peripheral influences as additional aspects for teachers to take into consideration when developing and implementing SSI lessons (Table 1). This framework although not prescriptive can guide curriculum design, professional development and classroom practice to support effective SSI teaching.

Presley et al. (2013) provide a framework for the development and implementation of SSI lessons. However, these are only an indication of core aspects and teachers need to understand and know how to adequately plan lessons that include SSI, since this does not happen automatically (Fillipidis, 2022). Zeidler and Kahn (2014, p. 32-33) therefore identify a number of steps (see Table 2) that can act as a guide for teachers who are interested in implementing SSI in their science classrooms.

Table 1 *Core aspects of an SSI based framework for science lessons*

Design Elements 1. Focus on a compelling social issue tightly connected to science. 2. Presenting the issue first at the beginning of instruction to ground learning. 3. Providing scaffolding to support higher-order practices such as argumentation, reasoning, and decision-making. 4. Including a culminating experience to integrate learning, such as debates or role play.
Learner Experiences 1. Engagement in higher-order cognitive practices like reasoning and position taking. 2. Confrontation and understanding of scientific ideas underlying the issue. 3. Collection or analysis of scientific data relevant to the issue. 4. Negotiation of social, political, and economic dimensions connected to the issue.
Teacher Attributes 1. Familiarity with both scientific content and social considerations related to the SSI. 2. Willingness to learn alongside students and share authority in the classroom. 3. Comfort with uncertainty inherent in open-ended, real-world discussions.
Classroom Environment • High expectations for participation, collaborative and respectful interactions, and a safe climate for discussing controversial issues.
Peripheral Influences • Support from school and community, access to quality curricular materials, curriculum flexibility, and alignment with state or national education policies significantly impact SSI implementation.

Note. Adapted from "A Framework for Scoio-scientific Issues Based Education," by M.L. Presley, A.J. Sickel, N. Muslu, D. Merle-Johnson, S.B. Witzig, K. Izci and T.D. Sadler, 2013, *Science Educator, 22*(1), 26-32.

Table 2 *Steps for the development of SSI in the science classroom*

1	Identify Topics	Review newspapers, books, internet sources, movies for current issues related to science such as climate change, genetically modified food, medical marijuana and diets.
2	Collect Resources	Look for articles and information about the topic that represent a variety of points of views.
3.	Introduce the Topic	Engage the students by presenting them with newspaper headlines, You Tube videos and other media.
4.	Prepare Discussion	Prepare students for a class discussion or debate, set ground rules emphasising collaboration and respect for different points of view.
5.	Pose a Question	Introduce a controversial question, such as “should schools charge a fat tax for unhealthy food?”
6.	Provide Instruction	Present the subject matter in a variety of ways, direct teaching, experiments, research, or guest speakers.
7.	Conduct Activities	Allow students to investigate or discuss in small groups. Put an emphasis on the analysis of evidence and active participation of students.
8.	Guide Evaluation	Students are guided to evaluate primary and secondary sources and assess trustworthiness of evidence.
9.	Assessment	Students are assessed through the use of various tasks such as presentations, posters, papers, videos, written assignments etc.
10.	Have Fun	Use SSI to provide students with the opportunity to be creative and engaged.

Note. Adapted from Zeidler, L., & Kahn, S. (2014). *It’s Debatable!: Using Socioscientific Issues to Develop Scientific Literacy, K-12*. National Science Teachers Association, 32-33

2.3 Teaching and Learning Science through Argumentation on SSI

As outlined in the previous section, the understanding of socioscientific issues has become increasingly important in a world where every day individuals need to make decisions about developments in science and technology such as whether it is ok to eat genetically modified food; what type of foods to eat; reproductive technologies and many other issues (Osbourne et al., 2004). But this understanding of SSI is not a natural process for students. As pointed out by Osbourne et al. (2004), "evaluating media reports of such socioscientific issues is not straightforward as it requires the ability to assess whether the evidence is valid and reliable, to distinguish correlations from causes, observations from inferences, and to assess the degree of risk" (p. 996). Students need to learn how to make sense of SSI, and one way of helping students to engage with SSIs in order to be more prepared to make decisions in real-world contexts, is the process of 'argumentation' (Zeidler & Kahn, 2014). In fact Zeidler & Sadler (2023) argue that "given the controversial nature of SSI, argumentation which involves the adjudication of ideas, aligns very well with SSI-based teaching and learning" (p. 910).

2.3.1 A definition of Argumentation in Science Teaching and Learning

According to Osbourne et al. (2016), "argumentation is a central feature of science" (p.1), because it teaches students to be critical thinkers who can reason for themselves (Zeidler & Kahn, 2014). Becoming critical problem-solvers is one of the main competencies of scientific literacy that is outlined in the PISA 2025 framework (OECD, 2023), which proposes that scientifically literate students can use their content knowledge, procedural knowledge and be able to build attitudes and values in the field of science. In this definition of scientific literacy (OECD, 2023), argumentation is essential in developing a scientific identity, since it goes beyond simply providing students with an explanation of facts and subject knowledge. As pointed out by Osbourne et al. (2016), argumentation enables students to create and evaluate scientific claims based on evidence to convince themselves and other members of their community. Argumentation can therefore be defined as, "a complex orchestration of construction and critique of claims, warrants, and evidence in situations that require scientific knowledge to resolve." (Osbourne et al., 2016, p 6).

Argumentation is a important pedagogical approach in science teaching and learning since: (1) it helps students to understand scientific concepts better and allows them to develop problem-solving skills that enables them to work like scientists (Faize et al., 2017); (2) it enables students to take an informed stance on SSIs based on evidence and critical thinking (Fillipidis, 2022); and (3) it motivated and encouraged students of all abilities and atttitudes towards science to participate in the science lesson (Attard, 2010).

2.3.2 The Learning Theories behind the use of Argumentation

The process of scientific argumentation is based on constructivist and sociocultural theories of learning. Drawing on Vygotsky's ideas that knowledge is actively constructed through social interaction, dialogue and the negotiation of meaning, argumentation is positioned as a social cultural practice (Kuhn et al., 2013). Research on argumentation (Sætra, 2020; Zeidler & Kahn, 2014) suggests that through argumentation students go through the process of moving from a point where they cannot form sound arguments until through scaffolding they are able to cross what is described by Vygotsky as the 'zone of proximal development' and can take part in active classroom discourse and argumentation.

Kuhn et al. (2013) claim that developing argumentation skills goes beyond the development of cognitive skills and drawing on Vygotsky's ideas that learning is both individual and social they argue that “the social context is central to the developing argumentative competence” (p. 457). Through argumentation students are able to shape each other's viewpoints since through discourse students learn to think more critically and are able to strengthen their arguments when new ideas collide with existing ones, (Melaville et al., 2006; Zeidler & Kahn, 2014; Zeidler & Nichols, 2009; Zeidler et al., 2019). Drawing on sociocultural theories of learning, conceptually argumentation is also based on Vygotsky’s ideas that individual learning cannot be separated from the social context in which it occurs. Research in the area of argumentation (Kelly et al., 2023) suggests that in developing arguments about SSIs for example students develop an argument and an opinion based not only on facts and evidence but also on personal and social values. Therefore the “role of values, emotions, and affective issues in argumentation” (Kelly et al., 2023, p. 420) needs to be acknowledged.

2.3.3 Implementing Argumentation in the science classroom

In the science classroom the process of argumentation involves an interactive process where students discuss and debate a position and try and convince students who do not hold the same point of view with their arguments (Faize et al., 2017). Sampson et al. (2011) suggest a model for the process of argumentation (see Figure 1). This involves an initial issue, an analysis of research data about the issue, and eventually reaching a concluding argument which is justified with reasonable evidence.

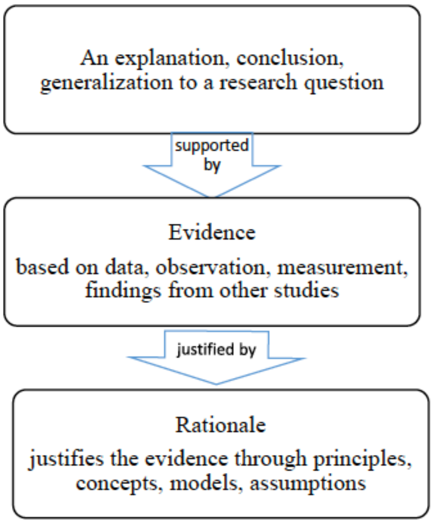

Figure 1 *The process of Argumentation*

Note. From Sampson, V., Grooms, J., & Walker, J. P. (2011). Argument-Driven Inquiry as a way to help students learn how to participate in scientific argumentation and craft written arguments: An exploratory study. *Science Education*, *95*(2), 217–257.

Zeidler and Khan (2014) suggest using debatable questions as an introduction to the topic at hand, which the students get to answer before attaining new knowledge, serving as a baseline. This question would then be revisited at the end of the topic to evaluate students' progress in forming ideas based on empirical evidence. This technique illustrates the growth of argument made by students, with the main difference being on the use of evidence. In fact the use of evidence in argumentation is a fundamental skill that needs to be emphasised and practiced in order to put forward strong arguments that are backed up by research (Sadler & Zeidler, 2009; Zeidler & Kahn, 2014). However, it also comes down to what kind of evidence to choose when formulating one's arguments. According to Zeidler and Kahn (2014) "students should not be instructed to avoid highly opinionated or biased sources, but rather, taught to identify the bias and use the material to understand the particular perspective being advanced" (p.42). One way of going about this is by providing students with different sources, and students are required to analyse the resources at hand for reliability (Zeidler & Kahn, 2014). Apart from building arguments on the reliability of evidence, this also allows students to get a feel of what the nature of science is which is also outlined in PISA (2025) aims for the learning of science.

According to Zeidler and Kahn (2014) in order to have successful argumentation in the classroom, a strong foundation should be put in place so that students are guided in how to use argumentation, since this is not something that comes automatically to many students. Students need to learn the skills of scientific argumentation which involves students understanding a scientific claim based on their content knowledge, analyse and interpret scientific data and research in order to reach conclusions that support or oppose a scientific claim (Evagorou & Osbourne, 2013). When carrying out argumentation students also need to be able to engage with scientific knowledge and evidence, critique this evidence and debate with their peers (Yilmaz et al., 2017). Students need to be provided with the opportunity to practice and participate in argumentation in the science classroom so that they can develop the necessary skills to engage in informed decision making as responsible citizens (Filippidis, 2022).

Developing such skills involves placing greater emphasis on building a respectful environment where students can actively listen to others' views and be sensitive and tolerant of diverse opinions (Zeidler & Nichols, 2009). As suggested by Zeidler and Nichols (2009), it could also be more productive if such behaviours are practised within the context of a classroom discussion before moving to actual debates. Research (Zeidler et al., 2019; Erduran & Aleixandre, 2008) shows that such developing and practicing scientific argumentation skills not only helps in the efficiency and fruitfulness of argumentation practices, but they also help to build morality and empathy in students and thus contribute to character formation. For the successful implementation of scientific argumentation within the science classroom, the teacher needs to create a positive learning environment where students feel willing and supported to take intellectual risks. Teachers can, in turn, serve as models for students to respect and listen to what others have to say (Zeidler & Kahn, 2014).

2.4 Assessment of Science Learning Through Socioscientific Argumentation

Using SSI for the promotion of scientific literacy has become increasingly more popular amongst science educators in the last two decades (Zeidler et al., 2019). The SSI learning experience provides students with the opportunity to develop skills that allow them to understand more science, develop argumentation skills and more aware of their science identity (Sadler et al., 2007). While much has been written in the literature about the development and implementation of SSI-based lessons, very little research has been carried out about how to assess how and what skills students manage to acquire through the use of argumentation in a socioscientific context. At the same time argumentation can provide an excellent opportunity for teachers as an assessment practice that is an alternative to traditional paper and pencil tests and examinations.

2.4.1 Argumentation as an Assessment Tool

Argumentation provides the opportunity for teachers to assess students on how to be able to form their own claims, use the right evidence to support their claims while also face different points of view (Danielowich, 2014; Osborne & Dillon, 2008). This is beyond assessing content knowledge which traditional modes of assessment such as written tests or examinations tend to focus on. Being able to develop such competencies leads to the growth of scientifically literate citizens who are able to address complex societal issues and make informed decisions (Osborne & Dillon, 2008). As Danielowich (2014) argues argumentation-based assessment can go beyond assessing the previously discussed competencies since students also learn collaborative and democratic behaviours and thus can be assessed in their listening, tolerance, and respectful critique, which are often overlooked in standardised testing.

The use of argumentation as an assessment tool is also in line with changing views on assessment in general. Traditionally the assessment of student learning is carried out through the use of tests and examinations at the end of a study unit, to provide a summative judgement about student learning (Gipps & Stobart, 2009). The use of tests and examinations are thought to provide a fair and valid judgement of student ability. They are considered to be high stakes since they are used for certification and entry into post-secondary education or various careers (Richardson, 2022). Recently, however, the views on assessment have shifted to place a greater focus on learning. Assessment within this framework is formative and establishes where students are in their learning providing feedback to help students improve and move forward (Wiliam, 2011). Formative assessment which is usually school based provides teachers and students with the opportunity to assess skills such as creativity, problem-solving, thinking and creativity (Stobart, 2021).

The characteristics of SSI based lessons and argumentation lend themselves very well to the philosophy of formative assessment. Through science lessons based on SSI, students are provided with scaffolds to help them improve their argumentation skills and reasoning, feedback to help them develop these skills and finally showing what they know in what

Presley et al. (2013) describe as “a culminating experience” (p. 28). This ‘culminating experience’ can be in the form of an assessment task and take the form of “role-play, debate, and service learning projects” (Presley et al., 2013, p. 28). Other ‘products’ that can be used to assess students include posters, presentations, letters, cartoons, experiments, participation in group discussions (Zeidler & Kahn, 2014). Though argumentation regarding SSI students can also learn how to use of evidence, integrate scientific content and to select reliable sources, (Sadler & Zeidler, 2009; Zeidler & Kahn, 2014). Recent research showcases that students' argumentation skills improve greatly through the integration of inquiry and debate. This is because while inquiry helps to generate new evidence, debate fosters rebuttal and counter-argument skills (Hendratmoko et al., 2024). In this way, argumentation can serve as a meaningful form of authentic assessment, closely mirroring the practices of scientists and democratic citizens. Using argumentation as an assessment tool can help evaluate higher-order competencies which include reasoning, critical thinking, and decision-making (Erduran & Aleixandre, 2008).

The assessment of student learning in an SSI context needs to be based on whether students have managed to develop knowledge of science context as well as the skills of argumentation that show evidence-based reasoning. Zeidler et al. (2019) point out that argumentation involves both cognitive and affective processes and these need to be all taken into consideration when assessing student learning. In assessing students using argumentation about socioscientific issues teachers need to develop clear assessment criteria that can for example include whether the student is using evidence in developing an argument, what is the source of the evidence and its reliablity, the quality of the evidence used, and how the student is interpreting the evidence (Zeidler & Kahn, 2014). Christenson and Chang Rundgren (2015) suggest that the way in which students develop socioscientific arguments can be assessed on the basis of the claims and justifications made by students based on pros and cons that include both relevant content knowledge as well as values. The assessment criteria need to be made explicit to the students and can be presented in the form of rubics which show clear expectations of achievement (Zeidler & Kahn, 2014).

2.4.2 Challenges faced by teachers when using argumentation as an assessment tool

Although argumentation-based assessment has multiple advantages, science teachers encounter multiple challenges when integrating argumentation into their classrooms. One of the main difficulties of using such an assessment mode is that students have pre-existing beliefs and misconceptions that may cause conflict with scientific explanations. Thus it is important that teachers establish a supportive environment where students feel safe to challenge and refine their ideas without fear of judgement (Zeidler & Nichols, 2009). Socioscientific issues (SSIs) are especially effective in safe envrionment because students can easily connect science to their values and everyday experiences which in turn allow for meaningful discourse (Zeidler & Kahn, 2014).

Another major challenge is related to how prepared and confident teachers are to use such a method of assessment since research shows that many teachers do not have adequate professional development to structuring and leading argumentation-based lessons (Simon, Erduran, & Osborne, 2006). In practice, this frequently results in going back to teacher-centered questioning or lesson delivery which ends up limiting opportunities for authentic discourse. (Osborne, Erduran, & Simon, 2004). Similarly, Sampson and Blanchard (2012) highlight that teachers tend to struggle balancing between covering the curriculum and carrying out dialogic activities which can be time-consuming, and thus if classroom argumentation does take place it could be with limited depth and quality.

In fact, in highly exam-oriented education systems such as Malta’s, teachers often feel compelled to prioritise preparation for summative assessments over open-ended argumentation tasks. This ends up creating tension between innovative pedagogies and traditional assessment demands. Additionally, assessment reliability could also be a cause of concern since evaluating oral discussions and interactive debates can be subjective which could in turn raise concerns about fairness and consistency (Newton, Driver, & Osborne, 1999). To overcome this, it is important for teachers to design good rubrics which can provide some standardisation in assessment together with sharing practice ideas with other professional individuals to ensure coherence, (Osborne, Erduran, & Simon, 2004; Sadler & Zeidler, 2009).

Furthermore, both teachers and students find argumentation difficult due to its underlying complexity. Argumentation is quite a demanding process that requires a lot of scaffolding. It requires making claims, backing them up with evidence, considering opposing responses, and also creating counterclaims (Archila et al., 2021; Hendratmoko et al., 2024). Thus without appropriate planning, students might only generate weak arguments that are unsupported opinions rather than well-reasoned claims. Teachers are therefore urged to use gradual, scaffolded approaches that include debate and inquiry in order to develop students' skills over time (Hendratmoko et al., 2024). As Zeidler and Kahn (2014) stress, “teachers must be willing to reflect on their practice and constantly strive to build and improve upon it” (p. 27). In order to overcome barriers and make argumentation a regular part of science education, it is important to take a reflective approach and get as much support as needed from educational institutions to carry out innovative assessment practices of the sort.

2.5 The teaching of Integrated Science in the Maltese context

Students in Maltese schools follow a curricular program that is regulated by the National Curriculum Framework (MEE, 2012). This framework stipulates that science is taught as a core integrated subject in primary level. For years 3 to 6 there is a fixed syllabus which includes the learning outcomes to be achieved and for year 1 and 2 the emergent approach is adopted where teachers have learning outcome guidelines available, but are not obliged to use them as long as science is taught in class, (Directorate for Learning and Assessment Programmes, n.d.). In state schools, the science lessons are conducted by the class teachers. The practice of sharing peripatetic teachers specialised in science around schools who visit the school once every two or three weeks, has been phased down, and these teachers now provide help to schools as needed. In church and independent schools it depends on the school. In some schools, the science is taught by the class teacher, in other schools the subjects are divided between the different teachers and a specific teacher would teach science together with other subjects to all the classes. In other schools a specialist science teacher teaches science or divides the syllabus with the class teacher. As outlined in the Vision for Science Education presented in 2011, science teaching in primary schools is very often traditional and based on students filling in and colouring handouts rather than conducting practical investigations.

Once they proceed to secondary school, in the first two years of middle school (Years 7 and 8), students learn Integrated science, which consists of topics that draw on the three science areas physics, chemistry and biology. When they proceed to upper secondary school (Years 9, 10, 11) students are expected to opt for at least one science subject from Physics, Chemistry and Biology. In state schools, physics is usually the compulsory subject of choice. Students can also opt to choose one or two more science subjects in addition to their compulsory science subject. At the end of their secondary schooling students then sit for their SEC examination in any of the science subjects they have opted to study (Mizzi, 2019). Therefore, science education in Malta follows what is described in a Eurydice report (2011) as a combination of a generalist approach in primary and middle school followed by a more specialist approach in higher secondary school.

Throughout the years there have been a number of attempts to reform this approach to science education with recommendations being made to move towards a single integrated science subject known as 'co-ordinated science' to be taught all throughout secondary school (Ministry of Education, 1999). In 2011, the Vision for Science Education (2011) in Malta, proposed a move towards a different mode of teaching science which would cater for the needs of both students who did not want to pursue a career in science as well as those students who wanted a career in science. The document proposed that the majority of students could opt for a 'core science' subject all throughout secondary school which would provide them with a basic scientific literacy and "enable them to make informed choices and decisions about science as citizens" (MEEF, 2011, p. 10). Students who wanted to continue with a career in science could opt from choosing from two or three subject options that would include materials sciences, physical sciences or life sciences. The Vision for Science Education in Malta (2011) also emphasises the need to shift to more inquiry-based learning that encourages students "to explore, construct their own understanding of scientific concepts, and relate to other concepts" (p. 13). It also proposes that assessment practices are more formative and that learning outcomes can be assessed through various formats and activities in addition to the traditional tests and examinations.

The aims of science education as outlined in the Vision for Science Education (2011), with a focus on scientific literacy are in line with the PISA 2025 Framework for Science Education

(OECD, 2023). Unfortunately, due to an amount of criticism made by a number of university academics in the science faculties, science teachers in schools and the teachers' union, the introduction of core science and a greater focus on scientific literacy was never implemented . The major critique was that students learning core science will not be well prepared to study science at post-secondary and university level (The Times of Malta, 25 March 2012). Currently, students still learn Integrated Science in Years 7 and 8, and one or more of the specialist subjects Physics, Chemistry or Biology in Years 8, 9, and 10 leading to the SEC examinations at the end of secondary school. Science teachers usually graduated from the University of Malta, or more recently the Institute of Education are expected to be able to teach their specialist subject as well as Integrated Science. In their initial teacher education program, they are helped to develop a personal identity as science teachers and exposed to innovative and creative pedagogical methods of teaching science (Mizzi, 2019).

2.5.1 Moving to a Learning Outcomes Framework

In 2009, a review of the National Curriculum Framework (NCF) was carried out. This review proposed the introduction of a Learning Outcomes Framework (2014) which was intended to meet the needs of individual learners. The Learning and Assessment Programme for Science at Levels 7 and 8 (DQSE, 2018), promotes an inquiry based and student centred methodology for teaching science with an emphasis on student engaging in scientific experiments with a relevance towards everyday life situations. The LOF sets out "what the learner is expected to know, understand or be able to do as a result of a process of learning" (p. 2). Diverse methods of teaching the LOs and their assessment are encouraged.

In the case of Biology, the LOs which cover the last three years of secondary schooling (Years 9, 10 and 11) are taken mainly from the SEC Biology syllabus. It “is an introduction to the study of life and provides a sound basis for future studies in the subject” (State school Biology syllabus, 2018, p. 4). The program covers the fundamental processes for life, the functions of life, the relationships between different organisms, the environment and human impact on the environment, evolution and the diversity of life (State school Biology syllabus, 2018). Similar to the Science program, the biology program encourages the use of experiments and scientific reasoning related to real life situations.

Both the Science and Biology Learning Outcomes cover the aims of science education outlined in the Vision for Science Education (2011) and aim to encourage both the development of scientific literacy as well as prepare students for a future career in science. They cover the core competencies that provide diverse qualifications for students at the end of their secondary schooling. Although, socioscientific issues and argumentation are not mentioned explicitiy, in the LOF (2014). The document highlights instead general aims of science education such as understanding, investigating, communicating, linking knowledge, and developing critical literacy and creativy in learners. The discussion of socioscientific issues is very limited in the Maltese science curriculum (2022).

More recently, the national education strategy for 2024 to 2030 emphasises that the focus of education should extend beyond exam results. Instead, it should prioritise broader outcomes as the ultimate goal, (Ministry for Education, Sport, Youth, Research and Innovation, 2024). Education should be about equipping students with a set of skills that prepare them for the world beyond school and to also ignite a love for lifelong learning, (Ministry for Education, Sport, Youth, Research and Innovation, 2024). In order for this to occur, we have to move beyond traditional teaching and put our students at the centre of their learning journey.

2.5.2. The Current State of Science Teaching and Learning in Maltese schools

While the NCF and LOF both proposed a teaching and assessment methodology that in science was focused on inquiry based learning, experiments, investigations and formative assessment practices, the actual situation in schools was slightly different. Research studies carried out mainly by researchers doing a Masters' or Bachelors' degree at the University of Malta indicate that there might be a discrepancy between what teachers feel they should be doing and what they are actually doing in science classrooms. Studies carried out by Gatt (2011) and Vella Bondin (2016) indicated that in principle science teachers believe that science should be based on inquiry, involved students, went beyond the memorisation of facts and involved investigations that led to deep learning of science concepts. However, both studies indicate that despite this philosophical belief, science teachers still used traditional approaches when actually teaching science in school. The teachers who participated in the study attributed this discrepancy between their teaching philosophy and their actual practice to lack of time available to covering the topics in the syllabus, lack of support and resources and very limited professional development and training.

These challenges to teaching science become even more pronounced when specialist science teachers are asked to teach generalist science which might fall outside their area of specialisation. Mizzi (2022) describes this switching from specialist to generalist science as 'crossing boundaries' (p. 7). Mizzi (2022) describes how in crossing boundaries science teachers face several challenges and may resort to coping strategies that result in them avoiding practical work, problem solving activities and creative methods for teaching science. These challenges are also faced by specialist teachers as Emiru (2021) describes the views of science teachers who suggest that in order to carry out the student-centred approach outlined by the LOF (2018), science teachers even if specialists require regular professional development that will allow them to hopefully put into practice what they believe in.

These research studies carried out in the local Maltese context indicate that even though in principle, the vision for science education in Malta through the LOFs is pushing towards a move towards more inquiry based learning, with active involvement of students, this is not really happening in practice. The focus still seems to be on teaching students science content rather than preparing them as citizens who can take responsible decisions as outlined in the PISA 2025 framework for science education. This might be because it is easier and safer for teachers to stick to what they are familiar with (Mizzi, 2022). A study by Attard (2010) suggests that students need to be guided to develop skills of argumentation and these opportunities need to be provided within the science classroom. Argumentation is not something that comes automatically to all students. Furthermore, Attard (2010) argues that even teachers need to be professionally trained so that students reap the greatest benefits from the use of argumentation in the science classroom.

2.5.3 The Introduction of School Based Assessment (SBA)

The introduction of the LOF (2014), led to changes in assessment practices in Maltese schools with the introduction of School Based Assessment (SBA). This was intended to allow students to be assessed on various skills and through different modes and activies, so as to allow all students to show better what they know and can do in science (Attard Tonna & Bugeja, 2016). This SBA approach is linked with inquiry based pedagogies and helping students develop scientific literacy as outlined in the PISA 2025 science framework. A study by Attard (2023), shows that although initially science teachers resisted the introduction of SBA, some teachers are now using a variety of assessment tasks. Such tasks include assignments, investigations, special homeworks, group projects and tests. As reported by Attard (2023), what remains problematic is that marks still need to be assigned to SBA tasks and this shifts the focus back to a summative judgement rather than a learning experience for students.

The introduction of SBA opens the way for teachers to shift their focus onto assessment tasks that are embedded within a real life context, and the use of argumentation on socioscientific issues. Attard (2010) highlighted the benefits of using argumentation with Maltese science students. In her study, she argues that although students had to be guided to learn the skills of argumentation, the use of argumentation in planned socioscientific contexts helped students to understand science concepts, resulted in meaningful transfer of learning, and improved metacognitive and argumentative skills that students were able to transfer beyond the science classrooms. The hope for the future is that more teachers take on the opportunities provided by SBA to introduce more creative and innovative assessment tasks based on argumentation within a socioscientific context.

Alongside these developments, the Integrated Science Continuous Assessment Guidelines for Years 7 and 8 further clarify the purpose of SBA by emphasising assessment practices that capture the broader aims of science education. These guidelines highlight that assessment should value not only factual recall, but also investigation, reasoning, communication, and the ability to apply scientific ideas in meaningful contexts (Integrated Science Continuous Assessment Guidelines, 2012; OECD, 2025). They encourage teachers to design tasks where students are able to observe, question, analyse information, and justify their thinking. These are skills that are strongly aligned with scientific literacy and with the competencies outlined in the PISA 2025 Science Framework.

The guidelines call for assessment opportunities that help students to demonstrate progress through discussions, collaborative problem-solving, inquiry tasks, and reflective work. This approach naturally complements socioscientific and argumentation-based learning, where students must weigh evidence, evaluate sources, and articulate claims (Zeidler & Kahn, 2014; Sadler & Zeidler, 2009; Osborne et al., 2004; Evagorou & Osborne, 2013).

2.6 Conclusion

Through this chapter there has been a thorough exploration and analysis of the evolving aims of science education. Through this exploration what was highlighted is the increasing need for approaches that move beyond memorisation and more towards the development of scientific literacy, critical thinking, and informed decision-making. Research on socioscientific issues and argumentation shows that these pedagogies allow students to connect scientific ideas with real-world concerns while developing reasoning, evaluative skills, and moral awareness. At the same time when looking at the Maltese educational context one can notice a gap between policy intentions which promote inquiry, relevance, and continuous assessment and the reality of classroom practice which includes a traditional, exam-driven approach. Local studies emphasise the challenges teachers face but also point to the potential of approaches like SSI to improve engagement and deepen understanding. Thus the literature establishes a strong justification for developing an SSI-based teachers' guide for the Year 8 Healthy Living topic, demonstrating both the pedagogical value and the local relevance of this project.

Chapter 3: Methodology

3.1 Aim of the research project

One of the main aims of science education as outlined in the PISA 2025 Framework for science education, is the development of scientific compentencies that move beyond the simple acquisition of science knowledge. The framework focuses on the development of competencies that enable students learning science to engage with science-related issues and be able to use scientific information for critical thinking and decision making. The overall aim is to prepare citizens who are scientifically literate and can use scientific knowledge and reasoning in real world contexts (OECD, 2023). One way in which this aim of science education can be reached in the science classroom is through the use of socioscientific issues. Zeidler and Kahn (2014) describe socioscientific issues in science teaching as real-world real-world, controversial, and ethically complex topics that are used in a way to combine scientific inquiry with social and moral aspects. The aim of this research project was to develop a Teacher's Handbook that would help science educators to teach science using socioscientific issues (SSI). The Teacher's Handbook focuses on the topic 'Healthy Living' in the Year 8 Integrated Science syllabus and emphasises the use of SSI as a real world context to help science students develop skills in research, analysis and argumentation.

The book aligns with the Learning Outcomes of the Year 8 Integrated Science syllabus. Several topics are covered in this syllabus, but the topic 'Healthy Living' was chosen for this project. This topic was selected because it focuses on various real world issues that give students the opportunity to discuss certain aspects of life that require both scientific information and value-based reasoning to make informed decisions. Some of the real world issues tackled in this topic include diet, exercise, and vaccinations. By discussing these issues in the safe space of the science classroom, science students are better prepared to engage in every-day decision making.

Through this Teacher's Handbook my main aim was to help teachers feel confident in creating the right environment for students to feel encouraged to discuss such debatable issues. The Handbook offers practical examples about how to implement teaching through SSI in the science classroom, in order to enable science students to develop the skills of analysing scientific information and give evidence-based reasoning when voicing their opinion about complex scientific issues. The main aim is to promote scientific literacy for responsible citizenship (Ministry for Health, 2022; MEYR, 2022).

3.2 Methodological framework

This dissertation is a qualitative, practice-based research (PBR), where theoretical reflection has been developed into an innovative instructional design (Candy, 2006; Candy & Edmonds, 2018). The methodological framework that guides this research project is based on what McKenney and Reeves (2013) describe as Education Design Research. Education Design Research, "is a genre of research in which the iterative development of solutions to complex educational problems provides the setting for scientific inquiry" (p. 133). The Teacher's Handbook, which is the artefact created in this study, under the PBR framework is seen not only as the product which came out of the research but also as a way to explore how this can be used as part of the teaching and learning process. This framework was chosen because research shows that science teachers find it difficult to apply new teaching methods they read or hear about into their classroom activities as part of their pedagogical practice and this is also the case for the incorporation of SSIs and debates in the classroom (Simon, Erduran, & Osborne, 2006; Zeidler & Kahn, 2014).

I chose to develop a practical tool that as described by Walliman (2002) allows the theory behind the use of SSI as a teaching pedagogy, to be applied by science teachers in their own classroom. In fact, this project involved the incorporation of interesting and thought-provoking SSIs which are presented to students as debatable questions, giving students an adequate scaffolded learning experience to be able to attain the necessary argumentation skills, (Attard, 2010; Presley et al., 2013; Zeidler and Kahn's, 2014).

3.3 A pragmatic approach

This dissertation uses a pragmatic research strategy since such a strategy argues that research is effective when it can address actual educational issues (Creswell, 2014). When it comes to educational research, pragmatism is especially useful when one main focus is to improve the method rather than to test out theoretical concepts. The pragmatist approach was chosen since as described by McKenney and Reeves (2012), the project focused on trying to address a real-life issue faced by teachers and it also tries to find a solution for the teachers. The research is based on developing 'usable knowledge' Lagemann (2002), "thus rendering the products of research relevant for educational practice" (McKenney & Reeves, 2012, p. 7).

As mentioned in the literature review, many Maltese science teachers have strong beliefs when it comes to inquiry-based, student-centered learning. However, at the same time they also encounter certain challenges which discourage them from adopting such teaching methods. Some of the mentioned barriers mentioned in the literature include lack of resources or training, time constraints, and syllabus demands (Gatt, 2011; Vella Bondin, 2016; Mizzi, 2022). Using a pragmatic approach, I tried to focus on creating a guide that offers science teachers adaptability and a clear structure together, and resources that they can use with little preparation time. These factors provide a tangible 'usable product' that supports science teachers in applying a student-centred teaching method in practice given these limitations.

Furthermore, pragmatism supports a variety of assessment methods, including group projects, discussions, and inquiry-based assignments, as promoted by the Learning Outcomes Framework and School-Based Assessment (Attard Tonna & Bugeja, 2016; MEDE, 2015). According to Zeidler and Nichols (2009), SSI-based learning supports these learning processes and thus the pragmatic approach is both practical and relevant in this project.

3.4 Practice-based research

Drawing on the pragmatist framework, in recent years, practice-based research has gained popularity as a methodological approach because of its emphasis on practical application and integration of theory with real-world issues. This method works well in specific fields, such as education, design, and the arts, where practical application is key. This is because, in such areas, it is very beneficial to apply specific theory to a tangible and innovative project that can be used to improve the practical aspect of that field of work (Leavy, 2020). The practice-based research method makes it possible to explore ideas creatively and open-mindedly while focussing on how to use knowledge and skills in the field of study in real life. It is beneficial for solving complicated, multidimensional problems because it encourages the growth of critical thinking through the use of tangible results. Practice-based research has only grown over the years and will continue to do so in multiple fields of study. The aim is for using research to impact the implementation in the here and now classroom situation (McKenney & Reeves, 2013).

Following the ideas of Candy (2006) and Candy and Edmonds (2018), this study employs a practice-based methodology and thus the 'Healthy Living Socioscientific Issues and Debate Guide' is recognised as both a creative and reflective form of inquiry. Practice-based research places the teacher-researcher at the core of the process since it involves the combination of academic study with professional experience in order to produce theoretical and practical insights. In fact the design of this project, helped to bring together what McKenney & Reeves (2013) describe as researcher and practitioner expertise.

Three gradual phases were used in this project's practice-based process with the first being the gaining of context and a theoretical foundation which involved (1) reading about the theoretical conceptualisation of the use SSI and argumentation (Sadler, 2004; Zeidler et al., 2019); and (2) the examination of literature to find pedagogical gaps and challenges in Maltese science education (Mizzi, 2022). This was followed by the design of the project where developing and organising SSI-based lesson plans for the 'Healthy Living' topic in the Year 8 Integrated Science syllabus, where developed and organised. This involved incorporating real-world issues and moral dilemmas which create the perfect opportunity for discussion and argumentation (Presley et al., 2013). Finally, the project would not have been complete without constant critical reflection and being able to assess the design choices made in accordance with the theoretical ideas I have read about together with the knowledge of how the classroom environment is in real life. This was important in order to have a finished guide which is both useful and pedagogically sound. During these phases, knowledge emerged by the creative design process itself and the reflective professional practice rather than the conventional data collection process.   This supports the idea that when educational research connects theory, design, and classroom practice, it can have a transformative effect (Candy & Edmonds, 2018).

3.5 Ethical considerations

Even though neither teachers nor students actively participated in this study, ethical considerations were still at the centre of both the design and reflection phases of the project creation process. The main ethical consideration was ensuring sensitivity and respect for all the diverse needs of the science students. When choosing and handling the SSI and debate topics about nutrition, exercise, smoking, infections and immunisations I made sure that sensitivity and respect was maintained. These were handled carefully to guarantee that conversations are inclusive, grounded on evidence, and opposing viewpoints are considered (Zeidler & Nichols, 2009).

The topics were also chosen to represent Maltese educational principles and public health issues, in line with the national education strategy for 2024 to 2030 (Ministry for Education, Sport, Youth, Research and Innovation, 2024) and the Healthy Weight for Life Strategy (2022–2030). In addition to this, the content and resources of the project have been developed to reflect factual accuracy and pedagogical appropriateness in accordance with the MEDE (2012) requirements, and any sources which have not been developed from by myself, have been appropriately credited.

The activities were created in a way that kept the student's well being as the main priority. Through this guide I made sure to provide a secure and safe learning environment that promotes communication as well as empathy, and respect for one another which are all critical values to hold onto for managing socioscientific discussions and debates. Therefore, the guide's educational design and content were guided by ethical considerations to guarantee that the teaching and learning which comes out of the project can promote the moral and intellectual growth of students.

3.6 Conclusion

The goal of this study was to provide a useful handbook to assist teachers in incorporating socioscientific issues (SSI) and debate within the topic of healthy living in the year 8 cohort. What has motivated the creation of this project are the growing demands for creative and student-centred teaching methods in the Maltese science education. I wanted to make a tool that would encourage students to develop critical thinking skills together with argumentation skills in their learning. Apart from this I also wanted learning to be more relevant by using real-world issues. These skills are lacking in students since many lessons in Malta still focus on remembering facts rather than applying them and thinking about them more profoundly. This is in line with both national and international educational priorities so that students are better prepared for life after leaving school.

Through this study I had the opportunity to become an active practitioner by using the creative design process to bridge theory and classroom practice through the use of a practice-based research methodology. By using my experience in the classroom to create the 'Healthy Living SSI and Debate Guide', I made sure that it was based on the realities of Maltese classrooms as well as research. A pragmatic framework was adopted, so that to create a practical and flexible resource that educators can use in a variety of ways in order to facilitate the limitations of their teaching environments. Incorporating this methodology into the project helps to support the continuous effort to enhance science education in Malta by making it more engaging, inclusive, and relevant to society.

Chapter 4: The project

4.1 Rationale

Drawing on my experience as a student teacher in Maltese science classrooms and from my review of local research studies (Gatt, 2011; Mizzi, 2022; Attard, 2010) I have come to the conclusion that science teachers acknowledge the importance of having lessons which involve inquiry and discussion. However, many of them feel reluctant to go beyond factual recall and written assessments due to several challenges they face, including lack of time, training and resources. Therefore, for my dissertation, I wanted to create a resource that teachers could easily use in their science lessons in order to engage students and enable them to become scientifically literate.

As part of my science pedagogy lectures, I was introduced to the idea of socioscientific issues as a teaching strategy to make science learning more relevant for students and at the same time enabling them to develop the skills of critical thinking and decision making (Zeidler & Kahn, 2014). I also came across a teaching guide called 'It's Debatable' written by Zeiler and Kahn (2014). This guide included instructions for science teachers on how to design lessons that focused on debatable questions related to a variety of socioscientific issues. This book inspired me to come up with the idea of developing a similar guide for Maltese Integrated Science teachers, entitled 'Healthy Living: Teaching Socioscientific Issues - A Teacher's Guide'. In this teacher's guide I wanted to provide Year 8 Integrated Science teachers with a resource tool that would enable them to develop lessons based on debatable questions related to socioscientific issues. I decided to focus on the topic in the Year 8 Integrated Science curriculum, 'Healthy Living'. I decided to choose this topic since in my view, encouraging students to develop a healthy lifestyle is very important, and the topic led itself nicely to real-life debates about issues such as vegetarianism, vaccination, smoking and infectious diseases amongst other issues. Being able to make informed choices is especially relevant in today's world of social media where students are constantly exposed to scientific about diet, health, and the environment. Assertations made on social media are not necessarily scientifically accurate and students need to learn how to think critically about the evidence they see and make informed choices (Osbourne, 2023).

My ultimate goal in developing this guide was to provide science teachers with a resource tool that would enable them to use SSI and debate as the main focus of their science lessons. The Teacher's Guide is divided into two parts. In the first part I try and provide a theoretical framework for teacher's who would like to use socioscientific issues in their science lessons. I also link the use of socioscientific issues to the current Learning Outcomes Framework for the topic 'Healthy Living', in the Year 8 Integrated Science syllabus. In the second part I present teachers with six 'Debatable Lesson Guides'. Through 'Debatable Lesson Guides', which will be described in more detail later on in this chapter, I present a series of lessons based on 'debatable questions' and socioscientific issues. The individual 'Debatable Lesson Guides' include flexible lesson plan ideas, ready-made materials, and reflective questions that connect what students are learning in school with what they are experiencing in their daily lives.

4.2 SSIs and debates as the teaching method for my project

In this project, I used socioscientific issues in several interconnected ways, each designed to promote a different aspect of socioscientific reasoning as shown in Figure 2. In my designs I always kept in mind to create lessons that explicitly teach students how to use evidence to justify opinions, how to engage respectfully in argumentation, and how to reflect critically on different perspectives. In this sense, SSI and debate were not chosen as add-ons to traditional instruction but as core methods for building scientific literacy, as emphasised in the PISA 2025 Science Framework (OECD, 2023).

I decided to centre the lessons around a debatable question, which is mainly a controversial question about a socioscientific issue we face in our daily lives. The introduction of these questions at the beginning of the lesson not only engages students' attention but also encourages them to begin connecting science with everyday issues they encounter. Some examples of these questions include "Should everyone become vegetarian?" or "Should governments increase taxes and enforce stricter smoking rules to reduce smoking among young adults, or does this infringe on personal freedom?" At this point students are prompted to take an initial stance which encourages students to draw their answers based on their existing beliefs and experiences. According to Högström et al. (2024), taking a position is an important step for developing moral reasoning and engaging students emotionally with the topic.

Evidence analysis is another important aspect of using socioscientific issues as a teaching method. In order to answer the question more profoundly, students examine various information sources to gather evidence so that they can back up their opinions based on appropriate knowledge. In my guide, I tried to develop lessons in which students are taught to analyse evidence be it from scientific reports, advertisements or media articles, which, at their age, they come across on a daily basis. In addition, guided by Zeidler and Kahn (2014), I chose to include both reliable and biased materials, encouraging students to identify bias and thus assess the quality of evidence. This process helps build media literacy and also aligns with Osborne et al. (2016), who emphasise that argumentation in science education requires students to evaluate claims and data critically rather than accept information. The guide also includes evidence collection and analysis, where students collect evidence to support their argument.

Argumentation and debates are fundamental when discussing socioscientific issues. The lessons included in the Teacher's Guide are based on different types of student debates, depending on the nature of the topic and the class dynamics. Some of the debates take the form of whole-class discussions where all students are encouraged to participate and which allow for open exchange of ideas. In some lessons the debate is developed as a think-pair-share exercise so that students feel more at ease in sharing ideas. Furthermore, this method could be a perfect scaffold for full-on debates. In one lesson scenario I also included an exercise where students are given specific roles so that they put themselves in that particular position and base their opinion as if they had that position in society. Other debate formats include small-group debates, where each group represents a particular stance and has to support it with evidence. In some of the 'Guides' I have also presented the debate in a role-play format so as to give a chance to students who express themselves better using drama and creativity. I have also provided teachers with guided questions and rubrics so they can encourage students to engage in debate and argumentation while maintaining a respectful classroom environment. These various debate formats draw on the ideas of Presley et al. (2013), who discuss the importance of flexible design elements that support higher-order reasoning, argumentation, and collaboration in SSI-based lessons.

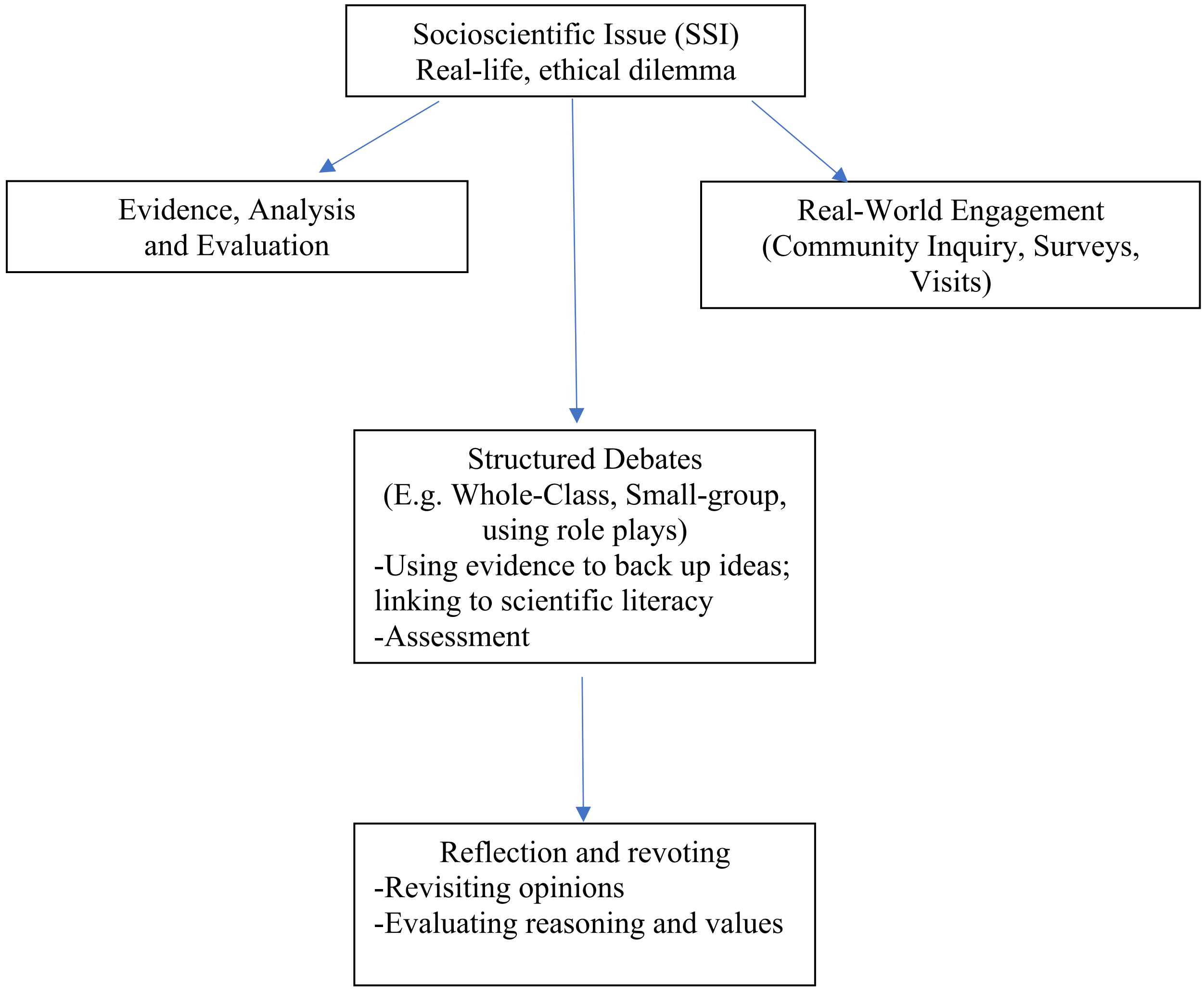

Figure 2 Interconnected Ways of Using SSI and Debate in Science Lessons

Linking socioscientific issues to real-life experiences continues to enhance the scientific relevance, and students are able to feel a deeper connection to the topic in question because they are experiencing and facing the social issue firsthand, which increases empathy and moral thinking, (Smit et.al., 2025). In fact, in one particular ‘Guide’, students get to engage with people in the community and obtain relevant information so that their reasoning is also based on social aspects, not only scientific. Such experiential tasks align with the framework of Presley et al. (2013) who argue that real-world applications deepen understanding and help students recognise the true nature of science as a lived practice, not something perfect that they get to learn about in class. These tasks were included to make debates more grounded and to enable students to bring authentic data and opinions into classroom discussions.

Finally, each ‘Guide’ concludes with a final reflection and chance for revoting, where students revisit their initial opinions and evaluate whether their stances have changed after analysing evidence and listening to others' opinions. This strategy, suggested by Zeidler and Kahn (2014), helps to support metacognitive growth and also encourages students to acknowledge how scientific reasoning can evolve through discussion.

In designing this project, I therefore treated SSI and debate as interconnected processes rather than isolated activities. Each debate is there to serve as a framework which can help students learn how to judge evidence and talk to each other with respect while making moral, well-thought-out choices. This integration also supports the broader aims of Maltese science education as outlined in the National Curriculum Framework (MEDE, 2012), which promotes inquiry, collaboration, and critical thinking as essential skills for lifelong learning.

4.3 Linking to the curriculum

After socioscientific topics and debates were chosen as the main teaching method for this project, it was important to put these methods in the context of the current Maltese science curriculum. Thus, the following phase was to find a topic that supports the use of SSI learning. This was done to make sure that the Teacher's Guide is both useful and in line with the curriculum so that Maltese science teachers could apply it in their classroom.

4.3.1 A National Curriculum Framework (NCF)

The National Curriculum Framework (NCF) principles served as a fundamental reference during the development process of the project so as to guarantee that the SSI-based lessons represent the national vision for scientific education in Maltese middle schools. First and foremost, according to the NCF, all students must have access to fundamental scientific literacy, which is divided into three main areas:

- learning to relate science to technology, society, and the environment;
- developing scientific understanding;
- developing inquiry skills (p. 11).

These strands directly reinforce the teaching choices made in this project since socioscientific issues encourage students to use what they know about science while also thinking about the bigger social and environmental effects.

The NCF (2012) advocates for a fundamental change in the way science is taught and suggests that teachers should go beyond simply listing competencies of students. Thus, the NCF (2012) emphasises that teachers should adobt an inquiry-based approach where students get to answer questions through investigation while working with each other collaboratively within "a community of practice" in order to create scientific meaning rather than depending solely on the transfer of information from the teacher (p. 12). This emphasis on inquiry and collaboration is in line with a socioscientific approach to science teaching and debate-based learning. In their debates students have to discuss with each other while also question and assimilate each others' beliefs so that to be able to arrive to better conclusions.

When it comes to assessment, the NCF (2012) states that this should be used to enhance learning by providing student with continuous, high-quality feedback. This feedback should encourage students to grow and become more autonomous learners by taking responsibility of their own learning. The NCF encourages a formative approach to assessment and I have tried to adopt this formative approach in a number of assessment tasks that are included in the lesson guides. Using rubrics to guide them, teachers are encouraged to observe students' thought processes. Through the rubrics they can offer focused feedback on how students develop arguments while supporting them with evidence, and how to reflect on their opinions. Students themselves can also use the rubrics to guide them through their preparation process and to help them grow in their learning process. The rubrics are in line with the NCF guidelines and focus on assessing communication together with scientific comprehension, and the ability to apply science to practical situations .

The NCF (2012) also acknowledges that the fields of science and technology have a significant impact on society. This is because they affect sustainability, well-being, and the decisions that we make as people and as members of communities. Thus, the NCF clearly states that science education must prepare students for making responsible decisions, which is the goal of SSI-based instruction. This project directly addresses this goal by having discussions about topics such diet, health, public safety, and lifestyle choices. This in turn helps students understand how scientific decisions affect their daily lives.

By using these NCF principles as the basis for the SSI and debate-based lesson guides I made sure that the instructional strategies adopted are in line with national educational standards. Therefore, the guide helps teachers achieve the larger aims of science education intended for Maltese students and at the same time provides them with the pedagogical support they need.

4.3.2 Topic Selection - Science Year 8 Learning Outcomes Framework 2018

The Year 8 Integrated Science Learning Outcomes Framework (2018) emphasises that middle school science should help students explain ideas, investigate simple relationships, communicate their reasoning, and apply science to real-life contexts, which are all features that align with the SSI teaching method. Thus, when it came to choosing a topic from this science curriculum, the Healthy Living topic was the topic of choice, primarily because the themes within the topic link perfectly with socioscientific-based learning. Themes included in the topic are food choices, exercise habits, smoking, microbes and disease transmission, immunity and vaccination, which are all real issues that people discuss, debate, and make decisions about in everyday life. Thus, this strong link between the topic and real-world issues makes Healthy Living an ideal context for SSI-based activities. In such activities students are encouraged to explore different viewpoints while weighing evidence so that they are able to form informed opinions on authentic, meaningful issues that connect science to society, and thus the Healthy Living topic provides the perfect fit.

The learning outcomes (Appendix 1) for this unit further support the SSI teaching approach. Students learn how the body uses nutrients, how exercise affects the circulatory system, the effects of smoking on the respiratory system, how microbes spread, and how the immune system responds to illness. These concepts are part of students' daily experiences, and because of this, students can relate the science they learn, including abstract science, to personal and community health choices, which is fundamental to having successful SSI-based learning. The learning outcomes of this topic help students to learn to think about the scientific background and how lifestyle choices affect well-being. Students can thus use the scientific evidence they gather throughout the topic to form a scientifically sound opinion supported by evidence. This strong link between curriculum content and real-life decision-making is the main reason 'Healthy Living' was selected as the focus of the project.

4.4 Organising the topic

Once the Healthy Living topic was selected, the next step was to organise its different areas into a clear structure so as to make the project more manageable and meaningful. Thus, using the learning outcomes themselves, five sub-topics emerged. These sub-topics were:

Part 1: Diet and Digestive System.

Part 2: Respiratory System.

Part 3: Circulatory System.

Part 4: Infections and their Prevention.

Part 5: Fighting infections and Immunity.

For each of the sub-topics a set of Learning Outcomes (from the Integrated Science Year 8 curriculum) were identified (Table 3). This ensured that the lesson guides were developed based on the Integrated Science Year 8 LOF.

In addition, when it came to organising the sub-topics and the LOs careful thought was given to organising them in a way that the difficulty of the scientific knowledge builds gradually. Scientific ideas were sequenced so that more personal and familiar concepts, such as food, exercise and smoking, were explored before moving on to more complex themes, such as disease spread and immunity. This is a scaffolded approach that allows students to form a solid scientific foundation before engaging in more complex discussions, (Smit, Rietz & Büchel, 2025).

Table 3 *Distributing the Learning Outcomes according to the 5 main parts*

Part 1:- Diet and Digestive System	**1**. I can identify the basic food substances, their use and sources. **2**. I can describe what a balanced diet is. **3**. I can apply my understanding of a balanced diet to suggest improvements to what I eat. **4**. I can identify reasons why the diet changes with age, occupation, and activity. **5.** I can label the digestive system and describe the function of the different parts. **6.** I can describe the role of enzymes during digestion. **7.** I can link certain foods with healthy or unhealthy diets.
Part 2:- Respiratory System	**8.** I can briefly describe the structure of the lungs and explain the role of rib cage and diaphragm during breathing. **9.** I can identify tar, nicotine and carbon monoxide as the main harmful ingredients in cigarette smoke. **10.** I can describe the effect of smoking on health. **16.** I can identify an increase in carbon dioxide in the breathed-out air and test for it.
Part 3:- Circulatory System	**11.** I can label the blood circulatory system. **12.** I can identify the main components of the blood circulatory system (the blood, heart, arteries and veins). **13.** I can name red blood cells, white blood cells, platelets and plasma as the main components of blood and describe their function. **14.** I can associate bad eating habits, lack of exercise and smoking with unhealthy lifestyles. **15.** I can describe the effect of exercise on the pulse / breathing rate.
Part 4a:- Infections and their prevention	**17.** I can identify examples of microbes (viruses, bacteria and fungi). **18.** I can describe how microbes can be harmful and identify examples. **19.** I can describe how microbes can be useful and identify examples. **20.** I can identify some common diseases and link some diseases with its corresponding microbes. **21.** I can describe how some common diseases are spread. **22.** I can assess basic hygiene procedures as a way of preventing spread of microbes.
Part 4b:- Fighting infections and Immunity	**23**. I can identify natural barriers (such as skin, tears, sticky mucus, acid in stomach and scabs) which can act to prevent disease. **24**. I can use the term 'immune' as meaning resistant to disease. **25**. I can describe the white blood cells' action against infections. **26**. I can link the use of antiseptics, disinfectants and antibiotics as ways of fighting infections. **27**. I can describe how immunisation protects the body against some diseases. **28**. I can discuss the importance of vaccines to prevent the disease and slow down the spread of disease.

4.4.1 Choosing the SSI and debate topics to discuss for each section

Following Presley et al. (2013) and Zeidler & Kahn (2019), a 'debatable question' on SSI was written for each emergent sub-theme in the topic 'Healthy Living'. The selection of the SSI and debatable questions for each sub-topic required some reflection. I wanted to ensure that every SSI connected meaningfully to the scientific concepts and LOs identified in the curriculum. The sub-topics (themes) healthy eating, physical activity, smoking, the spread of microbes, and vaccination, are often discussed in society often giving rise to conflicting opinions and ethical concerns. Thus, these themes provided a rich base for identifying debates that were both age-appropriate and scientifically grounded (Presley et al., 2013; Smit, Rietz & Büchel, 2025).

Each SSI was chosen because it created a strong link between the scientific learning outcomes and a real-life decision that individuals or communities may face (Zeidler & Kahn, 2019). For example, discussions about diet and food choices connect to the learning outcomes about nutrients and digestion. Exercise debates link with outcomes focusing on pulse, breathing rate, and circulatory health. Smoking relates naturally to outcomes dealing with gas exchange and harmful substances. On the other hand, disease prevention and the wearing of masks link to the transmission of microbes, and finally, vaccination debates connect with learning outcomes on immunity and the body's defence systems. In this way, every SSI in strengthens understanding of the scientific content and also helps students to think critically about societal issues as highlighted by Lee et al. (2013).

Another important factor in selecting the different SSIs was to ensure that there was a balance of personal, social, and ethical dimensions of the SSI in question as emphasised by Powell et al. (2021). Some of the issues chosen involve personal lifestyle decisions, while others raise questions which involve the bigger community. This balance allows students to experience different types of reasoning both on an individual level but also when it concerns public health, which is central to SSI-based learning (Zeidler et al., 2019). The SSIs and debatable questions selected create clear opportunities for evidence-based reasoning, reflection, and discussion, and the careful matching between the particular themes and debatable questions ensures that each debate strengthens, not distracts from, the scientific learning taking place.

The Teacher's Guide is presented in the form of what I am calling a 'Guide'. There are six 'Guides' in all, one for each of the sub-topics identified for the main topic 'Healthy Living'. Each Guide starts off with a 'debatable question' that sets the tone for the procedure for teaching through the socioscientific issue.

Table 4 *The chosen debatable questions*

Sub-Topic	**Guide**	**Debatable Question**
Part 1:- Diet and Digestive System	Guide 1: Healthy Eating	Should we all become vegetarian?
	Guide 2 – Fat Reduction	Are modern fat-reduction methods the real solution to weight loss?
Part 2:- Respiratory System and Smoking	Guide 3 – A Breath of Smoke	Should governments increase taxes and enforce stricter smoking rules?
Part 3:- Circulatory System and Exercise	Guide 4 – Taking Care of Our Heart	Should all schools start the day with a mandatory physical activity?
Part 4a:- Microbes and Transmission	Guide 5 – Fighting Infections	Should schools recommend or require masks during cold and flu season?
Part 4b:- Immunity and Vaccines	Guide 6 – How Our Body Fights Back:	Should vaccination for all children be mandatory, or should it be a parental choice?

4.4.2 Developing the lesson 'Guides'

The development of the lessons involved linking each Guide from the 'Healthy Living' topic with an authentic socioscientific experience in order to allow the scientific content to naturally progress into a meaningful discussion. To achieve this, every Guide was paired with a real-world context that students could relate to. For example, the vegetarian debate lesson (Guide 1) was developed around learning outcomes dealing with nutrients, food groups, and balanced diets. In this Guide students take part in a restaurant role play. First they are asked to choose a meal from a restaurant menu card. Then they are provided with information on nutrient cards and a my healthy plate diagram. This new information enables them to upgrade their food choices to create a more balanced meal. Then they compare their choices to a vegetarian meal. Once the students gain a clear scientific understanding of what a balanced diet is and what it includes, they are invited to revisit the debatable question "Should everyone become vegetarian?" This structure reflects Sadler's (2004) view that scientific understanding should precede socioscientific reasoning.

What is different for Guide 2 'the fat-reduction debate' is that students get to apply knowledge they gained in previous lessons about digestion and making the right healthy choices to take part in an actual debate after analysing evidence. The debate of 'quick fix weight loss' is a very current topic and there are widespread reports on news media and social media about new methods for losing weight. The aim of this Guide was to help students learn how to correctly analyse scientific evidene and identify bias in evidence. The main idea as suggested by Zeidler and Kahn (2014) is for students to understand why analysing source credibility and recognising promotional versus scientific information is essential. The Guide introduces the "miracle fat-burning drink" a product which people claim burns fat as a hook to highlight bias and unreliable health claims, and thus the need for careful evidence evaluation. Students are asked to react to the product's claim and then discuss what evidence would actually be required to demonstrate its effectiveness. After this introduction, students evaluate evidence from a selected set of online resources about Ozempic, gastric sleeve surgery, intermittent fasting, berberine, and the keto diet. They then have to use the Science Detective Checklist to assess the reliability of these sources.

Guide 3 involves respiratory health and smoking and students conduct a hands-on inquiry activity where they get to construct a working lung model and carry out a simple experiment to detect carbon dioxide in exhaled air, the 'limewater test'. What is unique in this Guide is that once the scientific foundation is established, students are asked to conduct a community inquiry, where they interview smokers to gather authentic data. This integration of scientific and societal perspectives aligns closely with SSI principles that stress the importance of moral, social, and personal dimensions (Zeidler et al., 2019). Students then combine scientific ideas with their interview findings before participating in a class debate on smoking regulations.

In Guide 4 which is about the effect of exercise on the heart students go out of the classroom to do some exercise in the form of a game to introduce the debate. Students also get to carry out a simple investigation measuring pulse and breathing rates before and after different activities, record trends, and discuss how the heart responds to increased exertion. This hands-on inquiry allows students to observe physiological changes directly, reinforcing learning outcomes related to pulse, breathing rate, and circulation. Only after introducing the actual science concepts do the students get to examine evidence on the health impacts of exercise and other lifestyle factors on the heart. This is then followed by an open classroom discussion where everyone is required to use both scientific data and value-based reasoning (Zeidler et al., 2019). when arguing whether increased school exercise time is necessary or beneficial. In this Guide students also get to prepare a health campaign that can be presented in a school assembly to promote exercise at the beginning of the school day.

The mask-use guide (Guide 5) also moves from scientific exploration to evidence-based reasoning. Students begin by watching a video about Covid-19 which serves as the hook as students have lived the realities of this pandemic first hand. They then record initial opinions by putting a pompom in one of the “microbe jars" labelled 'No', 'Yes' and 'Unsure'. They also take part in inquiry tasks such as the ‘telephone game’ and the ‘contact transmission using glitter’ to visualise different types of microbe transmission. A unique aspect in this guide is that groups analyse case-study cards to observe how diseases spread more when certain measures are not taken such as the use of masks, lack of cleaning, sharing of things, lack of ventilation and lack of distancing as well as inadequate handling of food. Students get to analyse different scenarios and see what makes infections spread more and if masks are needed so that they start forming their own opinion. These activities give students the required information that prepares them for the final narrated role-play debate, where this time students debate their views using a narrated role play. This Guide design mirrors the value of inquiry-based argumentation emphasised by Attard (2010) and Hendratmoko et al. (2024).

Finally, in the immunity and vaccination guide (Guide 6) , students are first immersed in a fictional ‘red fever outbreak’ scenario, where a new fever is affecting children and the government in considering to give the developed vaccination to all students, with some parents stating that it should be their choice. Students’ intial vote about the debate in question is expressed based on their assigned role (student, parent, doctor, politician) within a think-pair-share exercise. Then they work with Defence Squad cards to rekindle previously attained knowledge about barriers, white blood cells, antibodies, and vaccines and their function in immunity. This active, social construction of knowledge reflects Vygotskian theories that underpin argumentation-based learning (Kuhn et al., 2013). Only after this conceptual grounding are students given evidence packs to prepare for a courtroom-style structured debate on compulsory vaccination, requiring them to justify their arguments using both scientific and ethical reasoning.

Across all lessons, tools such as debate rubrics, evidence checklists, community inquiry sheets, nutrient cards, and structured worksheets support students' critical thinking. Research repeatedly shows that argumentative and evaluative skills must be explicitly scaffolded and practised (Evagorou & Osborne, 2013; Sadler & Zeidler, 2009). Therefore, each lesson was intentionally designed to provide guidance at first and gradually increasing student independence.

4.5 Developing the guide

The *'Healthy Living: Teaching Socioscientific Issues A Teacher's Guide'* was created to offer teachers a simple, ready-to-use resource for integrating socioscientific issues into the Year 8 science topic Healthy living. Its design was inspired by the practical teaching guide "It's Debatable" by Zeidler and Kahn (2014). The full guide, including all lesson plans and resources, is provided in Appendix 2 and 3, with a printed copy submitted to the Faculty of Education.

4.5.1 The presentation and layout of the teacher's guide

The guide was designed using an online graphic design tool known as Canva. This tool enabled the creation of a clean and professional layout throughout the booklet and also the accompanying resources. The final ‘Teacher’s Guide’ is printed as a spiral-bound A4 booklet, together with a separate set of loose resources which have been laminated for classroom use. Spiral binding was chosen because it is sturdy, lies fully flat on a desk, and can be folded back without damaging the pages from the binding. These are practical features for teachers who may need to refer to the ‘Teacher’s Guide’ during lessons. This can also prevent wear and tear since the booklet needs to be handled quite frequently. Furthermore, durable paper was chosen for the booklet to further prevent wear and tear from repeated usage from year to year and across different classes. The ‘Teacher’s Guide’ and all resources were printed in a standard A4 size so that to make photocopying easy especially for resources. The fact that resources are separate from the booklet also helps teachers to reproduce the resources easily.

During the design process it was made sure that the ‘Teacher’s Guide’ was visually appealing and presentation was clear. The cover pages and section dividers were designed in a simple and attractive design using soft pastel colours and clearly labelled, helping teachers navigate the guide quickly. The cover pages as seen in figure 3 below were designed with calm imagery and also included wellness symbols so that to reflect the guide’s focus on ‘Healthy Living’. The soft colours and natural elements provide a visual representation of the balanced and holistic approach which is promoted throughout the SSI lessons. The front cover shows a person sitting in a calm, reflective pose from the front, while the back cover mirrors this with the figure shown from behind. When the guide is closed, the two pages come together as if the book itself holds the person’s inner world, their thoughts, decisions, and wellbeing, symbolising the reflective and personal nature of the ‘Healthy Living’ topic explored inside.

When educational resources are well-designed and visually appealing research shows that they are more likely to be used by teachers. They also influence teachers positively on how they engage with them (Estrada-Molina et al., 2022).

Overall, the presentation and layout were carefully planned to make the guide both practical for classroom settings and visually engaging, supporting teachers in confidently implementing socioscientific and debate-based lessons.

Figure 3 The left-hand side shows the front page of the guide and the right-hand side shows the back page of the guide

4.5.2 The content of the guide

The 'Healthy Living: Teaching Socioscientific Issues (SSI) – A Teachers' Guide' is organised into clearly structured sections to help teachers navigate the material easily and understand how each component fits within the wider Healthy Living topic. The 'Teacher's Guide' is divided into two main parts, which are also reflected in the table of contents (Figure 4).

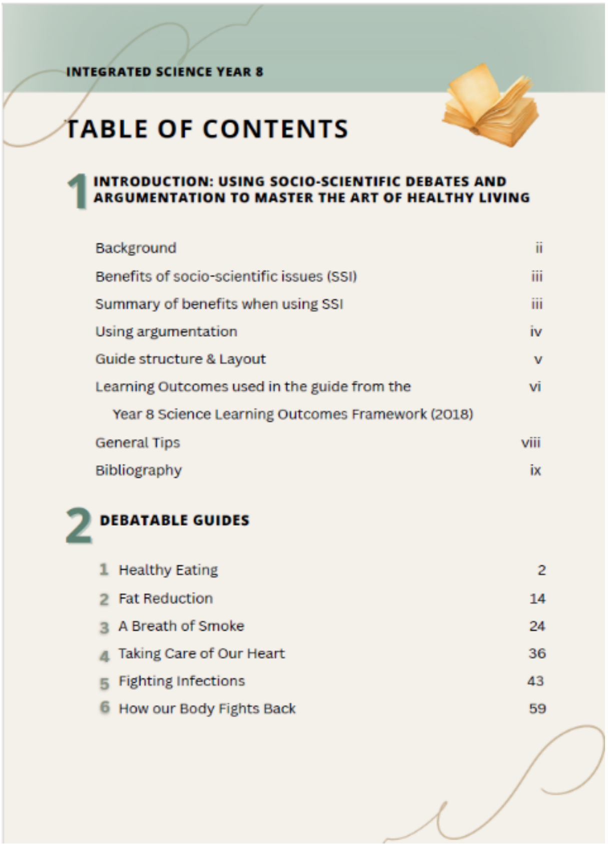

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TABLE OF CONTENTS

Figure 4 Table of Contents from the guide

The first part includes an **Introduction to the Approach.** This opening section explains why SSI-based learning and classroom debate were chosen as the core pedagogical methods for the Healthy Living topic. Drawing on key ideas from the literature review, it outlines the benefits of using real-world dilemmas, evidence evaluation, and argumentation in science education. This section also explains how to use the guide, the purpose behind its creation, and the learning outcomes behind the lessons.

The second part includes the actual **Guides:** This section includes the six full lesson Guides, each centred around one of the Healthy Living themes: vegetarian diets, fat-reduction methods, smoking and lung health, exercise and the heart, microbes and disease transmission, and immunity and vaccination. For each Guide, teachers are provided with:

- The debatable question.
- A note to give an overview of the teaching methods used.
- A lesson snapshot which gives a summary of all the activities within the Guide.
- The Learning Outcomes addressed or that should be addressed before the lesson.
- A list of resources required.
- A step-by-step sequence of the learning activities including the main debate or argumentation tasks which includes suggested questions and scaffolding.

Copies of the resources required to carry out the lessons are provided as separate loose laminated resources. These include student worksheets, debate rubrics, evidence/fact cards, community inquiry sheets, evidence checklists, and other visuals used across the lessons. Each resource has a reference number and letter as illustrated in figure 5 below. In the Guide there is a reference to the resource that the teacher should refer to both in the resource list and the step-by-step instructions to the resource. The number stands for the guide number and the letter for the consecutive resources within that guide. Any videos within the guide are presented as barcodes so that they are easily accessible to teachers through barcode scanning on their phone. The size of the barcode on the guide has been tested so that it is readable.

Figure 5 A resource reference number and title. The number marked in the red oval refers to the guide and the letter marked by the blue oval refers to the resource within the guide.

The 'Teacher's Guide' and the copies of the resources are presented as one main pack so that they are maintained together and no resources are lost. All these sections form a cohesive and practical guide which supports teachers to be able to introduce socioscientific issues, structured debates, and evidence-based reasoning into their Year 8 healthy living science lessons in a clear and accessible way.

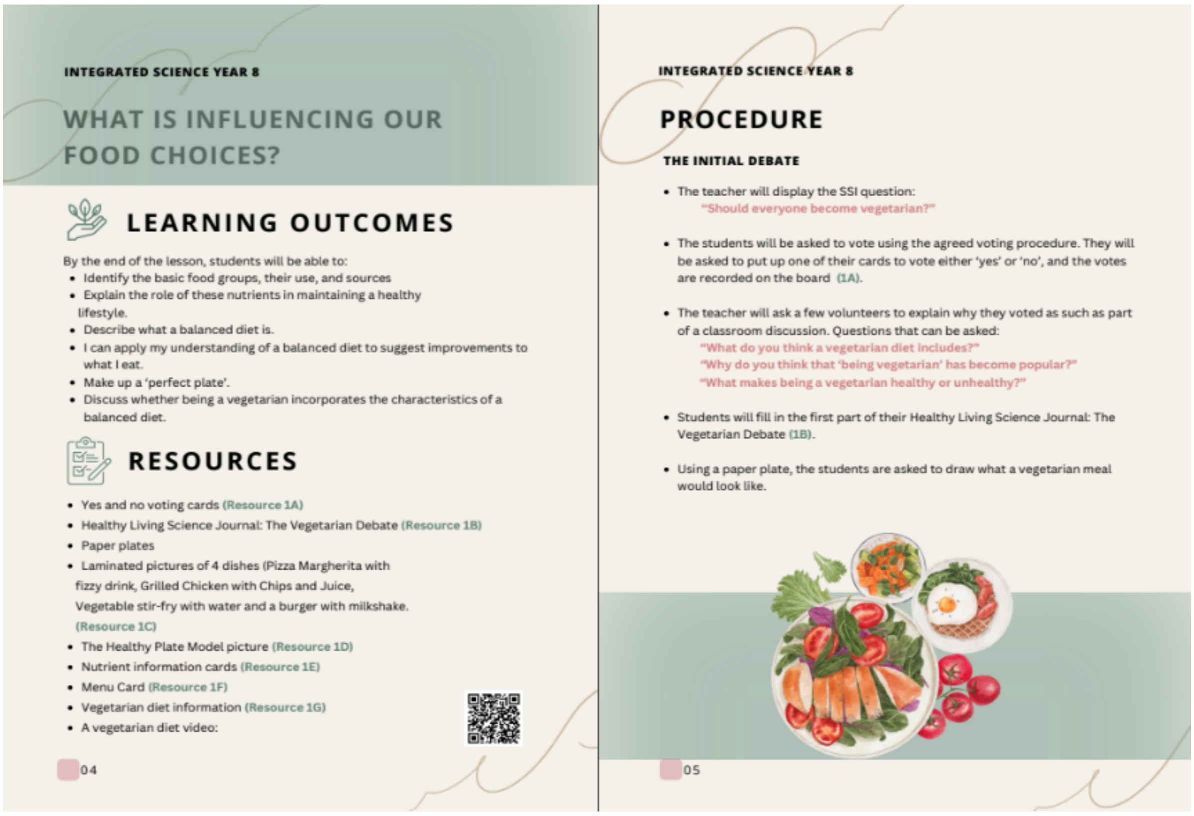
4.5.2.1 Guidance for teachers

To ensure the Guide is clear, practical, and easy for teachers to use, all lesson plans follow a consistent structure. Research on teacher resources highlights that well-organised and predictable layouts help teachers navigate resources more efficiently and reduce the cognitive load associated with planning (Cunningsworth, 1991; Piper et al., 2018). For this reason, each lesson in the guide adopts a standardised sequence of pages, visual cues, and icons that allow teachers to immediately recognise key components of the guide (Figures 6 and 7).

Each Guide opens with a dedicated title page presenting the theme of the guide (e.g., Healthy Eating) along with the central debatable question for that lesson (Figure 6). This question is intentionally given prominence on its own page to emphasise its role as the anchor of SSI-based learning. A large, thematic illustration accompanies the question for example, the vegetarian debate page features a variety of colourful foods, visually introducing the context in a way that captures the teacher's and students' attention. The following page presents the Note to Teacher and Lesson Snapshot, each marked by distinctive icons: a small notebook symbol for the teacher's note and a camera symbol for the snapshot (Figure 6). These icons are cues which are there to allow teachers to quickly identify the purpose of each page at the first glance so that to make it easier for them to navigate through the guide.

Figure 6 The left-hand side shows the debatable question page while the right-hand side shows the note to teacher and lesson snapshot page

This format continues with a page dedicated to Learning Outcomes and Resources (Figure 7), also supported by identifiable icons. The Learning Outcomes are always marked with a hand holding a growing plant icon, while the resources section uses a clipboard icon. These symbols were intentionally selected for clarity and consistency, helping teachers immediately recognise key planning information without needing to search through text. This is then followed by the procedure across the remainder of each guide which has a step-by-step format with clearly separated sections (Figure 7). Headings appear in the same style throughout the procedure to maintain cohesion. The icons and colour accents across the guide help teachers to maintain attention without distracting from the actual content.


INTEGRATED SCIENCE YEAR 8

WHAT IS INFLUENCING OUR FOOD CHOICES?

LEARNING OUTCOMES

By the end of the lesson, students will be able to:
- Identify the basic food groups, their use, and sources
- Explain the role of these nutrients in maintaining a healthy lifestyle.
- Describe what a balanced diet is.
- I can apply my understanding of a balanced diet to suggest improvements to what I eat.
- Make up a 'perfect plate'.
- Discuss whether being a vegetarian incorporates the characteristics of a balanced diet.

RESOURCES

- Yes and no voting cards (Resource 1A)
- Healthy Living Science Journal: The Vegetarian Debate (Resource 1B)
- Paper plates
- Laminated pictures of 4 dishes (Pizza Margherita with fizzy drink, Grilled Chicken with Chips and Juice, Vegetable stir-fry with water and a burger with milkshake. (Resource 1C)
- The Healthy Plate Model picture (Resource 1D)
- Nutrient information cards (Resource 1E)
- Menu Card (Resource 1F)
- Vegetarian diet information (Resource 1G)
- A vegetarian diet video:

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INTEGRATED SCIENCE YEAR 8

PROCEDURE

THE INITIAL DEBATE

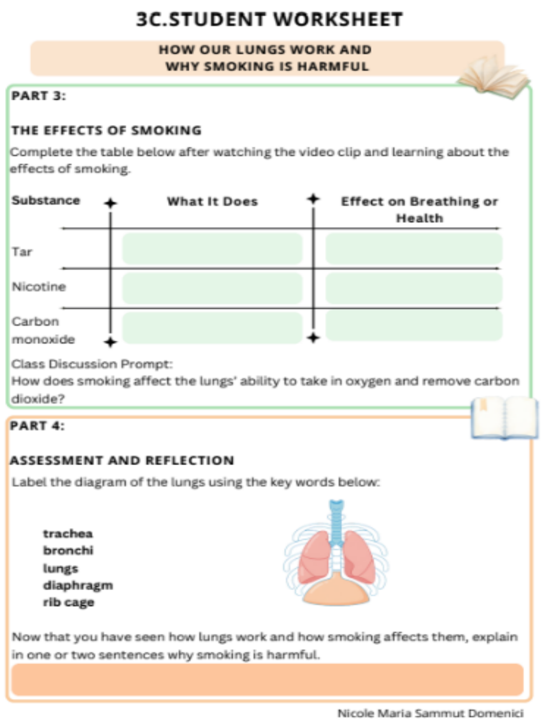
- The teacher will display the SSI question:
  "Should everyone become vegetarian?"
- The students will be asked to vote using the agreed voting procedure. They will be asked to put up one of their cards to vote either 'yes' or 'no', and the votes are recorded on the board (1A).
- The teacher will ask a few volunteers to explain why they voted as such as part of a classroom discussion. Questions that can be asked:
  "What do you think a vegetarian diet includes?"
  "Why do you think that 'being vegetarian' has become popular?"
  "What makes being a vegetarian healthy or unhealthy?"
- Students will fill in the first part of their Healthy Living Science Journal: The Vegetarian Debate (1B).
- Using a paper plate, the students are asked to draw what a vegetarian meal would look like.

05

Figure 7 The left-hand side shows the learning outcomes and resources page while the right-hand side shows the introduction to the procedure

The student worksheets and rubrics (Figure 8) included in the guide generally follow the same, structured style throughout the guide to maintain unity. However, some worksheets such as the restaurant-style Menu Card (Figure 9) have a unique look so that they match better with the activity's theme so that to make certain tasks more engaging.

Finally, all the resources are presented on uncluttered pages with consistent spacing and visual coherence. As Piper et al. (2018) note, consistency in layout supports smooth classroom implementation by teachers.


3C.STUDENT WORKSHEET

HOW OUR LUNGS WORK AND WHY SMOKING IS HARMFUL

PART 3:

THE EFFECTS OF SMOKING

Complete the table below after watching the video clip and learning about the effects of smoking.

Substance	What It Does	Effect on Breathing or Health
Tar		
Nicotine		
Carbon monoxide		

Class Discussion Prompt:
How does smoking affect the lungs' ability to take in oxygen and remove carbon dioxide?

PART 4:

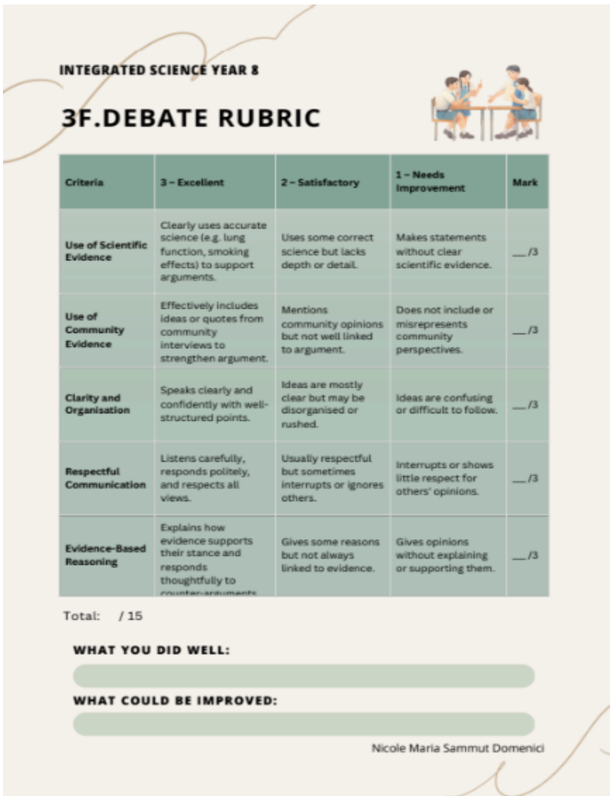
ASSESSMENT AND REFLECTION

Label the diagram of the lungs using the key words below:

trachea
bronchi
lungs
diaphragm
rib cage

Now that you have seen how lungs work and how smoking affects them, explain in one or two sentences why smoking is harmful.

Nicole Maria Sammut Domenici


INTEGRATED SCIENCE YEAR 8

3F.DEBATE RUBRIC

Criteria	3 – Excellent	2 – Satisfactory	1 – Needs Improvement	Mark
Use of Scientific Evidence	Clearly uses accurate science (e.g. lung function, smoking effects) to support arguments.	Uses some correct science but lacks depth or detail.	Makes statements without clear scientific evidence.	__ /3
Use of Community Evidence	Effectively includes ideas or quotes from community interviews to strengthen argument.	Mentions community opinions but not well linked to argument.	Does not include or misrepresents community perspectives.	__ /3
Clarity and Organisation	Speaks clearly and confidently with well-structured points.	Ideas are mostly clear but may be disorganised or rushed.	Ideas are confusing or difficult to follow.	__ /3
Respectful Communication	Listens carefully, responds politely, and respects all views.	Usually respectful but sometimes interrupts or ignores others.	Interrupts or shows little respect for others' opinions.	__ /3
Evidence-Based Reasoning	Explains how evidence supports their stance and responds thoughtfully to counter-arguments.	Gives some reasons but not always linked to evidence.	Gives opinions without explaining or supporting them.	__ /3

Total: / 15

WHAT YOU DID WELL:

WHAT COULD BE IMPROVED:

Nicole Maria Sammut Domenici

Figure 8 Left image shows the structure of a standard student worksheet and right image shows the structure of a debate rubric

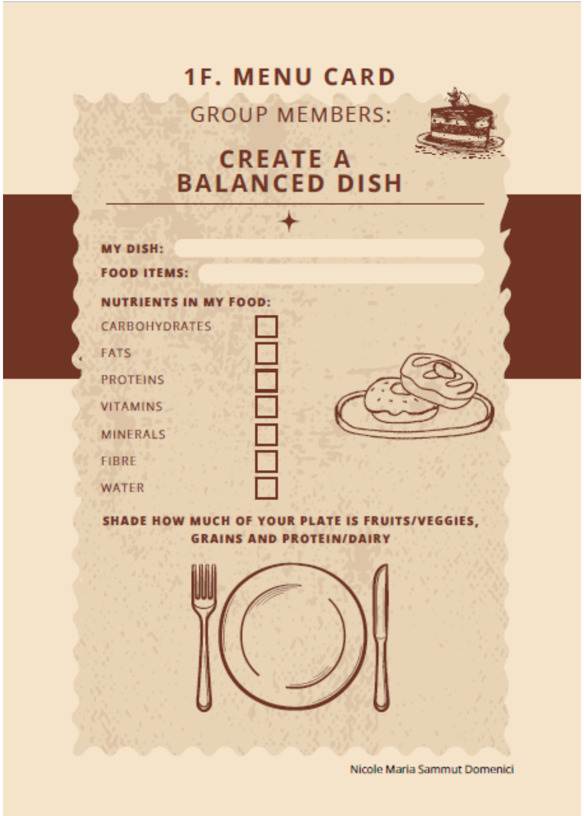


Figure 9 Menu Card Worksheet

4.5.3 Text and legibility

When it came to formatting styles for the 'Teacher's Guide' such as background colour, font style, size, spacing, and alignment, these were chosen keeping in mind that text is easy on the eye and legible to a wide range of users. Such decisions were taken with caution and a lot of attention since this Guide is intended to be read and used frequently by teachers and certain aspects are intended to be shared with students. A soft pastel was chosen for pages' background of the guide to reduce glare and increase visual comfort. As suggested by Henderson et al. (2012), light coloured or off-white backgrounds can support readers who experience visual stress or specific learning difficulties such as dyslexia since there would be less contrast with dark text. Apart from these questions and statements were written in soft pink so as to maintain less contrast.

For the main body text across the ‘Teacher’s Guide’, a Canva Sans font was selected to support smooth reading and minimise visual clutter since sans font styles are recommended for improving readability, particularly among younger readers and those with reading difficulties (Rello & Baeza-Yates, 2016). A minimum 12-point size was used, in line with guidance suggesting that adolescents can read smaller text comfortably but still benefit from larger, clearly spaced fonts (Gosnell & Schles, 2023). Headings are distinguished using a complementary display font and increased size to establish a clear hierarchy which is an important distinction to be made since teachers need to quickly move between sections. The headings appear consistently across lessons with a common style design known as Open Sans that maintains visual coherence across the guide. The student worksheets also follow legibility principles where clear section labels are included, and the layouts are uncluttered with generous spacing available (Figure 8) . In some cases, such as the themed Menu Card, the design adopts a more stylised approach to match the activity context while still maintaining readability (Figure 9).

All the text within the Guide and resources is spaced at 1.5 lines which helps to make the text less crowded and to make longer sections easier to read which is an approach aligned with recommendations for child-friendly documents (European Commission, 2021). Left alignment is also used throughout the guide so that the reading flow is smooth, while centred text is used selectively on student printouts where visibility and symmetry support the task. Figure 10 below shows a page sample from the Guide which presents the characteristics mentioned above.

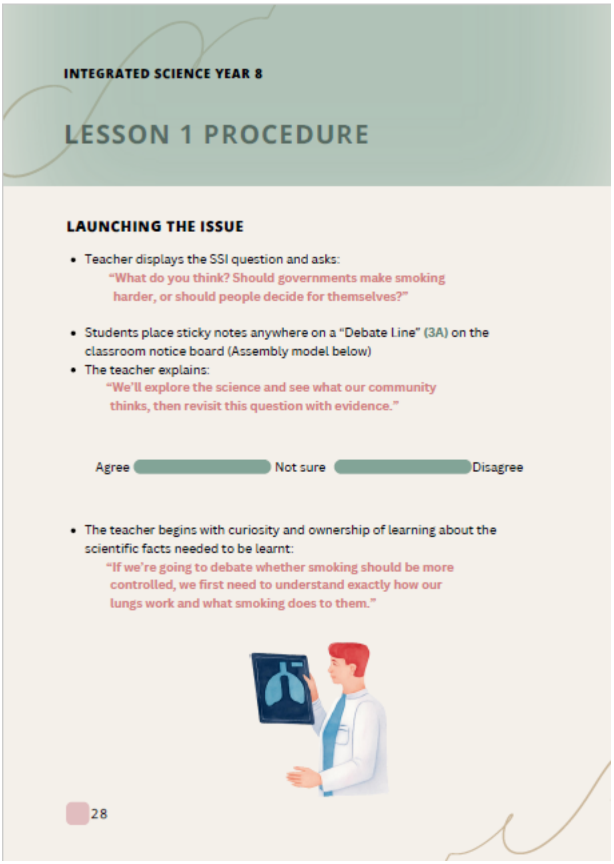


Figure 10 A sample page from the guide showing the text format

4.5.4 Conclusion

This chapter has provided the steps that were followed in the development of the 'Teacher's Guide', *'Healthy Living: Teaching through Socioscientific Issues – A Teacher's Guide'*. The chapter provides a rationale for the choice of socioscientific issues and debate as a teaching approach that can be used by teachers teaching Integrated Science in Maltese classrooms. I have tried to show how all my choices in the development of the 'Teacher's Guide' were grounded in a strong theoretical framework and linked to the aims of science education that promote the development of scientific literacy. The development of the 'Teacher's Guide' is also closely linked to the Learning Outcomes of the Integrated Science Year 8 syllabus. I have also tried to explain the content chosen for each of the six 'Guides' which is drawn from current socioscientific issues that I believe are of relevance to science students in Maltese classrooms. All throughout attention is paid to the development of content and resources that allow science students to develop the skills of debate and arugmentation allowing them to be able to take decisions based on analysis of evidence and critical thinking in their daily lives. The chapter also underlines how the presentation, layout and legibility of the 'Teacher's Guide' including the Resources, draw on recommendations from the European Commission (2021) on developing friendly versions of written documentation.

Chapter 5: Discussion and Conclusion

5.1 Link Between Literature and Project

5.1.1 Choosing the Project

The idea for this project first came to me during my first year of teaching practice in a secondary school. Although I was teaching Biology to older students, I quickly realised that many of them had never experienced science as something they could discuss, question, or relate to real life. This made me think about how valuable it would be for students if they were introduced to such skills earlier, before they had the added pressure of their high-stakes Matsec examinations. In my second teaching practice, I was able to teach Year 7 students Integrated Science. This was a different experience to teaching the older students Biology. In my view, the younger students were naturally enthusiastic, chatty, and curious. Therefore, I thought it would be a good idea to try teaching them through socioscientific issues and argumentation. They responded well to this pedagogical approach, they wanted to share their ideas and ask questions, and they enjoyed talking about real issues.

I shared my enthusiasm about teaching science through socioscientific issues and argumentation with my peers at university and with science teachers in the school where I was teaching. I shared with them my belief that this approach would help students develop scientific literacy at a young age, motivate them to learn science, and enable them to make sound decisions in their daily lives. I was met with scepticism from most of the teachers I shared my experience with because they felt that they had to rush through the syllabus, and some felt unsure about teaching topics outside their specialisation. For this reason eventhough students showed a lot of interest, the teachers very rarely based their science lessons on debates about real life socioscientific issues.

I therefore decided to focus my project-based dissertation on the use of socioscientific issues in the teaching of Integrated Science. More specifically I wanted to develop a guide that would help other teachers if they too chose to use this pedagogical approach.

5.1.2 Meeting the Aims of the Project

The literature reviewed in Chapter 2 played an important role in forming the theoretic framework for this project. Many international studies stress that science education should help students think critically, make informed decisions, and understand how science connects to everyday life (Zeidler et al., 2019; Sadler & Zeidler, 2009). These aims go beyond memorising facts and point toward helping students develop scientific literacy. When thinking about my observations in the Maltese classrooms I could see that there was a complete discrepancy between the aims for science education and what was really happening in the classroom. The reality we are facing is that students' learning often focuses having the teacher covering the content as quickly as possible so that to 'cover' what is needed for exam purposes with students listening to this information and regurgitating this information most of the time in a written format. This approach leaves little to no chance for students to reason, question, or apply science to real situations. The need for a shift in science teaching from a content based approach to one that emphasises the development of a science identity is outlined in local policy documents, such as A Vision for Science Education in Malta (MEDE, 2012). This need is also outlined in a number of local research studies (Pullicino & Bonello, 2020; Farrugia et al., 2009). The need for a paradigm-shift in science teaching formed the theoretical base of this project and also led me to design a project which involves a student centred teaching approach where students are able to engage in a deeper way with the knowledge they ought to know.

I also turned to the literature to shape my ideas about how socioscientific issues and argumentation could be used to teach science effectively. When reading about socio-scientific issues my main interest was how such a teaching method could put science into everyday contexts especially when it comes to health since I also come from that background, which would in turn increase interest in the subject and also motivate students more, (Zeidler & Kahn, 2014; Högström et al.,2024). This would in turn help students to be more engaged in the subject and be open to discuss topics which affect them directly especially in the case of a lot of Maltese students that I have come across even from secondary school days who often ask the teacher "Why are we learning this?" and "Why does this matter to us?'. In fact, even though the vision for science education emphasises the need to connect science to everyday life, this is rarely achieved in practice (MEDE, 2012).

SSI contexts naturally require argumentation which helps to complement my rationale quite perfectly since students would be able to discuss and think critically about topics they come across on a daily basis which is the reason why I decided to centralise my project around debates in particular (Smit et al., 2025). Argumentation helps students move beyond rote learning and be able to reason using evidence they analyse around them while also considering ethical and moral perspectives which helps them to learn about the true nature of science, (Badeo & Duque, 2022; Erduran & Aleixandre, 2008). On top of this something which complemented the idea of using SSI as the teaching method for my project was the added element of character and citizenship formation through discussion and debates since these characteristics benefit students beyond education. Students would be able to carry these moral and ethical values complemented by scientific literacy through out their lives even when it comes to democratic participation (Presley et al., 2013).

The topic healthy living was the ideal choice to connect this teaching method to the curriculum since this one topic provides the opportunity to discuss multiple SSI which are associated with the array of subtopics within the same topic and in turn be able to showcase the different varieties how SSIs can be applied to teaching. Apart from this, the topic involves the following themes diet, smoking, exercise, infections and vaccination which are of great relevance to adolescents since they are exposed to issues related to these themes both social and culturally which thus make them ideal topics for SSI-based argumentation.

Applying the SSI teaching method into the project was not an easy task since the lessons had to reflect the core aspects of an SSI based framework for science lessons by Presley et al (2013) as seen in Table 1 (Chapter 1). Several of these aspects were effectively integrated into the project. The themes within the healthy living topic provided the possibility to present compelling social issues which are public health concerns. These were presented at the beginning of the lesson and used as the backbone for learning and throughout the lessons students are provided with scaffolded support for higher-order practices such as argumentation. Each lesson has a different way how these argumentations take place such as whole classroom discussions, debates or narrated role-play debates so as to capture different ways how argumentation can be applied in the classroom. Something which is ideal in the classroom is that in order to acclimatise students to argumentation they should start slowly using more structured classroom discussions and slowly start building confidence in students to participate in more independent debates.

A very important aspect of these lessons is that student take on a stance and after building enough evidence, they are able to reflect and revisit that position. This is fundamental to critical thinking since students realise that opinions should be based on holistic evidence. In fact along the lessons students are exposed to scientific evidence which sometimes they get to collect and assimilate themselves together with the social, political and economic -effects of that issue.

When it comes to delivering lessons based on SSI a very important asset is the teacher's knowledge on the subject and the will to speak about certain sensitive topics. The more awareness on the matter both scientifically and socially the better the outcome of the lesson. This is something which depends on the teacher's will to read and obtain more confidence in speaking about the subject to help support students' questions along the way without giving inaccurate information. In return it all depends on the classroom being taught, teachers should ask themselves whether students are ready to participate in such deep conversations and if the topics of choice are too sensitive for the particular students. Still, I believe that it is possible to use even the most basic of SSI and use a highly structured format of argumentation and still be able to attain the aims of science education. Thus, it depends on the teacher's will and the school's support to implement the right format of SSI teaching with their students.

These ideas directly shaped how the guide was designed with argumentation as the central aspect to teaching. Instead of placing debate at the end of a lesson, each lesson begins with a debatable question that drives the learning from start to finish. This follows recommendations in SSI research showing that scientific concepts should be explored within the context of the issue itself (Zeidler & Kahn, 2014; Presley et al., 2013). This was fundamental when creating the lessons since I wanted to create lessons that are about the issue in question and supported by the science content that has to be learnt and not the other way round. This does not only allow motivated engagement, but it allows science to be learnt in a seamless way and maybe help students see science and science thinking from a different lens and thus students are able to assimilate and retain the content on a deeper level.

Apart from driving a very interesting lesson, argumentation can also be used as a innovative way to assessment. The project in fact aligns well with the recent School-Based Assessment in Malta. The emergent School-Based Assessment guidelines encourage learning experiences and tasks that are able to encourage students to think rather than to simply recall of facts (Attard Tonna & Bugeja, 2016; Attard, 2023). Thus, throughout the guides teachers and students are provided with scaffolded assessment guidelines and rubrics so that more meaningful assessment opportunities are given to students. Through argumentation students are able to demonstrate a higher-order level of reasoning, reflection, and decision-making skills not just simply giving back information provided by the teacher. Students are also given feedback so as to improve their skills which helps to foster a growth mindset in them.

All these aspects influenced the overall design of the guides as seen in figure 2 (Chapter 4). Although the debatable questions are central to the lessons, throughout the lessons students get to engage with science content through hands-on activities, investigations, discussions, and evidence analysis which are all connected to the socioscientific theme, (Presley et al., 2013; Zeidler & Kahn, 2014). When it comes to evidence analysis students are taught to recognise bias and not accept information at face value. This is particularly important in today's context, where learners are constantly bombarded with inaccurate information presented in professional formats that appear credible, especially with the emergence of AI-generated content, (Högström et al., 2024). Thus, it is essential to teach students at this age not to accept everything they see, particularly on social media, which can impact their mental wellbeing as well, (Badeo & Duque, 2022). After collecting the right evidence, students then engage in argumentation and debate, and even present their views to audiences beyond the classroom. In one of the guides, the outside school community was also involved, helping students connect to the matter on a deeper level and consider the broader social impact surrounding the issue. This approach reinforces the idea that science extends beyond the classroom and into society, (Smit et al., 2025).

Something which the literature emphasises is the importance of scaffolding when teaching students how to evaluate sources and recognise bias, and argumentation skills (Attard, 2010; Evagorou & Osborne, 2013). This scaffolding is crucial since students cannot be expected to argue confidently without support. For this reason, the guide includes tools such as debate templates, evidence checklists, structured worksheets, and student-friendly visuals. These resources make it easier for teachers to introduce argumentation in a stepwise manner which is especially important in classrooms where students may be new to open discussion, (Sampson & Clark, 2008)

On top of these aspects, what have helped to shape the project are the realities of Maltese science classrooms. Teachers often work under tight time constraints and must cover all learning outcomes within the school year. Apart from this, certain topics within the integrated science curriculum are outside the teacher's specialisation, which can thus make the teacher hesitant to try unfamiliar teaching methods. Thus, the guide offers clear, ready-to-use lesson plans and resources so that to make SSI-based teaching achievable in a practical way. In this way, the project meets its aims by combining strong theoretical foundations with an understanding of what teachers and students realistically experience every day.

5.2 Limitations of the Project

Although the guide aims to be useful and practical for teachers, several limitations must still be acknowledged. The lessons focus only on the Healthy Living topic in the Year 8 Integrated Science Learning Outcomes Framework. While this topic connects naturally with socioscientific issues, the guide does not address other science topics that may need different contexts, activities, or styles of debate. Teachers who wish to apply the same approach elsewhere will need to adapt the materials and reshape certain activities to fit different scientific concepts. Another challenge is the level of teacher knowledge required. To lead strong discussions, teachers need to feel confident about the socioscientific issues themselves, and some may need extra reading or preparation to handle student questions or to guide debates effectively, (Sadler, 2004; Presley et al., 2013). SSI lessons also demand confidence in managing disagreements and helping students use evidence when forming arguments, and not all teachers may feel ready for this type of classroom dialogue, (Evagorou & Osborne, 2013; Erduran & Aleixandre, 2008).

A further limitation relates to the sensitivity of certain issues. Healthy Living includes topics such as diet, weight, smoking, and vaccination, which may be personal or emotional for some students. Although the guide encourages respectful discussion, it cannot predict how every student will respond, and teachers may need to decide carefully whether certain topics are appropriate for their group. In addition, many middle-school students in Malta are used to very teacher-led lessons, and open discussion may be new or uncomfortable for them. It may take time for students to build confidence in sharing their opinions, questioning each other, or speaking in front of the class, which could influence how smoothly the activities run.

Finally, an important limitation is that the guide has not yet been tested in real classrooms. The worksheets, debates, and teaching sequence were thoughtfully designed, but they have not been tried out with students or reviewed by teachers in practice. It is therefore still unknown how effective the lessons will be, how students will respond, or how manageable the activities will feel during an actual science lesson. These aspects will need to be explored in future work.

5.3 Areas for Future Research

There are several important ways in which this project can grow in the future. The most immediate step would be to try out the guide in real Maltese classrooms. Piloting the lessons with teachers and students would help to provide clearer insight into how the activities work in practice and how students respond to the debate-based lessons. By obtaining teacher feedback through interviews or surveys would help to identify which parts of the guide are most helpful and which areas may need updating by for example providing more support or clearer explanations. Classroom observations would also show how students interact with evidence, participate in discussions, and handle the argumentation tasks which would help to give a more complete picture of the guide's impact on learning.

Future research could also explore how students themselves experience SSI-based learning. Valuable information would be provided for improving the guide if one could understand how confident students feel in discussions, how relevant they find the topics, and whether the approach helps them make connections between science and everyday life. Even researching teachers' perspectives would be just as important, especially to better understand the challenges they face when trying new pedagogies such as limited time, exam-oriented expectations, or lack of experience with debate and discussion.

Another useful direction for future work would be to develop SSI-based guides for other science topics even from the Biology, Chemistry or Physics curricula. Healthy Living is well suited for SSI, but many other topics such as energy or climate also offer rich opportunities for discussion and argumentation. There could also be collaborative projects in which researchers could co-design new SSI materials. Finally, future versions of the guide could include a digital component, such as online evidence packs, interactive debate tools, or simple simulations which would make the resources more accessible and adaptable for blended learning environments.

5.4 Conclusion: Personal Reflections

Creating this project was both a challenge and a learning journey. It made me think carefully about how science should be taught not just to help students pass exams, but to help them become curious, thoughtful, and informed individuals. Throughout the process, I kept going back to my own experiences in the classroom, both as a student and as a student teacher. I saw clearly how easy it is for science to become focused only on memorising facts, when in reality, science education should prepare young people to ask questions, think critically, and make responsible choices.

This project showed me just how much work and time goes into designing lessons and resources that are meaningful. When it came to writing the content, it did not just involve writing what first came to my head, but I had to do a lot of research and on top of that be very careful that everything I wrote was accurate and clear to my readers. In addition to the content, I also learned how important it is when it comes to the presentation of a guide like this. The way things look and are organised matters just as much as what is written. A visually appealing resource that is also easy to follow and practical can make a big difference in whether teachers choose to use it.

Most of all, this experience reminded me of how important teachers are in shaping how students see science. Socioscientific issues are not just topics to study, but they are real-life questions that enable students to think about people, the planet, and the future. This type of teaching encourages students to explore and question real situations around them, and also helps them to listen to others' perspectives which helps them grow as both thinkers and citizens. I hope that this guide will give teachers the courage and support they need to try out new ways of teaching. Even small steps can lead to big changes, and I believe that with time, this approach can make science more meaningful for students in Maltese schools.

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Appendix 1: The Learning Outcomes of the Healthy Living Topic from the Year 8 Integrated Science Learning Outcomes Framework

Subject: **SCIENCE** Year 8 /Form 2
LOF Subject Focus: **CELLS AND BODY SYSTEMS**
Unit code and title: **SCI LOF 8.1 HEALTHY LIVING**

Objectives Teacher will:
1. guide students to identify the basic food substances and their use and describe the importance of a balanced diet
2. illustrate the digestive system and guide students to describe the process of digestion.
3. guide students to describe the breathing process.
4. illustrate the blood circulatory system.
5. guide students to identify different microbes and explore ways in which they can be useful.
6. describe how harmful microbes cause diseases and how infections can be spread.
7. guide students to identify (natural) ways of preventing and fighting infections
8. guide students to explore the use of medicines in preventing illnesses and fighting infections.

Key words
Basic food substances, carbohydrates, proteins, fats, minerals, vitamins, enzymes, fibre, water, balanced diet, starch, digestive system, enzymes, mouth, gullet, stomach, small intestine, large intestine, anus, digestion, absorption, breathing, respiration, lungs, windpipe (trachea), bronchi, air sac, diaphragm, ribs, blood circulatory system, heart, arteries, veins, blood vessels, red blood cells, white blood cells, platelets, plasma, microbe, micro-organisms, diseases, bacteria, viruses, fungi, infection, antibodies, infectious disease, immunity, poisoning, vaccination, immunisation, antibiotic.

Points to note
The learning outcomes approach promotes an inquiry based and student centred methodology based on the 5E approach to teaching and learning of science in which students are encourage to engage, explore, explain, elaborate and evaluate.

Note the following misconceptions:
- The word 'diet' is often used in the context of 'going on a diet' to lose body mass rather than 'what you eat'.
- Some students (and even books!) may confuse respiration with breathing

Note the following misconceptions that you might come across:
- Some students may think that all micro-organisms are harmful.
- Some students might mix antibodies with antibiotics.

LEARNING OUTCOMES
SCI LOF 8.1 - Unit: HEALTHY LIVING - Focus: CELLS AND BODY SYSTEMS

Note other Learning Outcomes related to skills and competencies. (p5 & 6)

1. I can identify the basic food substances, their use and sources.
2. I can describe what a balanced diet is.
3. I can apply my understanding of a balanced diet to suggest improvements to what I eat.
4. I can identify reasons why the diet changes with age, occupation and activity.
5. I can label the digestive system and describe the function of the different parts.
6. I can describe the role of enzymes during digestion.
7. I can link certain foods with healthy or unhealthy diets.
8. I can briefly describe the structure of the lungs and explain the role of rib cage and diaphragm during breathing.
9. I can identify tar, nicotine and carbon monoxide as the main harmful ingredients in cigarette smoke.
10. I can describe the effect of smoking on health.
11. I can label the blood circulatory system.
12. I can identify the main components of the blood circulatory system (the blood, heart, arteries and veins).
13. I can name red blood cells, white blood cells, platelets and plasma as the main components of blood and describe their function.
14. I can associate bad eating habits, lack of exercise and smoking with unhealthy lifestyles.
15. I can describe the effect of exercise on the pulse / breathing rate.
16. I can identify an increase in carbon dioxide in the breathed out air and test for it.

17. I can identify examples of microbes (viruses, bacteria and fungi).
18. I can describe how microbes can be harmful and identify examples.
19. I can describe how microbes can be useful and identify examples.
20. I can identify some common diseases and link some diseases with its corresponding microbes.
21. I can describe how some common diseases are spread.
22. I can assess basic hygiene procedures as a way of preventing spread of microbes.
23. I can identify natural barriers (such as skin, tears, sticky mucus, acid in stomach and scabs) which can act to prevent disease.
24. I can use the term 'immune' as meaning resistant to disease.
25. I can describe the white blood cells' action against infections.
26. I can link the use of antiseptics, disinfectants and antibiotics as ways of fighting infections.
27. I can describe how immunisation protects the body against some diseases.
28. I can discuss the importance of vaccines to prevent the disease and slow down the spread of disease.

Note. The objectives, key words, points to note and learning outcomes of the topic Healthy Living, *Science Year 8 Learning Outcomes Framework 2018* (p. 7, 9, 10)

https://curriculum.gov.mt/wp-content/uploads/2024/04/Science_yr08_2019_LOF_Curriculum_plus_CCP.pdf

Appendix 2: The teacher's guide titled '*Healthy Living: Teaching through Socioscientific Issues – A Teacher's Guide*'

Appendix 3: The resources complementary to the '*Healthy Living: Teaching through Socioscientific Issues – A Teacher's Guide'*