IEA Research for Educators 2
Evidence-based and Instructional Materials for Teachers Using Data from the International Association for the Evaluation of Educational Achievement (IEA)

Marian Bruggink · Nicole Swart
Annelies van der Lee · Eliane Segers

Teaching Reading Comprehension in a Digital World

Evidence-Based Contributions Using PIRLS and Digital Texts

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Volume 2

The International Association for the Evaluation of Educational Achievement (IEA) is an independent nongovernmental nonprofit cooperative of national research institutions and governmental research agencies that originated in Hamburg, Germany in 1958. For over 60 years, IEA has developed and conducted high-quality, large-scale comparative studies in education to support countries' efforts to engage in national strategies for educational monitoring and improvement.

IEA continues to promote capacity building and knowledge sharing to foster innovation and quality in education, proudly uniting more than 60 member institutions, with studies conducted in more than 100 countries worldwide.

IEA's comprehensive data provide an unparalleled longitudinal resource for researchers and educators. The founders of IEA viewed the world as a natural educational laboratory, where different school systems experiment in different ways to obtain optimal results from educating their youth. They assumed that if research could obtain evidence from across a wide range of systems, the variability would be sufficient to reveal important relationships that would otherwise escape detection within a single education system. They strongly rejected data-free assertions about the relative merits of various education systems and aimed to identify factors that would have meaningful and consistent influences on educational outcomes.

In line with this, this series of peer-reviewed publications is established to contribute to educational practices. The goal is to inspire educators by translating IEA research findings into evidence-based practice, and to foster engagement and conversation between researchers and practitioners.

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Foreword

The International Association for the Evaluation of Educational Achievement (IEA's) mission is to enhance knowledge about education systems worldwide and to provide high-quality data that will support education advancement and lead to better teaching and learning in schools. In pursuit of this aim, it conducts, and reports on, major studies of student achievement in literacy, mathematics, science, citizenship, and digital literacy. These studies, notably International Civic and Citizenship Education Study (ICCS), International Computer and Information Literacy Study (ICILS), Progress in International Reading Literacy Study (PIRLS), and Trends in International Mathematics and Science Study (TIMSS), are well established and have set the benchmark for international comparative studies in education.

The studies have generated vast datasets encompassing student achievement, disaggregated in a variety of ways, along with a wealth of contextual information, which contains considerable explanatory power. The numerous reports that have emerged from them are a valuable contribution to the corpus of educational research.

Valuable though these detailed reports are, IEA's goal of supporting education advancement needs something more: deep understanding of education systems and the many factors that bear on student learning advances through in-depth analysis of the global datasets. IEA has long championed such analysis and facilitates scholars and policymakers in conducting secondary analysis of our datasets. So, we provide software such as the International Database Analyzer to encourage the analysis of our datasets and support numerous publications including a peer-reviewed journal, *Large-scale Assessments in Education*, our policy brief series, *IEA Compass: Briefs in Education*, and our *IEA Research for Education* book series providing a powerful information avenue for researchers and policymakers. We also organize a biennial international research conference to nurture exchanges between researchers and policymakers working with IEA data.

The **IEA Research for Educators** series represents an exciting effort by IEA to capitalize on our datasets for a key audience, teachers. IEA studies have always been a great resource for researchers and policymakers. However, the desire remained to give something back to those schools and teachers who responded to studies and provided the valuable information that is gathered and organized in the

form of an international database. Our aim is to connect the growing body of knowledge based on IEA studies, as well as other research findings, with school and classroom realities. This series aims to translate IEA study data into evidence-based and instructional materials for teachers and, in doing so, foster engagement and conversation between researchers and practitioners.

With the advancing digitization of our everyday lives and the widespread distribution of digital texts, "digital reading" is becoming an active research area. This book, "Teaching Reading Comprehension in a Digital World," is the second volume in the IEA Research for Educators series, and focuses on evidence-based teaching principles for digital reading. Like the first volume, this book utilizes data from IEA PIRLS. PIRLS is one of the core studies of IEA and provides trends and international comparisons of fourth grade students' reading literacy achievement and associated factors. Directed by IEA's TIMSS & PIRLS International Study Center at Boston College's Lynch School of Education and Human Development and conducted every five years since 2001, PIRLS is recognized as the global standard for assessing trends in reading achievement at the fourth grade. The PIRLS data utilized in this volume provides an overview of the current insights and literature on reading comprehension, and the use of an ePIRLS text and question items assist to provide practical illustrations of the digital reading processes and didactic suggestions discussed.

The book begins by describing current research on digital reading comprehension and provides an overview of recent scientific insights. Factors that influence the development of students' digital reading comprehension skills are then discussed with an eye on access to opportunities to learn. Evidence-based didactic principles in digital reading comprehension and practical teaching suggestions are then illustrated with example digital texts and accompanying lesson plans. In the third chapter, the authors use an ePIRLS 2021 text and question items to concretize the reading processes outlined previously and provide useful didactic suggestions for teachers. The book's concluding chapter provides real-world examples from schools in Italy, Ireland, and Singapore. Teachers from these schools present how they and their schools work on digital reading comprehension, with practical tips and tools, and example lessons. We thank the schools for these valuable contributions that provide concrete examples that teachers can take inspiration from.

From inception it was recognized that in order to achieve the aims of this series, IEA would need to tap into the skillset and experience of its member institutions, national research centers, and other partners involved in IEA studies. This additional expertise would allow us to create a bridge between the available resources, classroom contexts, and those who can appreciate and use them, teachers. We are extremely grateful to the team of authors from the Dutch Center for Language Education (Expertisecentrum Nederlands), an institution that has been the national study center for PIRLS in the Netherlands since 2001, for their dedication to the development of the first and second volumes in this important series. This book will be a valuable resource for teachers and teacher educators and likewise an important contribution to the research on digital reading. Future volumes in the series include one dedicated to supporting civic and citizenship education and another on teaching and learning mathematics with meaning.

Paulína Koršňáková
Andrea Netten
Series Editors

Preface

The use of digital texts in schools has increased substantially in recent decades. In addition to paper books, children also acquire new information through the internet and the use of digital technologies, where they can find many types of digital texts. Teaching reading in this digital world raises many additional challenges and questions for teachers.

In this second volume in *IEA Research for Educators*, our aim is to help teachers to include the reading of digital texts in their curriculum and provide practices associated with using them based on scientific research. In this book, we discuss digital reading and evidence-based teaching principles for digital reading, with the use of ePIRLS. Additionally, our goal is to raise awareness about digital inclusion and its different aspects and to provide guidance on how to stimulate digital inclusion within schools.

The digital world is developing rapidly, and with it, the number of scientific studies on digital reading is also increasing, and it is therefore not our intention to present a complete picture of research on digital reading. Rather, with this book, we aim to give teachers a hand in better understanding digital reading in the current media landscape and to provide evidence-informed suggestions to integrate digital reading into the curriculum in a meaningful way. Therefore, it is our hope that this book can be seen as a bridge between science and practice.

In Chap. 1, we briefly describe what digital reading is and how its characteristics influence reading comprehension, to create a solid base for the rest of the book. Chapter 1 serves as an introduction to the evidence-based didactic principles presented in Chap. 2. These principles can be used to help students develop their reading comprehension skills for digital texts. In Chap. 3, an ePIRLS text is used to show how teachers and other educational professionals can apply the didactic principles presented in Chap. 2, when reading a digital text and answering different kinds of questions. Finally, Chap. 4 highlights good practices from schools in three participating ePIRLS countries, giving insight into daily practice for reading digital texts.

With this book, we aim to aid teachers in strengthening their skills of instruction in digital reading and comprehension of digital texts for all students. We hope to

inspire teachers to reflect on their current lessons where digital reading is included, and base their lessons on evidence-based didactic insights, so that they can in turn prepare their students for the digital world.

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1.1 Introduction

Many readers of this book will have learned how to read and comprehend written texts using print-based materials. These readers conjure up images of going to libraries and bookshops full of printed reading materials and may remember the look, feel, and even the smell of books. However, in this day and age, students do not only encounter paper-based texts, they may also spend time browsing the internet, gaming, using social media, or reading digital (online) texts for pleasure, as well as for schoolwork. Many students have to look up new information using the internet for school assignments instead of using a book. Learning to read and learning to comprehend is increasingly taking place in a digital environment. Some virtual reading materials follow a similar fixed order to printed ones with a clear beginning and end. However, digital materials may also have different formats, for example, have no clear start and end, or have no fixed order of reading required. Websites with hyperlinks (e.g., Wikipedia) are examples of the latter category. In addition, many online texts require the reader to pay greater attention toward the credibility of the source. It is important that teachers are aware of the differences between reading on paper and reading digital texts, and the unique challenges and opportunities digital texts bring. In this chapter, we take a closer look at digital reading and the differences and similarities to paper-based reading, based on scientific research. We also discuss aspects of the variation in access to and use of digital

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materials that may cause additional differences between children. In the following chapters, we translate the theory described in the current chapter into didactic principles for digital reading and provide suggestions for stimulating digital inclusion within schools (Chap. 2), followed by a worked example of these principles using an ePIRLS[1] text (Chap. 3). Finally, Chap. 4 highlights good practices in digital reading education from schools in three countries that administer IEA's Progress in International Reading Literacy Study (PIRLS).

The digital (reading) world is rapidly evolving. Since the COVID-19 pandemic, online educational activities have increased across the world, such that digital reading has become even more prominent. However, it has also led to a so-called "infodemic": an overabundance of information that may or may not be true (WHO, n.d.). It can be overwhelming for readers to navigate these large amounts of information, even more so for young students, who are less experienced readers. When online, children need to be able to deal with this digital content, comprehend what they read, and discriminate between reliable and unreliable sources. Additionally, new technologies, such as artificial intelligence chatbots (e.g., ChatGPT) are developing daily, with the consequences for education as yet unclear. We do not yet know if using chatbots will ultimately impact reading comprehension. If children use a chatbot to compose texts and do not read the original sources themselves, they may not develop the comprehension skills they need. But this is something that would need further research and is out of the scope of the current volume. A rapidly evolving digital world also leads to differences between children, which may become more pronounced due to personal and environmental factors. The term "digital inclusion" that is used in this respect refers to attitude and motivation, physical access, digital skills, and usage, all of which may impact comprehension in digital reading.

As a first step, it is important to define what we mean by "digital reading." Some would argue that it is reading anything from a screen instead of paper. When school materials are made available digitally, this is indeed what often happens. The print-based material is made available for screen reading, without adjustments to the elements (for example, like a PDF). But digital reading goes a lot further than than that. In current society, many more factors need to be considered to prepare students for digital reading. Students need to be able to find information online, decide between skimming versus the deep reading of multiple documents, judge their reliability, deal with different kinds of media in one document, and be able to make sense of it all. Many of these documents are informative texts, but narrative texts are also delivered in digital form. Digital reading is part of a larger set of skills that fall under the umbrella term digital literacy. Digital literacy is a term that covers a very broad range of skills. Dobson and Willinsky (2009) place it on a continuous scale of being literate in a culture with a heavy focus on written materials. Due to the immense

[1] The Progress in International Reading Literacy Study (PIRLS) is an international study that measures reading achievement in the fourth grade. PIRLS is conducted every five years in countries across the globe. PIRLS assesses both reading for literary experience and reading to acquire and use information. ePIRLS is part of PIRLS and monitors reading comprehension in a digital, online environment.

amount of knowledge available through the internet, being digitally literate is asking a lot of a person. In IEA's International Computer and Information Literacy Study (ICILS), computer and information literacy is defined as "an individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace and in society" (Fraillon et al., 2020). This definition is connected to digital literacy, as it not only encompasses being able to read and comprehend texts. It also means being able to create digital materials, such as writing online texts (for example, creating a webpage), using digital communication (e.g., email, video conferencing, instant messaging, etc.), online navigation, and so on. Coiro (2021) describes digital literacy in terms of reading, writing, collaboration, navigation, and critically evaluating within digital contexts.

In this book, we focus on digital reading, which can be seen as a subskill of digital literacy. As mentioned above, it is important to realize that digital reading is more than just reading text from a screen (the narrow definition). Coiro (2021, p. 12) gives the following definition, "a range of multifaceted meaning making experiences whereby readers engage with multiple texts for particular purposes that are situated in diverse contexts." Salmerón et al. (2018) take this definition further by stating that readers of digital texts need to have three skills:

1. the ability to navigate the internet and be able to select the needed documents,
2. the ability to integrate information from different sources; and finally
3. the ability to evaluate the reliability of the information.

By taking this broader definition, digital reading becomes a more complicated skill than what is traditionally seen as reading comprehension. In this book, we include all three skills concerning the reading of digital texts, in line with the PIRLS 2026 framework.

To grasp the digital reading landscape, the current chapter will first explain differences between paper and digital reading (Sect. 1.2), and then move on to describe the unique characteristics of digital texts and how they may have an impact on reading (Sect. 1.3). We delve into the skills that are specifically needed for digital reading: navigating, integrating, and evaluating (Sect. 1.4) and finally, in Sect. 1.5 the importance of digital inclusion in schools is emphasized.

1.2 Digital Reading vs. Reading from Paper

What are the differences between digital reading and reading on paper? It is important to realize, in general, individual differences in digital reading are largely the same as individual differences in reading comprehension. In essence, digital reading is still reading. This means that the basic principles of reading comprehension apply as they do for paper-based reading. In volume 1 of the *IEA Research for Educators* series, *Putting PIRLS to Use in Classrooms Across the Globe* (Bruggink et al., 2022), we described the main theories of reading comprehension:

> [Reading] comprehension ideally results in an adequate and representative model of the text. According to the construction-integration model of reading comprehension, texts are represented at three levels: the surface structure, the textbase, and the situation model (Kintsch, 1998). The surface structure consists of the words in the text and the ideas that these words represent. The ideas are referred to as propositions and reflect on what is explicitly stated in the text (i.e., facts, events, feelings, etc.). The textbase of the text is created by connecting the single propositions and 'represents the meaning of the text, as it is actually expressed by the text' (Kintsch & Rawson, 2005, p. 211). Although the textbase provides the reader with information stated in the text, comprehension will be shallow since the reader only understands what is explicitly stated in the text. For a deeper understanding, the reader has to create a model of the situation. Creating such a situation model requires the integration of both information explicitly stated in the text (i.e., the textbase) and relevant prior/ background knowledge. (p. 4).

Additionally, in the first volume, we also provided two purposes for reading that account for most of the reading done by young students, and four comprehension processes within each of the two purposes for reading, according to the PIRLS 2021 assessment framework. In the PIRLS 2026 assessment framework (Sabatini et al., 2023), the purposes and processes have been expanded and elaborated to be inclusive of digital reading literacy environments, such as the internet. Textbox 1.1 gives an overview of the purposes and processes in the PIRLS 2026 assessment framework.

Textbox 1.1: The Two Purposes for Reading and the Four Comprehension Processes as Described in the PIRLS 2026 Assessment Framework

PIRLS 2026 purposes for reading and comprehension processes

Purposes for reading:

1. Reading for literary experience

In literary reading, readers engage with the text to become involved in events, settings, actions, consequences, characters, atmosphere, feelings, and ideas, and to enjoy language itself.

2. Reading to acquire and use information

Informational texts are both read and written for a wide variety of functions. While the primary function of informational text is to provide information, writers often address their subject matter

(continued)

Textbox 1.1 (continued)

with different objectives. [..] Information can be presented in many different formats. Both static texts (e.g., manuals and newspapers) and websites present a considerable amount of information via lists, charts, graphs, diagrams, video, and other multimodal formats.

Processes of comprehension:

1. Focus on and retrieve explicitly stated information

Readers vary the attention they give to explicitly stated information in the text. Some ideas in the text may elicit particular focus and others may not. [..] Successful retrieval requires fairly immediate or automatic understanding of the words, phrases, or sentences, in combination with the recognition that they are relevant to the information sought.

2. Make straightforward inferences

As readers construct meaning from text, they make inferences about ideas or information not explicitly stated. Making inferences allows readers to move beyond the surface of texts and to resolve the gaps in meaning that often occur in texts. [..] With this type of processing, readers typically focus on more than just word-, phrase-, or sentence-level meaning in focusing on the local meaning residing within one part of the text. [..] In online reading, this often involves making some inferences about the best approaches to use in searching for information. On the web, readers also may infer whether it is necessary or useful to follow a link to a definition or another page.

3. Interpret and integrate ideas and information

As with the more straightforward inferences, readers who are engaged in interpreting and integrating ideas and information in text may focus on local or global meanings, or may relate details to overall themes and ideas. In any case, these readers may be making sense of the author's intent and are engaged in developing a more complete understanding of the entire text. [..] Using the internet requires the ability to read and digest information from multiple online sources. [..] In an online environment, this includes integrating relevant written information across web pages that may also include graphics, animations, or videos, as well as pop-up windows and rollover text and graphics.

4. Evaluate and critique content and textual elements

As readers evaluate the content and elements of a text, the focus shifts from constructing meaning to critically considering the text

(continued)

Textbox 1.1 (continued)

itself. Readers engaged in this process step back from a text in order to evaluate and critique it. [..] Because internet sources vary widely in purpose and intent of the website producers, readers must make judgments about the relevance of the source of the information, as well as determine the perspective, point of view, and potential bias in written content as conveyed by the producers of the website. [..] The visual, textual, and multimodal features on websites can be more varied than found in static written texts. Thus, evaluate and critique processes are a prominent part of online reading.

Source: Sabatini et al., 2023.

To comprehend a text, whether it is digital or on paper, students need to know the meaning of single words, integrate single word meanings into sentence representations and combine these representations into a model of the text. The amount and the quality of word knowledge has an impact on the ease with which a reader comprehends a text (Perfetti & Stafura, 2014; Swart et al., 2017; Tannenbaum et al., 2017). Students who know more words and know more about these words, are better able to understand written texts as compared to students with less vocabulary knowledge. For example, in a text about astronomy, a student who already knows the meaning of words such as "planet," "orbit," or "universe," and has knowledge about these words (e.g., what kind of planets there are, how the word is written and how it is pronounced) will find the text easier to understand. These findings also apply to digital reading. In addition to a rich vocabulary, having sufficient prior knowledge also eases the process of comprehending a written text. Where vocabulary relates to the extent to which specific words are known, prior knowledge relates to the extent to which knowledge structures are stored in the brain; whether students have experience with the information presented in the text. Various studies have indeed shown the importance of prior knowledge in reading comprehension (e.g., Cho et al., 2019, with primary school students). In terms of digital reading, research shows that topic-specific prior knowledge plays a significant role in online reading comprehension among readers with low levels of online reading skills (Coiro, 2011, with middle school students). For example, when reading a text online, if the reader encounters the statement "all spiders are poisonous," knowledge about spiders will help the reader determine if this statement could be true, and whether they need to look up more information about spiders to confirm this statement. Then, if the second text they encounter contradicts this statement, with their prior knowledge, they can determine which of the two sources is more reliable.

Digital reading is often thought to be more difficult than reading on paper. However, because of the many differences within digital texts (e.g., screen size, scrolling vs. clicking, hyperlinks, multimedia), a direct comparison between reading on paper and digital reading is actually quite difficult. When making the comparison, therefore, researchers often resolve to only look at digital texts that are similar to paper texts; in other words, to more or less compare reading from paper to reading from screen using a narrow definition of digital reading. When combining research from the last decades, Clinton (2019), Delgado et al. (2018), and Schwabe et al. (2022) (each including both studies with children as well as with adults) found that there are no differences between reading on paper and digital reading in narrative texts. For informative texts, Delgado et al. (2018) found a small disadvantage for digital reading, but only when reading under time-pressure. The medium used for digital reading also seems to have an impact; the advantages of digital reading are mostly seen when students read from a computer screen, and far less when they read from a tablet (Salmerón et al., 2023). The readers' posture, or the touchscreen nature of a tablet may explain this effect.

Thus, even though the combined research in general shows no differences in understanding, there may be differences in the way readers approach a digital text versus a printed text. Clinton (2019) proposes three factors that may play a role: (1) calibration accuracy (readers think they understand the text better than they actually do), (2) more mind-wandering when reading from a screen, and (3) readers may perceive digital texts as less of a challenge than reading on paper, affecting their reading strategies. This last factor is linked to the "shallowing hypothesis" proposed by Carr (2010). The shallowing hypothesis suggests that readers are so used to digital content being brief and unchallenging to understand (for example, social media posts), that they have difficulty engaging in challenging tasks that require sustained attention when using digital devices, including reading comprehension (Annisette & Lafreniere, 2017; Carr, 2010). Being able to skim a text is a relevant skill, but the reader also needs to be able to switch to intensive reading when needed. Therefore, deeper attention and reflective thought are required to truly understand a text.

1.3 Characteristics of Digital Texts

Many digital texts are more complicated than a paper-based text that has been converted into a digital format. The difficulty of reading non-paper-based digital texts may be caused by their additional features (i.e., characteristics that distinguish them from paper texts). The most important of these characteristics are the use of scrolling, the use of multimedia, the use of hyperlinks, the type and difficulty of the texts, and any additional distracting elements. These features, as well as features such as line length, number of columns, and screen size may also affect reading time and comprehension, though the results from research are mixed (Dyson, 2005; Sanchez & Wiley, 2009). In the following sections, we distinguish between different kinds of digital texts. First, there are plain, linear digital texts without hyperlinks. These are

texts that are read from a screen but are otherwise very similar to paper texts. Next, there are digital texts with embedded hyperlinks (both linear and non-linear), also known as hypertexts. In the following sections, we describe the main characteristics of these texts.

1.3.1 Plain Linear Digital Texts

As mentioned, plain linear digital texts are largely the same as most paper texts, besides the fact that they are read from the screen. The two main differences between paper texts and plain linear digital texts are the characteristics of the device used and the use of scrolling and clicking.

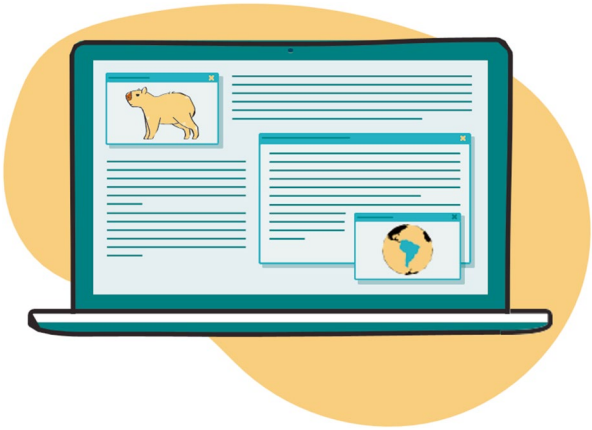
Plain linear digital texts can be read from a variety of digital devices, such as a laptop, desktop, tablet, e-reader, or smartphone. These devices differ in the size of their screens; the bigger the screen the more text can be shown at once. Most digital devices have a screen whose brightness can be adjusted (or adjusts automatically). Notably, e-readers often have no backlight but make use of e-ink. Reading from such electronic paper more closely resembles reading on paper. Electronic devices are also used in different ways; for example, laptops and computers are controlled with a mouse (pad), while tablets, e-readers, and smartphones are controlled with your fingers on the screen itself.

The size of the screen and type of device determine the amount of scrolling and clicking that is needed. With longer digital texts, the text requires readers to scroll through the text while reading it, especially when reading on a smaller screen. This can negatively affect the reader's performance, especially in students with a lower working memory capacity. There are a number of possible explanations for this. Sanchez and Wiley (2009) suggest that readers with a lower working memory capacity may become disoriented or lose their place when scrolling. Reading while

scrolling, instead of clicking, requires the reader to simultaneously maintain a surface representation of the text while also engaging in the comprehension processes, which leads to a higher cognitive load for the reader. Finally, the lack of page breaks may lead to readers with a lower working memory capacity failing to regularly activate consolidation or integration processes. Adding meaningfully paginated design to a digital text may, therefore, aid readers in their comprehension.

1.3.2 Hypertexts: Linear, Hierarchical, and Networked

Hypertexts are digital texts that contain hyperlinks, which lead the reader to a text with new information (see Textbox 1.2 for an explanation of the different types of hypertexts and Textbox 1.3 for an overview of different types of hyperlinks).



In their perhaps easiest form, hypertexts may be linear texts that have hyperlinks that are a kind of pop-up, with, for example, the definition of a difficult word. Such features can actually improve the comprehension of digital text (Clinton-Lisell et al., 2023).

Comprehension of texts that contain hyperlinks to other parts of the text or another text requires the reader to make inferences between the different parts of the text. To be able to do so, a reader may need more prior knowledge than when reading a linear text (Segers, 2017). For readers with less prior knowledge, which children often are, reading texts with hyperlinks is then more complicated by default.

Not a lot of research has been done yet on the comprehension of hypertexts, especially not in children. Researchers found that university students used the hyperlinks as a signal, that in fact, helped them understand the structure of a text better. This turned out to be especially helpful for weaker readers (Naumann et al., 2007). However, Schurer et al. (2023) found that a difficult networked hypertext led to more mind wandering, especially in readers with a poorer working memory capacity. And, in a sample of secondary school students, Blom et al. (2018) found that networked hypertexts were especially difficult for weak readers with a low vocabulary.

Textbox 1.2: Different Kinds of Hypertexts

Hypertexts are digital texts that contain hyperlinks—the reader can click on these to be brought to a different part of the hypertext. There are three types of hypertexts:

Linear: Linear texts are the most similar to paper texts: each page contains one hyperlink which leads to the next page.

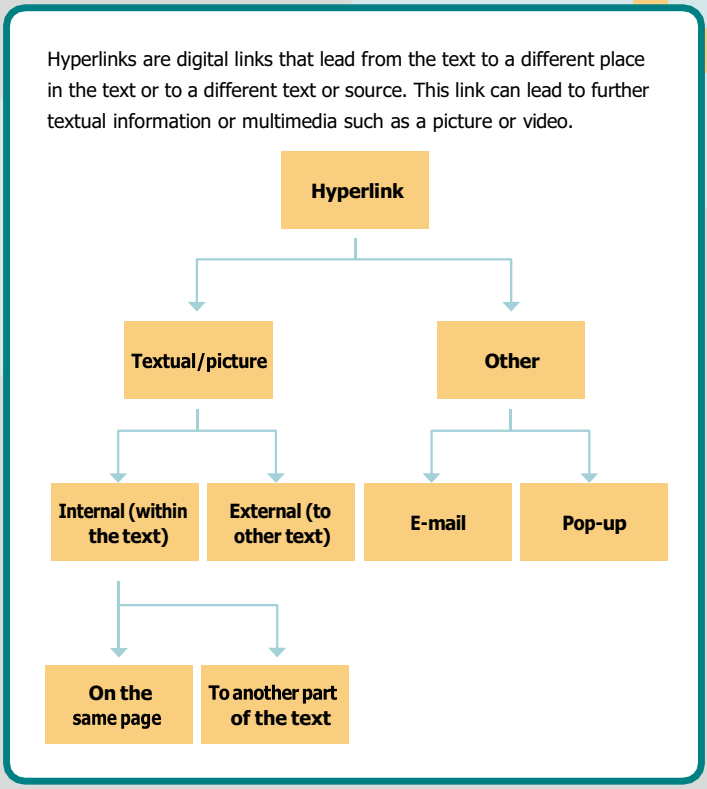
Hierarchical: Hierarchical hypertexts are nonlinear and have a tree-like structure through which the reader can go deeper into the text and track back through the structure.

Networked: Networked hypertexts are also nonlinear and have hyperlinks that cross-reference to other parts of the document without a clear structure. Networked hypertexts are the most common type of hypertexts. The hyperlinks in a networked hypertext can either link to another part on the same page, to another page of the same document, or to another document (website).

1.3.3 Hypertexts with Multimedia

When reading digital texts, readers not only encounter the text itself, but a number of multimedia additions such as pictures, videos, or audio. Hypertexts that make use of this multimedia are called hypermedia.

Textbox 1.3: Types of Hyperlinks



"The Cognitive Theory of Multimedia Learning" (Mayer & Moreno, 1998) is based on the fact that our working memory can process visual and auditory information, but has a limited capacity. The basis of this theory is that information enters the brain through both the visual canal and the auditory canal. The working memory processes this information, and the information is subsequently stored in the long-term memory. Working memory capacity serves as a bottleneck: an overload of working memory leads to less learning. The theory thus argues that auditory information with pictures is better for learning than written information with pictures, as the latter would overload working memory. This has indeed been evidenced many times (see Reinwein, 2012). However, most of these studies present the text like an automated PowerPoint. This induces a certain time pressure, with less control for the reader. In addition, knowledge is assessed directly after learning, while in a school setting, the teacher would want the child to remember what they have read.

Indeed, when there is no time pressure, reading a text with pictures actually was found to lead to higher learning gains, especially over time (see, for example, Witteman & Segers, 2010).

In a multimedia context, students have to integrate different kinds of information and combine these into one cohesive story. In general, pictures can help students comprehend a digital text, provided they are not distracting (Carney & Levin, 2002). For example, images can be used to illustrate the concepts described in the text. Pictures that distract from the text add to the cognitive load and make it more difficult to understand the text. On the internet, most information is in a hypermedia format, i.e., multimedia texts that also include hyperlinks. For example, digital texts that are found on websites, apps, etc. may include advertisements or other multimedia that is not relevant to the text. For the reader, this means a lot of potential distractions, and a lot of decisions to be made (e.g., whether to click on a hyperlink or not). This adds to the cognitive load placed on students when reading these texts.

1.4 Skills for Digital Reading

Digital reading of multiple documents has been defined as being able to navigate, evaluate, and integrate information from multiple sources (see Salmerón et al., 2018). When reading online, the reader (student) **navigates** through the digital landscape in search of the documents or texts that are needed, for example, when doing an assignment for school. The first challenge for the student is to figure out the best search terms. If, for example, a student has an assignment to write an essay about the life of polar bears, it helps to know where polar bears live. But also, that climate change affects their lives, and that there is debate on this. This prior knowledge helps to refine an internet search. The second challenge is to select relevant documents from the list of options that the search engine provides. Young readers tend to select one of the first options, which is also related to their evaluation skills (see below). It is crucial for a teacher to realize that prior knowledge is a prerequisite for successful navigation. A ten-year-old who has no prior knowledge about a topic and little experience in searching the web will need help to find relevant sources. Developing search skills requires direct instruction (see Kuiper et al., 2005). A web search often leads to a long list of potential sources. Students need to look further than the superficial cues, such as a bold-faced keyword, and also take into account the deeper semantic cues (the type of information needed for their task). Teaching children about such cues may foster a better selection of texts in a search task (see Rouet et al., 2011). Well-developed search skills may partly compensate for less knowledge (Vibert et al., 2009).

When a document is found, **evaluation** comes into play. Students need to determine whether the source is trustworthy, whether the information on the website is reliable, and whether the information is relevant for their reading goal. A document may look promising but may be less relevant or appear to contain unreliable information once the full document is critically examined. When evaluating documents,

the texts should be skimmed first, for example, by looking at headings and boldfaced words or searching for keywords. With the reading goal in mind, the reader decides whether or not to read the full document. Again, being able to evaluate sources and texts requires a certain amount of prior knowledge, both on the topic (comparing what they have read against what they think is true based on their prior knowledge) and their knowledge of the internet (e.g., knowing the meanings of .com, .net, .org etc.). Understanding the concept of trustworthiness is also needed, for example the ability to distinguish the credibility of a certain established news site versus a blog from a popular person. In a digital world, such ability is more needed than, say, 40 years ago, when a young student might have just gone to the library and looked through several books and/ or newspapers. When evaluating a document, digital readers seem to rely on their prior knowledge, even when their prior knowledge is insufficient (Scharrer et al., 2012). Readers also tend to make judgments about a text's trustworthiness in only a few seconds—based on superficial clues such as the professional design or even just a gut feeling—instead of a critical consideration of the content. Instruction is needed to help students learn to skim and evaluate texts (see Almeida et al., 2022). Chapter 2 elaborates on the instruction techniques that can be used for teaching skimming and evaluating digital texts.

Finally, the (possibly) relevant information should be read thoroughly and **integrated** from several documents into one mental model, since reading online (often) involves reading more than one text. The student faces the challenge of reading multiple documents, this forces them to detect where information overlaps, where information contradicts, or where further information on a topic can be found (Salmerón et al., 2018). This is more complicated than single document reading as it includes processing information about the source of the documents, as well as about their contents. Regarding the contents, the reader must build a mental model for each document and then integrate the information from the different documents into an integrated documents model (Britt & Rouet, 2012; Perfetti et al., 1999). Additionally, the reader needs to make a "task model" that contains the reader's goals when reading the texts (Rouet et al., 2017). Furthermore, as in the comprehension of a single document, prior knowledge is key to multiple document reading. When the reader has low prior knowledge, it is difficult to integrate information.

These theories show the importance of self-regulation in all three components of multiple document reading. For example, students need to be aware of their navigation path, evaluate information with their reading goal in mind, and monitor their comprehension of the texts. Also, they need to stay committed to the task, ignoring irrelevant information, instead of wandering the internet.

It should be noted that the process of navigating, evaluating, and integrating may ask too much of students. Therefore, a teacher may decide to present the students with a set of online documents, as a first step. To learn to integrate the multiple documents and deal with the hypertext structure of the texts, without the skills of navigating and evaluating, could already be enough of a challenge for students. A next step in the curriculum could be to focus on evaluation by including less trustworthy documents and discussing how these can be detected. In a final step, navigation of online texts can be included. This may also be an earlier option for those

students who need an extra challenge in class. In Chap. 2, we will further elaborate on evidence-based didactic principles for digital reading.

1.5 Digital Inclusion

The concept of "digital inclusion" relates to access to digital means in the broadest sense. The Digital Equity Act defines digital inclusion as:

> The activities necessary to ensure that all individuals and communities, including the most disadvantaged, have access to and use of Information and Communication Technologies (ICTs). This includes: affordable, robust broadband internet service; internet-enabled devices that meet the needs of the user; access to digital literacy training; quality technical support; and applications and online content designed to enable and encourage self-sufficiency, participation and collaboration. (National Digital Inclusion Alliance, n.d.)

As mentioned previously, digital transformation is developing rapidly, and digital skills have become increasingly important to participate successfully in society. In education, learning is also increasingly taking place with digital resources. The COVID-19 crisis has further reinforced this evolution in education, as lockdowns led to remote learning, which often included online activities. It is, therefore, more necessary than ever to ensure that digital education is accessible to all students, as is the need to ensure equal access to print materials, and to promote digital inclusion in education. In this section, we emphasize the importance of digital inclusion in schools and its different dimensions. Chapter 2 elaborates further on guidelines for teachers on how to prepare students for the digital world and how to stimulate digital inclusion within schools.

Digital inclusion in education is about creating an inclusive environment with digital learning opportunities for all students to prepare them for a digital society. The digital divide can be seen as the opposite of digital inclusion. In the late 1990s and early 2000s, the digital divide was mostly used to refer to differences in physical access to ICT and the internet. In the 2010s, the digital divide became a more multifaceted concept and other dimensions came forward, such as skills and motivation. Similar to the digital divide, digital inclusion is now seen as a process with the following four phases or dimensions: (1) attitude and motivation, (2) physical access, (3) digital skills, and (4) usage access (van Deursen & van Dijk, 2015).

First of all, there must be a positive attitude toward the internet and students should be motivated to use ICT and the internet. A positive attitude and motivation in relation to (learning to use) ICT and the internet are crucial conditions for benefiting from it. Secondly, students should have sufficient physical access. Physical access refers to all the means required to use the internet on the one hand (i.e., a reliable internet connection), and to use hardware, software licenses, and support services on the other hand. Next, students need digital skills to use ICT and the internet. Digital skills can be divided into medium-related skills (i.e., the technical basic skills required to operate internet technology, such as knowing how to use a smartphone) and content-related internet skills (i.e., the skills to seek information

and strategic skills to reach the goal in the most efficient way). Finally, students need to be given sufficient opportunity to practice using ICT and the internet.

Each of these dimensions is relevant, and the dimensions interact together. For example, digital skills cannot be practiced without access to a device and the internet. Also, without a positive attitude and motivation, ICT and the internet will not be used often, and digital skills will not be developed sufficiently. Therefore, to promote digital inclusion in education, attention must be paid to all four dimensions simultaneously.

In Summary
Key findings on digital reading:

- Although there is a lot of overlap between digital reading and reading from paper, there are also important differences in terms of text characteristics and the skills required to read the text. Research in general shows no differences in understanding digital text versus printed text, but there may be differences in the way readers approach a text.
- Texts from the internet are mostly non-linear networked hypertexts, often with additional (distracting) multimedia. Reading networked hypertexts can be especially difficult for weak readers with a low vocabulary. Prior knowledge and vocabulary are crucial for understanding online texts.
- Reading multiple digital texts from the internet requires three skills: navigating, evaluating, and integrating. Self-regulation plays an important role in developing these skills.
- Digital inclusion is an important concept that refers to an inclusive environment with digital learning opportunities for all students to prepare them for the digital society. Its four dimensions are: (1) attitude and motivation, (2) physical access, (3) digital skills, and (4) usage access.

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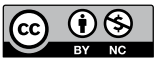


Chapter 2
Evidence-Based Didactic Principles for Digital Reading

An Overview of Evidence-Based Didactic Principles for Digital Reading

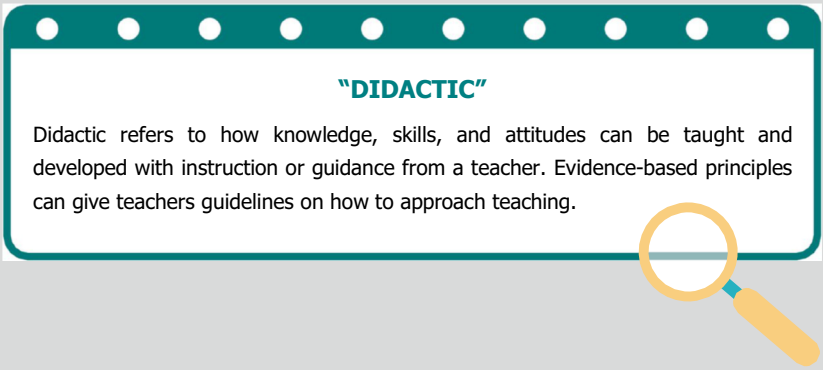
Contents

2.1 Introduction

In the first volume of the *IEA Research for Educators* series, *Putting PIRLS to Use in Classrooms Across the Globe* (Bruggink et al., 2022), we described the complex processes of reading comprehension. Various underlying skills, such as word identification, word-to-text integration, and the use of comprehension strategies, play a role in this complex and multidimensional process. This makes teaching reading comprehension a challenging task for teachers. In today's digital world, students acquire new knowledge through texts on paper and a multitude of digital texts from the internet, which increases the challenges associated with teaching reading comprehension. In Chap. 1, we explained how reading digital texts differs from reading on paper and what this means for the reader (student). Additionally, we highlighted different dimensions of digital inclusion and the importance of creating an inclusive environment with digital learning opportunities for all students. In the current

M. Bruggink et al., *Teaching Reading Comprehension in a Digital World*,
IEA Research for Educators 2, https://doi.org/10.1007/978-3-031-75121-9_2

Textbox 2.1: Explanation of the Term "Didactic"



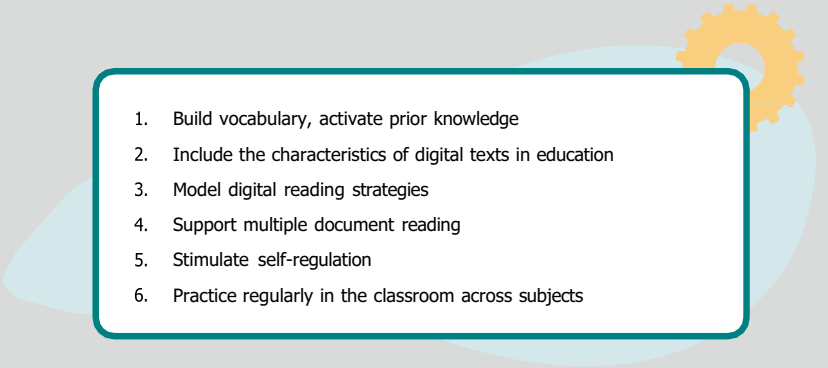
Source: Bruggink et al., 2022.

chapter we discuss how teachers can support their students in comprehending digital texts and the importance of taking into account the differences between reading digital texts and paper texts. Finally, we provide guidelines for digital inclusion in classrooms. Our aim for this chapter is to give teachers practical teaching suggestions that are directly applicable in the classroom.

Before we highlight the didactic guidelines for digital reading (see Textbox 2.1 for an explanation of the term 'didactic'), it is important to know that the skills and knowledge required for reading on paper are also important in digital reading, or, in other words the comprehension of digital texts. This means that well-developed paper-based reading skills are a solid foundation for developing digital reading skills. This is reflected in the Progress in International Reading Literacy Study (PIRLS) 2026 assessment framework,[1] where reading on paper and digital reading are seen as the same construct with the same underlying purposes (literary experience and acquiring and using information) and processes (focus on and retrieve explicit stated information, make straightforward inferences, interpret and integrate ideas and information, and evaluate and critique content and textual features) for both types of reading (Sabatini et al., 2023; see also Textbox 1.1 in Chap. 1 of this volume). Evidence-based didactic principles for comprehending paper-based texts are therefore also applicable for reading digital texts. As mentioned above, in volume 1 of the *IEA Research for Education* series, we explained these general principles in detail, with examples and practical suggestions for teachers. As in volume 1, we maintain that reading comprehension instruction should take place in a

[1] The 2026 cycle of PIRLS marks the complete transition from paper-based reading to digital reading in which texts are not only presented in a digital format, but ePIRLS computer-based tasks will also be incorporated and integrated into the general PIRLS framework.

Textbox 2.2: Six Didactic Principles for Teaching Reading Comprehension Using Digital Text



meaningful and functional context, that students should engage in in-depth interaction about the text, that explicit instruction should be provided on a limited set of reading strategies, that reading education should be integrated with other subjects, that underlying factors should be monitored, and that instruction should be differentiated.

Above and beyond these general guidelines, we have identified several evidence-based guidelines for digital reading specifically, and clustered them into six didactic principles, see Textbox 2.2.

In Sects. 2.2, 2.3, 2.4, 2.5, 2.6, and 2.7, we discuss these six evidence-based didactic principles for digital reading. In Sect. 2.8, two examples of non-linear hypertexts are given and supplemented with didactic suggestions. Finally, in Sect. 2.9, we discuss guidelines for teachers to stimulate digital inclusion within their school.

2.2 Build Vocabulary and Activate Prior Knowledge

As described in Chap. 1, prior knowledge and vocabulary are essential aspects of text comprehension and play an even more significant role in digital reading. Students with less developed vocabularies tend to have more difficulties understanding hypertexts in which students need to navigate through hyperlinks as compared to students with more developed vocabularies (Blom et al., 2018). In addition, it has been shown that prior knowledge is crucial to being able to integrate information from multiple documents (Segers, 2017). To integrate information from multiple sources, students need to create multiple mental models (one for each text) and integrate them into one single mental model. Vocabulary knowledge and prior

knowledge are not only warranted to create these mental models for each individual text, but it is also necessary to determine how these mental models should be combined. The more vocabulary and prior knowledge a student has, the easier it is to create and combine mental models. This is especially true when not the exact same words, but synonyms are used across multiple documents. Students can then benefit from prior knowledge as they cannot rely on an overlap of words used in the texts (see also Sect. 2.5). Furthermore, when searching for and selecting relevant information on the internet, students can benefit from prior knowledge of the meaning of keywords, and knowledge on the subject.

Education in a rich learning environment ensures that students have the opportunity to gain new knowledge about concepts and words. In a rich learning environment, novel words and concepts will be read and used repeatedly in different contexts, this strengthens the connection between words in the mental lexicon. The mental lexicon is the place in memory where word knowledge is stored. It can be compared to a web of interconnected elements, in which each word is represented by a node, and nodes that are related (e.g., based on their meaning or use in language) are connected to each other (see Fig. 2.1). The learning environment can be enriched by integrating different language skills (reading, writing, and oral language) with other subjects (e.g., history, biology, and geography), by reading different types of authentic reading materials on the same subject, and by organizing meaningful and functional reading activities. Authentic reading materials refer to reading materials that include a varied and rich vocabulary, include low-frequency words, have sentences of different lengths, are structured, and make use of structural cues such as transitions or linking words (e.g., first-second, also, neither-nor, therefore, despite, because). Meaningful and functional reading activities refer to activities that resemble real-life reading tasks with a clear purpose, such as solving a specific problem.

To ensure that all students have the necessary prior knowledge to form a mental representation of the situation described in the text (the situation model, see Chap. 1), teachers can check what students already know about the subject before reading the text in the digital environment. For example, teachers can ask their students to make a mind map of the things they already know about the subject. Based on the students' prior knowledge, teachers can adjust their instruction by paying explicit attention to important keywords of the text. When giving explicit vocabulary instruction, it is important not to present the words in isolation, but in a network with other related words, and thereby pay attention to various aspects of words. Research has shown that words are better incorporated into the mental lexicon when vocabulary instruction is not only focused on the meaning of the word, but also on the pronunciation and spelling of the word (Swart, 2018). By adding and/or extending knowledge, all students create a (minimal) conceptual network to which the new knowledge from the text can be connected. In this way, all students are prepared to acquire new knowledge and expand their network of knowledge.

The mental lexicon is the place in long-term memory where word knowledge is stored. For each known word a lexical representation is created and within this representation orthographic (how a word is written), phonological (how a word is pronounced), and semantic (what a word means) information is stored. The mental lexicon can be compared to a web of interconnected elements in which each lexical representation represents a single node and these nodes are connected with each other. When a single word is activated, for instance because it has been read, other related words are also activated. "While Lot was riding her bike, dark clouds gathered. When she got home, she had to put on dry clothes." The picture below is of a network around the word "cloud." Notice the related words "rain" and "water," which are crucial in understanding the example sentence. When a reader has not established the relationship between cloud and rain, it is hard or probably even impossible to truly understand the example sentence.

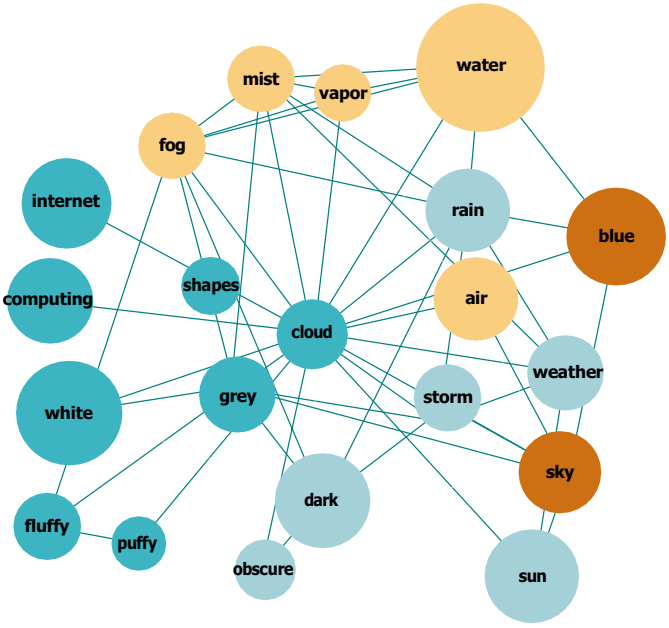


Fig. 2.1 An illustrative example of the mental lexicon. (*Source:* Bruggink et al., 2022)

2.3 Include the Characteristics of Digital Texts in Education

Digital texts on the internet often contain hyperlinks, which can complicate the structure of a text and may lead to difficulties in comprehension, especially for students with a low vocabulary and little prior knowledge (see Chap. 1). Additionally, hypertexts often contain different kinds of multimedia, which can distract the readers' attention from the text. In this paragraph, we highlight guidelines for teachers on how to take these characteristics of digital texts into account.

2.3.1 Digital Texts Structure

Research has shown that readers with less prior knowledge on a topic (low-knowledge readers) learn more by following a strategy that leads them to read a hypertext in a coherent order (Salmerón et al., 2005, 2006). With clearly structured texts such as a hierarchical text, the reading path is often fixed. In the digital reading landscape, most online pages contain networked hypertexts, where the structure of the text is often unclear. A graphic overview of the structure of a networked hypertext can help readers make decisions about the reading order of the different pages of a hypertext and help them to navigate through the hypertext (Salmerón et al., 2005; see Fig. 2.2 for an example). With a graphic overview of the text, students explicitly see the underlying structure of the hypertext and learn how to connect and integrate various parts of information into a situation model of the text (Blom, 2020). Graphic overviews, such as concept maps, display the main concepts of hypertext content and the semantic relationships between the concepts. These overviews also support the construction of a mental representation of the text, provided that they match with the link structure of the text (Amadieu & Salmerón, 2014). When reading a networked hypertext, teachers can create a visualization of the text structure during their reading instruction, for example, by placing the topics in an overview and adding arrows to visualize the relationships between text-subjects.

In addition, to meet students' reading level and experience in reading online, it is important to gradually build up the difficulty of the text structure (Blom, 2020). Teachers can initially offer students a limited set of more structured digital texts on a specific topic, for example from an education website for children. As a next step, teachers can use a less-structured networked hypertexts, with a graphical overview. Practice in reading different types of texts and discussing the relationships between pages helps students gain insight into how a hypertext is structured. Also, students may benefit from explicit instruction on what aspects they should pay attention to while navigating through a networked hypertext (Blom et al., 2018; Fesel et al., 2018).

An example of digital texts that are more structured are WebQuests. A WebQuest is an online assignment presented together with a series of web pages to help guide children's learning. Students search for information in a sheltered internet

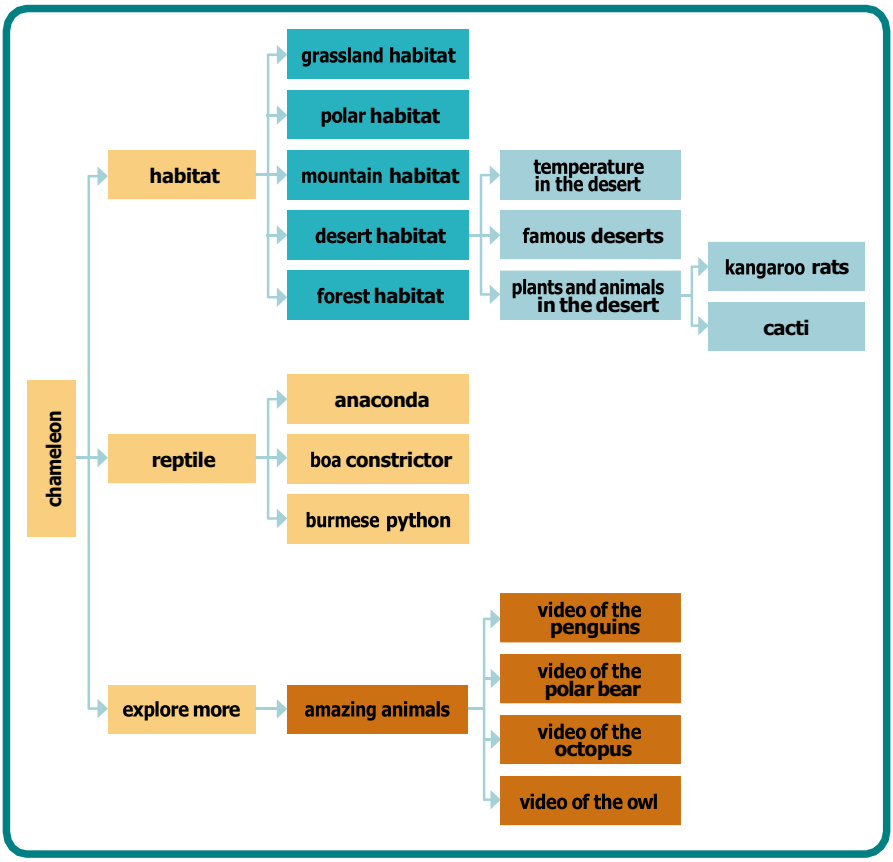


Fig. 2.2 Example of a graphic overview, based on pages of the website National Geographic Kids

environment, process this information, and integrate it into a writing assignment. Considerable research has been conducted on the concept of WebQuests and its positive effects for teaching and learning (Segers & Verhoeven, 2009). WebQuests may be a first step in digital reading education because the reading assignment is connected to relevant websites that are age appropriate. In this way, the complexity of searching for information is set aside, while students practice reading on the internet. WebQuests have been developed across the globe and may inspire teachers who are not yet very familiar with digital reading. WebQuests materials on various topics for all grades can be found on the internet, mostly for free.[2] Teachers can also easily create their own WebQuest with templates on the internet.

[2] For more information see: https://www.createwebquest.com/

2.3.2 Ensure that Hypermedia Supports the Text

In general, research has shown that pictures in the text aid comprehension of the text for both digital and non-digital texts, provided they are complementary to the text (Carney & Levin, 2002). However, the inclusion of hypermedia in text can interfere with comprehension. For example, a digital text that contains pictures as well as audio can lead to cognitive overload for the reader. Therefore, it is important for teachers to be aware of the amount of hypermedia that is included within digital texts when guiding students on the internet and help them to ignore certain hypermedia. When teachers select webpages in advance, it is recommended to select texts where images, clips, or audio support the content of the text and help their students comprehend the text. The more relevant information an image contains, the more it can help students understand the content of the text. For example, a picture showing what a volcano looks like from the inside and what it looks like underground helps in understanding a text about how volcanoes are formed. A picture of the same text with a cartoon or a picture of Pompeii can distract the student from the purpose of the text and therefore may have adverse effects on text comprehension. Of course, the extent to which hypermedia supports text comprehension depends on the student's prior knowledge. For example, for young students, a picture of a colorful parrot may support a text page about the external characteristics of this type of bird. For older students, the picture is not as relevant when reading about the parrot's habitat and enemies, since they probably already know what a parrot looks like.

2.4 Model Digital Reading Strategies

An evidence-based didactic principle of reading comprehension in general is explicit instruction in the following effective reading strategies (Bruggink et al., 2022): (1) orienting on the text: making predictions and setting reading goals; (2) asking questions; (3) visualizing the content of the text; (4) recognizing text structure; (5) making connections; (6) summarizing; and (7) monitoring and clarifying comprehension.

Although the above reading strategies are mainly focused on linear, single texts, (which most paper-based books and articles are), they are also applicable for reading digital text (Cho, 2014). In both paper-based reading and digital reading, the student has to create an adequate and representative model of the text, for which these reading strategies can be used. However, since online digital reading involves additional challenges, it is important to teach students additional strategies specific for digital reading (Cho, 2014; Fesel, 2015).

Cho (2014) defined four types of digital reading strategies (see also Afflerbach & Cho, 2009). All four strategies can be taught by modeling the questions students can

ask themselves (thinking aloud) about the information they are confronted with when searching and reading on the internet (see Table 2.1). In the classroom, teachers can ask and answer these questions while interacting with their students, with the ultimate goal of the students learning how to ask these questions themselves. Students can use a checklist with these types of questions as a reminder. Furthermore, teachers and students can browse the internet together and think aloud, allowing teachers to monitor how their students are developing in this area.

The first strategy for digital reading involves exploring, identifying, and selecting sources. This process starts with choosing relevant key words. Students first need to define the questions that need to be answered to achieve their reading goal and then select the relevant terms to use in a search engine. Students often need the support of their teacher in selecting keywords. It is important that students realize that the keywords they choose partly determine what kind of information appears. For example, typing the words "evidence that sunlight is bad" into a search engine produces a one-sided picture of the effects of sunlight. Studies have shown that students have a lot of trust in search engines. They are inclined to look at the search results quite superficially, and while doing this, focus mainly on the keywords (Rouet et al., 2011). After providing a search request, students need to critically examine the sources available to them before clicking on one of the given hyperlinks. They should identify what sort of texts could be behind the source and decide if the sources are reliable. Teachers can model this aloud by asking questions, for example, "Looking at the source, what type of text could be behind this link? Can the author of the text be traced, and does the link to the website look credible? Are there any spelling errors? Is this the type of text you expected to read?" Next, students need to scan the text(s). Teachers can also support this process by modeling and reading aloud the heading or providing key words from the text. While scanning the text, students need to decide if the text is relevant to their reading goal and worth reading in more detail. In other words, they should be reminded of their original question/reading goal for the topic.

A second strategy refers to constructing meaning. As stated previously, reading strategies that help comprehend a paper text can also be used to comprehend a digital text. For example, orienting on the text, activating prior knowledge, visualizing the content of the text, or recognizing the structure of the text, all help to comprehend the content of the text, both digitally and on paper. However, with digital reading, students often have to construct meaning from multiple webpages. This means they need strategies to construct a mental model of the content of multiple texts. To do this, students need to integrate the information (the mental models) of the individual texts (see also Sect. 2.5). It is important that teachers encourage their students to take time to read the information, even if they think they already know about the subject, and to think about the relationships between the texts (Sullivan & Puntambekar, 2015). Teachers can ask questions about these relationships, to help construct meaning. Examples of these questions are: "What are the main topics of these texts? Have you read about this before? What do these texts say about ...?

Table 2.1 Example questions for digital reading strategies

Strategy:	Example questions:
1. Exploring, identifying, and selecting sources	• *Which search terms can best be selected from the research question?* • *What type of text could be behind this source?* • *Is this the type of text I expected to read?* • *Can the author of the text be traced and does the link to the website look credible? Are there any spelling errors?* • *Could this type of information answer my question?*
2. Constructing meaning	• *What are the main topics of these texts?* • *Have I read about this before?* • *What do these texts say about …?* • *What have I learned from these texts so far?* • *Does this text support the text I have read before? Or are they conflicting?* • *How does this text relate to the other texts I have read?*
3. Self-monitoring	• *What type of information am I reading?* • *Is this information still relevant for my reading goal?* • *Which hyperlink in the text should I click on first?* • *How do I get back to the original source?* • *Do I understand what I have just read?* • *Which text can help me understand this specific topic better?* • *Do I ignore irrelevant parts of the text?*
4. Evaluating the information	• *Given the source, how should I interpret the text I have read?* • *Looking at the characteristics of this text (e.g., the style, age, and author of the text), how accurately and reliably do I estimate this information?* • *Looking at the characteristics of these contradictory texts, which text do I find the most credible?* • *What information on this page do I not fully trust, and should I check on another website?* • *Which information is the most useful?* • *What type of information is still missing?*

What have you learned from these texts so far? Does this text support the texts you have read before? Or are they conflicting? How does this text relate to the other texts you have read?" To further aid their comprehension, students can write small summaries or represent relationships between texts through graphic organizers, such as concept maps, Venn diagrams, or schemes.

Another strategy that students can use relates to self-monitoring. In Chap. 1, we highlighted the importance of self-regulation in multiple document reading. With self-monitoring strategies students learn to control their own reading process and develop self-regulation in digital reading. While students navigate through online texts during a lesson, teachers can help students apply these self-monitoring strategies. Self-monitoring strategies include making conscious decisions about the reading path, holding on to the reading goal and the reading task, and monitoring text comprehension and text location. Think aloud questions related to these aspects are: "What type of information am I reading? Is this information relevant for my reading goal? Which hyperlink in the text should I click on first? How do I get back to the original source? Do I understand what I have just read? Which text can help me understand this specific topic better? Do I ignore irrelevant parts of the text?"

A final strategy involves evaluating the information in the text on relevance and reliability. Evaluating information on reliability is an important aspect of digital reading because reading relevant and credible information contributes to a coherent understanding of the topic. This is especially true with online texts, where the source is not always clear, the diversity of sources is high, and the quality and reliability of information are variable. Students therefore need to be able to estimate the quality and reliability of texts. In interaction, where students discuss information in small groups, and where teachers provide instruction, explanation, and feedback, students can learn how to evaluate information from different texts (Macedo-Rouet et al., 2013). To stimulate students to evaluate texts, teachers can model asking questions such as: "Given the source, how should I interpret the text I have read? Looking at the characteristics of this text (e.g., the style, age, and author of the text), how accurate and reliable do I estimate this information? Looking at the characteristics of these contradictory texts, which text do I find the most credible? Which information on this page do I not fully trust, and should I check on another website? Which information is the most useful? What type of information is still missing?"

2.5 Support Multiple Document Reading

As mentioned before, when reading online, students seldom read only one text. Often students have to navigate through two or even more texts (documents or webpages) to find the information they need to reach their reading goal. Reading multiple documents presents various difficulties. Not only do students have to evaluate the reliability of all these sources, they also need to create multiple text models (one

for each document) and integrate these models into one comprehensive integrated document model (see Sect. 1.4). Primor and Katzir (2018) defined three levels of multiple text integration. The first level is selecting information. In single document reading, a document is selected based on the main idea of that single document. When reading multiple texts, students should learn to select documents that are supplementary to the reading goal and avoid selecting multiple documents that cover the exact same information. In doing this, students should keep track of which information they have already found and which information is missing and needs to be looked for in other documents. When reading multiple documents as part of an assignment, teachers can support students in deciding if a document is complementary to the one(s) read before.

The second level of integration is about generating relationships between documents, which means that readers need to link pieces of information extracted from one text to pieces of information read in other text(s) and to establish relationships between these pieces of information, while keeping in mind the information contained in all other documents. This is also referred to as making intertextual connections. Pieces of information extracted from various sources can be complementary or conflicting. When reading single documents, establishing these relationships is often easier because of textual cues in the text (e.g., signal words for exampling, contracting, sequencing, etc.). When contrasting information is present in single documents, these pieces of information are connected by "textual clues," by using words such as "however," "but," and "on the one hand," "on the other hand." In multiple document reading, the reader has to establish these relationships themselves by evaluating the content of what is being read and then consider the links between the different texts, without the use of textual cues. These readers have to rely more on the content of the pieces of information, meaning that a deeper understanding of the topic is needed. When teaching multiple document reading, teachers should make students aware of the potential unavailability of textual cues and explain the need for a deeper understanding of the content in order to accurately establish relationships between pieces of information from various texts.

The third level relates to establishing connections, where readers need to transform pieces of information into new knowledge. To transform information into knowledge, readers have to draw conclusions based on the information they have read and connect it to knowledge already stored in the long-term memory. When reading single documents, previously stored information (prior knowledge) has to be retrieved in the context of only one document and combined with a model of only one text. When reading multiple documents, various settings can be present, forcing readers to retrieve and integrate new information from multiple formats and contexts.

To support integration on all three levels, a didactic principle helpful to teachers is to use specific inquiry questions with their students. An inquiry question can serve as a criterion to help students select the relevant information from each text and locate conflicts, detect associations between the texts, and join pieces of information together.

For example, teachers provide two or three texts that are partly conflicting, for example, about the substances in milk and whether they are healthy. Teachers then present an inquiry question for their students, such as, "Is drinking milk healthy? Why or why not? And for whom?" Teachers can remind students of the inquiry question while they select information, search for relationships, and derive conclusions. By focusing on the inquiry question, teachers can provide direction and support with answering the question based on the content within multiple texts. This didactic principle is also applicable for reading multiple paper-based texts.

2.6 Stimulate Self-Regulation

To meet the challenges of digital reading, students need a certain degree of self-regulation. If searching on the internet does not immediately give the desired result, it is temping for students to "surf around." Self-regulation is important for staying committed to the task or search. For example, when searching for information online, students should be able to ignore irrelevant but highly ranked search results.

Self-regulation requires various metacognitive skills—in short, learning how to learn. Students with well-developed metacognitive skills are able to control or regulate their own learning process. These students think about what to learn, how to learn, and why they are learning. Metacognitive skills play a role during all stages of learning (Zimmerman, 2002). As a first step, students need to familiarize themselves with (orienting on) the digital reading task. For this phase, teachers can help students by formulating a specific reading goal together with the students and create a step-by-step plan that divides the task into smaller steps. Also, during this stage, it is important to inform students about the relevance and importance of the task and to motivate them. Secondly, during the task, students need to follow the plan, concentrate on the task, apply (digital) reading strategies, and monitor their text comprehension. Scaffolds such as modeling strategies, helping to start a task, or giving concrete examples are helpful in this stage. Finally, students should reflect on the task afterwards. The step-by-step plan and the reading goal set prior to the task can also be used in evaluating the task. To what extent has the plan been adhered to? And has the reading goal been achieved? Based on this reflection and with the help of the teacher, students can determine the next steps and learning points.

2.7 Practice Regularly in the Classroom Across Subjects

The more experience students gain reading digital texts, the easier it becomes to comprehend digital texts (Salmerón et al., 2018). Therefore, it is important to include digital reading in the curriculum from the start, so that reading all kinds of digital texts on a regular basis in the classroom becomes as common as reading on

paper. Many students already have experience with using digital devices, and many of the accompanying digital skills. However, this experience is often associated with games and social media. They may have less experience with reading and comprehending digital (hyper)texts. It is therefore important for teachers to expose students from the start to short, structured digital texts and gradually build up the complexity and length of the text. Instruction on how to read multiple digital texts is necessary for students to become skilled digital readers in an ever-changing digital landscape.

Embedding various types of digital texts in the curriculum in a meaningful way is the most effective means of supporting digital reading (Flewitt et al., 2015). Meaningful in that students read these texts to answer an educationally related question and not just to read a digital text. Digital reading can easily be integrated into school subjects such as history or science. Students can search for informative texts on the internet to complement the information in their textbooks or set up their own online research about a specific topic. By integrating digital reading into these subjects, students practice digital reading skills in different settings while acquiring new knowledge about the subject.

2.8 Examples of Hypertexts with Didactic Suggestions

In the following section, we provide two examples of non-linear hypertexts: one hierarchical hypertext and one networked hypertext (see Textbox 1.2 for an explanation of these terms). For each text, we describe suggestions for reading this type of text in classrooms based on the didactic principles from Sects. 2.2, 2.3, 2.4, 2.5, 2.6, and 2.7.

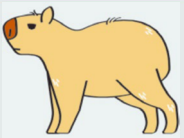
These two example texts also demonstrate the changing world of digital texts. Both were written using the artificial intelligence chatbot ChatGPT (OpenAI, 2023). Firstly, a text was generated by entering a prompt in ChatGPT and then subsequently edited by the authors to produce these example texts.

2.8.1 Example of a Hierarchical Hypertext

THE FASCINATING CAPYBARA: NATURE'S GENTLE GIANT

The capybara (Hydrochoerus hydrochaeris) is a unique and captivating creature that captures the hearts of many nature enthusiasts. Known as the world's largest rodent, the capybara is a semiaquatic mammal native to South America. On this website, we will delve into the fascinating characteristics, habitat, behavior, and conservation status of the capybara.

Capybara



Physical characteristics

The capybara possesses a barrel-shaped body, with a head that is small in proportion to its body. It can reach an impressive length of up to 1.5 meters (4.9 ft) and can weigh between 35 and 65 kilograms (77 and 143 lbs.). Its short legs end in partially webbed feet, enabling it to be an excellent swimmer. Capybaras have coarse, brownish-gray fur, with sparse hair covering their bodies, and their eyes, ears, and nostrils are strategically positioned on top of their heads, allowing them to stay submerged in water while maintaining awareness of their surroundings.

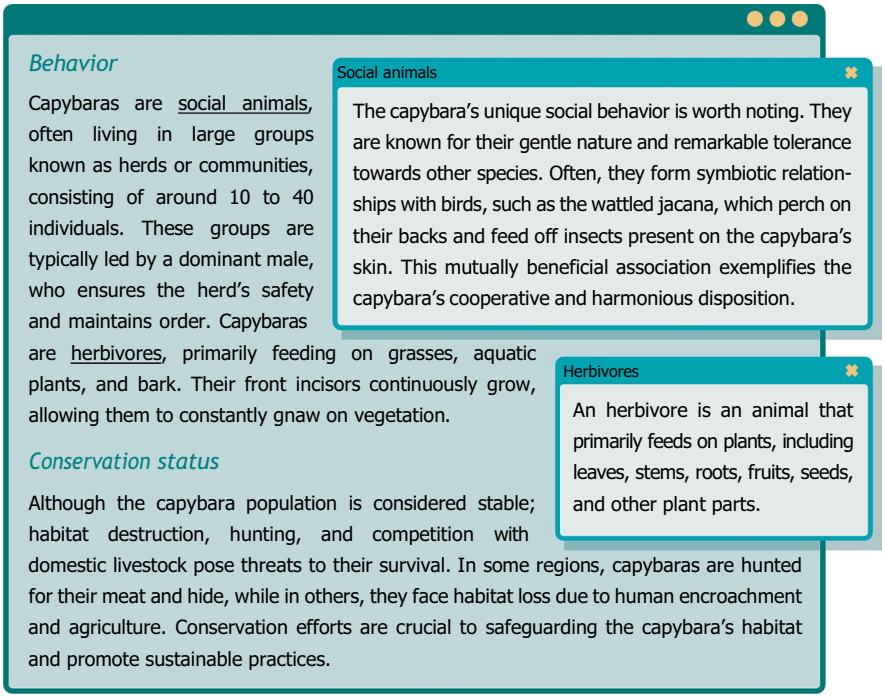
Habitat

Capybaras are predominantly found in the wetlands, marshes, and grassy regions of South America. They are highly adaptable to different environments, ranging from savannas and rainforests to swamps and riverbanks. Due to their semiaquatic nature, capybaras are commonly found near bodies of water, such as rivers, lakes, and ponds, where they can retreat when feeling threatened or to regulate their body temperature.

Grassy regions of South America

The grassy regions of South America are primarily found in the central and southern parts of the continent, particularly in the countries of Argentina, Uruguay, and southern Brazil. These regions are characterized by vast grasslands known as "pampas" in Argentina and Uruguay, and "campos" in Brazil. The pampas and campos are expansive, flat areas covered with tall grasses and few trees, creating a unique and diverse ecosystem.

South America



2.8.1.1 An Example for Teaching Reading with Hierarchical Hypertexts

A class is learning about mammals in biology. To explore more about different mammals, the teacher shows a video in class about rodents. One of the animals mentioned in the video is the capybara. Most students have never heard of a capybara. The teacher suggests searching for more information and together they determine a research question: "What do capybaras look like, and in what environment do they live?" Then, together, they select keywords to accompany the research question, such as "appearance of the capybara" and "life of a capybara." After critically examining the search results, the teacher selects the webpage about "the fascinating capybara: nature's gentle giant" as reading material. (**Model digital reading strategies**).

Before reading the text and clicking on the hyperlinks, it is important for students to familiarize themselves with (orienting on) the text by reading the title and looking at the picture of the capybara. The teacher activates students' prior knowledge about this animal by asking questions like, "Do you recognize the capybara? Does this animal remind you of another animal? Why is it sometimes called "a gentle giant?" (**Activate prior knowledge**). Also, to identify the type of text, the teacher asks questions such as, "What kind of text is this? What information do I expect to read about?" To examine the structure of the text, the teacher emphasizes the hyperlinks in the main text and navigates the students through the text. The teacher also demonstrates how to go back to the main text. While doing this, students make an

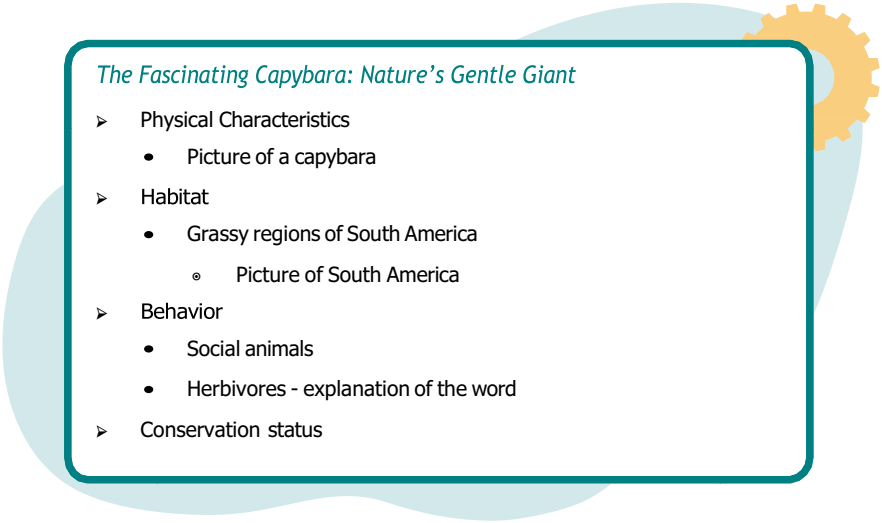


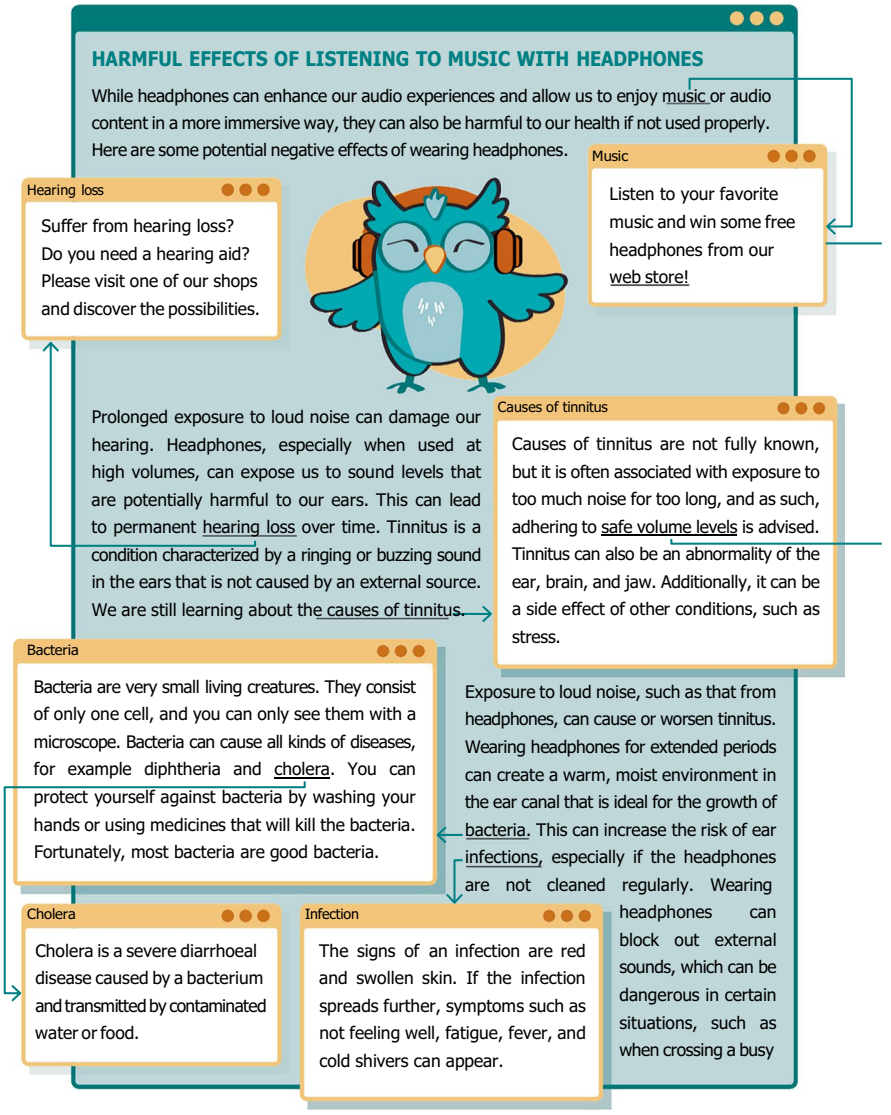
Fig. 2.3 Structure of the text "The Fascinating Capybara: Nature's Gentle Giant"

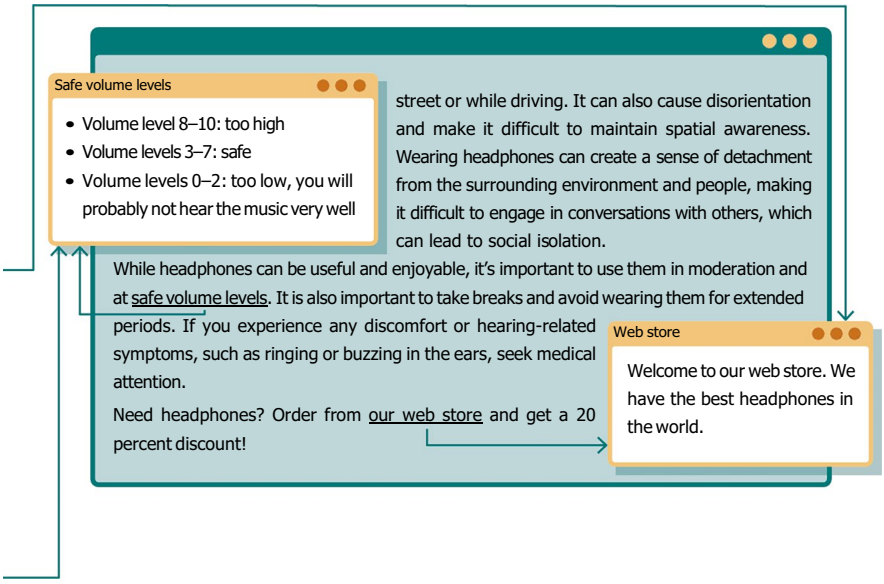
index to visualize the structure of the text (see Fig. 2.3). The teacher explains that the hyperlinks go deeper into the topic, often providing more information with pictures or a definition of the word (**Include the characteristics of digital texts**).

While reading the text, the teacher makes sure that students understand the seemingly difficult words in the text. For example, the teacher highlights the sentence, "They are highly adaptable to different environments, ranging from savannas and rainforests to swamps and riverbanks." The teacher then inquires whether students have knowledge about these environments: "Savannas, rainforests, swamps, and riverbanks are all natural environments. Do you know what these environments look like?" The teacher suggests searching for photos on the internet of the unknown environments and discussing the characteristics of each environment. (**Build vocabulary**). Additionally, the teacher models the self-monitoring strategies and the strategies for integrating parts of information, for example: "Let's click on the link 'social animals.' What do we expect to read behind this link? We will probably read more about why the capybara is seen as a social animal. Let's find out if we are right." While reading, the teacher thinks aloud and asks if the students understand what they have just read.

After reading the text, the teacher discusses the content of the various texts: "In the main text, we have read that capybaras live in large groups and what they eat. From the information in this link, we learned that they are very tolerant towards other species. So the link gives us more information on how they coexist with other animals." (**Model digital reading strategies and support multiple document reading**). The teacher also evaluates the information and sees if it raises any questions about the capybara. "Do we think this text is credible? Why do we think that? What kind of information is missing? Where can we find this information?" (**Model digital reading strategies**).

2.8.2 *Example of a Networked Hypertext*





2.8.2.1 An Example for Teaching Reading with Networked Hypertexts

In a school music project, the teacher asks students to work together in groups to create a poster about whether listening to music is good for your health. The text about the harmful effects of wearing headphones is an example of a networked hypertext, which students come across when searching for information to answer the research question. To help students better understand this text and determine which hyperlinks may be useful, the teacher decides to explore this text together with the students.

In this text, students' attention will probably be quickly drawn to the picture of the owl. The teacher says: "Let's read the title. Do we expect that this text has anything to do with an owl? Should we ignore this picture or does it help us understand the text?" (**Model digital reading strategies**). Before reading the text, the teacher and students orient themselves on the structure and content of the text by asking themselves: "What type of text is this? What kind of links do we see? Can we identify the structure of this text? What type of information do the links lead us to?" (**Include the characteristics of digital texts**). The teacher starts a discussion about students' experiences wearing headphones: "Do you ever wear headphones? What do you use them for? For listening to music or maybe to protect your ears from loud noises? Have you ever experienced harmful effects from wearing your headphones?" (**Activate prior knowledge**).

While reading the text, the teacher asks students which words are unclear and need more explanation. If the word is included in a hyperlink, the teacher explores together with the students whether the meaning of the word is explained in the link. Difficult words are explained by talking about different aspects of the word, using

the word in a sentence, or by demonstrating or pointing out something (**Build vocabulary**). While navigating through the text, the teacher draws a simple graphic overview of the structure of the text and writes down what type of information is behind each link through keywords. For example, key words/phrases such as "more details about…," "examples of…," or "advertisement" can help clarify the relationship between texts. The teacher discusses the intertextual relationships with students and together they evaluate which information is relevant. This helps students gain insight into their navigation strategy and how to integrate relevant information (**Include the characteristics of digital texts and model digital reading strategies**).

After reading, the teacher discusses the arguments that are given in this text. Do students think that the arguments are valid and reliable? The teacher also discusses the benefits of wearing headphones. A new research question appears and by modelling aloud, the teacher helps the students to search for and select texts about the benefits of wearing headphones (**Model digital reading strategies**).

2.9 Guidelines for Stimulating Digital Inclusion

In the previous paragraphs we described guidelines for helping students in their comprehension of (multiple) digital texts. However, to ensure that all students are able to participate in digital education and are prepared to participate in digital society, attention should be paid to digital inclusion within schools. In Chap. 1, we emphasized the importance of the four phases or dimensions of digital inclusion: physical access, a positive attitude and motivation, opportunities to use ICT and the internet, and developing the medium-related and content-related digital skills that are needed (see Sect. 1.5). In this section, we will further elaborate on these guidelines for the purpose of helping stimulate digital inclusion in the classroom.

Physical access to ICT and the internet can be increased by giving students who do not have access to digital devices at home, (extra) access at school, or possibly setting up a program where students can borrow or rent devices from school. Other dimensions of digital inclusion can be stimulated by teaching digital skills and giving students the opportunity to practice together in a meaningful way. To support students in this, it is important that teachers have the necessary skills in ICT and make use of relevant professional development opportunities to deepen their understanding. In this section, we highlight three recommendations: teaching digital skills, giving students opportunities to practice together in a meaningful way, and making use of relevant professionalization opportunities.

2.9.1 Teaching Digital Skills

Research has shown that although students are digital natives, exposure to digital devices alone is not enough for students to gain the needed digital (reading) skills (Delgado et al., 2018). For most primary school students, digital devices and the internet have been around since they were born. The fact that they grew up in a digital world could lead teachers to think that students know how to find information on the internet and have the technical skills to use devices. However, teachers should not automatically assume that students know how to deal with the digital world. Students need explicit instruction in technical (medium-related) skills and in (content-related) skills for navigating, evaluating, and integrating (see Sects. 2.2, 2.3, 2.4, 2.5, 2.6, and 2.7 for guidelines). To anticipate students' level of digital skills, it is important to monitor how digitally skilled students are. For example, teachers can observe how well students use (new) digital programs, how fast and correctly they can type, or how they navigate on the internet and integrate information into an assignment. Based on these observations, teachers can discuss with colleagues what steps should be taken within the school to improve students' digital skills. They can also discuss what kinds of friendly and safe tools, educational learning environments, and software the students need to ensure that they experience success in their online activities.

2.9.2 Giving Students Opportunities to Practice Together in a Meaningful Way

Students need to have sufficient time and opportunities to practice using ICT and the internet. Practicing digital skills can be done by integrating ICT and the use of the internet in a diversity of subjects across the curriculum. By integrating ICT with other subjects, the use of ICT and the internet becomes a meaningful activity for students. For example, students can create their own webpage about different kinds of herbivores (e.g., cows, geese, and rabbits) and connect the webpages through hyperlinks from a central page about the herbivore. In this example, the subjects biology and languages are both integrated with teaching and practicing ICT and internet skills. Integrating digital skills in language areas or other subjects will not only save valuable teaching time, but it can also positively affect students' motivation (Wei, 2022). However, when integrating ICT tools into the curriculum, teachers should be aware that the focus of the activity is on the subject of the lesson and not on the use of the tool. Especially for students who have insufficient technical skills, using ICT they are not familiar with can distract them from the content of the activity and lead to frustration. To ensure that all students become and stay motivated, specific instruction about a digital tool can therefore best be done in separate ICT lessons. Another way to practice digital skills is through the use of cooperative

learning activities. Collaborating with peers in digital activities has been found to positively impact the development of digital skills (Boomgaarden et al., 2022).

2.9.3 Making Use of Relevant Professionalization Opportunities

Stimulating digital inclusion in education requires teachers with sufficient digital skills and knowledge to effectively integrate technology into their teaching practices. Therefore, it is important that teachers reflect on the gaps in their own digital skills and knowledge and are open to deepening their teacher professionalism in this area. With professional development programs, workshops, and training, teachers can enhance their familiarity with educational technologies and learn more about digital teaching strategies. With these courses teachers can become skilled at determining when technology supports learning and when it does not, so that they can make well-informed choices in the use of ICT in their teaching practices. When searching for an appropriate professional development program, it is advisable for teachers to follow a course with a specific focus, for example training on the use of a specific program or developing teaching strategies for digital reading (Zaslow et al., 2010). Teachers should also consider if the skills and knowledge taught in the course are applicable and relevant for their classroom. Finally, it is recommended for teachers to collaborate with colleagues. For example, teachers can support each other to master specific digital skills or work together to develop lessons that include digital reading.

In Summary
Six didactic principles for teaching reading comprehension of digital texts:

1. Build vocabulary and activate prior knowledge by creating a rich learning environment. Use explicit vocabulary instruction and present new words in a network of related words, By adding and/or extending knowledge, all students create a (minimal) conceptual network to which the new knowledge from the text can be connected.
2. Include the characteristics of digital texts in education. Structure digital texts by creating a visualization of the text structure and gradually build up the difficulty. When selecting webpages in advance, ensure that hypermedia supports the content of the text.
3. Model digital reading strategies for:
    - exploring, identifying, and selecting sources
    - constructing meaning from multiple webpages
    - self-monitoring
    - evaluating the information

4. Support multiple document reading by helping students to decide whether or not a document is complementary to the one(s) read before. Be aware of the unavailability of textual cues in multiple documents and stimulate deeper understanding of multiple texts. Help students connect conclusions from various texts to prior knowledge. Define a specific inquiry question to support students in reading multiple documents.
5. Stimulate self-regulation by helping students control or regulate their own learning process.
6. Practice digital reading regularly in the classroom and include digital reading in the curriculum from the start, in a meaningful way.

To ensure that all students are able to participate in digital education, it is important to stimulate digital inclusion in schools. This can be done by teaching students the digital skills they need, giving students sufficient time and opportunities to practice their digital skills in a meaningful and collaborative environment, and by deepening teachers' own digital skills and knowledge.

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Chapter 3
Exploring Digital Reading Using ePIRLS

Schematic Description of an ePIRLS Text and Items

Contents

3.1 Introduction

This chapter uses the digital text "Oceans" from IEA's Progress in International Reading Literacy Study (PIRLS) 2021. Approximately half of the participating countries evaluated fourth grade students with a computer-based assessment (ePIRLS) that uses an engaging, simulated internet environment to present students with authentic school-like assignments involving science and social studies topics. This chapter is not intended to provide a method for testing reading comprehension of digital texts or to use test material as a teaching tool. Rather, its purpose is to provide teachers with further insight into digital reading by using a simulated example of a website to provide concrete suggestions for implementing the didactic principles described in Chap. 2. Through these insights and ideas, our aim is to support teachers to identify the aspects of (digital) reading with which their students need most support and inspire them on how to help their students improve their digital reading comprehension skills. The full storyboard for the ePIRLS Oceans text is available at the end of the book.

M. Bruggink et al., *Teaching Reading Comprehension in a Digital World*,
IEA Research for Educators 2, https://doi.org/10.1007/978-3-031-75121-9_3

3.2 How to Read this Chapter

In the schematic description below (see Sect. 3.3) we discuss each item from the ePIRLS 2021 text "Oceans." The correct answer for each question is given, as well as the corresponding process of comprehension (see Chap. 1 and the PIRLS 2026 assessment framework; Sabatini et al., 2023). Descriptions are provided of what students need to know or do in terms of their digital reading skills, vocabulary, and prior knowledge, to answer the question correctly. Additionally, we provide didactic suggestions, both in connection to specific items (see Tables 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, and 3.18) and more generally with the text as a whole (see paragraph 3.4). As mentioned before, the didactic principles for general reading comprehension are also applicable for reading digital texts. Therefore, it is not surprising that the suggestions in this example text are also related to general didactic suggestions for reading comprehension, which can be found in *Putting PIRLS to use in classrooms across the globe* (Bruggink et al., 2022). However, in the provided suggestions we mainly focus on the principles of digital reading. Therefore, where applicable, we refer to the specific didactic principle for digital reading, as described in Chap. 2.

3.3 Schematic Description of 'Oceans' ePIRLS Text and Items

The ePIRLS assessment is a digital reading assessment that focuses on reading for information in a digital environment. Using a simulated website environment, students are given tasks in which they use links and tabs to navigate through texts and graphics and gather information. The tasks are similar to science or social studies projects students may work on at school (Mullis & Martin, 2019).

In ePIRLS, students navigate through webpages that include a variety of features, such as graphics, multiple tabs, hyperlinks, pop-up windows, and animations. Distracting advertisements, related to the subject of the text, are also embedded in the ePIRLS tasks in order to imitate the real situation on the internet. In a pane at one side of the screen, a teacher avatar (Mr. Webster) guides students through the ePIRLS assignments, prompting the students with questions about the online information. To ensure students can continue to progress through the assessment, they will be taken to the correct webpage even if they do not click the correct buttons.

The ePIRLS text "Oceans" is an informative (hyper)text about the world's oceans[1] with graphics, animations, and a video. This text explains the benefits of oceans, provides information about ocean life and habitats, and discusses the

[1] Text and illustrations from the ePIRLS text "Oceans" are by TIMSS & PIRLS International Study Center, Boston College. Photos obtained from Sea Life Scarborough, Monterey Bay Aquarium, and Deposit Photos.

Table 3.1 Click on the link that is most likely to explain why oceans are important

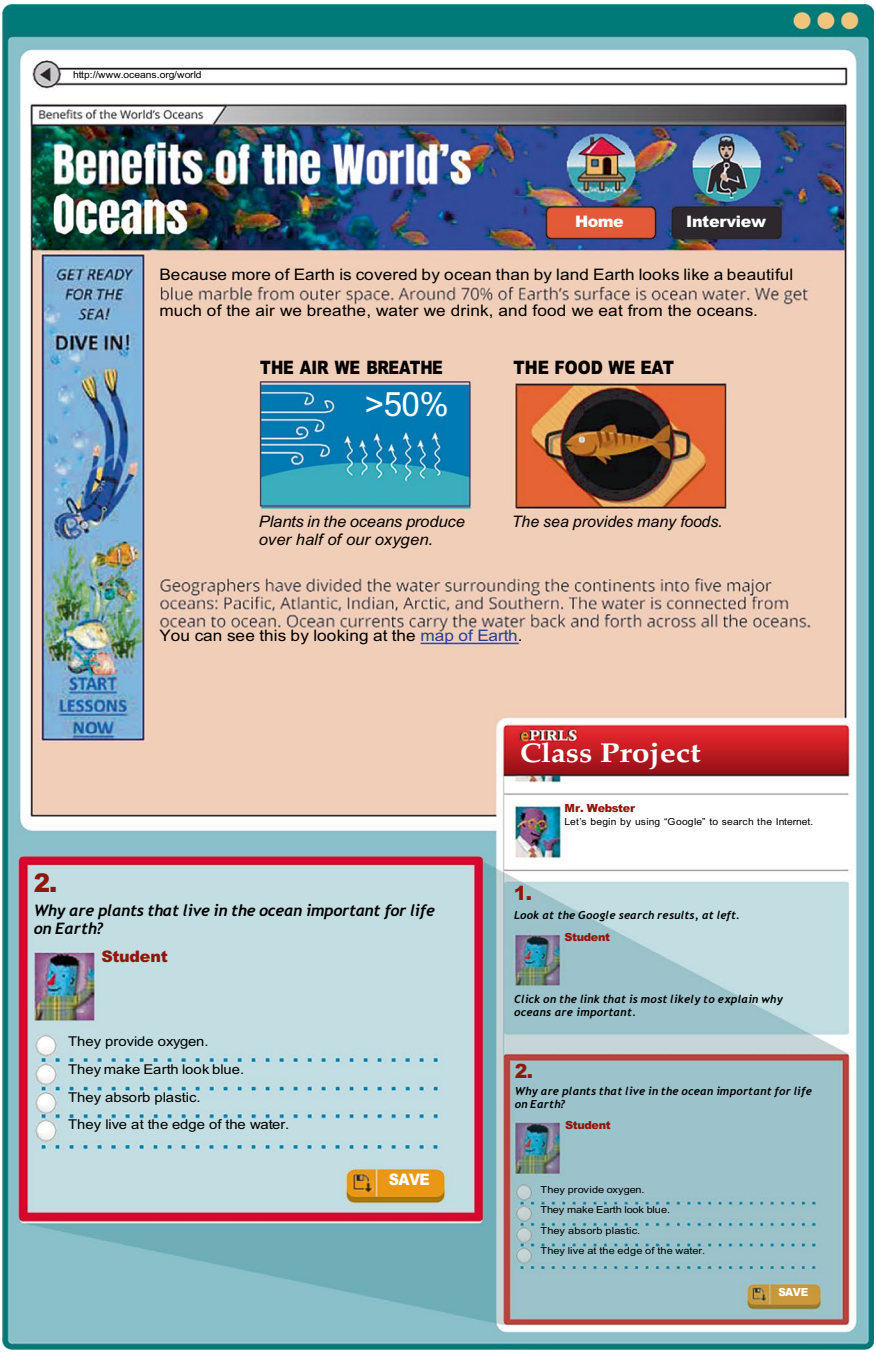
(continued)

Table 3.1 (continued)

Correct answer	Benefits of the world's oceans.
Process of comprehension	Make straightforward inferences
Skills	Students need to combine three aspects of a website link —the title, the URL, and the first part of the descriptive sentence—to determine whether this website is about why oceans are important.
Vocabulary/prior Knowledge	Knowledge of the meaning of the words "cruises," "treasures," "property," and "benefits" will help students click on the correct link.
Didactic suggestion	Stimulate students to first think about how they would try to find information on the internet, which words they would use, and which words or phrases relate to the word "important." Model how to examine the links critically before clicking on a hyperlink. Suggestions for modeling include: *What type of text could be behind this source? Could this type of text answer my question? I believe that the third link is about houses near the ocean. The URL starts with real estate, so this is probably a website on which real estate agents try to sell houses near the ocean. This will not answer the question of why oceans are important.* **Didactic principle**: model digital reading strategies: exploring, identifying, and selecting sources.

problem of plastic pollution. The reading purpose is to acquire and use information. The storyboard for "Oceans" is divided into screens with the question items, the corresponding skills, and didactic suggestions related to each screen shown in Tables 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, and 3.18. The full storyboard for the "Oceans" text is available at the end of this book. In Sect. 3.4, we provide general didactic suggestions that can be used before, during, or after reading the text.

Table 3.2 Why are plants that live in the ocean important for life on Earth?

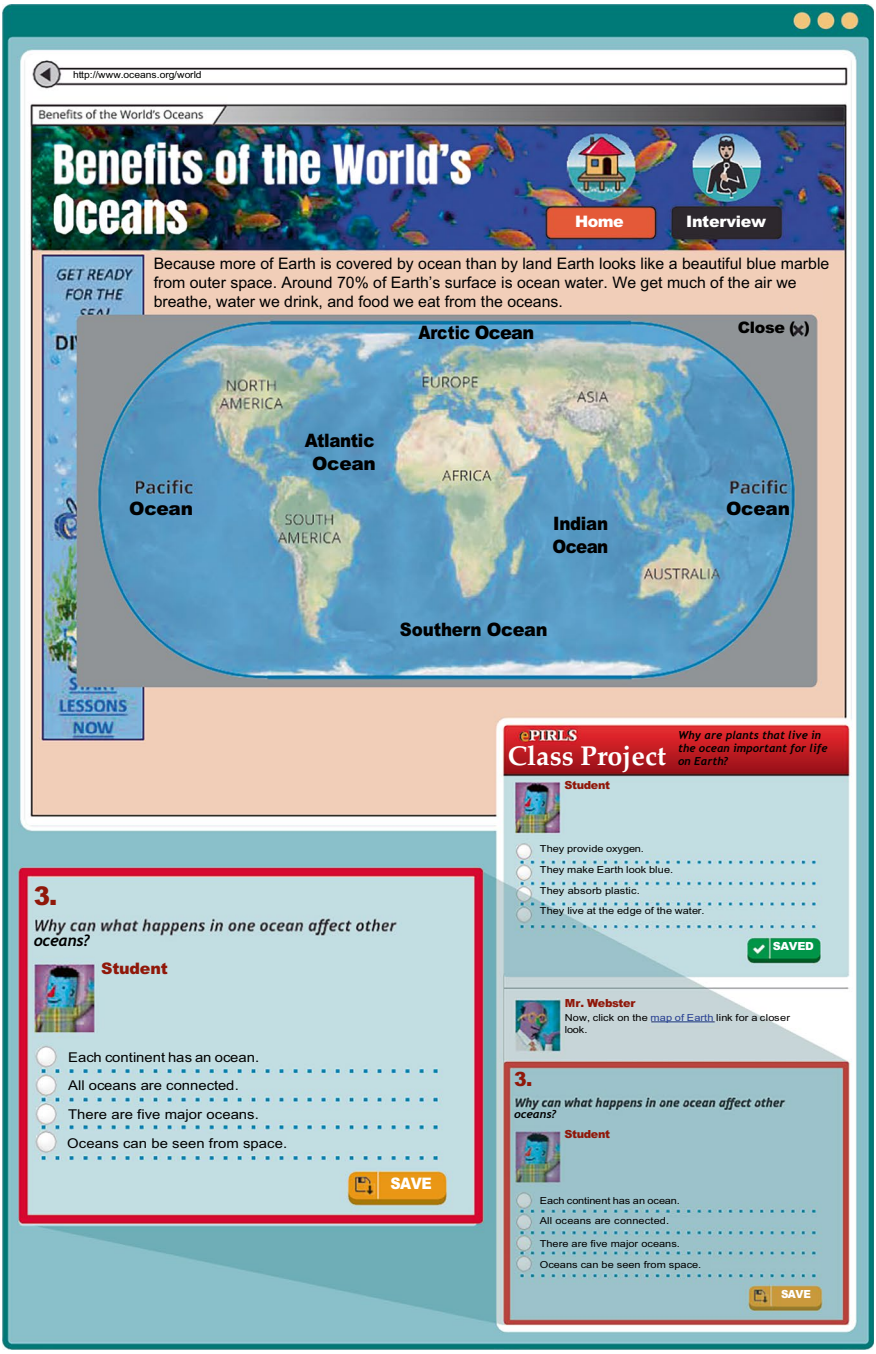


(continued)

Table 3.2 (continued)

Correct answer	They provide oxygen.
Process of comprehension	Make straightforward inferences
Skills	To answer this question correctly, students need to read and interpret the text around the left picture to conclude that plants in the ocean produce oxygen. The oxygen is absorbed in the air we breathe.
Vocabulary/prior Knowledge	Students need to know what oxygen is (on a basic level) and that humans need to breathe oxygen to live.
Didactic suggestion	Activate students' prior knowledge about what people and animals need to stay alive (oxygen, food, water) and explain concepts such as "oxygen" and "produce." **Didactic principle**: build vocabulary and activate prior knowledge. Model how to interpret this part of the text. Suggestions for modeling include: *We get much of the air we breathe from the oceans. How does the ocean give us air? Let's look at the picture and the text around it. Ah, plants in the oceans produce oxygen. So, these plants provide oxygen which is absorbed into the air. I know we need to breathe oxygen to stay alive. So that is why plants in the ocean are important for life on earth.*

Table 3.3 Why can what happens in one ocean affect other oceans?

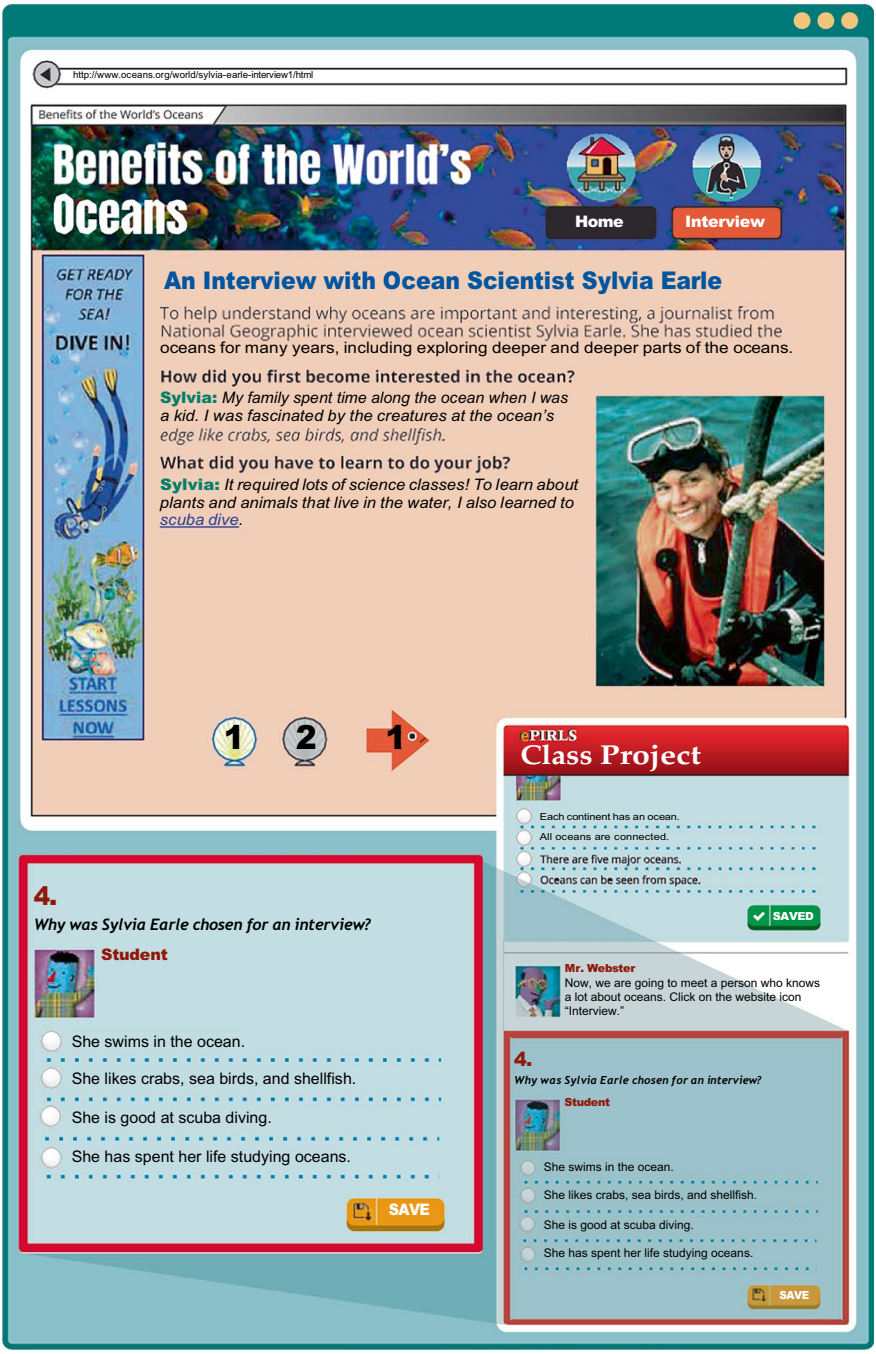


(continued)

Table 3.3 (continued)

Correct answer	All oceans are connected.
Process of comprehension	Make straightforward inferences
Skills	For this item students need to remember the information in the text under the pop-up and combine it with the information they derive from the world map.
Didactic suggestion	If necessary, make clear that the world map is a pop-up that is in front of the original text. For example, ask students whether they can still see a part of the text behind the map. Do the students know how they can close this pop-up, so they can read the text again? **Didactic principle**: include the characteristics of digital texts. Additionally, demonstrate to students how the world map is related to the text behind it. Suggestions for modeling include: *How does this map help me to understand the content of the previous text? Geographers have divided the water surrounding the continents into five major oceans: the Pacific, Atlantic, Indian, Arctic, and Southern. Can we see these five oceans on the map? The water is connected from ocean to ocean. Ocean currents carry the water back and forth across all the oceans. Can we see on the map that the oceans are connected to each other? Is there an ocean that is different from the rest? Can water travel through all the different oceans?* **Didactic principle**: model digital reading strategies: constructing meaning.

Table 3.4 Why was Sylvia Earle chosen for an interview?

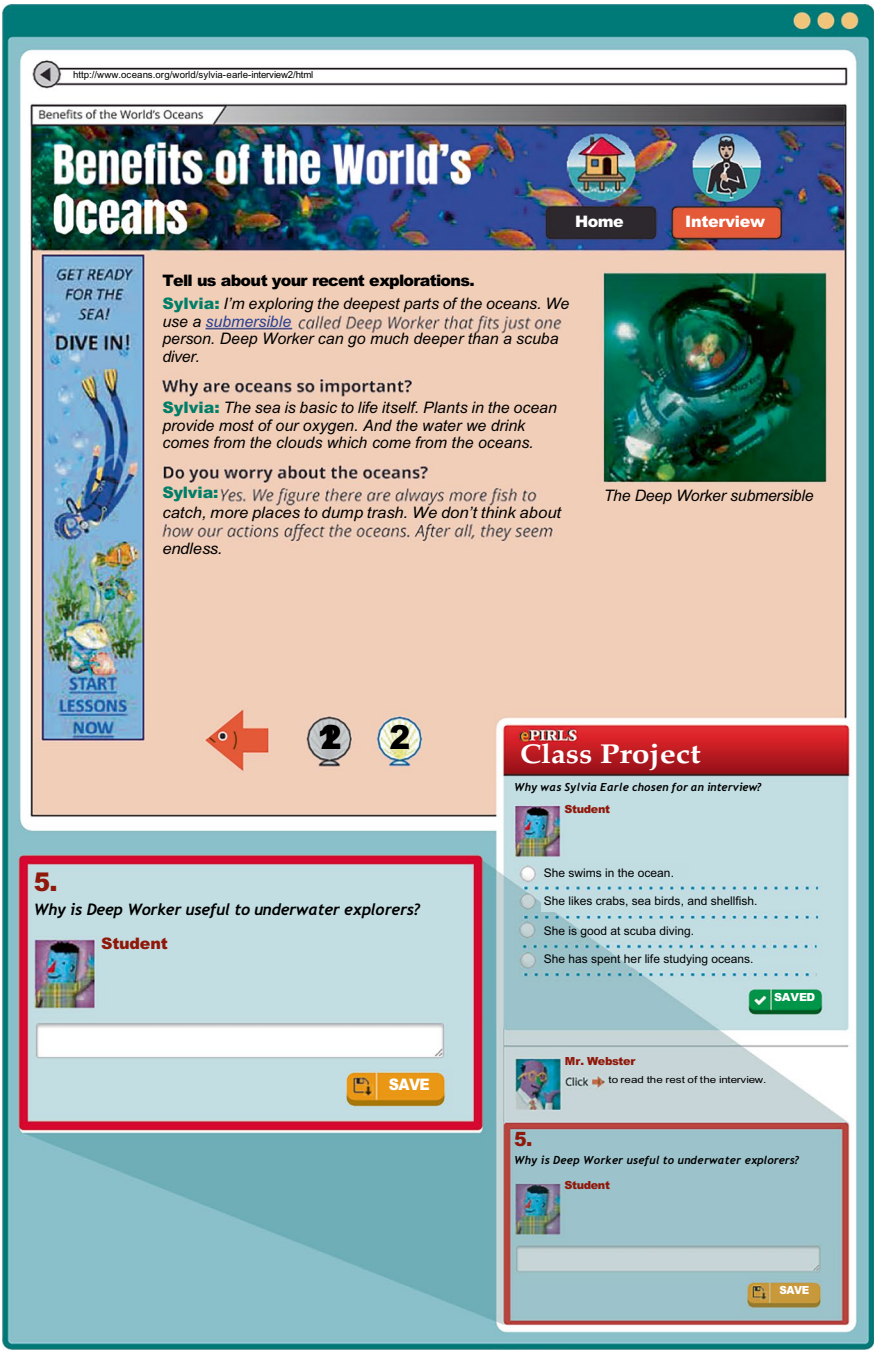


(continued)

Table 3.4 (continued)

Correct answer	She has spent her life studying oceans.
Process of comprehension	Make straightforward inferences
Skills	To answer this question correctly, students must read and interpret the sentence after the name "Sylvia Earle": "She has studied the oceans for many years, including exploring deeper and deeper parts of the oceans." They need to understand that this makes her an expert on the topic of the interview—why oceans are important and interesting.
Vocabulary/prior Knowledge	Students can click on the word "scuba dive" and learn about the meaning of the word. However, knowing the meaning of this term is not necessary to answer the question.
Didactic suggestion	Read the text with your students and make connections between the sentences, for example, "She has studied…" to the name "Sylvia Earle" and her picture. Suggestions for modeling include: *Looking at the picture, I can see Sylvia scuba dives. The text says Sylvia is a scientist and studied the oceans for many years. She must know a lot about the oceans. I think that is why she is wearing scuba diving gear, for doing research in the oceans. The scuba diving gear allows her to breathe underwater and to stay there for a while.*

Table 3.5 Why is Deep Worker useful to underwater explorers?



(continued)

Table 3.5 (continued)

Correct answer	The response shows understanding that using Deep Worker enables explorers to go to very deep parts of the ocean.
Process of comprehension	Make straightforward inferences
Skills	To answer this question, students need to read and interpret Sylvia's first answer. The picture next to the text can help students understand what a Deep Worker looks like and what it is, which can help decipher this part of the text.
Vocabulary /prior Knowledge	Students can click on the word "submersible" and learn about the meaning of the word. This might help them get a better idea of what a Deep Worker is.
Didactic suggestion	Read Sylvia's first answer with the students and discuss what is behind the link "submersible." Click on the word and see if the students were right. **Didactic principle**: Model digital reading strategies: constructing meaning. Talk about what a Deep Worker is, what it looks like, and what the difference is between a Deep Worker and a scuba diver. Make connections to the deeper parts of the oceans and explain why it is hard or impossible to go there as a scuba diver. Encourage students to pretend they are Sylvia. Suggestions for modeling include: *Would you dare to scuba dive? And would you dare to go into a Deep Worker?* **Didactic principle**: build vocabulary and activate prior knowledge.

Table 3.6 Why are the oceans important?

(continued)

Table 3.6 (continued)

Correct answer	They provide our drinking water.
Process of comprehension	Focus on and retrieve explicitly stated information
Skills	To answer this question correctly, students need to derive from the text that the water we drink originally comes from the oceans.
Vocabulary/prior Knowledge	For a better understanding of this part of the text, it is important that students know about the water cycle and how water from the oceans eventually becomes our drinking water.
Didactic suggestion	Use the internet or a geography textbook to find an illustration of the water cycle. By using a clear, informative picture, explain to students how the water cycle works. If some students already know how it works, let them explain it to others and provide additional information. **Didactic principle**: build vocabulary and activate prior knowledge.

Table 3.7 Click on the link that is most likely to include information about different habitats in the ocean

(continued)

Table 3.7 (continued)

Correct answer	Ocean life and habitats.
Process of comprehension	Make straightforward inferences
Skills	Students need to combine three aspects of a website link—the title, the URL, and the first part of the descriptive sentence—to determine whether this website is about different habitats in the ocean.
Vocabulary/prior Knowledge	Students who are not familiar with the word "habitat," can derive the meaning of this word from the comment of Mr. Webster.
Didactic suggestion	Since every link contains the word "habitat," it is important to look closely at the link and the information beneath it. Model how to examine the links critically before clicking on a hyperlink and discuss the different links with students. Modeling suggestions include: *This link is about supporting healthy habitats and something called the Oceans Program. I believe that they would like us to give money so that they can improve ocean habitats. At least that is what it says beneath the link. I wonder if this website will give us all the information we need about the different habitats of the ocean.* **Didactic principle**: model digital reading strategies: exploring, identifying and selecting sources.

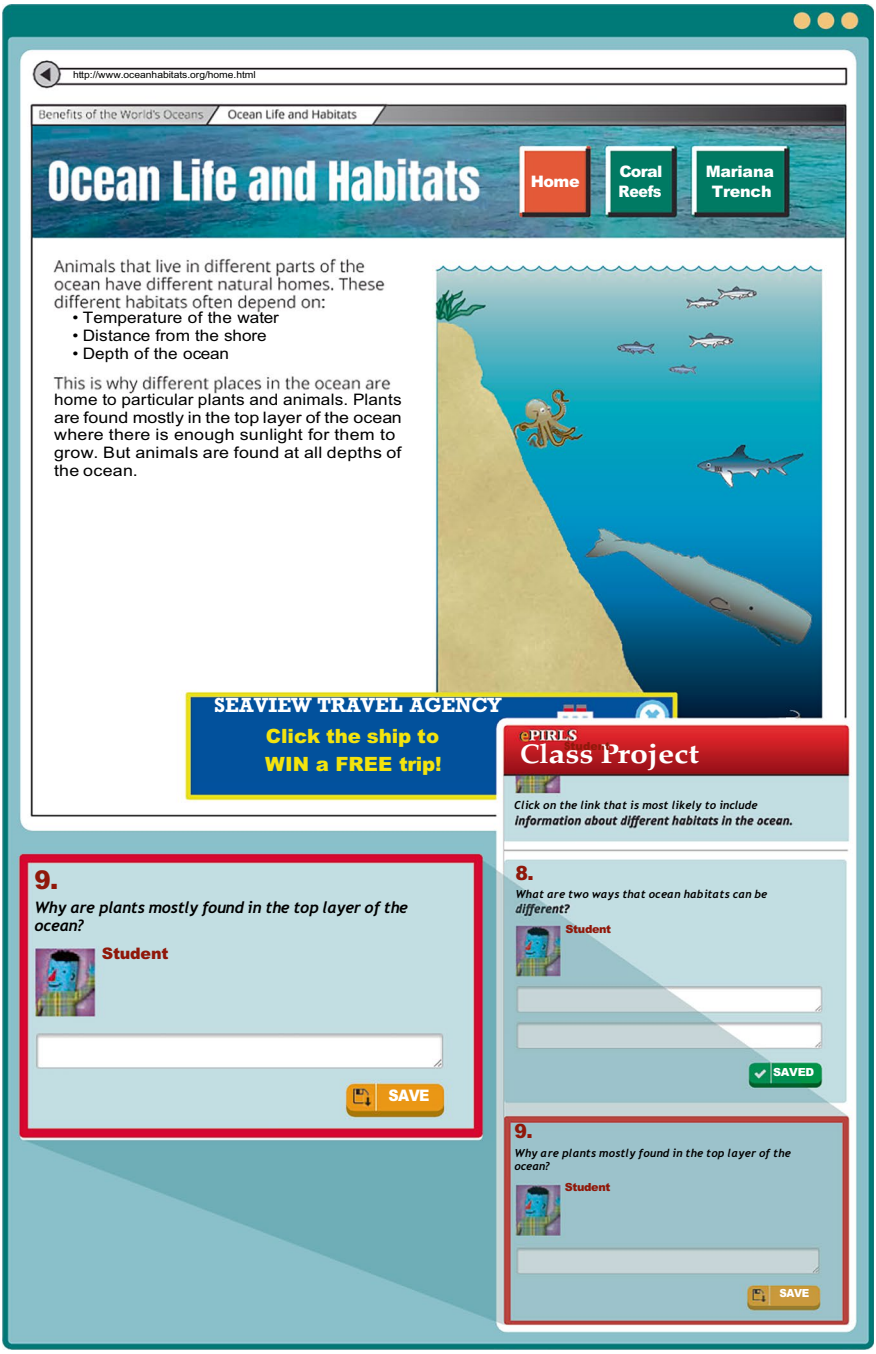
Table 3.8 What are two ways that ocean habitats can be different?

(continued)

Table 3.8 (continued)

Correct answer	The response gives **two** of the following ways that ocean habitats can be different from one another. • temperature of the water • distance from shore • depth of ocean • amount of light/darkness • plants in the top layer (not in bottom) • types of animals For partial credit, the response gives **one** of the acceptable ways from the above list.
Process of comprehension	Focus on and retrieve explicitly stated information
Skills	Students need to read and interpret at least the first part of the text to select two ways that ocean habitats can be different.
Didactic suggestion	Discuss the relationships between aspects of the habitat (i.e., temperature, distance from the shore, depth of the ocean) and the different animals and plants that live in the oceans. *Why do you think some animals live in the top layer of the ocean and others live deep in the ocean? What is the difference between these animals? Why do you think some animals live close to the shore?* Stimulate students to reason about this topic. **Didactic principle**: build vocabulary and activate prior knowledge.

Table 3.9 Why are plants mostly found in the top layer of the ocean?



(continued)

Table 3.9 (continued)

Correct answer	The response states that plants need to be near sunlight/ sun/light so they can grow.
Process of comprehension	Focus on and retrieve explicitly stated information
Skills	Students need to read and interpret the sentence "Plants are found mostly in the top layer of the ocean, where there is enough sunlight for them to grow."
Didactic suggestion	Focus on the picture next to the text. Can students see that there is more light in the top layers of the water? Stimulate students to share their own experience with looking underwater. *Did you see anything under the water? What would it be like if you dive deeper? Can you see in the picture that it gets darker deeper in the ocean?* **Didactic principle**: include the characteristics of digital texts.

Table 3.10 Use all of the information on this webpage to describe coral reef habitats

(continued)

Table 3.10 (continued)

Correct answer	The response gives **two** of the following characteristics or conditions of coral reef habitats from the text, video, and/or animated map on the "coral reefs" webpage. • found around the world/specific location or area shown on the map • provide protection for fish/animals • coral is an animal/alive • coral reefs are dying/leaving behind its skeleton • warm/sunlit waters • near shore/not deep water • fish live in coral reefs • pollution is killing coral reefs • new corals grow on the skeletons of the previous generation • they are colorful/beautiful For partial credit, the response gives **one** characteristic or condition of coral reef habitats from the above list.
Process of comprehension	Make straightforward inferences
Skills	For this question, students need to integrate the information from the text and the video.
Vocabulary /prior knowledge	Students need to know what coral reefs are. By looking at the picture and the video and by reading the text, they can build their knowledge about coral reefs.
Didactic suggestion	Activate students' prior knowledge about coral reefs. Look at the pictures of the coral reef and stimulate students to describe what they see and what they already know about it. Summarize students' prior knowledge, for example, by creating a mind map. While reading the text and watching the video, students can add new information to the mind map. **Didactic principle**: build vocabulary and activate prior knowledge. Before clicking on the video, ask students what they expect to see in this video or model how to ask yourself the question: *How does this video help me to understand the content of the text?* After watching the video, discuss if the information in this video is what they expected to learn about. **Didactic principle**: include the characteristics of digital texts; model digital reading strategies: self-monitoring.

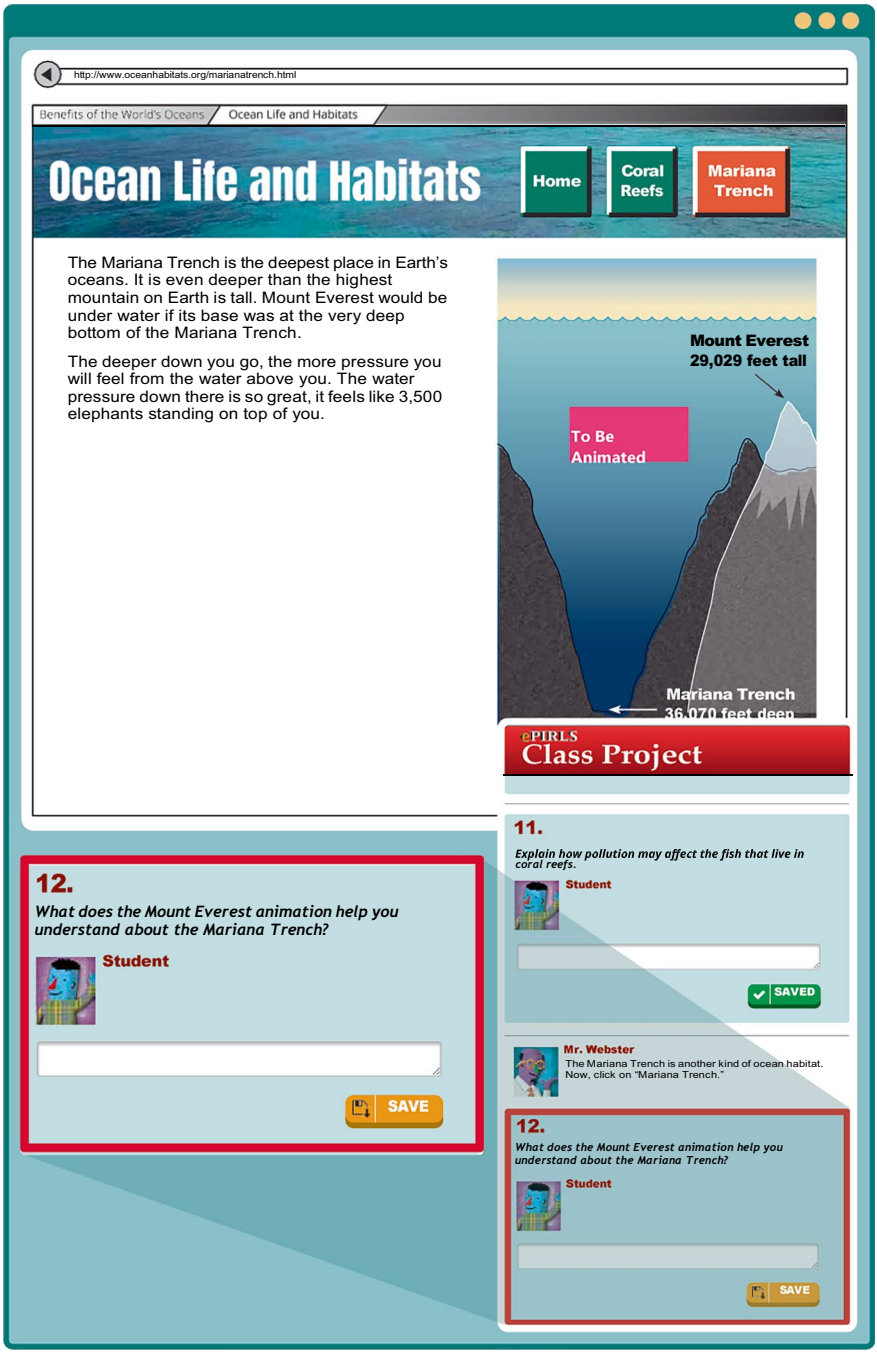
Table 3.11 Explain how pollution may affect the fish that live in coral reefs

(continued)

Table 3.11 (continued)

Correct answer	The response explains how or why pollution will kill or harm the fish. Responses may refer to fish losing protection, not having a place to live, or not having food.
Process of comprehension	Interpret and integrate ideas and information
Skills	Students need to understand the following causes and consequences: Many fish live in the coral reef and pollution causes coral to die. If the coral dies, the fish can no longer live in the coral reef, and they may also die.
Vocabulary /prior knowledge	Students need to know what pollution is.
Didactic suggestion	Explain the word "pollution" to the students by looking at videos or pictures of pollution in nature. Discuss how pollution affects plant, animal, and human life. **Didactic principle**: build vocabulary and activate prior knowledge. Make a visualization of the consequences of pollution that are described in this text. Make a scheme with arrows and discuss the causes and consequences.

Table 3.12 What does the Mount Everest animation help you understand about the Mariana Trench?



(continued)

Table 3.12 (continued)

Correct answer	The response says that the Mariana Trench is deeper than Mount Everest is tall. For partial credit, the response says it shows that the Mariana Trench is extremely deep/tall; or states that Mount Everest fits or is underwater in the Mariana Trench (provides a description of the animation and not an evaluation).
Process of comprehension	Evaluate and critique content and textual elements
Skills	Students need to relate information from the animation to information in the text.
Vocabulary /prior knowledge	Students need to know that Mount Everest is the highest mountain in the world. They can derive this information from the text.
Didactic suggestion	Model how to connect the two sources to each other. Suggestions for modeling include: *The text says "It is even deeper than the highest mountain on Earth is tall. Mount Everest would be underwater if its base was at the very deep bottom of the Mariana Trench." Let's take a look at the animation. How does the picture help me to understand this part of the text? I can see they drew Mount Everest in the Marina Trench. It shows it would be under water, just as the text describes. Wow, I never thought the oceans could be this deep. This picture makes it really clear.* **Didactic principle**: include the characteristics of digital texts; model digital reading strategies: constructing meaning.

Table 3.13 Why is the dragonfish a good example of a weird fish?

(continued)

Table 3.13 (continued)

Correct answer	The response shows an understanding that certain physical features of the deep-sea dragonfish or the conditions in which it lives makes it unusual, as described in the text and shown in the picture, by giving **two** of the following acceptable characteristics. • has a light coming out of its head • has oversized teeth • has an ugly face • has slippery skin • it lives in dark water • it lives in the deepest part of the ocean • long and bendy body shape • it lives in freezing water • it is scary-looking/looks like a dragon • unusual way of catching prey • it lights up/can glow/shine For partial credit, the response gives **one** characteristic from the list above that shows understanding that the deep- sea dragonfish is unusual.
Process of comprehension	Make straightforward inferences
Skills	Students need to understand the weird and unique characteristics of the dragonfish that are mentioned in the text. The picture of the dragonfish supports the text.
Didactic suggestion	Discuss how this picture supports the text. *How does this picture help you understand the appearance of the dragon fish?* Read about the characteristics of the dragonfish and let students point these out in the picture. The text says, *"It can make itself glow." How can this fish do that?* Do the students discover in the picture that the dragonfish is carrying some kind of light? **Didactic principle**: include the characteristics of digital texts; model digital reading strategies: constructing meaning.

Table 3.14 Click the link that is most likely to explain ocean pollution from plastic

(continued)

Table 3.14 (continued)

Correct answer	Plastic in the ocean.
Process of comprehension	Make straightforward inferences
Skills	Students need to combine three aspects of a website link—the title, the URL, and the first part of a descriptive sentence—to determine whether this website explains ocean pollution from plastic.
Vocabulary /prior knowledge	Students who are not familiar with the word 'pollution,' can derive the meaning of this word from Mr. Webster's comment.
Didactic suggestion	Model how to examine the links critically before clicking on a hyperlink and ask yourself questions such as: *What type of text and information could be behind this source? The second link looks like it contains information about plastic in the oceans, because I see the words "plastic," "pollution," and "ocean." But it says... "pollution is a problem as big as the ocean." So, this link is probably not about the ocean, but the word ocean indicates how big the problem is. I don't think this webpage is the one that I am looking for*. **Didactic principle**: Model digital reading strategies: exploring, identifying, and selecting sources.

Table 3.15 How does the sentence support the idea that plastic is everywhere in the ocean?

(continued)

Table 3.15 (continued)

Correct answer	Plastic bags have reached such a remote place.
Process of comprehension	Interpret and integrate ideas and information
Skills	To answer this question correctly, students have to integrate the information about the Mariana Trench that they have read before on a different webpage, with the information about plastic in the ocean on this page.
Didactic suggestion	Model strategies for constructing meaning from two different sources. While reading about plastic on this page, think aloud and refer to the previous text on the Mariana Trench: *"A plastic bag was even found all the way down in the Mariana Trench." Hey, haven't we read about this before? What did that previous page say about the Mariana Trench? Let me go back to that webpage. Oh, now I remember! The Mariana Trench is so deep that Mount Everest could fit in it. What have we learned from these two texts? The Mariana Trench is the deepest place in Earth's oceans, and even there, they found plastic!* **Didactic principles**: support multiple document reading; model digital reading strategies: constructing meaning When students cannot remember the information about Mariana Trench, teachers should instruct them to go back to the webpage. Teachers can create a graphic overview of the structure of the webpages about the ocean to help students find the information about Mariana Trench. **Didactic principle**: Include the characteristics of digital texts.

Table 3.16 Why did the author include the sentence?

(continued)

Table 3.16 (continued)

Correct answer	To emphasize the hidden danger.
Process of comprehension	Evaluate and critique content and textual elements
Skills	Students need to understand that in the sentence the author refers to the tiny pieces of poisonous plastic. Students should be able to interpret the author's intention to emphasize the danger of plastics that cannot be seen.
Vocabulary/prior knowledge	Students need to know the meaning of the word "poisonous" to interpret that the little pieces of plastic are dangerous.
Didactic suggestion	Explain the content for students who have trouble understanding the text, for example, by drawing on how plastic breaks up into tiny pieces and how fish eat these pieces of plastic. Ask students to think about what happens when we eat those fish. Discuss the sentence and the intentions of the author or let students discuss the sentence in small groups. *What is the author telling us? How dangerous is the plastic in the ocean to animals and humans? Can you think of solutions for reducing the plastic in the oceans?* **Didactic principle**: Build vocabulary and activate prior knowledge.

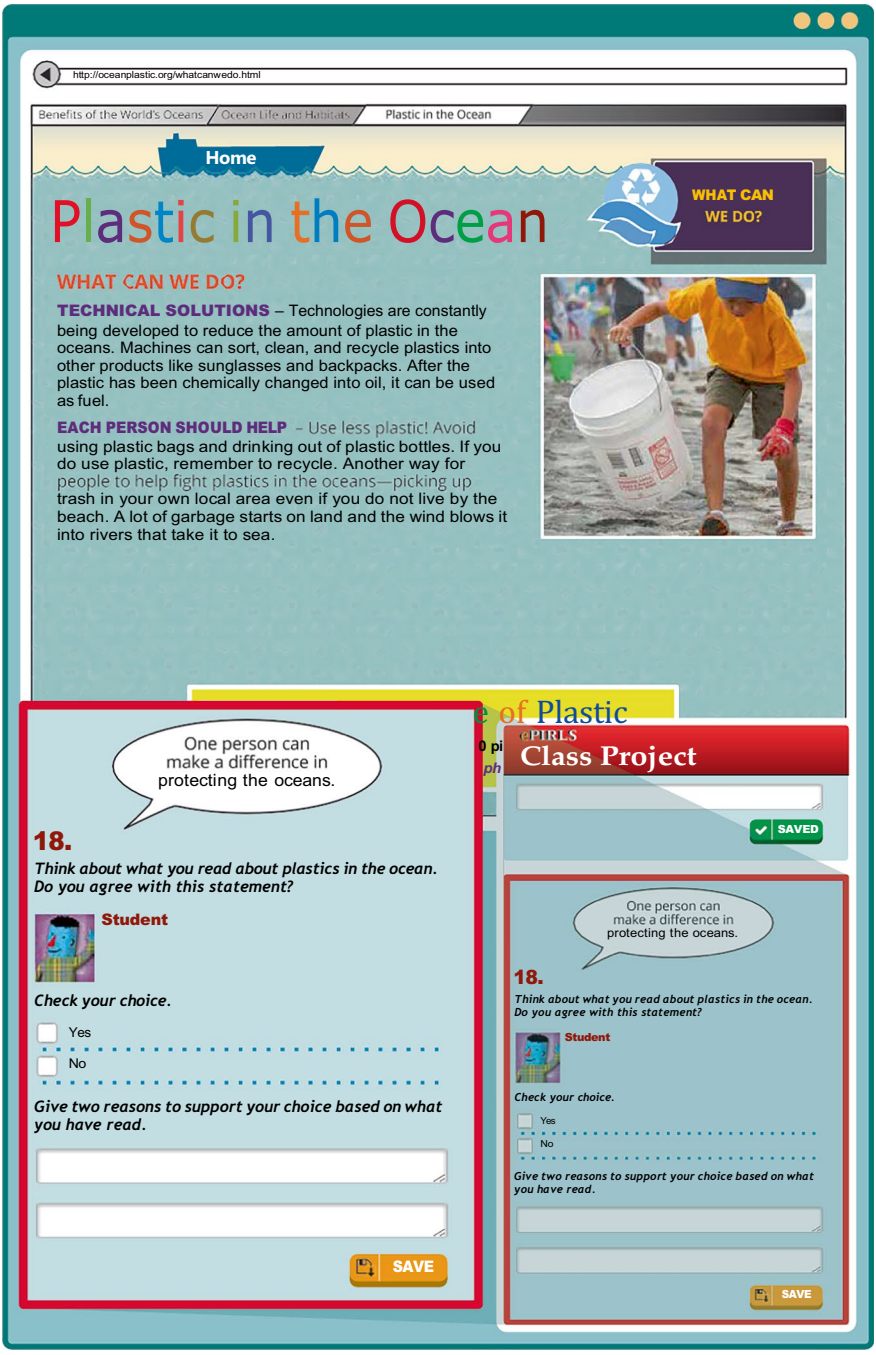
Table 3.17 Give one way technology can help reduce the amount of plastic in the ocean

(continued)

Table 3.17 (continued)

Correct answer	Response shows understanding by giving one of the acceptable responses below: • Plastics can be recycled into other products. • Some plastic products can be chemically changed into oil and used as fuel.
Process of comprehension	Make straightforward inferences
Skills	Students should understand and interpret the first part of the text about technical solutions.
Vocabulary/prior knowledge	Students need to know the meaning of the word "recycle."
Didactic suggestion	Explain the word "recycle" by using pictures and videos of products being recycled into new products. Discuss with students what they think about recycling and how they can help the recycling process. Set up the classroom to separate different types of waste. *How can we use less plastic in the classroom? Where should we throw away apple peels?* **Didactic principle**: build vocabulary and activate prior knowledge.

Table 3.18 Do you agree with this statement?



(continued)

Table 3.18 (continued)

Correct answer	The response evaluates the statement and supports the choice by giving **two** pieces of evidence from the appropriate list below. No is supported by two of the following: • There is so/too much plastic in the ocean. • The oceans are enormous/too big. • It needs the actions of a lot of people to make a (meaningful) difference. Yes is supported by two of the following: • We can use less plastic/use reusable bottles. • We can recycle. • We can pick up trash. • Don't litter/Put into the bin/Don't throw plastic in the ocean. • If you help clean up, then other people will too. • Even the actions of a single person can make a small difference. • One person can become an advocate for reducing waste. [Needs to go beyond restating quote.] • Donate to/support the companies that are helping reduce the amount of plastic. For partial credit, the response gives **one** piece of evidence to support their choice of yes or no, from the appropriate list above.
Process of comprehension	Evaluate and critique content and textual elements
Skills	Students should form their own opinion on the question: Can one person make a difference? If they answer "no," they can use information from previous pages to support their opinion ('oceans are very big,' 'there is a lot of plastic in the oceans'). If they answer "yes," they can take arguments from the text on the current page, under the heading "each person should help."
Vocabulary/prior knowledge	Students need to know the meaning of "protecting."

(continued)

Table 3.18 (continued)

Didactic suggestion	Start a group discussion on the question *"Can one person make a difference?"* Ask students' opinions and make two groups (yes-and-no-group). Each group collects arguments from the "Oceans" webpages to support their opinion. Students can also collect arguments from the text that the opposing team could use and consider how they can counter those arguments. Model how to summarize what students have learned about the oceans while clicking through the webpages for the class. Discuss the relationships between these pages. **Didactic principle:** support multiple document reading. Encourage students to think critically about whether the information is useful in supporting their opinion. Suggestions for modeling include: *Which information that I have read is the most useful? Which information about oceans is missing? Where can I find this information?* **Didactic principle**: model digital reading strategies: evaluating the information.

3.4 General Didactic Suggestions

The suggestions for each item in Tables 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, and 3.18 do not cover all didactic principles as described in Chap. 2. In this paragraph, the remaining four more general principles are (further) discussed in relation to the ePIRLS text "Oceans" as a whole: stimulate self-regulation, support multiple document reading, include the characteristics of digital texts in education, and practice regularly in the classroom.

3.4.1 Stimulate Self-Regulation

In the "Oceans" text, the hypermedia can distract students from the text and the specific assignments. To help students stay focused, formulate a reading goal before reading the text and repeat it aloud while the students are reading. When students try to click on the hypermedia or advertisements in the text, ask them what type of text they expect to see behind this link. Is this something they need for their reading goal? Break down the task into smaller steps to help students focus on the specific texts and related questions. For example, encourage students to follow the step-by-step instructions of the virtual teacher "Mr. Webster." After finishing, discuss how Mr. Webster helped them learn.

3.4.2 Support Multiple Document Reading

Before reading a hypertext, formulate an inquiry question that helps your students search for and select the relevant information. For the "Oceans" text, the inquiry question can consist of multiple questions, such as, "Why are oceans important? What do ocean life and habitats look like? How are the oceans threatened?" Ask students to write down these questions as a reminder and stimulate them to focus on these questions while reading. After clicking through and reading the text, ask students if they can already answer part of the question. *Which part of the question has not been answered yet? In which hyperlink can you find the answers you need?*

3.4.3 Include the Characteristics of Digital Texts in Education

Provide the structure of the hypertext by creating an overview of the different pages and pop-ups of the text. Make sure that the overview clarifies how the webpages are related to each other, what types of sources they are, and what kind of information students can find. Present the overview before students start reading and use it to help students navigate through the text. *Which hyperlink did you click on? How does this information relate to the information on the previous page?* Later on, when students are more familiar with hypertexts, they can draw these overviews themselves in small groups and discuss the structure of the text.

3.4.4 Practice Regularly in the Classroom Across Subjects

Embed the "Oceans" text in a larger school project about the world's oceans and integrate subjects such as geography and biology with (digital) reading, writing, and oral skills. The theme can be a focus in the classroom for a few weeks, and students can read different types of texts about oceans (on paper and digitally). Discuss the content of the texts and let students process their acquired knowledge on a variety of different assignments. For example, students can work in small groups and become the "experts" on a specific subject about the ocean (e.g., big animals in the ocean, the coral in the ocean, or the way some animals camouflage themselves in the ocean). Each group researches their topic by watching videos and reading texts on the internet and then makes a poster presentation to inform the rest of the class.

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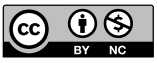


Chapter 4
Good Practices for Teaching Reading Comprehension with Digital Text from Three PIRLS Countries

Inspiring Examples of Digital Reading Education

Contents

4.1 Introduction

In this final chapter, we aim to inspire teachers all over the world by sharing good practices from three countries for teaching reading comprehension with digital texts. The countries were selected based on their participation in IEA's Progress in International Reading Literacy Study (PIRLS) 2016. We asked for contributions from one country from each of the following categories (based on Mullis et al., 2017):

- A country that performs relatively well on ePIRLS compared to regular PIRLS informational reading achievement: Singapore

M. Bruggink et al., *Teaching Reading Comprehension in a Digital World*, IEA Research for Educators 2, https://doi.org/10.1007/978-3-031-75121-9_4

- A country that performs relatively well on regular PIRLS informational reading compared to ePIRLS achievement: Italy
- A country where there is no significant difference between regular PIRLS informational reading and ePIRLS achievements: Ireland

One school from each of these countries presents their teaching practice. We asked each school in what way digital texts are being used in their classrooms, how their teachers teach students the skills needed for digital reading, and how they support the comprehension of digital texts. The description of the school's teaching practice for digital reading is supplemented with practical tips and example lessons. We hope these practical suggestions and ideas will be an inspiration for other teachers to strengthen their own digital reading lessons. The descriptions of the education system for each of these countries are based on the PIRLS 2021 Encyclopedia (Reynolds et al., 2022). The schools that contributed to this chapter are:

- Admiralty Primary School in Singapore
- The Istituto Comprensivo "Via Linneo" in Italy
- Talbot Senior National School in Ireland

4.2 Good Practices from Singapore

The education system in Singapore has a strong central focus with a national curriculum and government-centralized recruitment process for public schoolteachers, with schools and the Ministry of Education working closely together. However, schools also have autonomy within broad parameters and are encouraged to customize the national curriculum to meet the learning needs of their students.

Early childhood education is widely accessible, with nearly all children enrolled by age five. Primary school (grades 1–6) is compulsory and starts at age seven. Most students then follow secondary school for four to five years. The main focus of primary school is to give students a strong foundation in literacy and numeracy. Additionally, schools offer science, art, music, character and citizenship lessons, social studies, physical education, and co-curricular activities.

Singapore's educational approach for literacy development in primary school is emphasized by a "strong foundation and rich language for all," which focuses teachers on "building a strong foundation in language and enriching language learning for all students" (Reynolds et al., 2022). Language in Singapore is taught by integrating the teaching of listening, speaking, reading, and writing, based on purpose, audience, context, and culture. As many students are multilingual, they are expected to have learned to speak, read, and write in English when finishing primary school (around the age of 12). To build a strong language foundation, schools use a systematic and engaging approach, using meaningful texts to teach grammar. Teachers provide a rich language environment using multimodal texts from print and nonprint sources. The use of blended learning was accelerated due to the COVID-19

pandemic. The National Digital Literacy Program ensures that all secondary students own a personal learning device.

ABOUT ADMIRALTY PRIMARY SCHOOL

Established in 1997, Admiralty Primary School is a government primary school built in the midst of a flourishing public housing neighborhood in Singapore.

Teacher Nurazreen Binte Samsudin and Head of the English Language Department, Charlotte Sng Yi May, discuss teaching digital reading at Admiralty Primary School.

4.2.1 The Use of Digital Texts in Lessons

The main method of instruction for English Language in Singapore primary schools is STELLAR, which stands for Strategies for English Language Learning and Reading. Digital texts are first introduced in grade 4 and are taught in reading and viewing lessons. These texts are multimodal, typically combining semiotic modes such as linguistic, audio, visual, gestural, and spatial to contribute to the overall meaning of the text and to engage readers. These texts vary in their purposes—there are texts that explain, texts that describe and inform, and texts that contain more than one type or form of text (hybrid texts).

During lessons using digital texts, our teachers draw on students' prior knowledge and use contextual and semiotic cues to facilitate the comprehension of the texts. Through close and critical reading lessons, teachers use questioning techniques to enable students to make text-to-text, text-to-self, and text-to-world connections. For extension activities, teachers may upload a video or include hyperlinks to reading materials on different online learning platforms such as Google Classroom, One Note, or Singapore Student Learning Space (SLS[1]).

[1] The SLS is the core platform for teaching and learning of the Singapore Ministry of Education (MOE) and is one of the MOE's key initiatives to transform the learning experiences of Singaporean students through the purposeful use of technology.

Our school practices blended learning, by introducing Learning with Technology[2] on a termly basis to all levels. How to navigate digital platforms, such as uploading audio or physical artifacts, is integrated into the respective subject's lesson plans.

4.2.2 Guiding Students in Searching, Navigating, and Comprehending

After establishing clear objectives for reading, teachers will draw students' attention to the navigational tools such as the "Home," "Glossary," "Previous," and "Next" buttons found in the digital text. Teachers may demonstrate the functions that can help students in their reading and viewing, for example, by replaying or pausing the audio.

Since the reading path of digital texts can be non-linear or non-sequential, teachers first model reading the texts using the think-aloud technique. Through questioning and thinking aloud, teachers guide students in comprehending the texts and the purpose of the different elements, such as the use of videos, hyperlinks, and visuals.

Students are explicitly taught skimming and scanning, to get an overview of the text or to locate specific information. Teachers demonstrate, by thinking aloud, how to skim a webpage to identify main ideas, how to evaluate the credibility of a source, and how to distinguish between relevant and irrelevant information. Students are taught skills to critically distinguish between facts and opinions. For example, for a digital text on the life of a vet, students are guided to reflect on the purpose of a blog, as well as its context and intended audience.

Students are guided to use search engines effectively, learn how to navigate through other blogs and different websites, and use features such as bookmarks and tabs to keep track of important information.

Students' critical and close reading skills are further supported through the use of a hard copy version of the digital text. Students are shown how to actively engage with the text through highlighting or annotating to aid comprehension. During guided reading, the teachers model critical thinking through questions that evaluate the text, including understanding its purpose, audience, and context.

To support vocabulary acquisition and activate prior knowledge, teachers use a variety of strategies such as tuning-in activities, questioning, and discussion. Teachers may pre-teach key vocabulary words before students begin reading a text or encourage students to use contextual clues to infer the meaning of unfamiliar words. Graphic organizers are used to help students organize and connect their prior knowledge to the new information they acquire from the reading.

[2] Learning with Technology (LwT) is the incorporation of technology in our school's daily teaching and learning, and identified skillsets are specifically set out in every department's Scheme of Work. Skillsets are developed through day-to-day teaching and lead up to scheduled LwT assignments.

4.2.3 Using Technology for Learning

A school-based initiative our school has introduced is one-to-one computing (one device for each student) during the middle primary years (grades 3 and 4), and teachers deliver lessons that integrate the use of technology. The handling and use of personal learning devices, and the navigation skills needed to access the information on these platforms are guided by teachers.

Students are highly motivated when using personal learning devices for learning. Classroom online etiquette and rules are established from the start to prevent distraction and abuse of the devices. Devices are loaned to students who do not have any, thus ensuring that all students have a device to work with. Only apps for educational purposes and approved websites are allowed during school hours from 07:00 to 16:00. Screen time and apps used at home from 16:00 to 19:00 are co-managed by parents. Thus, students continue to have access to digital media and learn digital skills in safe and controlled environments both in school and at home.

Admiralty Primary adopts a differentiated approach to cater to students' different levels of digital literacy competencies. In our school, we offer a range of digital activities, such as video-editing, creating presentations, scripting, or designing graphics, which students use in collaborative project work. Students can choose tools that are aligned with their abilities and interests, allowing students to work at their own pace. Through collaborative work, students make use of group members' talents and proficiencies while sharing devices to produce their final project.

4.2.4 School's Advice: Model (Metacognitive) Strategies, Vary in Types of Texts, and Professionalize Teachers

Teachers could consider employing different strategies and techniques to support students with varying needs and competencies in reading comprehension. Both bottom-up (decoding-based) and top-down (meaning-based) processing approaches help students to activate prior knowledge to better understand a text. Through examining the use of semantic and contextual cues, and the incorporation of think-aloud, annotation and note-taking skills, students can engage with the text and build their vocabulary while also developing reflective and critical thinking. Deliberate teacher questioning focusing on, for example, how and why writers use different semiotic modes to achieve a variety of effects, is particularly effective.

Teachers could also model thinking aloud to get students to think metacognitively about the text as they bounce ideas off one another. For digital texts, because reading can be non-linear, it is imperative that teachers first model the process through thinking aloud and demonstrating how to navigate or access the different features in the digital text. Then, teachers could gradually release the responsibility of the reading to students by letting them read independently.

Teachers can help students access and navigate texts to become confident and fluent readers. Dedicated time set aside for extensive reading also needs to be incorporated in the curriculum as it not only promotes reading fluency but also allows students time to read for enjoyment. Additionally, wide exposure to a diverse range of texts (hard copy and digital), such as news articles, blogs, infographics, videos, animations, e-books, and other multimedia content, promotes students' application of navigational skills and enables them to understand the unique features and structures of different types of texts and their purposes. Finally, teachers must be supportive and encouraging in providing students with a conducive and safe environment to thrive.

Some challenges faced in teaching digital reading included technical issues such as an unstable internet connection, issues with students logging in to SLS (e.g., forgetting their passwords), and accommodating to different specifications of devices or platforms for doing annotation. Students also needed to be guided to contain their enthusiasm while using personal learning devices in order to focus better during the lesson. Some teachers may lack the confidence to use ICT devices or are not familiar with the terms used in digital and multimodal texts. Through professional development and sharing information about using ICT for teaching, teachers' confidence and competency can be raised.

4.2.5 Lesson Example: Reading the Blog "Life of a Vet"

In a grade 4 English Language class, we read a digital text in the form of a blog on the life of a vet for the first time. Students read and comprehend the digital text by:

- navigating a webpage in the form of a blog;
- identifying the purpose and audience of the text; and
- noticing how visual cues help in the comprehension of the text.

The teacher guides the students' reading through questioning and explicitly teaching the different navigational features of the digital text. Students are encouraged to ask questions as they read. The teacher introduces common terms found in digital texts, such as, tabs, menu, header, homepage, buttons, mouse-over, scroll, blog entry, post, sidebar, and subscribe. The teacher then points out the different media accompanying the digital text, such as audio, video, and photographs while students navigate the text with the teacher. Next, students are guided to analyze the features of the blog, such as, the use of the different tabs. The teacher directs the students to notice that each tab has a specific purpose. Besides the blog entries, the tab on "Animal Care" provides tips on animal care, and the tab "About Me" provides information on the author of the blog. Students learn about text organization and discuss relevant information that can fit the context of each tab.

Examples of questions posed by the teacher:

1. What is the main purpose of this text?

2. Other than the words, what are some of the things in this text that help you understand more about the topic? How do these features help you in understanding the text?
3. Which feature of the blog did you enjoy the most? Why?
4. After the main blog entry, there is a "comments" section. Why do you think blogs have this feature?
5. What is the purpose of this tab? Why did the author decide to include this information in her blog?

Students are guided by the teacher to notice the language structures as well. For example, the use of the past tense for recounting events in the blog and the use of the present tense for providing facts and advice on animal care. Students were able to annotate their comprehension of the text using the interactive thinking tool in the Singapore SLS. At the end of the lesson, students worked together collaboratively to co-construct a graphic organizer in the form of a chart. The chart enabled students to demonstrate their understanding of the content and features of the blog they had read:

- What information is presented?
- How is it organized?
- What is the main purpose of each tab?
- Why do you think the author chose to present the information in this way?

As a follow-up activity, students were encouraged to choose a topic to create their own blog, for example, a blog about pet ownership.

DIDACTIC PRINCIPLES AT ADMIRALTY PRIMARY SCHOOL

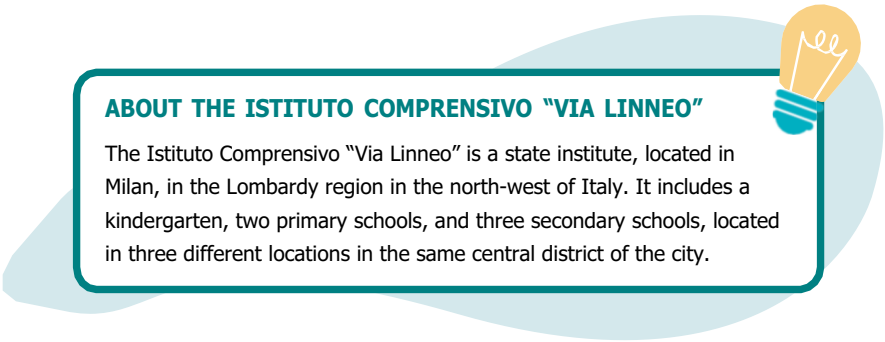
At Admiralty Primary School, different types of digital texts are introduced starting from grade 4, and technical digital skills are taught from a young age. The teachers pay explicit attention to activating students' prior knowledge and increasing their vocabulary. Also, they model how students can approach a digital text. For example, teachers demonstrate how to skim texts, how to use different hypermedia, and how to evaluate a text. By using strategies such as asking questions about the text, teachers increase students' reading comprehension.

4.3 Good Practices from Italy

In Italy, primary schools follow a national curriculum set by the Ministry of Education. However, schools have autonomy regarding didactics, organization, research, experimentation, and development.

Education is compulsory from age 6 to 16, or until a professional qualification is obtained. Most children start preprimary school at age three. At age six they start primary school which takes five years. All students then follow lower secondary school for three years. Students can then take a state examination to start the five years of upper secondary and vocational education and training.

Throughout the first cycle of education (pre-primary and primary school), reading practice is considered central. In Italy, reading is seen to have a dual learning function "a fundamental means of socialization and the exchange of ideas" and "a way to foster autonomy and study" (Reynolds et al., 2022). It stimulates students' learning progress and maturation, the development of attention skills and critical reflection, and is considered an essential ability to learn to search for information and develop knowledge. Additionally, spontaneous and creative forms of reading are also promoted. In the past years, a number of national initiatives have started to promote reading. Digital teaching was organized during the COVID-19 pandemic, and this form of integrated distance instruction is likely to stay on for students who cannot attend school in person.



Teacher Marina Paola Mariano discusses teaching digital reading at Istituto Comprensivo Via Linneo Primary School.

4.3.1 Digital Reading in Classes 1 to 5

At Istituto Comprensivo Via Linneo Primary School, digital texts are used daily in the classroom through the interactive whiteboard. The adopted digital didactic texts provide structured material and suggest thematic, in-depth courses with videos,

interactive games, quizzes, and guided paths. This starts in grade 1, at first only with videos and then gradually introducing interactive exercises. Digital reading is mainly carried out in the classroom, while at home it is primarily used by those who are absent to update themselves. In grades 3 to 5, research work units are included regarding the themes of the assigned work units.

The ability to use information on the internet is taught through activities carried out in the classroom or the computer lab. Students are guided by the teacher, who shows the path to be taken to reach the information sought. In the classroom, prepared diagrams are used to build the path for searching for information and provide and build the vocabulary knowledge that is necessary. In the classroom, pupils who are more familiar with the use of devices function as tutors by applying peer-teaching techniques, also using the protected navigation of the school network.

4.3.2 The Use of Digital Devices at Via Linneo

Pupils in classes have different skills regarding the use of digital devices. Teachers have administered a satisfaction questionnaire in the primary school classes that carried out the Invalsi tests and the Trends in International Mathematics and Science Study (TIMSS) tests in April of 2022. The first question was whether a personal computer (PC) was used at home. Among the groups interviewed, 82 percent of males and 92 percent of females who took the TIMSS test answered yes, 95 percent of males and 96 percent of females who carried out the Second Primary Invalsi Test answered "yes," and 96 percent of males and 100 percent of females who carried out the Invalsi Fifth Primary Test answered "yes," demonstrating that our pupils use ICT.

The second question of the questionnaire asked what the PC was used for (see Table 4.1).

While the use is widespread, the mode of use is not generally known. This finding suggests that it is necessary to discuss with pupils the issues that lead to a conscious use of technology. The school must guide the students' skills to encourage the development of quality products built through ICT.

Table 4.1 What use do you use the PC for?

	TIMSS	Class II Invalsi	Class V Invalsi
To study	22%	24%	45%
To do homework	29%	32%	35%
To do research	58%	26%	89%
To play	61%	68%	66%
To play online	49%	25%	48%
To talk to someone remotely	58%	43%	50%

4.3.3 School's Advice: Create a Starting Point and Focus on Media Education

It is fundamental to start with what students can already do, to have a starting point based on the certainties acquired. Therefore, exploit the children's curiosity and guide them towards the conscious and responsible use of technology. For example, create contexts for transcoding texts, create original productions, involve students, and make them aware what they post online remains in the public domain. Media education is fundamental, otherwise children are led to use technology without information and critical understanding about the nature and categories of the media. Our school not only has the duty to train students in the use of media and new technologies, but also has to be prepared to help pupils develop a conscious knowledge of media and of the techniques used to build messages and produce meaning, using specific genres and language. I think that the twenty-first century teacher is not only a specialized teacher who deals with media education courses, but a teacher capable of integrating the different media into their pedagogical practice, inserting media education to support traditional teaching.

4.3.4 Lesson Example: Reading About the History of Photography

This example describes an activity performed in a grade 2 primary class.

To conclude a two-month photography project, students were given an assignment using Canva, a free-to-use online graphics tool that is versatile and intuitive. During the project, students had the opportunity to become familiar with the camera, learning its functions and developing skills for reading images. The final lesson actively involved the children in a media education assignment, in which they designed a presentation slide that summarized the entire project. During this phase, the children deepened their digital reading by figuring out how to use one slide to enter specific and meaningful information about the project. Students chose to focus on the history of photography and on a particular function of the camera, such as the aperture, and on the importance of holding a camera correctly. The use of the features offered by the Canva platform and writing on a digital application allowed the children to become aware of and familiar with current technologies. Teacher's guidance helps the class to work on awareness, direct their research, and circumscribe dangers, and teaches students to choose from the many proposals offered by the web.

A common point for all of us at Linneo is working in a protected "environment," so all proposals from teachers for digital reading are formulated and processed through our institute's site and published on the "Classroom" page. In addition to being able to take advantage of various free platforms, this has the advantage of evading advertising messages and public comments unrelated to the world of school.

DIDACTIC PRINCIPLES AT LINNEO PRIMARY SCHOOL

At Istituto Comprensivo Via Linneo Primary School, the teachers realize that their students need to develop a conscious use of technology and need guidance in developing digital skills. The students are guided step-by-step to search for information on the internet and also taught to critically evaluate information. Teachers help students build the necessary vocabulary, and students help each other learn the technical skills. The school emphasizes the importance of media education.

4.4 Good Practices from Ireland

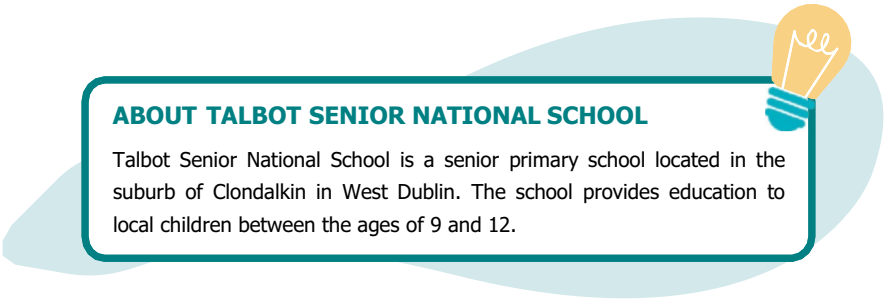
The education system in Ireland is largely centralized. The majority of primary and post primary schools are state-funded, which leads to their following the national curriculum, assessment, and evaluation framework. Some aspects of the curriculum may be adjusted according to the character or ethos of the school.

Children first follow early childhood education and start primary school by age six. The eight years of primary school are followed by a postprimary junior cycle for three years. Students then go on to the senior cycle, which takes two years. However, many students choose a one-year transition program before the senior cycle. All primary schools in Ireland are bilingual, with either English (the majority) or Irish as the first language.

The Primary Language Curriculum is an integrated language curriculum. The program is the same for English and Irish to promote transfer between the two languages. The three main themes are: children and their lives, children's communications and connections with others, and children's language learning and development. Language-wise, there are three strands: oral language, reading, and writing. "Across the strands, three elements describe essential language learning: developing communicative relationships through language; understanding the content and structure of language; and exploring and using language" (Reynolds et al., 2022). The curriculum also names effective teaching approaches, including second language learning, linguistic diversity, transfer of skills, immersion, Content Language Integrated Learning (CLIL), language and cultural awareness, play, digital literacy, disciplinary literacy, and critical literacy.

There are a number of initiatives in Ireland to stimulate reading practice and enjoyment, such as the National Strategy to Improve Literacy and Numeracy. There

is also a Digital Strategy for Schools, which, among other things addresses the digital divide in access to ICT.



Teacher Caitriona Wynne discusses teaching digital reading at Talbot Senior National School.

4.4.1 Digital Reading at Talbot Senior National School

Our school is for children in senior primary, so they start at age 9 and finish around age 12. At all class levels, digital texts are used on a daily basis. Very often, digital texts are used on the large interactive panel a number of times per day (e.g., for mathematics, Irish, and English) and then for possibly one extra subject in the afternoon (e.g., for science, social personal and health education). Children get to study a digital text at least twice a week on an iPad and once or twice a week on a Chromebook. These are often digital texts in a sheltered environment without hyperlinks. For research topics such as science, geography, and history, hyperlinks are more common. The digital texts vary and are usually chosen to suit the learning outcome of the subject area. For example, in mathematics, it could be a digital text that incorporates videos and pictures; in science, it could be a text on magnetism or any other area. A type of assignment I might give my students using digital reading could be a mathematics problem-solving activity, a history investigation of a particular event, or a geography research project on a particular place.

Digital reading is always integrated into other subjects rather than taught as a separate lesson, but some children who have difficulties with reading use special apps to help them to read better.

4.4.2 Lessons About Source Reliability and Vocabulary

At our school, we do lessons on the critical selection of sources and checking for reliability. Students are taught to investigate sources. Students are asked to check whether the source is up-to-date? What is its intent? Whether the source is from a genuine authority on the subject? We train students to think critically about advertisements and memes that they see on social media and ask themselves the question: Is what is said really credible or is it trying to deceive you?

To teach vocabulary, we use a method called "Talktime," which uses a PowerPoint which includes a digital representation of the word through, for example, a picture, sound, or rap song. The vocabulary taught throughout the year is selected by the teacher to represent the current needs of their students.

4.4.3 Differences in Access, Skills, and Motivation

We respond to differences in access to digital media by providing access to an iPad and Chromebook to each individual child four times per week. Each child sees a digital representation of schoolwork on the large interactive panel throughout the day.

We respond to differences in skills and motivation in the same way as we do to children's differences in skills in any other aspect: through universal design for learning. We design each lesson so that it is accessible to all. We plan for students with additional needs beforehand, at the lesson plan stage, rather than as an afterthought. We endeavor that the content for each lesson will have a low threshold entry level and a high ceiling level for students who can use an extra challenge, so that all learners are catered for.

4.4.4 School Advice: Use a Guided Setting, Motivate Students, and Combine Digital Tasks with Oral Language

Although we would appreciate more guidance in the area of digital reading, we also have some advice for other teachers, based on our experience. First of all, increase the access to digital reading in a guided setting to improve digital reading. Also, teach with enthusiasm to create motivation among students. Finally, design lessons so that children will have a chance to share their opinion and voice. Our students create their own digital presentations and then go on to present these at school or at the class level.

4.4.5 Lesson Example: Mathematics Problem Solving Task Through Digital Representation of Information

This is an example of a mathematics lesson on measurement, using a website that promotes a conceptual understanding of mathematics. The vocabulary of measurement was pre-taught during previous lessons. The task presents three different digital parts (act 1, 2, and 3) on a large interactive panel.

The teacher presents Act 1—a short video—and then shows the students these four questions:

1. What did you notice?
2. What did you wonder?
3. Estimate how far he threw the disc.
4. Give an estimate that is too high and an estimate that is too low.

At this point, children discuss their ideas in pairs. The teacher checks that everyone has been able to read the questions and takes responses. The children note their thoughts on an accompanying worksheet.

Act 2 is a digital text that gives more clues in written format and poses a problem question to be solved. This digital text is revealed by the teacher to the whole class step-by-step. Students read these texts in pairs or together with the teacher. After reading the text, the teacher then directs students to paired discussions on the problem question and asks them to write out their ideas/efforts to solve the problem.

Act 3 is another video that shows how the problem works out.

This type of lesson works very well, engagement is maintained through the three distinct acts, and the topic of digital representation of information through words and videos is very motivational for students. Organized pairwork between the three acts helps all students to engage, share ideas, and support each other.

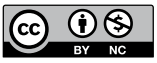
DIDACTIC PRINCIPLES AT TALBOT SENIOR NATIONAL SCHOOL

The students at Talbot Senior National School use various types of digital texts on a daily basis. Digital reading is integrated into school subjects such as mathematics, geography, and history, and into a variety of activities. For these activities, the teachers provide explicit instruction in vocabulary and emphasize different aspects of a word. Students are taught to critically select sources and check the reliability of these sources. Additionally, teachers pay attention to differences in students digital skills and motivation to use ICT.

References

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2017). *ePIRLS 2016 International Results in Online Informational Reading*. Retrieved from Boston College, TIMSS & PIRLS International Study Center website: http://timssandpirls.bc.edu/pirls2016/international-results/

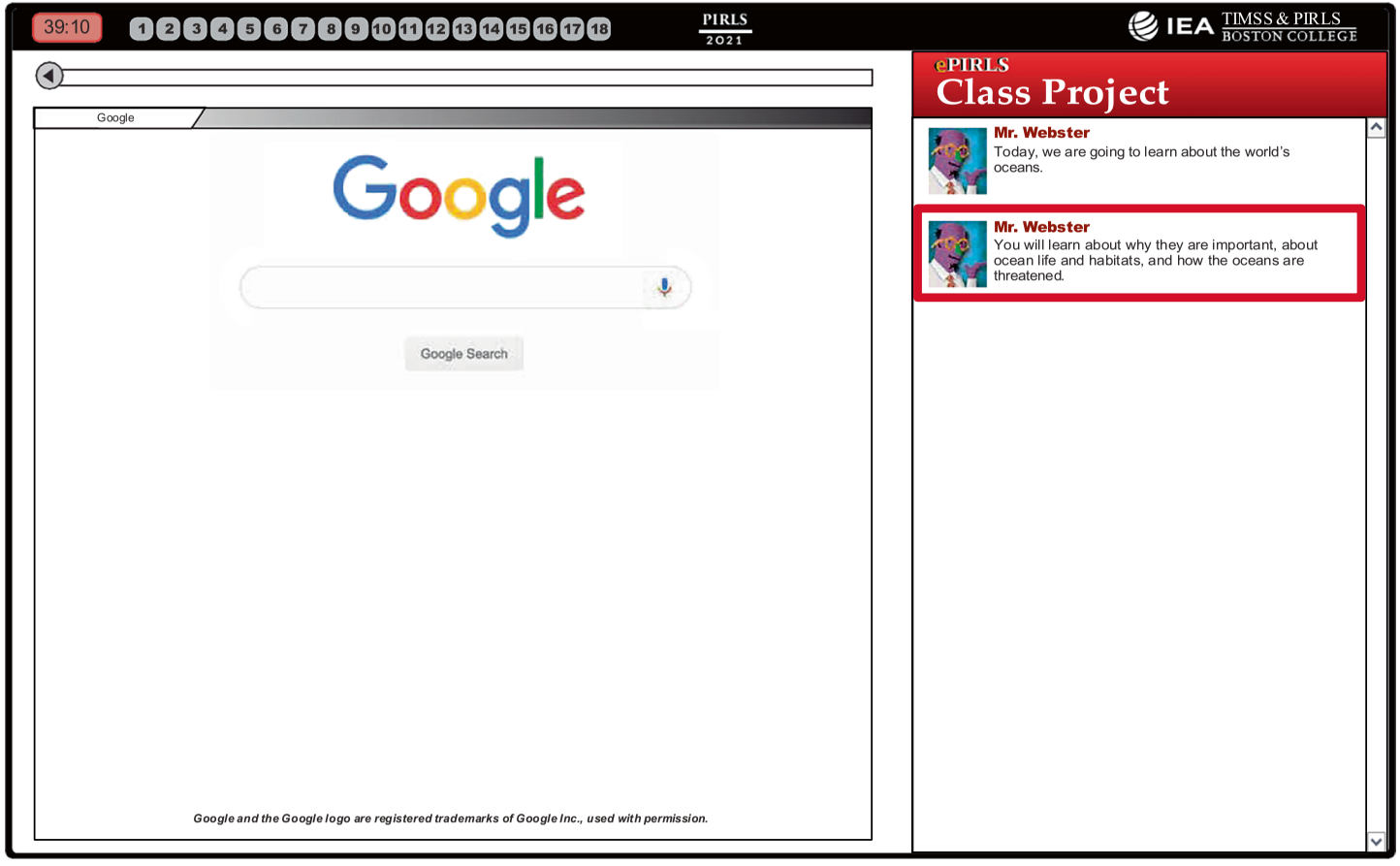
Reynolds, K.A., Wry, E., Mullis, I.V.S., & von Davier, M. (2022). *PIRLS 2021 Encyclopedia: Education policy and curriculum in reading.* Retrieved from Boston College, TIMSS & PIRLS International Study Center. https://pirls2021.org/encyclopedia



The Full Storyboard for the ePIRLS Oceans Text

M. Bruggink et al., *Teaching Reading Comprehension in a Digital World*,
IEA Research for Educators 2, https://doi.org/10.1007/978-3-031-75121-9

39:10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
PIRLS 2021
IEA TIMSS & PIRLS BOSTON COLLEGE
IEA ePIRLS 2021
In this class project, you will be doing an online study of the oceans. You are going to read about why oceans are important, about ocean life and habitats, and about how oceans are threatened.
Next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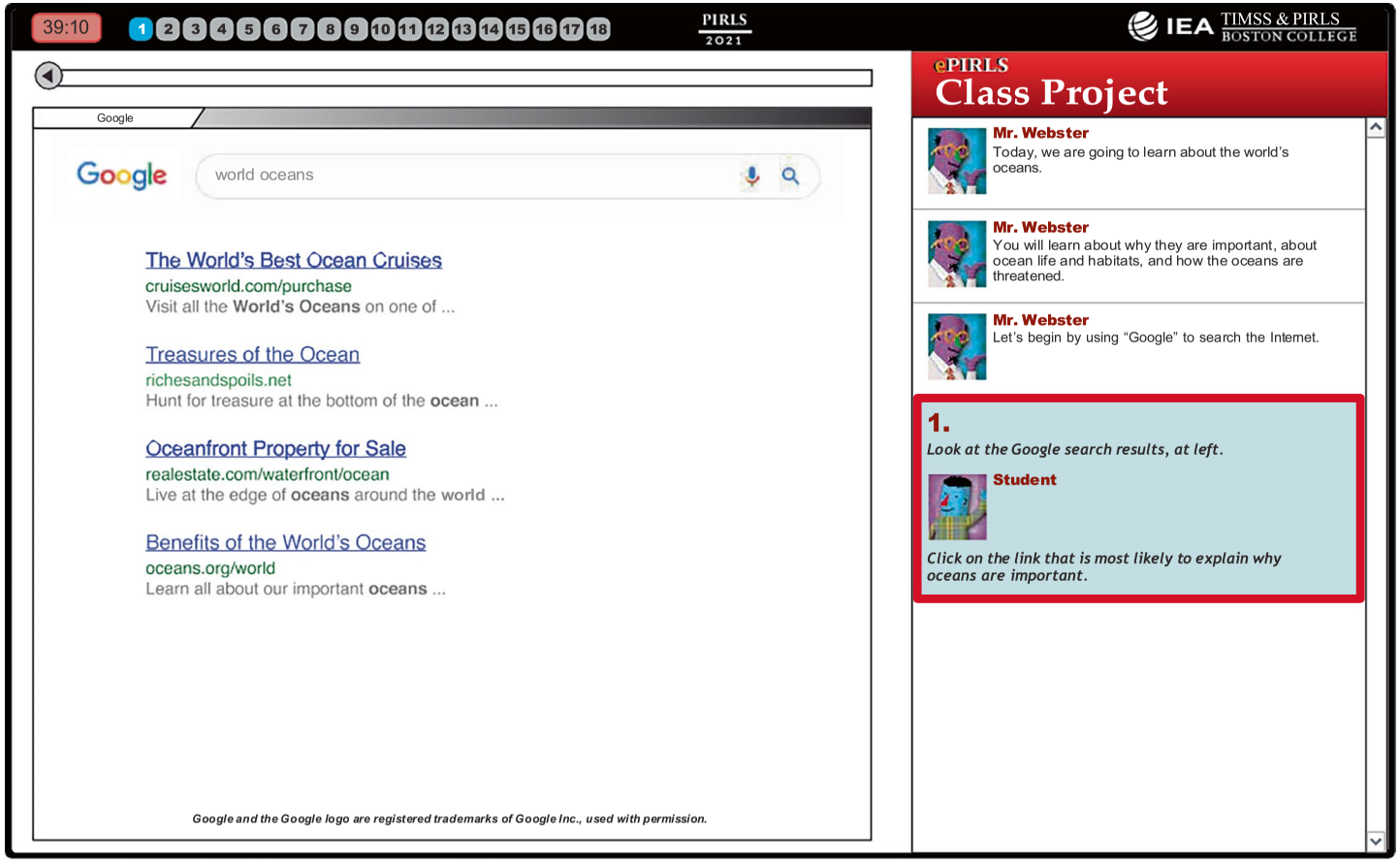
PIRLS 2021
IEA TIMSS & PIRLS BOSTON COLLEGE
Google
Google
Google Search
Google and the Google logo are registered trademarks of Google Inc., used with permission.
ePIRLS
Class Project
Mr. Webster
Today, we are going to learn about the world's oceans.
Mr. Webster
You will learn about why they are important, about ocean life and habitats, and how the oceans are threatened.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PIRLS 2021
IEA TIMSS & PIRLS BOSTON COLLEGE
Google
Google
world oceans
The World's Best Ocean Cruises
cruisesworld.com/purchase
Visit all the World's Oceans on one of ...
Treasures of the Ocean
richesandspoils.net
Hunt for treasure at the bottom of the ocean ...
Oceanfront Property for Sale
realestate.com/waterfront/ocean
Live at the edge of oceans around the world ...
Benefits of the World's Oceans
oceans.org/world
Learn all about our important oceans ...
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ePIRLS
Class Project
Mr. Webster
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Mr. Webster
You will learn about why they are important, about ocean life and habitats, and how the oceans are threatened.
Mr. Webster
Let's begin by using "Google" to search the Internet.
1.
Look at the Google search results, at left.
Student
Click on the link that is most likely to explain why oceans are important.

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceans.org/world

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

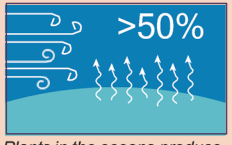
GET READY FOR THE SEA!

DIVE IN!

START LESSONS NOW

Because more of Earth is covered by ocean than by land Earth looks like a beautiful blue marble from outer space. Around 70% of Earth's surface is ocean water. We get much of the air we breathe, water we drink, and food we eat from the oceans.

THE AIR WE BREATHE



Plants in the oceans produce over half of our oxygen.

THE FOOD WE EAT

The sea provides many foods.

Geographers have divided the water surrounding the continents into five major oceans: Pacific, Atlantic, Indian, Arctic, and Southern. The water is connected from ocean to ocean. Ocean currents carry the water back and forth across all the oceans. You can see this by looking at the map of Earth.

ePIRLS
Class Project

Mr. Webster
Let's begin by using "Google" to search the Internet.

1.

Look at the Google search results, at left.

Student

Click on the link that is most likely to explain why oceans are important.

2.

Why are plants that live in the ocean important for life on Earth?

Student

- They provide oxygen.
- They make Earth look blue.
- They absorb plastic.
- They live at the edge of the water.

SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceans.org/world

Benefits of the World's Oceans

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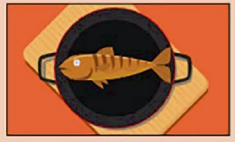
THE FOOD WE EAT



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ePIRLS

Class Project

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Student

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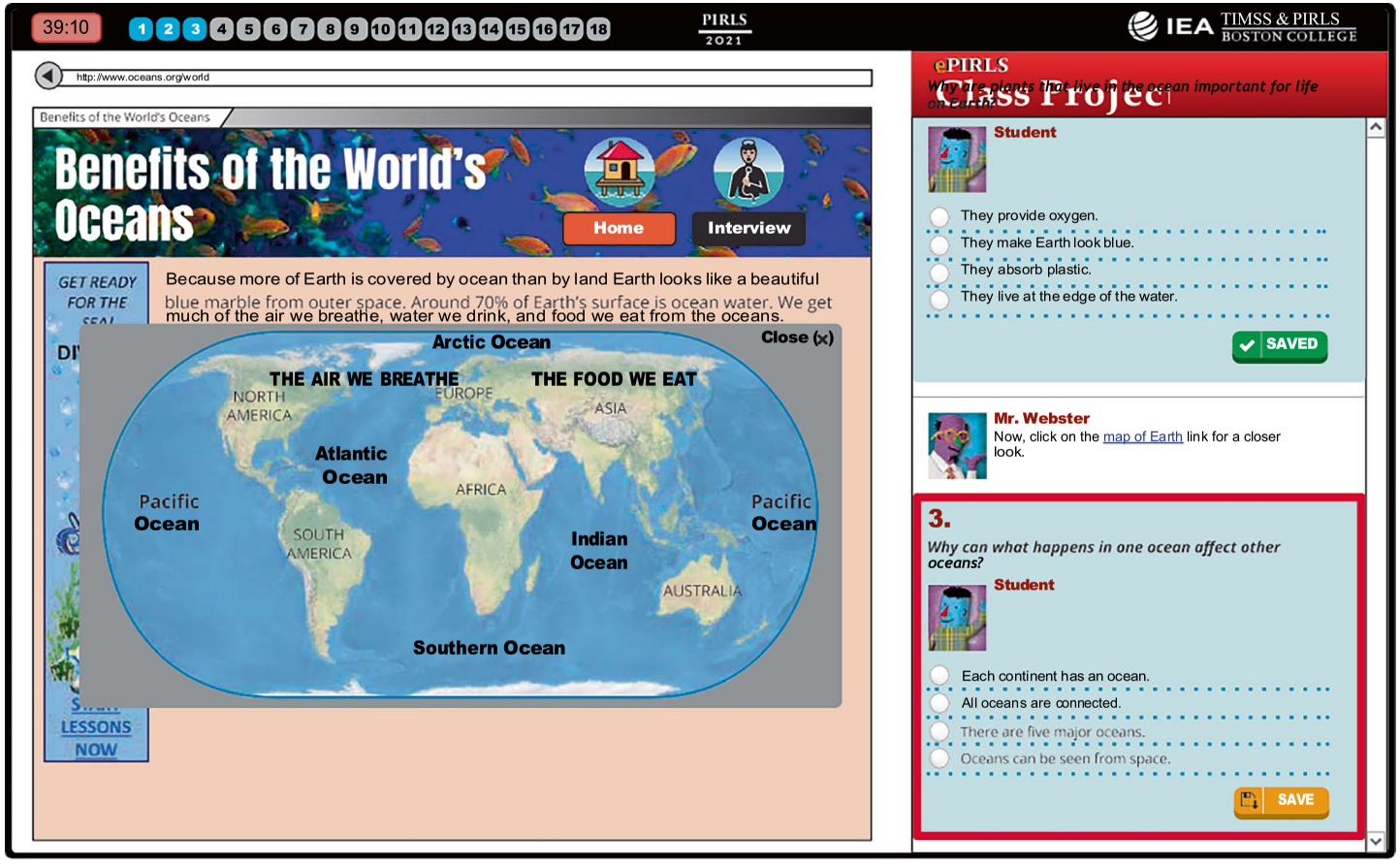
SAVED

Mr. Webster

Now, click on the map of Earth link for a closer look.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IEA TIMSS & PIRLS BOSTON COLLEGE
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Close (x)
Arctic Ocean
THE AIR WE BREATHE
THE FOOD WE EAT
NORTH AMERICA
EUROPE
ASIA
Atlantic Ocean
AFRICA
Pacific Ocean
Pacific Ocean
SOUTH AMERICA
Indian Ocean
AUSTRALIA
Southern Ocean
ePIRLS
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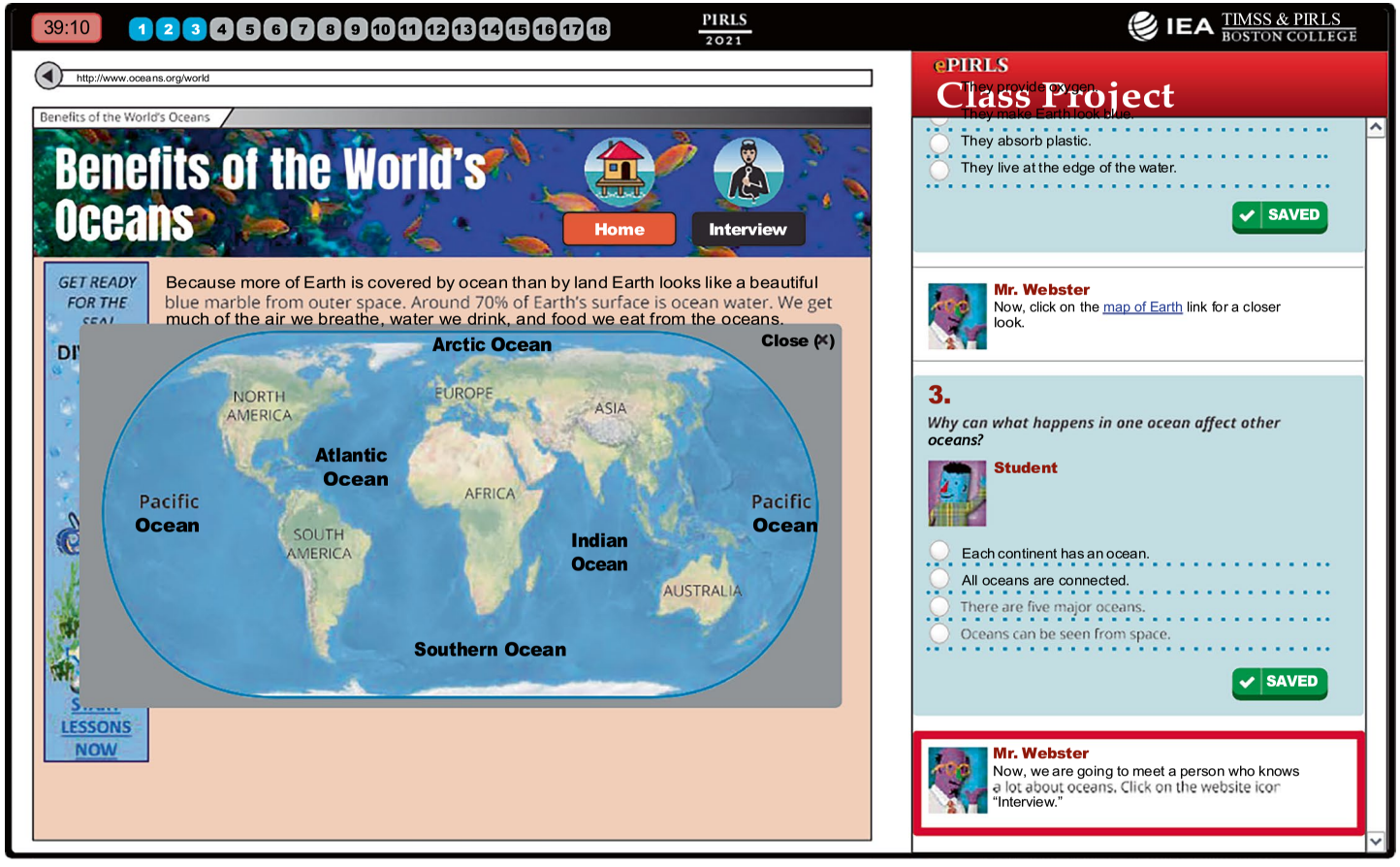
Student
They provide oxygen.
They make Earth look blue.
They absorb plastic.
They live at the edge of the water.
SAVED
Mr. Webster
Now, click on the map of Earth link for a closer look.
3.
Why can what happens in one ocean affect other oceans?
Student
Each continent has an ocean.
All oceans are connected.
There are five major oceans.
Oceans can be seen from space.
SAVE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Benefits of the World's Oceans
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ASIA
Atlantic Ocean
Pacific Ocean
AFRICA
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ePIRLS
Class Project
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Each continent has an ocean.
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There are five major oceans.
Oceans can be seen from space.
SAVED
Mr. Webster
Now, we are going to meet a person who knows a lot about oceans. Click on the website icon "Interview."

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceans.org/world/sylvia-earle-interview1/html

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

GET READY FOR THE SEA! DIVE IN!

START LESSONS NOW

An Interview with Ocean Scientist Sylvia Earle

To help understand why oceans are important and interesting, a journalist from National Geographic interviewed ocean scientist Sylvia Earle. She has studied the oceans for many years, including exploring deeper and deeper parts of the oceans.

How did you first become interested in the ocean?

Sylvia: *My family spent time along the ocean when I was a kid. I was fascinated by the creatures at the ocean's edge like crabs, sea birds, and shellfish.*

What did you have to learn to do your job?

Sylvia: *It required lots of science classes! To learn about plants and animals that live in the water, I also learned to scuba dive.*

1 2

ePIRLS Class Project

- Each continent has an ocean.
- All oceans are connected.
- There are five major oceans.
- Oceans can be seen from space.

SAVED

Mr. Webster
Now, we are going to meet a person who knows a lot about oceans. Click on the website icon "Interview."

4.

Why was Sylvia Earle chosen for an interview?

Student

- She swims in the ocean.
- She likes crabs, sea birds, and shellfish.
- She is good at scuba diving.
- She has spent her life studying oceans.

SAVE

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http://www.oceans.org/world/sylvia-earle-interview1/html

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

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How did you first become interested in the ocean?

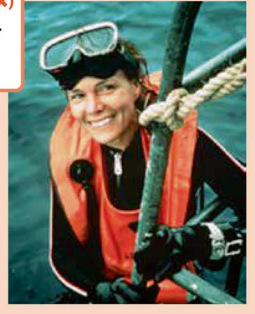
Sylvia: *My family spent … a kid. I was fascinated … edge like crabs, sea bird…*

Close (✖)

Underwater diving with your own air in a tank.

What did you have to …

Sylvia: *It required lots of science classes! To learn about plants and animals that live in the water, I also learned to scuba dive.*



1 2

ePIRLS

Class Project

Oceans can be seen from space.

SAVED

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SAVE

Mr. Webster

Click ➡ to read the rest of the interview.

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

Tell us about your recent explorations.

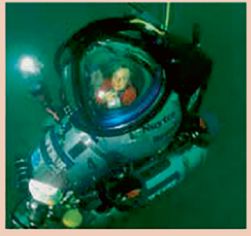
Sylvia: *I'm exploring the deepest parts of the oceans. We use a submersible called Deep Worker that fits just one person. Deep Worker can go much deeper than a scuba diver.*

Why are oceans so important?

Sylvia: *The sea is basic to life itself. Plants in the ocean provide most of our oxygen. And the water we drink comes from the clouds which come from the oceans.*

Do you worry about the oceans?

Sylvia: *Yes. We figure there are always more fish to catch, more places to dump trash. We don't think about how our actions affect the oceans. After all, they seem endless.*



The Deep Worker submersible

2 2

ePIRLS

Class Project

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SAVED

Mr. Webster

Click to read the rest of the interview.

5.

Why is Deep Worker useful to underwater explorers?

Student

SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceans.org/world/sylvia-earle-interview2/html

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

GET READY FOR THE SEA!

DIVE IN!

START LESSONS NOW

Tell us about your recent explorations.

Sylvia: *I'm exploring the deepest parts of the oceans. We use a submersible called Deep Worker that fits just one person. Deep Worker can go much deeper than a scuba diver.*

Why are o

Sylvia: *The* *cean provide mo* *k comes from* *s.*

Close (✖)

A vehicle designed to work deep underwater.

Do you worry about the oceans?

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The Deep Worker submersible

1 2

ePIRLS

Class Project

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SAVED

Mr. Webster

Click to read the rest of the interview.

5.

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SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceans.org/world/sylvia-earle-interview2/html

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

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Why are oceans so important?

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The Deep Worker submersible

2 2

ePIRLS
Class Project

Click to read the rest of the interview.

Why is Deep Worker useful to underwater explorers?

Student

SAVED

6.

According to Sylvia, why are the oceans important?

Student

- They provide our drinking water.
- They are a place to dump trash.
- They are a good place for scuba diving.
- They are deep and endless.

SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceans.org/world/sylvia-earle-interview2/html

Benefits of the World's Oceans

Benefits of the World's Oceans

Home Interview

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The Deep Worker submersible

2 2

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Class Project

Student

SAVED

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Student

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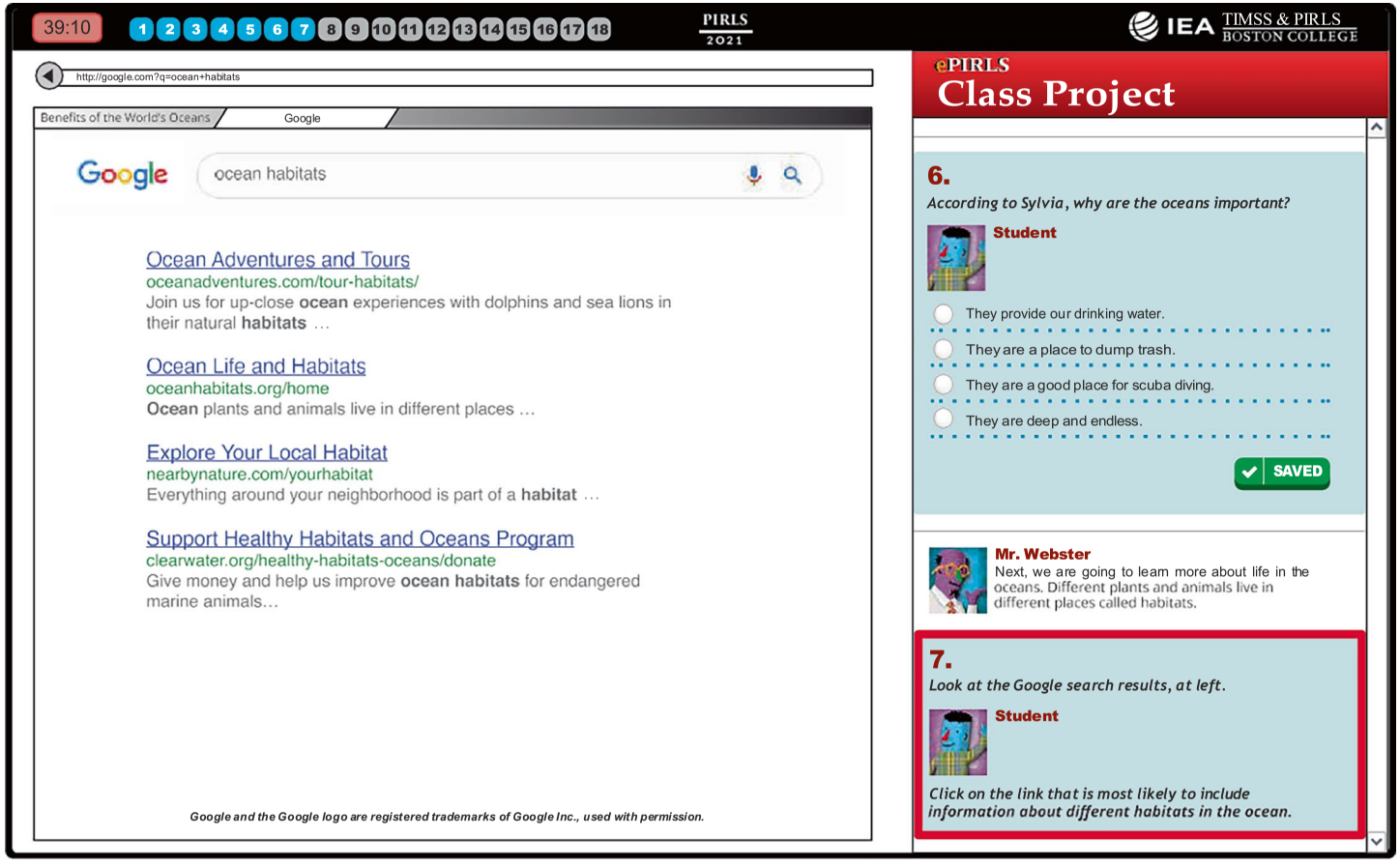
- They are a place to dump trash.
- They are a good place for scuba diving.
- They are deep and endless.

SAVE

Mr. Webster

Next, we are going to learn more about life in the oceans. Different plants and animals live in different places called habitats.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http://google.com?q=ocean+habitats
Benefits of the World's Oceans
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ocean habitats
Ocean Adventures and Tours
oceanadventures.com/tour-habitats/
Join us for up-close ocean experiences with dolphins and sea lions in their natural habitats …
Ocean Life and Habitats
oceanhabitats.org/home
Ocean plants and animals live in different places …
Explore Your Local Habitat
nearbynature.com/yourhabitat
Everything around your neighborhood is part of a habitat …
Support Healthy Habitats and Oceans Program
clearwater.org/healthy-habitats-oceans/donate
Give money and help us improve ocean habitats for endangered marine animals…
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ePIRLS
Class Project
6.
According to Sylvia, why are the oceans important?
Student
They provide our drinking water.
They are a place to dump trash.
They are a good place for scuba diving.
They are deep and endless.
SAVED
Mr. Webster
Next, we are going to learn more about life in the oceans. Different plants and animals live in different places called habitats.
7.
Look at the Google search results, at left.
Student
Click on the link that is most likely to include information about different habitats in the ocean.

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/home.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench

Animals that live in different parts of the ocean have different natural homes. These different habitats often depend on:

- Temperature of the water
- Depth of the ocean

This is why different places in the ocean are home to particular plants and animals. Plants are found mostly in the top layer of the ocean where there is enough sunlight for them to grow. But animals are found at all depths of the ocean.

ePIRLS
Class Project

SAVED

Mr. Webster
Next, we are going to learn more about life in the oceans. Different plants and animals live in different places called habitats.

7.

Look at the Google search results, at left.

Student

Click on the link that is most likely to include information about different habitats in the ocean.

8.

What are two ways that ocean habitats can be different?

Student

SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/home.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench

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ePIRLS Student
Class Project

Click on the link that is most likely to include information about different habitats in the ocean.

8.

What are two ways that ocean habitats can be different?

Student

SAVED

9.

Why are plants mostly found in the top layer of the ocean?

Student

SAVE

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http://www.oceanhabitats.org/home.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

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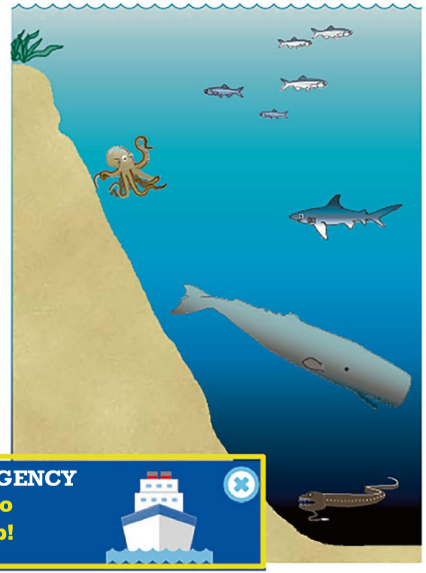

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Class Project

8.

What are two ways that ocean habitats can be different?

Student

SAVED

9.

Why are plants mostly found in the top layer of the ocean?

Student

SAVED

Mr. Webster
Now, click on "Coral Reefs."

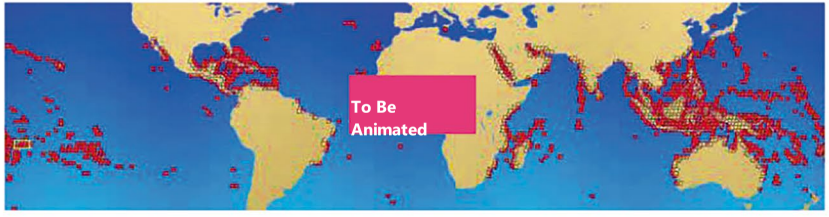
39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/coralreefs.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench



Most coral reefs are located in warm water.

Coral reefs provide a natural habitat and protection for many different fish and animals. Coral reefs are found around the world in warm waters near shorelines where the water is not very deep.

Corals themselves are animals! As a coral dies, it leaves behind its skeleton. New corals grow on the skeletons of the previous generation. This grows the reef over time. Unfortunately, pollution in the ocean is killing the corals.

Watch this video of life in a coral reef.

ePIRLS
Class Project

SAVED

9.

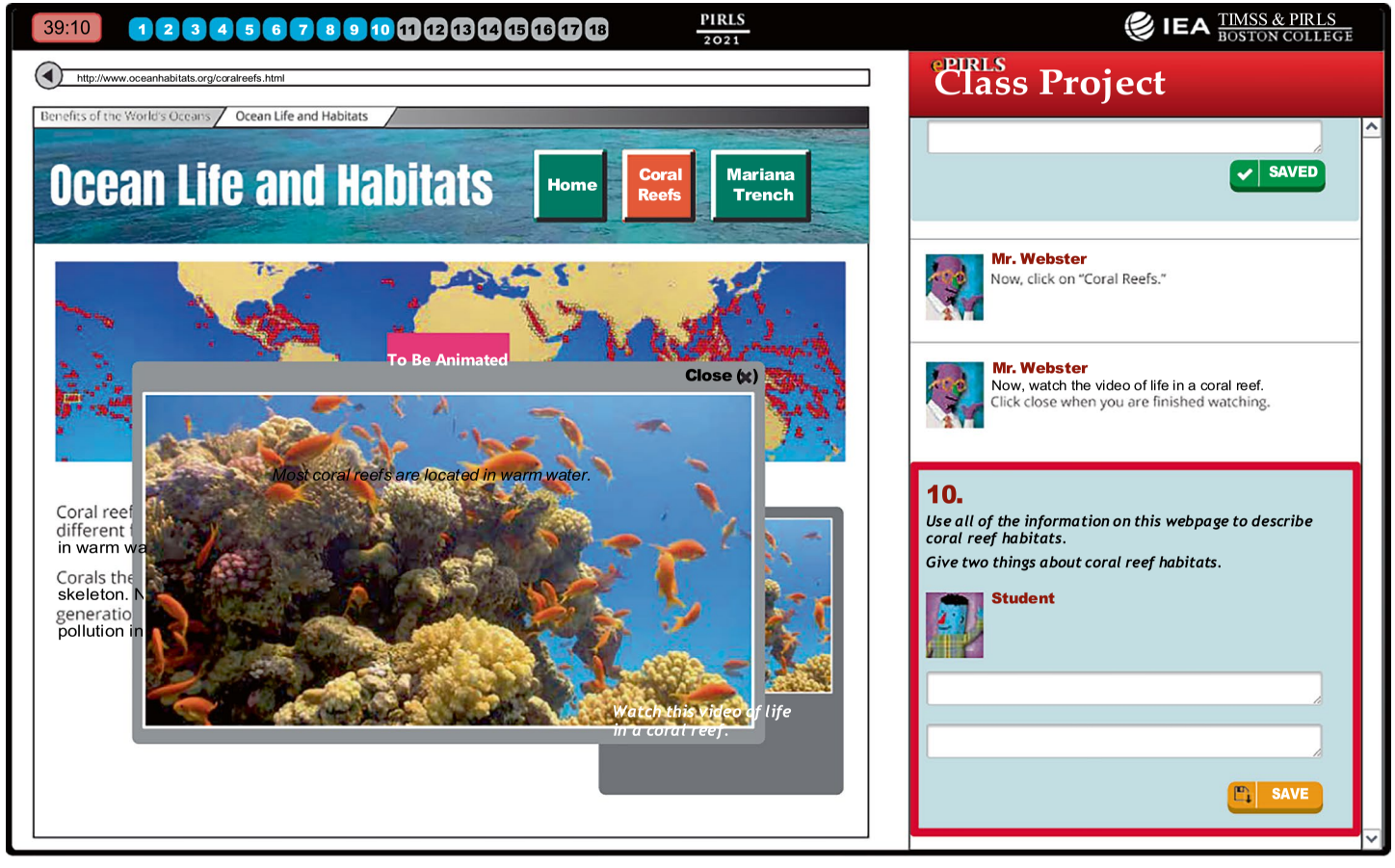
Why are plants mostly found in the top layer of the ocean?

Student

SAVED

Mr. Webster
Now, click on "Coral Reefs."

Mr. Webster
Now, watch the video of life in a coral reef.
Click close when you are finished watching.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http://www.oceanhabitats.org/coralreefs.html
Benefits of the World's Oceans
Ocean Life and Habitats
Ocean Life and Habitats
Home
Coral Reefs
Mariana Trench
To Be Animated
Close (x)
Most coral reefs are located in warm water.
Watch this video of life in a coral reef.
ePIRLS Class Project
SAVED
Mr. Webster
Now, click on "Coral Reefs."
Mr. Webster
Now, watch the video of life in a coral reef.
Click close when you are finished watching.
10.
Use all of the information on this webpage to describe coral reef habitats.
Give two things about coral reef habitats.
Student
SAVE

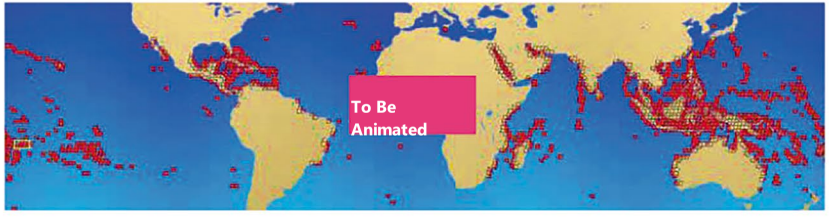
39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/coralreefs.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench



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ePIRLS
Class Project

10.

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Give two things about coral reef habitats.

Student

SAVED

11.

Explain how pollution may affect the fish that live in coral reefs.

Student

SAVE

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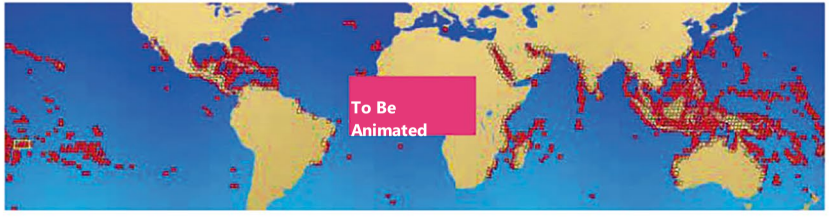
http://www.oceanhabitats.org/coralreefs.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench



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PIRLS

Class Project

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Give two things about coral reef habitats.

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SAVED

11.

Explain how pollution may affect the fish that live in coral reefs.

Student

SAVED

Mr. Webster

The Mariana Trench is another kind of ocean habitat. Now, click on "Mariana Trench."

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/marianatrench.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench

The Mariana Trench is the deepest place in Earth's oceans. It is even deeper than the highest mountain on Earth is tall. Mount Everest would be under water if its base was at the very deep bottom of the Mariana Trench.

The deeper down you go, the more pressure you will feel from the water above you. The water pressure down there is so great, it feels like 3,500 elephants standing on top of you.

ePIRLS
Class Project

11.

Explain how pollution may affect the fish that live in coral reefs.

Student

SAVED

Mr. Webster
The Mariana Trench is another kind of ocean habitat. Now, click on "Mariana Trench."

12.

What does the Mount Everest animation help you understand about the Mariana Trench?

Student

SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/marianatrench.html

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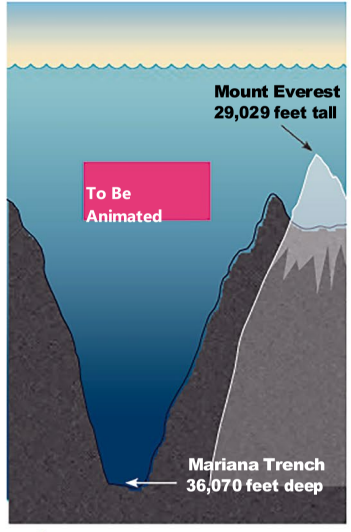

ePIRLS Class Project

coral reefs.

Student

SAVED

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What does the Mount Everest animation help you understand about the Mariana Trench?

Student

SAVED

Mr. Webster
Click to learn about weird fish that live in the deepest part of the ocean.

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/marianatrench.html

Benefits of the World's Oceans / Ocean Life and Habitats

Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench

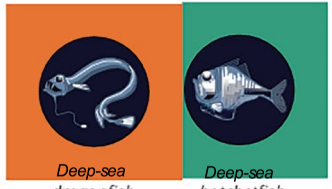
A few specially made vehicles have explored the bottom of the trench, proving that there are weird fish living in this dark, freezing cold water.

The deep-sea dragonfish has oversized teeth, an ugly face, and slippery skin.

It can make itself glow to attract its food. The sudden bright light in the pitch black water lures prey, making it easy for the dragonfish to catch its food.

DEEP-SEA DRAGONFISH Close (x)

To Be Animated



Deep-sea dragonfish

Deep-sea hatchetfish

ePIRLS

Class Project

What does the Mount Everest animation help you understand about the Mariana Trench?

Student

SAVED

Mr. Webster

Click → to learn about weird fish that live in the deepest part of the ocean.

13.

Why is the deep-sea dragonfish a good example of a weird fish?

Give two reasons, using the text and picture to explain.

Student

SAVE

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://www.oceanhabitats.org/marianatrench.html

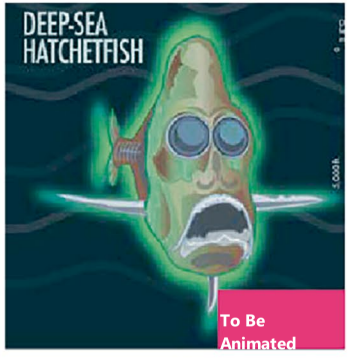
Benefits of the World's Oceans / Ocean Life and Habitats

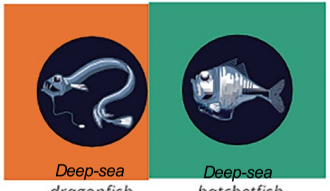
Ocean Life and Habitats

Home | Coral Reefs | Mariana Trench

The deep-sea hatchetfish has an extremely skinny body and shiny scales.

From living in the dark, the deep-sea hatchetfish has big eyes that together are as wide as its entire body.





Deep-sea dragonfish

Deep-sea hatchetfish

ePIRLS
Class Project

SAVED

Mr. Webster
Click ➡ to learn about weird fish that live in the deepest part of the ocean.

13.

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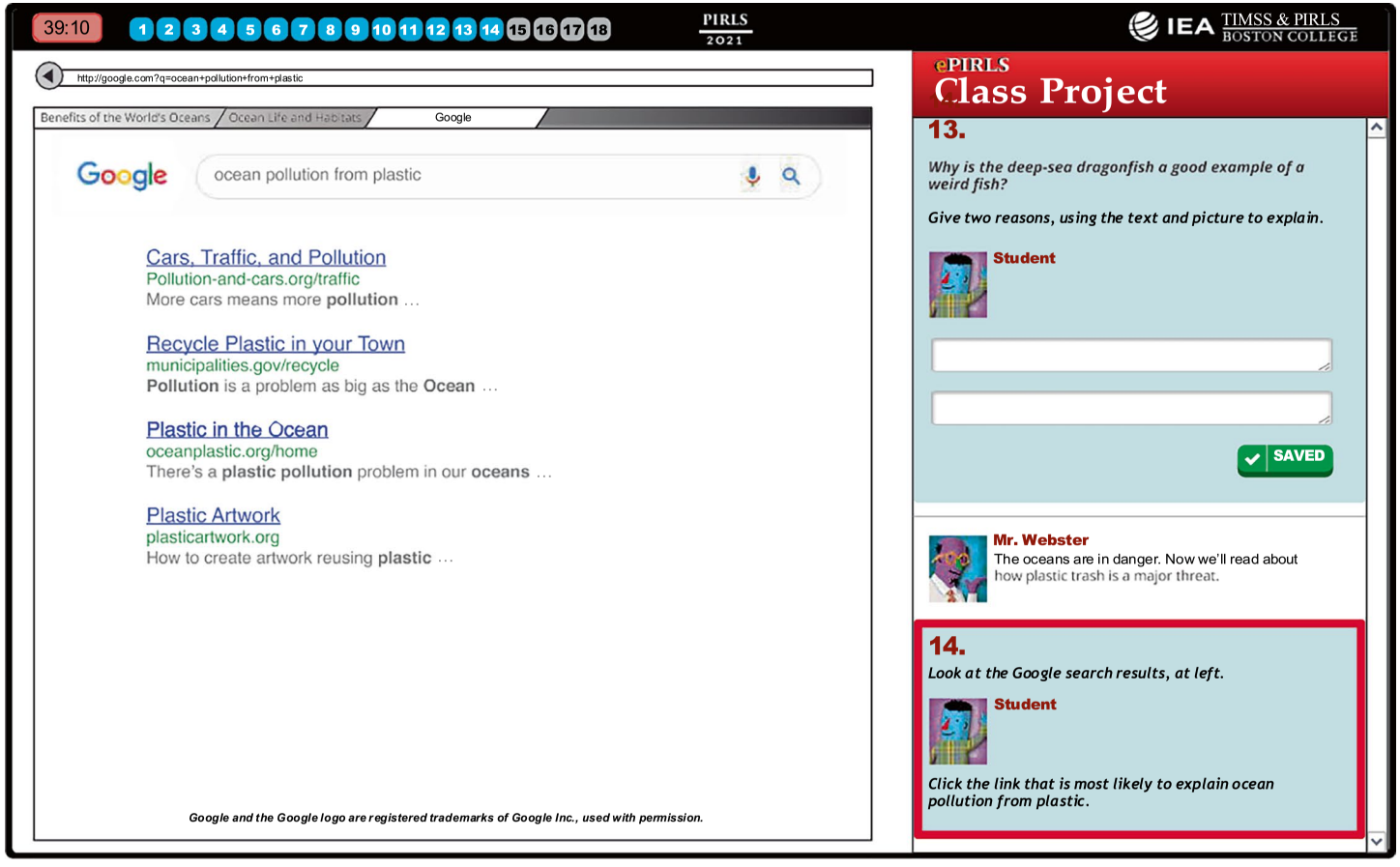
Give two reasons, using the text and picture to explain.

Student

SAVED

Mr. Webster
The oceans are in danger. Now we'll read about how plastic trash is a major threat.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http://google.com?q=ocean+pollution+from+plastic
Benefits of the World's Oceans
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ocean pollution from plastic
Cars, Traffic, and Pollution
Pollution-and-cars.org/traffic
More cars means more pollution …
Recycle Plastic in your Town
municipalities.gov/recycle
Pollution is a problem as big as the Ocean …
Plastic in the Ocean
oceanplastic.org/home
There's a plastic pollution problem in our oceans …
Plastic Artwork
plasticartwork.org
How to create artwork reusing plastic …
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Class Project
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Student
SAVED
Mr. Webster
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14.
Look at the Google search results, at left.
Student
Click the link that is most likely to explain ocean pollution from plastic.

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://oceanplastic.org/home.html

Benefits of the World's Oceans | Ocean Life and Habitats | Plastic in the Ocean

Home

Plastic in the Ocean

WHAT CAN WE DO?

Plastic is very useful, but half the plastic we produce is only used once. Much of it is thrown away and then ends up in the oceans. So much plastic is in the ocean that there is a giant floating pile of plastic bottles and garbage called the Great Pacific Garbage Patch. A plastic bag was even found all the way down in the Mariana Trench.

Besides the garbage that you can see, there also is a lot of garbage that you can't see. After plastic is in the ocean a long time, the sunlight and waves break it up into tiny pieces. Fish and animals eat these tiny pieces of poisonous plastic and then humans often eat the poisoned fish.

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Class Project

14.

Look at the Google search results, at left.

Student

Click the link that is most likely to explain ocean pollution from plastic.

15.

"A plastic bag was even found all the way down in the Mariana Trench."

How does this sentence support the idea that plastic is everywhere in the ocean?

Student

- The ocean has a floating pile of plastic bottles.
- Plastic bags are a serious threat to wildlife.
- The ocean's garbage is over a third plastic.
- Plastic bags have reached such a remote place.

SAVE

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Class Project

Student

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- The ocean's garbage is over a third plastic.
- Plastic bags have reached such a remote place.

SAVED

16.

"Besides the garbage that you can see, there is also a lot of garbage that you can't see."

Why did the author include this sentence?

Student

- To explain about the garbage patch
- To emphasize the hidden danger
- To tell what you can do to help
- To tell you not to worry about it

SAVE

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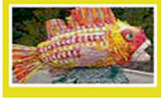

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SAVED

Mr. Webster
Now, click on "What Can We Do?"

39:10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 PIRLS 2021 IEA TIMSS & PIRLS BOSTON COLLEGE

http://oceanplastic.org/whatcanwedo.html

Benefits of the World's Oceans / Ocean Life and Habitats / Plastic in the Ocean

Home

Plastic in the Ocean

WHAT CAN WE DO?

WHAT CAN WE DO?

TECHNICAL SOLUTIONS – Technologies are constantly being developed to reduce the amount of plastic in the oceans. Machines can sort, clean, and recycle plastics into other products like sunglasses and backpacks. After the plastic has been chemically changed into oil, it can be used as fuel.

EACH PERSON SHOULD HELP – Use less plastic! Avoid using plastic bags and drinking out of plastic bottles. If you do use plastic, remember to recycle. Another way for people to help fight plastics in the oceans—picking up trash in your own local area even if you do not live by the beach. A lot of garbage starts on land and the wind blows it into rivers that take it to sea.

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Student

- To explain about the garbage patch
- To emphasize the hidden danger
- To tell what you can do to help
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SAVED

Mr. Webster
Now, click on "What Can We Do?"

17.

Give one way technology can help reduce the amount of plastic in the ocean.

Student

SAVE

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http://oceanplastic.org/whatcanwedo.html

Benefits of the World's Oceans | Ocean Life and Habitats | Plastic in the Ocean

Home

Plastic in the Ocean

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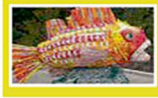

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One person can make a difference in protecting the oceans.

18.

Think about what you read about plastics in the ocean. Do you agree with this statement?

Student

Check your choice.

- [ ] Yes
- [ ] No

Give two reasons to support your choice based on what you have read.

SAVE

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http://oceanplastic.org/whatcanwedo.html

Benefits of the World's Oceans / Ocean Life and Habitats / Plastic in the Ocean

Home

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WHAT CAN WE DO?

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Check your choice.

☐ Yes

☐ No

Give two reasons to support your choice based on what you have read.

SAVED

Mr. Webster
Well done! You have completed your research on oceans.

Mr. Webster
You may now review your responses by scrolling up. If you change a response, remember to click "SAVE." Questions you haven't answered yet are shaded gray in the progress bar.

Mr. Webster
If you would like to finish, please click the Log Out button, below.

LOG OUT

Glossary

Cognitive load: The amount of mental effort or capacity required to process information and perform a task.

Didactic: The way in which teachers teach and help develop knowledge, skills, and attitude.

Digital inclusion: The ability to fully participate in a digital society, in terms of in terms of attitude and motivation, physical access, digital skills, and usage.

Digital literacy: A broad range of skills concerning reading, writing, collaboration, navigation, and critically evaluating within digital contexts.

Digital reading: Reading texts using a digital device.

Digital text: Texts that are read from a screen.

Evaluating: The process of determining whether the source is trustworthy, the information is reliable, and the information is relevant for the reading goal.

Hierarchical text: Texts with a clear tree-like structure.

Hyperlink: A digital link that leads the reader to a different place in the text or to a different text or source.

Hypermedia: Hypertexts that contain multimedia.

Hypertext: Digital texts that contain hyperlinks.

Integrating: The process of combining two or more texts into one mental model.

Linear text: Text presented in a sequential or chronological order.

Mental lexicon: Place in long-term memory where knowledge about words is stored.

Modeling: The process of making thoughts audible by saying what one is thinking while performing an action.

Multimedia: Pictures, videos, or audio that may be added to a text.

Multiple document reading: The process of reading different texts and integrating the information from the different texts.

Navigating: The process of using web browsers and search engines to find digital content.

M. Bruggink et al., *Teaching Reading Comprehension in a Digital World*,
IEA Research for Educators 2, https://doi.org/10.1007/978-3-031-75121-9

Networked text: Text with hyperlinks that cross-reference to other parts of the document without a clear structure.

Reading comprehension: The ability to construct meaning from written texts.

Reading strategies: Techniques and approaches that readers use to comprehend and interpret written texts more effectively.

Self-regulation: The ability to manage one's thoughts, emotions, behaviors, and impulses in order to achieve goals, meet standards, and adapt to various situations.

Working memory: A cognitive system responsible for temporarily storing and manipulating information needed to perform cognitive tasks.