The Institution of Engineering and Technology

FIRST LEGO LEAGUE EXPLORE

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Teacher Guide for Ireland

Developed by the DCU Institute of Education

FIRST® LEGO® League Explore

Presenting: SUBMERGED℠

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Science Foundation Ireland sfi For what's next

Welcome to the *FIRST*® LEGO® League Explore SUBMERGED℠ Teacher Guide for Ireland

Science Foundation Ireland

The development of this guide has been enabled by Science Foundation Ireland through the SFI Discover Programme.

Dublin City University Institute of Education

This guide has been developed by a leading team from the DCU Institute of Education to support teachers across Ireland to engage with *FIRST*® LEGO® League Explore within their classrooms.

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IET

We're passionate about STEM (science, technology, engineering and maths) and inspiring children to follow their dreams, get creative and have fun whilst learning how the world around them works. Our programmes are for children aged 4 to 16 years and aim to bring their imaginations alive to inspire them to engineer a better world in the future.

CreativeHUT

Since 2010 CreativeHUT, formerly Learnit, has been on a mission to 'inspire the creators of tomorrow by making learning fun for the children of today'. We are the delivery partners for *FIRST*® LEGO® League in Ireland. We are proud to partner with the IET and DCU to bring STEM to life through this hands-on, minds-on approach to learning.

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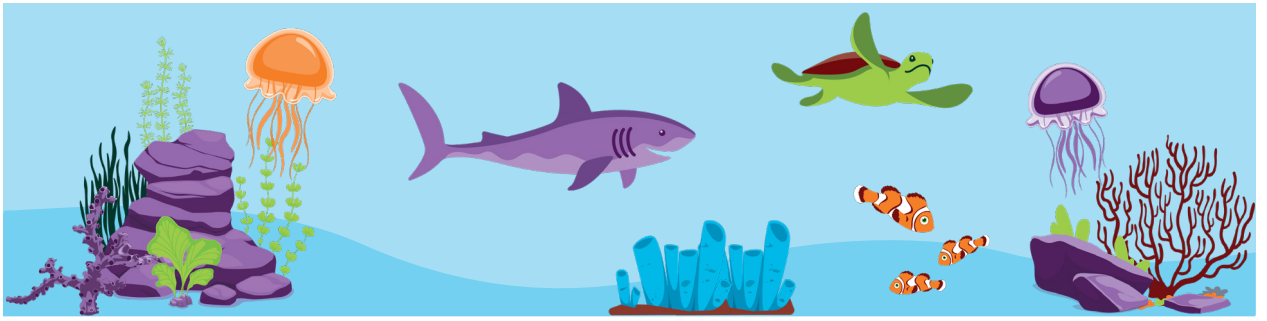
fll.ie/submerged

Contents

Welcome to the SUBMERGED℠ Teacher Guide

The **theme** of this year's *FIRST*® LEGO® League Explore season is **SUBMERGED℠**. Through the SUBMERGED challenge learners will examine how and why people explore the oceans. Our discoveries beneath the ocean surface teach us how this complex ecosystem not only supports the plants and animals that live there, but also plays a crucial role in making the Earth habitable for humans. **Oceans cover 70% of the planet** and provide food, energy and water, as well as absorbing carbon dioxide, providing oxygen, regulating the Earth's temperature and influencing our weather and climate. The oceans are home to a plethora of sea life. As **more than 80% of the ocean remains unexplored**, curious minds are offered opportunities to dive into expeditions. The oceans absorb over 25% of all carbon dioxide (CO_2) emissions, thereby **mitigating climate change** and alleviating its effects. They also provide over 50% of the world's oxygen (O_2); the surface layer of the ocean is teeming with plankton.



The **oceans are also under threat** and in need of conservation and protection. Approximately 8 million tonnes of plastic end up in our oceans every year. Other **threats to the oceans** include overfishing, noise pollution, chemical pollution, rising temperatures and acidification. Steadily rising temperatures in our oceans are forcing fish to move away from their normal habitats in search of cooler temperatures. **Ireland** can likely expect more tropical and subtropical fish to move into our waters while Irish fish such as herring, cod and mackerel are likely to move further north to colder waters closer to the arctic. This has already been observed with increased catches of herring, cod and mackerel in Norway and Iceland.

Throughout their engagement in the SUBMERGED challenge and this **authentic real-world issue**, learners will investigate the role of oceans in providing oxygen, absorbing CO_2, regulating planetary temperatures, influencing weather and climate and providing food and livelihoods to billions of people. Learners will also develop an understanding for the threats to our oceans such as overfishing, rising temperatures, pollution and acidification and develop an appreciation for how people safely observe and support ocean habitats.

This **SUBMERGED Teacher Guide** aims to support Irish primary school teachers by connecting *FIRST* LEGO League Explore SUBMERGED with the Irish Primary School Curriculum. Learners will identify issues and design solutions which represent a unique way to share their ocean discoveries with others. Through this authentic real-world context, children learn to design, build and code, in order to create unique solutions made with LEGO elements and powered by a LEGO Education Set (SPIKE Essential or WeDo 2.0). *FIRST* LEGO League Explore SUBMERGED is embedded throughout the different subjects of the Irish Primary School Curriculum achieving the curriculum objectives, skills, and competencies in a holistic and integrated manner.

This Teacher Guide is organised in two parts:

Part A provides a background to *FIRST* LEGO League Explore SUBMERGED. An overview of the Irish Primary Curriculum and Policy connections is presented alongside general support and advice for teachers.

Part B is a detailed overview of each of the 12 sessions of the SUBMERGED Teacher Guide for Ireland. Primary curriculum links and skill development opportunities are highlighted in each session. Throughout the sessions, learners will be exploring themes and ideas, creating solutions, testing them, iterating on them and sharing with others what they have learned. The learning activities are specifically designed with plenty of scope for differentiation so the sessions can be adapted to suit each participating class. Resources required, details of coding, teacher support, and guiding questions are provided for each session. It is important to note that each session has core curriculum links that are necessary for the learners to learn about the importance of the ocean and how and why people explore the oceans. Extension activities which link across the curriculum and support the development of the learners' knowledge and skills are presented, thereby enhancing their understanding of this real-world context and achieving the aims of the curriculum simultaneously. Engagement with the 12 sessions of the SUBMERGED Teacher Guide for Ireland will involve approximately 15 hours of class time.

What is *FIRST* LEGO League Explore?

FIRST LEGO League Explore is a non-competitive, hands-on programme geared towards primary school aged learners from 2nd class (aged 7-8) to 6th class (aged 11-12).

The programme aims to inspire learners to experiment and grow their confidence, critical thinking, and design skills through meaningful, hands-on learning activities. Each year *FIRST* LEGO League Explore focuses on a relevant, real-world theme with this year's challenge called SUBMERGED. Children work together in teams using elements from a LEGO Education Set (SPIKE Essential or WeDo 2.0) and a SUBMERGED Explore Set to build a Team Model that represents a unique way to share their team's ocean discoveries with others.

This SUBMERGED Teacher Guide has been designed to provide learners with authentic and meaningful curriculum connections to this year's theme of how and why people explore the oceans, and the importance of oceans and the threats they face. The sessions in this Teacher Guide have been intentionally laid out so that learners build up their knowledge, understanding and skills, in advance of designing and building their Team Models and accompanying posters in session 10, preparing to present at a Showcase Event in session 11, and reflecting upon their learning journey in session 12. Figure 1 provides an overview of SUBMERGED sessions 1-12.

Sessions 1-9	Context and knowledge	Developing familiarity and understanding of knowledge, skills and concepts including ocean literacy, computational thinking and coding
Session 10	Team Model and Poster	Building and coding Team Model Creating Team Poster
Sessions 11-12	Showcase Event Reflecting on the SUBMERGED experience	Sharing what the team have learned during the Showcase Event and reflecting on their SUBMERGED learning journey

Figure 1. SUBMERGED Sessions 1-12

Core Values of *FIRST* LEGO League

FIRST LEGO League Explore is underpinned by the six *FIRST* Core Values that are the cornerstones of the programme. *FIRST* LEGO League envisions that through the Core Values, learners use discovery and exploration in each session and learn that helping one another is the foundation of teamwork. Throughout each session it is important that the learners have fun and are motivated. You will find reference to the six Core Values (see Table 1 below) throughout each of the sessions. You can take time to emphasise the Core Value when you see the symbol.

Core Value	Description
	We are stronger when we work together.
	We respect each other and embrace our differences.
	We use creativity and persistence to solve problems.
	We enjoy and celebrate what we do!
	We explore new skills and ideas.
	We apply what we learn to improve our world.

Table 1. Core Values of FIRST LEGO League

The Core Values have strong connections to the Irish SPHE curriculum:

Subject	Strands	Strand Units/Elements	Skills and Concepts
SPHE	Myself and others Myself and the wider world	My friends and other people Relating to others Developing citizenship	Communication skills Working collaboratively and co-operatively with others Personal and self management skills Confidence and competence using language Decision-making skills

Table 2. Irish SPHE curriculum

Learning principles behind SUBMERGED

The Engineering Design Process underpins the entire SUBMERGED challenge, see Figure 2. Here, learners are encouraged to work like real engineers, using scientific, geographical and mathematical skills and understanding to investigate and think critically about real-world problems and propose creative solutions. The Engineering Design Process has four stages: Explore a problem; Create one or more solution(s); Test the solution(s); Share with others what you have learned.

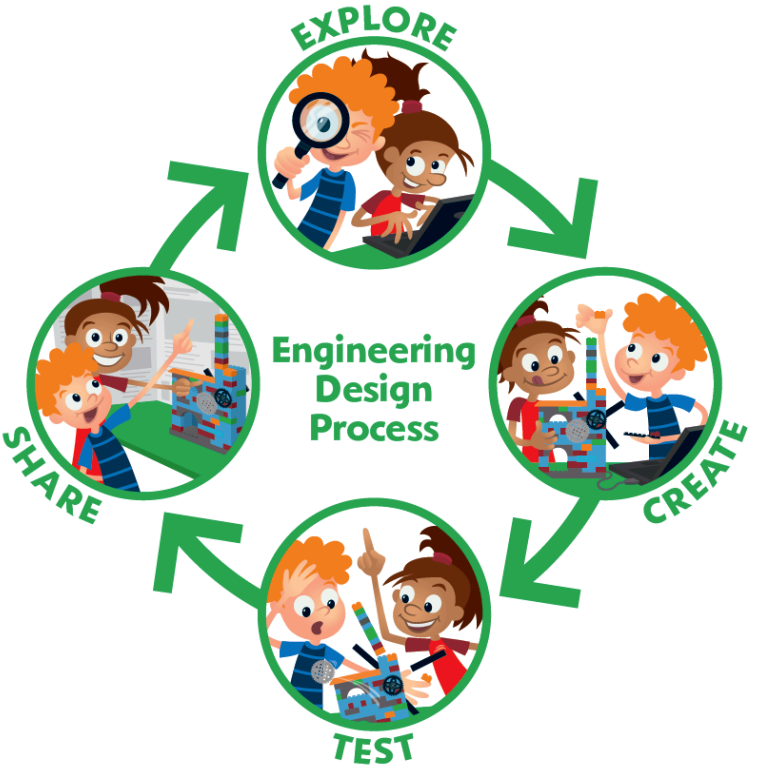


Figure 2. Engineering Design Process

There is no fixed order for this process. Learners may go through some or all parts several times throughout the sessions. These four stages of the Engineering Design Process align with the stages of enquiry-based learning, particularly for both science and geography.

The enquiry-based learning process comprises a child-centred, experiential, constructivist approach whereby learners are active in their learning and participate in the leading of investigations through posing questions and generating ideas before actively creating and collecting data to help develop their understanding. These teaching and learning approaches are advocated throughout the Irish Primary School Curriculum. Enquiry-based learning begins with a problem or obstacle to a learner's development; they analyse the situation; they identify possible solutions; they compare the implications of the different solutions and select the best course of action; they implement this in practice. Roberts' (2013) Framework for Enquiry (Figure 3) is an example of an enquiry-based learning process for teaching and learning in geography and science. As outlined below it has explicit correlations with the Engineering Design Process.

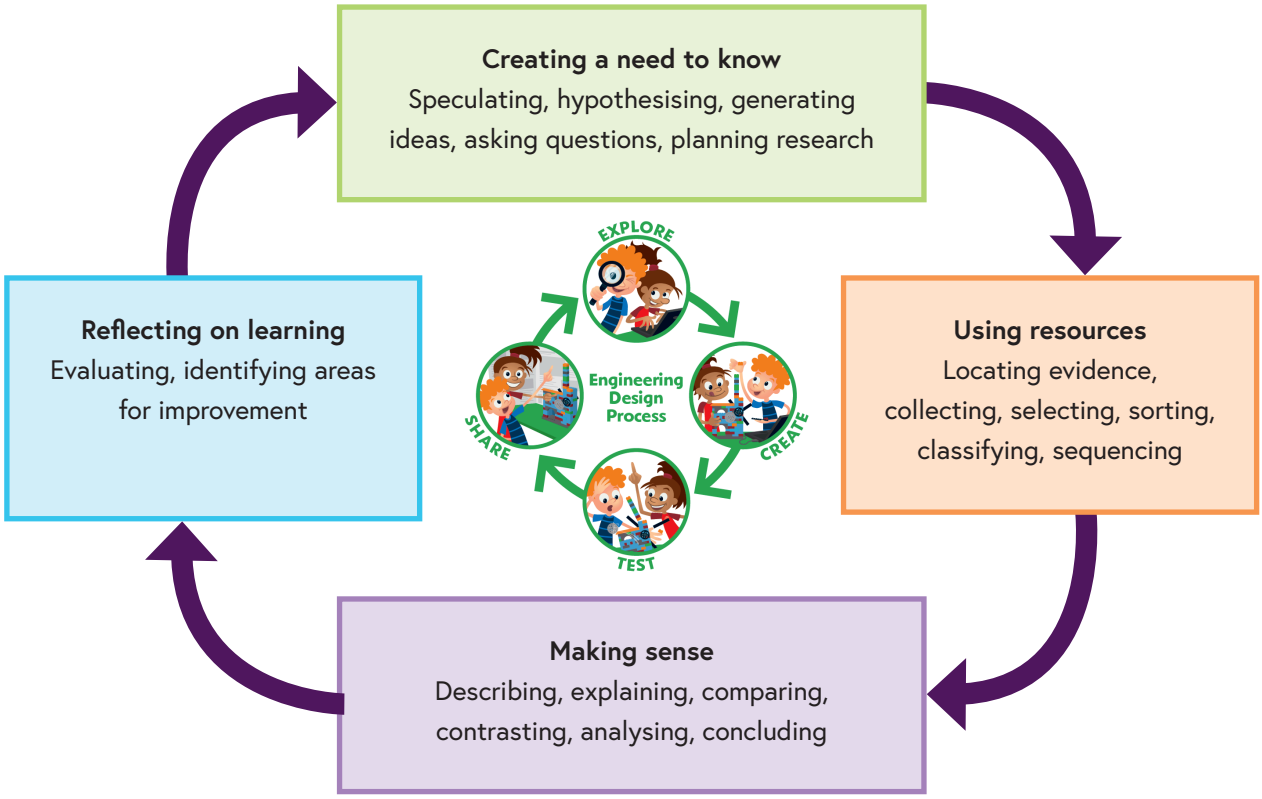
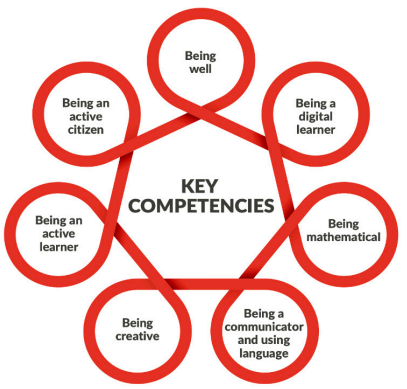
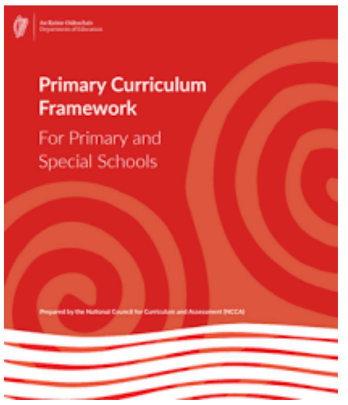


Figure 3. Enquiry-based learning framework (Roberts, 2013)

The Explore stage of the Engineering Design Process is directly aligned with the Creating a Need to Know stage of the enquiry framework. Here, the learners are introduced to the problem or scenario through a stimulus. This involves the learners hypothesising, speculating and generating ideas and questions for investigation drawing on their existing knowledge and everyday experiences. The Create stage of the Engineering Design Process is connected to the Using Resources stage of the enquiry framework. This involves the learners actively carrying out investigations on the issue at hand. Here they use a range of resources to both create and collect data to be used as evidence for their investigations. In both the Test stage of the Engineering Design Process and the Making Sense stage of the enquiry process, the learners analyse and interpret the data pertaining to their investigations, thus reflecting on and modifying their ideas and concepts and developing specific recommendations and solutions for issues. Finally, similar to the Reflecting on Learning stage in the enquiry process, the Share stage of the Engineering Design Process culminates in the learners presenting their work, reflecting on what they learned, and identifying areas where they were successful and areas in need of improvement.

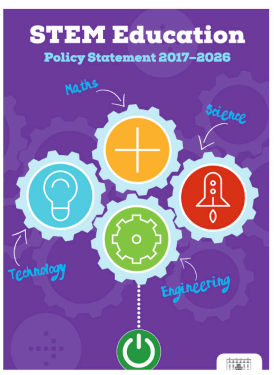
Connections to policy

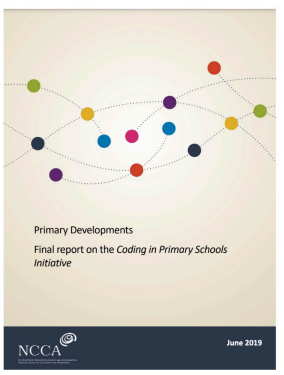


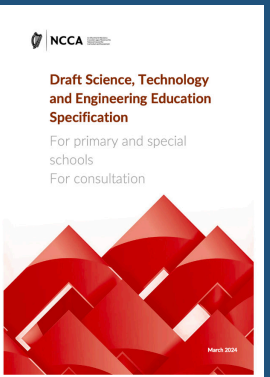


FIRST LEGO League Explore has explicit and embedded connections across the Irish Primary School Curriculum.

FIRST LEGO League Explore is directly linked with a number of domains, standards and statements across both dimensions of the Digital Learning Framework (DLF). This is a school self-evaluation process and aligns with the Digital Strategy for Schools to 2027.

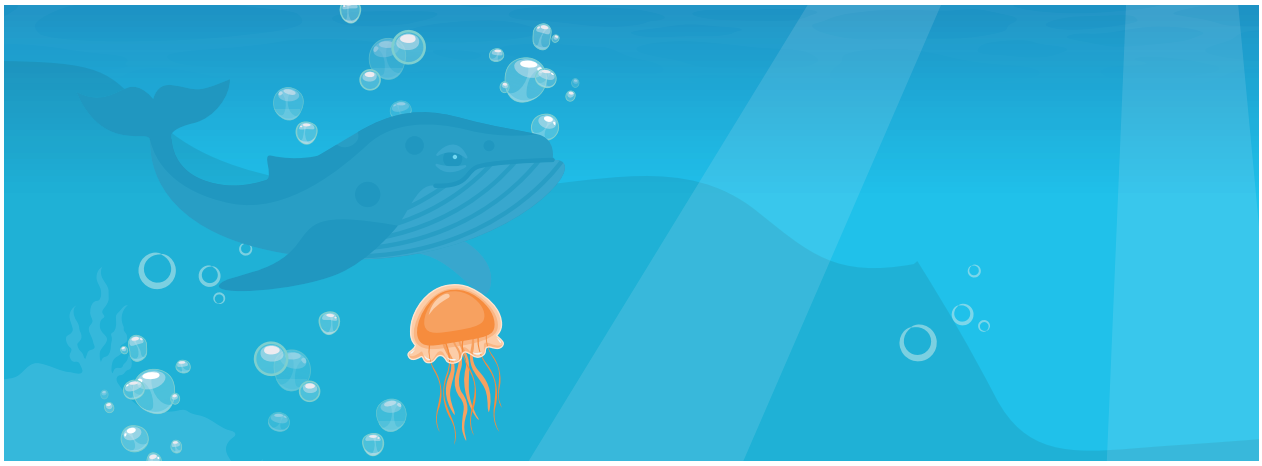






FIRST LEGO League Explore has strong connections with a range of recent policy initiatives, including the proposed Science, Technology and Engineering Education specification which will sit alongside the Primary Mathematics Curriculum to comprise the new primary Science, Technology, Engineering and Mathematics (STEM) curriculum area.

Table 3. Policy connections



How does *FIRST* LEGO League Explore SUBMERGED connect to the Irish Primary Curriculum?

Table 4 below below presents the connections to the Irish Primary School Curriculum (strands and skills associated with curriculum subjects).

Science Living Things; Environmental Awareness and Care; Energy and forces; Materials *Scientific Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating); Sorting and classifying; Designing and making*	**Geography** Natural Environment; Environmental Awareness and Care; Human Environments *Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)*	
Visual Arts Drawing; Construction *An awareness of line; An awareness of form; An awareness of space*	**History** Continuity and Change over Time; Life, society, work and culture in the past *Time and chronology; Change and continuity; Analysing; recording and communicating; predicting*	**SPHE** Myself and others; Myself and the wider world *Communication; Cooperation; Decision-making*
Mathematics Number; Shape and space; Measures *Applying and problem solving; integrating and connecting; Reasoning; Communicating and expressing; Implementing*	**Literacy** Oral Language; Writing *Communicating; Understanding; Exploring and using*	

Table 4. Irish Primary Curriculum connections

Table 5 provides a more explicit overview of the curriculum Strand and Strand Unit links in each of the SUBMERGED sessions.

SUBMERGED curriculum connections

Session	Session 1: What are oceans? Where are oceans? Why are oceans important?	Session 2: Experiments to understand how oceans work	Session 3: Ocean zones and habitats	Session 4: Threats to our oceans
Overview of the session	Learners will identify the locations of oceans on maps/globes and investigate the ways in which oceans are important.	Learners will conduct three separate experiments to explore and demonstrate how the oceans work; focusing on the role of the ocean in the Water Cycle, the function of the ocean in regulating the Earth's temperature; and exploring properties of sea water.	Learners will be introduced to the different zones of the ocean and how different animals adapt to life at these depths.	Learners will explore the major threats to our oceans, identifying the causes, effects and possible solutions and actions.
Curriculum connections	**Geography** *Strand(s):* Natural Environment; Environmental Awareness and Care *Strand Unit(s):* Lands, Rivers and Seas; Environmental Awareness ; Caring for the Environment *Skill(s):* Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Science** *Strand(s):* Environmental Awareness and Care; Living Things *Strand Unit(s):* Environmental Awareness; Caring for the Environment; Plants and Animals *Skill(s):* Working as a Scientist Scientific Investigation Skills (Questioning, Hypothesising, Predicting, Investigating, Experimenting, Observing, Analysing, Recording, Communicating)	**Science** *Strand(s):* Environmental Awareness and Care; Living Things; Materials *Strand Unit(s):* Environmental Awareness; Caring for the Environment; Plants and Animals; Properties & Characteristics of Materials; Materials & Change *Skill(s):* Working as a Scientist Scientific Investigation Skills (Questioning, Hypothesising, Predicting, Investigating, Experimenting, Observing, Analysing, Recording, Communicating) **Geography** *Strand(s):* Natural Environment; Environmental Awareness and Care *Strand Unit(s):* Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment *Skill(s):* Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)	**Science** *Strand(s):* Living Things *Strand Unit(s):* Plants and Animals *Skill(s):* Investigating, Questioning, Hypothesising, Recording, Communicating **Geography** *Strand(s):* Natural Environment; Environmental Awareness and Care *Strand Unit(s):* Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment *Skills(s):* Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using	**Geography** *Strand(s):* Natural Environment; Environmental Awareness and Care *Strand Unit(s):* Lands, Rivers and Seas; Environmental Awareness ; Caring for the Environment *Skills(s):* Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Science** *Strand(s):* Environmental Awareness and Care; Living Things *Strand Unit(s):* Environmental Awareness; Caring for the Environment; Plants and Animals; *Skill(s):* Working as a Scientist Scientific Investigation Skills (Questioning, Hypothesising, Predicting, Investigating, Experimenting, Observing, Analysing, Recording, Communicating) **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using

Session	Session 5: Developments in underwater navigation and exploration	Session 6: How marine biologists explore the sunlight zone	Session 7: How marine archaeologists explore the twilight zone	Session 8: How oceanographers explore the abyssal zone
Overview of the session	Learners will develop an understanding of how humans navigate and explore the ocean and build an underwater vessel for this purpose.	Learners will explore the work of a marine biologist in the ocean's sunlight zone.	Learners will be introduced to the work of a marine archaeologist in the twilight zone. They will adapt and improve the submarine model by adding sensors and outputs.	Learners will go even deeper to learn about the abyssal zone and the work of an oceanographer to explore it. Learners will modify an autonomous underwater vehicle (AUV).
Curriculum connections	**History** *Strand(s):* Continuity and change over time *Strand Unit(s):* Transport *Skill(s):* Time and chronology; Change and continuity **Geography** *Strand(s):* Natural Environment; Environmental Awareness and Care *Strand Unit(s):* Lands, Rivers and Seas; Environmental Awareness ; Caring for the Environment *Skill(s):* Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using	**Science** *Strand(s):* Environmental Awareness and Care; Living Things *Strand Unit(s):* Environmental Awareness; Caring for the Environment; Plants and Animals *Skill(s):* Working as a Scientist Scientific Investigation Skills (Questioning, Hypothesising, Predicting, Investigating, Experimenting, Observing, Analysing, Recording, Communicating) **Geography** *Strand(s):* Natural Environment; Human Environments *Strand Unit(s):* Lands, Rivers and Seas; People at work *Skill(s):* A sense of place; a sense of space; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using	**Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using **Geography** *Strand(s):* Human Environments *Strand Unit(s):* People at work *Skill(s):* Analysing; recording and communicating; predicting **History** *Strand(s):* Life, society, work and culture in the past; Continuity and change over time *Strand Unit(s):* Life during World War II; Transport *Skill(s):* Change and continuity; cause and effect; using evidence; synthesis and communication; empathy **Mathematics** *Strand(s):* Number; Shape and space *Strand Unit(s):* Fractions; Decimals; 2D / 3D shapes; Lines and angles *Skill(s):* Applying and problem-solving; Communicating and expressing; Integrating and connecting; Reasoning; Implementing	**Science** *Strand(s):* Living Things; Energy and Forces *Strand Unit(s):* Plant and animal life; Forces *Skill(s):* Questioning; Observing; Sorting and classifying; Designing and making **Geography** *Strand(s):* Human Environments; Natural Environment; Environmental Awareness and Care *Strand Unit(s):* People at work; Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment *Skill(s):* Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using

Session	Session 9: A closer look at marine life	Session 10: Team Model and Poster	Session 11: Let's share - preparation for showcase and Showcase Event	Session 12: Let's reflect
Overview of the session	Learners will investigate one marine animal to tie together the importance of oceans, the different ocean zones, marine careers, and how marine animals adapt to their environment and threats.	Learners will work in teams to create their Team Model and Poster which represent a unique way to share their team's ocean discoveries with others.	Learners will prepare to share their SUBMERGED Team Model and Poster at a Showcase Event.	Learners will reflect upon the SUBMERGED sessions, their Team Model and Poster, and their understanding of the importance of our oceans, as well as how and why people explore the oceans.
Curriculum connections	**Science** *Strand(s):* Living Things; Environmental Awareness and Care *Strand Unit(s):* Plants and Animals; Caring for the Environment *Skill(s):* Questioning; Observing; Sorting and classifying; Designing and making **Geography** *Strand(s):* Human Environments; Natural Environment; Environmental Awareness and Care *Strand Unit(s):* People at work; Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment *Skill(s):* Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating) **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using **SPHE** *Strand(s):* Myself and others *Strand Unit(s):* My friends and other people; Relating to others *Skill(s):* Communication; Cooperation; Decision-making	**Mathematics** *Strand(s):* Shape and space; Measures *Strand Unit(s):* 2-D/3-D shapes; Time *Skill(s):* Applying and problem-solving; Communicating and expressing; Integrating and connecting; Reasoning; Implementing **Science** *Strand(s):* Energy and Forces; Materials *Strand Unit(s):* Forces; Properties and characteristics of materials *Skill(s):* Design and Make **Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using **Visual Arts** *Strand(s):* Construction; Drawing *Strand Unit(s):* Making constructions; Making drawings *Skill(s):* An awareness of line; An awareness of form; An awareness of space **SPHE** *Strand(s):* Myself and others; Myself and the wider world *Strand Unit(s):* My friends and other people; Relating to others; Developing citizenship *Skill(s):* Communication; Cooperation; Decision-making	**Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using **Visual Arts** *Strand(s):* Construction; Drawing *Strand Unit(s):* Making constructions; Making drawings *Skill(s):* An awareness of line; An awareness of form; An awareness of space	**Literacy** *Strand(s):* Oral Language *Strand Unit(s):* Communicating *Skill(s):* Communicating; Understanding; Exploring and using **Visual Arts** *Strand(s):* Construction; Drawing *Strand Unit(s):* Making constructions; Making drawings *Skill(s):* An awareness of line; An awareness of form; An awareness of space

Table 5. SUBMERGED curriculum connections

Ocean Literacy

This SUBMERGED Teacher Guide for Ireland aims to enable learners to appreciate the **complex nature of the ocean** and its crucial function in shaping and supporting life for all beings on Earth. The interdependence and interconnectedness existing between us and oceans is best understood through the concept of Ocean Literacy. Ocean Literacy is an "understanding the ocean's influence on myself and my influence on the ocean". SUBMERGED aims to enable learners to develop a clear understanding of these connections and to be able to communicate their learning in a meaningful way and make positive, informed decisions and solutions for the future of the Oceans of our planet.

An Ocean Literacy Framework comprising 7 Ocean Literacy Principles has been developed by scientists and educators to better facilitate learning about the oceans of the world (UNESCO, 2017). These principles are designed to introduce learners to the most important connections we have with our oceans with each principle acting as an excellent trigger to any inquiry, investigation and/or discussion.

The 7 Ocean Literacy Principles:

1. Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

Digital Learning Framework (DLF) and School Self-Evaluation (SSE) connections

As part of the process in writing a digital learning plan, schools should firstly familiarise themselves with the Digital Learning Framework (DLF). Having reviewed the domains and standards, the school should identify the standard or standards on which it wishes to focus. This could be **one standard**, but not more than three. In some instances a school might identify one standard from the Teaching & Learning Dimension, and one standard from the Leadership & Management Dimension. For each standard there are a number of statements of effective practice and highly effective practice.

This SUBMERGED Teacher Guide will only refer to statements of effective practice, however a school may feel the statement of highly effective practice is more suitable to their context.

For further information on the Digital Learning Framework and the process of completing a Digital Learning Plan for your school visit **dlplanning.ie**. The **Digital Learning Planning Guidelines book** is a very useful guide in creating a Digital Learning Plan.

Tables 6 and 7 give an overview of the connections between SUBMERGED and the DLF and SSE.

For a school beginning to use a LEGO Education Set (SPIKE Essential or WeDo 2.0) and *FIRST* LEGO League Explore for the first time, one or two of the following standards and statements could be considered when preparing your Digital Learning Plan:

	Teaching and Learning	
Subject	**Detail from DLF**	**Guidance**
Pupil	**Domain 1:** Learner Outcomes **Standard:** Pupils enjoy their learning, are motivated to learn and expect to achieve as learners. **Statement:** Pupils use appropriate digital technologies to foster active engagement in attaining appropriate learning outcomes.	Through engagement with SUBMERGED, pupils will use appropriate digital technologies (e.g. LEGO Education materials & digital devices etc.) to actively explore the 'challenge question' and create Team Models.
	Domain 1: Learner Outcomes **Standard:** Pupils enjoy their learning, are motivated to learn and expect to achieve as learners. **Statement:** Pupils use digital technologies to collect evidence and record progress.	Pupils will use digital devices and a portfolio tool to document the engineering design process while exploring the challenge question in SUBMERGED.
Teacher	**Domain 3:** Teachers' Individual Practice **Standard:** The teacher selects and uses planning, preparation and assessment practices that progress pupils' learning. **Statement:** Teachers use appropriate digital technologies to design complex, real-world problems and structure them in a way that incorporates key subject matter concepts.	Teachers adapt and use the SUBMERGED learning activities in order to provide pupils with complex, real-world problems which incorporate key subject matter concepts. .
	Leadership and Management	
Leaders	**Domain 1:** Leading Learning and Teaching **Standard:** Promote a culture of improvement, collaboration, innovation and creativity in learning, teaching, and assessment **Statement:** The principal and other leaders in the school encourage teachers to use digital technologies to enhance their learning, teaching and assessment practices, and to share their practice.	School leaders actively encourage and support teachers in their use of SUBMERGED with pupils. Teachers are encouraged and facilitated to share their *FIRST* LEGO League Explore practice with colleagues.

Table 6. Connections between SUBMERGED and the DLF and SSE.

For schools who have previously engaged with a LEGO Education Set (SPIKE Essential or WeDo 2.0) or *FIRST* LEGO League resources, or schools who would like to take a different focus within their DL plan, the following section identifies several standards which could be met through participating in *FIRST* LEGO League Explore.

Remember, in order for the DL plan to be achievable, a school should ideally only select one/two standard(s) in a given DL planning cycle.

	Teaching and Learning	
	Detail from DLF	**Guidance**
DOMAIN 1	**Domain 1:** Learner Outcomes **Standard:** Pupils enjoy their learning, are motivated to learn and expect to achieve as learners. **Statement:** Pupils use appropriate digital technologies to foster active engagement in attaining appropriate learning outcomes.	Through engagement with *FIRST* LEGO League Explore, pupils will use appropriate digital technologies (e.g. LEGO Education materials & digital devices etc.) to actively explore the 'challenge question' and create Team Models.
	Domain 1: Learner Outcomes **Standard:** Pupils enjoy their learning, are motivated to learn and expect to achieve as learners. **Statement:** Pupils use digital technologies to collect evidence and record progress.	Pupils will use digital devices and a portfolio tool to document the engineering design process while exploring the challenge question in SUBMERGED.
	Domain 1: Learner Outcomes **Standard:** Pupils demonstrate the knowledge, skills and understanding required by the primary curriculum **Statement:** Pupils can use a range of digital technologies to demonstrate the knowledge, skills and understanding required by the Primary School Curriculum.	Through engagement with the SUBMERGED challenge question, pupils will use a range of digital technologies (e.g. LEGO Education materials & digital devices etc.) to demonstrate knowledge, skills and understanding in the form of Team Models, Team Posters and other tasks included in SUBMERGED.
	Domain 1: Learner Outcomes **Standard:** Pupils demonstrate the knowledge, skills and understanding required by the primary curriculum **Statement:** Pupils use digital technologies effectively to develop their knowledge, skills and understanding in accordance with the content objectives, learning outcomes, skills and concepts of the Primary School Curriculum.	Pupils develop their knowledge, skills and understandings through engagement with the SUBMERGED challenge question; specifically through the Engineering Design Process, in designing and building Team Models and in preparing a Team Poster.
DOMAIN 2	**Domain 2:** Learner Experiences **Standard:** Pupils engage purposefully in meaningful learning activities **Statement:** Pupils use digital technologies for sourcing and exchanging information to develop understanding and support basic knowledge creation.	While engaging with the SUBMERGED challenge question and tasks, pupils use digital technologies for sourcing, exchanging of information to develop understanding and support the creation of their Team Model and Team Poster
	Domain 2: Learner Experiences **Standard:** Pupils reflect on their progress as learners and develop a sense of ownership of and responsibility for their learning **Statement:** Pupils use digital technologies to collect evidence, record and reflect on their progress, and develop their competence as self-directed learners.	The SUBMERGED challenge question and focus on Engineering Design Process enable pupils to engage in self-directed learning activities which involve the collection, recording and reflection on their projects, including Team Models and Team Posters.

	Teaching & Learning	
	Detail from DLF	**Guidance**
DOMAIN 3	**Domain 3:** Teachers' Individual Practice **Standard:** The teacher has the requisite subject knowledge, pedagogical knowledge and classroom management skills **Statement:** Teachers design or adapt learning experiences that incorporate digital technologies and make learning activities relevant and meaningful to support pupils' learning.	Teachers adapt and differentiate the SUBMERGED learning activities which incorporate digital technologies (e.g. LEGO Education materials & digital devices etc.) to support pupils' learning.
	Domain 3: Teachers' Individual Practice **Standard:** The teacher selects and uses planning, preparation and assessment practices that progress pupils' learning **Statement:** Teachers use appropriate digital technologies to design complex, real-world problems and structure them in a way that incorporates key subject matter concepts.	Teachers adapt and use the SUBMERGED learning activities in order to provide pupils with complex, real-world problems which incorporate key subject matter concepts.
DOMAIN 4	**Domain 4:** Teachers' Collaborative Practice **Standard:** Teachers value and engage in professional development and professional collaboration **Statement:** Teachers engage in professional development and work with colleagues to help them select and align digital technologies with effective teaching strategies to expand learning opportunities for all pupils	Teachers engage with professional learning opportunities (e.g. DCU/CreativeHUT/Oide) in order to develop confidence and competence in making use of the LEGO SPIKE Essential or WeDo 2.0 and *FIRST* LEGO League resources to design learning opportunities for all pupils.
	Domain 4: Teachers' Collaborative Practice **Standard:** Teachers work together to devise learning opportunities for pupils across and beyond the curriculum **Statement:** Teachers participate in professional online communities to help them design learning opportunities for pupils across and beyond the curriculum.	Teachers engage with outside agencies (e.g. DCU/CreativeHUT/Oide) in order to develop confidence and competence in making use of the LEGO SPIKE Essential or WeDo 2.0 and *FIRST* LEGO League resources to design learning opportunities for pupils across and beyond the curriculum.
	Domain 4: Teachers' Collaborative Practice **Standard:** Teachers contribute to building whole-staff capacity by sharing their expertise **Statement:** Teachers collaborate in determining how digital technologies can be used effectively for teaching, learning and assessment (TLA).	Teachers collaborate to discuss and determine how the SUBMERGED resources and equipment can be used effectively for teaching, learning and assessment.

Table 7 a. Connections between SUBMERGED and the DLF and SSE.

Leadership and Management		
Detail from DLF	**Guidance**	
Domain 1: Leading Learning and Teaching **Standard:** Promote a culture of improvement, collaboration, innovation and creativity in learning, teaching, and assessment **Statement:** The principal and other leaders in the school encourage teachers to use digital technologies to enhance their learning, teaching and assessment practices, and to share their practice.	School leaders actively encourage and support teachers in their use of SUBMERGED with pupils. Teachers are encouraged and facilitated to share their SUBMERGED practice with colleagues.	DOMAIN 1
Domain 1: Leading Learning and Teaching **Standard:** Manage the planning and implementation of the curriculum **Statements:** The principal and other leaders in the school plan for and implement a broad and balanced curriculum using digital technologies that offer new opportunities for learning. They are committed to ensuring that the school curriculum is implemented in a way that provides valuable learning experiences designed to exploit the potential of digital technologies.	School leaders plan to implement SUBMERGED in order to provide valuable learning experiences which both exploit the potential of digital technologies and facilitate a broad and balanced curriculum with new opportunities for thematic teaching.	
Domain 1: Leading Learning and Teaching **Standard:** Foster teacher professional development that enriches teachers' and pupils' learning **Statement:** The principal and other leaders in the school support teachers' continuing professional development to develop teacher competence in the use of digital technologies, to support high-quality teaching and learning.	Teachers are encouraged and supported to engage with professional development which supports their engagement with SUBMERGED.	
Domain 2: Managing the Organisation **Standard:** Manage the school's human, physical and financial resources so as to create and maintain a learning organisation **Statements:** The board of management ensures the provision and maintenance of digital teaching aids and equipment to a good standard. Physical learning spaces have been designed or adapted to harness and optimise the use of a range of digital technologies for learning.	All required digital technologies (e.g. LEGO Education materials & digital devices etc.) are available to the teacher and pupils. Considerations are made to the maintenance of this equipment. Considerations have been made to the layout of the classroom/multi-purpose space to best facilitate the Engineering Design Process and engagement with the SUBMERGED learning activities.	DOMAIN 2

Leadership and Management		
Detail from DLF	**Guidance**	
Domain 3: Leading School Development **Standard:** Manage, lead and mediate change to respond to the evolving needs of the school and to changes in education **Statement:** The principal and other leaders in the school are informed by national policy and technological developments, and see their relevance to the school.	School leaders support and encourage teachers in use of SUBMERGED due to its clear alignment with policy and relevance to the school.	DOMAIN 3
Domain 4: Developing Leadership Capacity **Standard:** Empower staff to take on and carry out leadership roles **Statements:** The principal and other leaders in the school encourage teachers to take on leadership roles and to lead the use of digital technologies for learning, teaching and assessment, and are willing to distribute significant leadership responsibilities. They develop organisational structures to facilitate and encourage the sharing of practice and peer mentoring in the use of digital technologies for learning, teaching and assessment.	School leaders encourage teachers to participate in SUBMERGED. Teachers are then facilitated to share their experiences and expertise with colleagues in order to enable another teacher and class to participate in SUBMERGED.	DOMAIN 4

Table 7 b. Connections between SUBMERGED and the DLF and SSE.

The Seven Key Competencies of the new Primary Curriculum Framework

In order to support learners interacting with and engaging in the social world of their home, school and community, the Irish Primary Curriculum Framework includes seven 'key competencies' which are inextricably interconnected. These competencies were identified specifically in order to support and enable learners to develop a deep appreciation for the natural world and an understanding of how the world works. It is envisaged that this approach will enable learners to develop the essential knowledge, skills, concepts, dispositions, attitudes and values to adapt and deal with a range of situations, challenges and contexts in support of broader learning goals. These seven key competencies are presented in Figure 4.

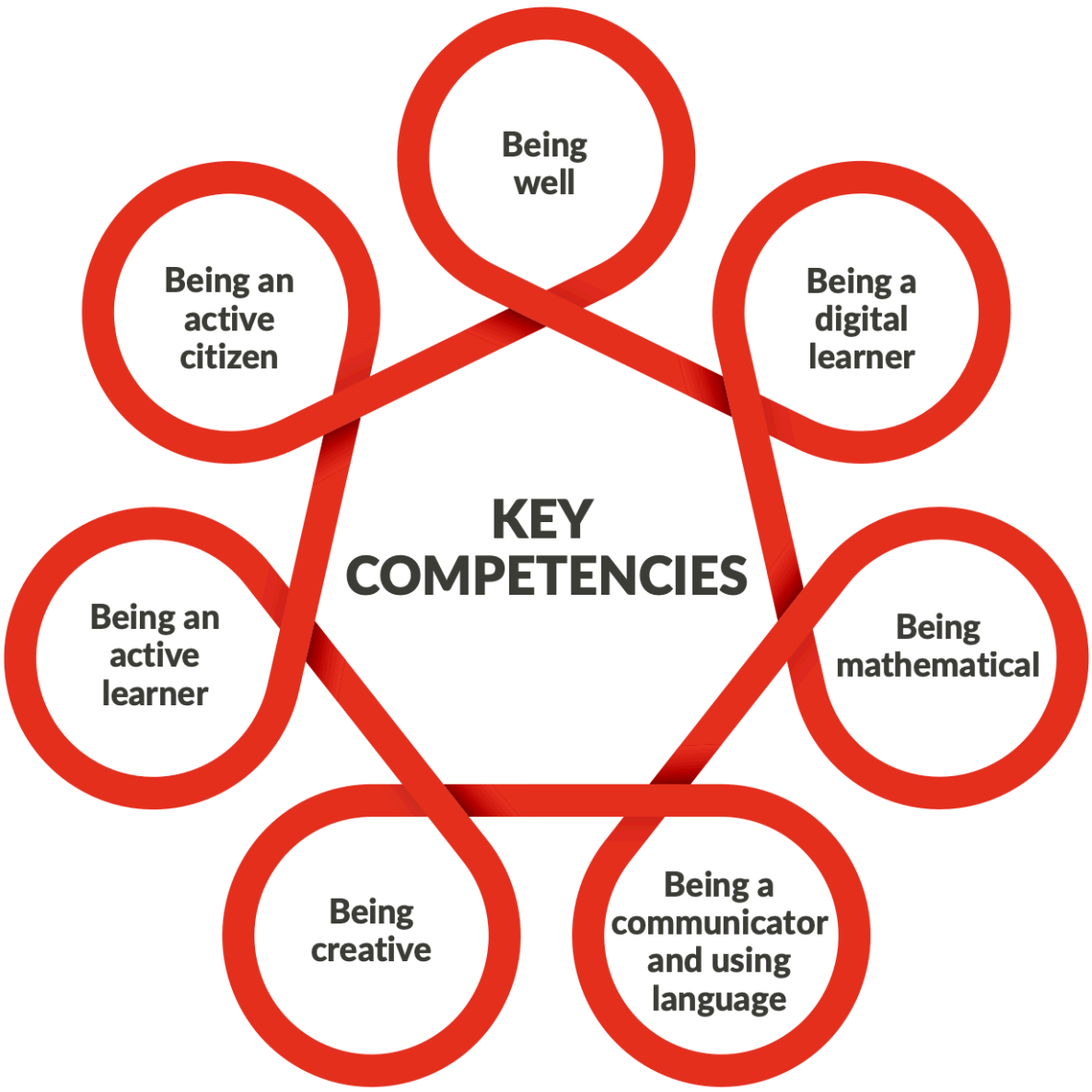


Figure 4. The Seven Key Competencies of the Primary Curriculum Framework.

This *FIRST* LEGO League Explore SUBMERGED Teacher Guide has been designed to support the development of all seven of the key competencies of the Primary Curriculum Framework in an integrated way as presented in Figure 5 and outlined below:

The '**Being an Active Citizen**' competency fosters within learners the knowledge, skills, concepts, attitudes, values and dispositions that motivate and empower them as citizens to take positive actions to live justly and sustainably. It enables learners to question, critique and understand what is happening in the world and how aspects of our lives can be improved. It places democratic practices at the centre of the learning process. Through engaging in *FIRST* LEGO League Explore SUBMERGED, learners are facilitated in understanding the interconnectedness and interdependence of people and the ocean. *FIRST* LEGO League Explore SUBMERGED encourages and enables learners to appreciate the importance of the oceans and to understand the issues related to oceans, investigating causes and effects and proposing solutions. Learners are working collaboratively to identify and solve problems, and make decisions through democratic practices. The 'Being an Active Citizen' competency is embedded within *FIRST* LEGO League Explore SUBMERGED in that the challenge and associated sessions fosters within learners the knowledge, skills, concepts, attitudes, values and dispositions that motivate and empower them as citizens to take positive actions to live justly and sustainably with regard to the rights of others and the natural world.

The '**Being Creative**' competency focuses on recognising and nurturing learners' innate creativity, providing learners with opportunities for meaningful creative experiences through exploring and expressing ideas and reflecting on experiences. *FIRST* LEGO League Explore SUBMERGED holds that learners are creative learners, and as such, should be encouraged to be curious, open minded and imaginative. It comprises the attributes of 'Being Creative' such as participating in and enjoying creative experiences, being curious, being imaginative, being innovative, using creative processes and exploring alternative ways of communicating. Throughout the learning activities and sessions of this challenge, learners are encouraged to share and challenge each others' ideas, to reflect upon new learnings and their own experiences and to think critically about realistic solutions to real-world problems associated with our oceans.

The '**Being a Digital Learner**' competency in the new Primary Curriculum Framework aims to support learners in becoming creative, confident and critical users of digital technology. Throughout *FIRST* LEGO League Explore SUBMERGED, learners will develop their knowledge, skills, concepts, attitudes, values and dispositions through problem-solving, experimenting and creating, using a wide range of digital technologies including digital mapping, collaborative planning, coding and communication software. *FIRST* LEGO League Explore SUBMERGED develops learners' responsible, safe and ethical use of technology by embedding digital technologies in the learning process.

The '**Being Mathematical**' competency aims to aid learners in developing and applying mathematical thinking to solve a range of problems in everyday situations. In order to participate in today's world, learners need to be able to think and communicate quantitatively, to make sense of data, to have spatial awareness and to recognise and understand patterns and sequences. Being mathematical involves learners drawing upon a range of knowledge, skills, concepts, attitudes, values and dispositions as they recognise and interpret real-world information presented mathematically. Core attributes of the 'Being Mathematical' competency are inherently ingrained throughout the sessions for *FIRST* LEGO League Explore SUBMERGED. Throughout SUBMERGED, learners are challenged to solve problems and make sense of real-world contexts using mathematics by recognising relationships, connections, patterns, as well as interpreting and processing information and data.

According to the new Primary Curriculum Framework, the '**Being a Communicator and using Language**' competency develops learners' understanding and enjoyment of interacting with others. Communicating and using language means being able to understand, interpret and use different forms of communication including gesture, expression, spoken language, printed text, broadcast media, and digital media. *FIRST* LEGO League Explore SUBMERGED involves learners engaging purposefully with different text types including spoken, print and electronic formats. Here learners are encouraged to share and reflect upon their experiences, thoughts, ideas and feelings in a variety of ways, as well as learning how to observe, listen to, interpret and show respect for the perspectives of others.

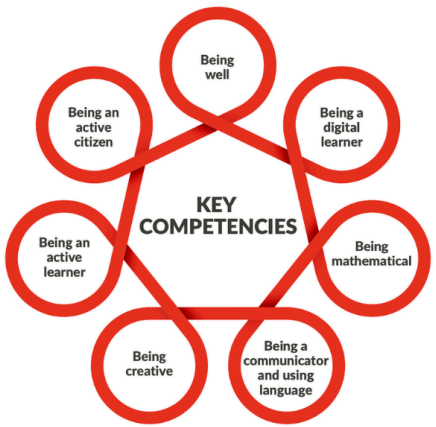
The '**Being Well**' competency fosters self-awareness and promotes the importance of learners seeing themselves as capable and resourceful. It helps children become positive and engaged in their learning and realise their own uniqueness and potential. It supports healthy relationships with themselves, their peers, their family and the wider world. The Core Values of *FIRST* LEGO League Explore SUBMERGED facilitate learners in being self-aware and resilient, acting responsibly and showing care towards themselves and others and being persistent and flexible in solving problems. The investigative, problem-based approach of the challenge is conducive to fostering cooperation, positive team relationships and self-improvement.

Finally, the '**Being an Active Learner**' competency is aimed at aiding learners to develop themselves as learners, individually and in collaboration with others. It promotes the development of the knowledge, skills, concepts, attitudes, values and dispositions needed for being an active and continuous learner. The structure of *FIRST* LEGO League Explore SUBMERGED facilitates learners in being active learners whereby they learn how to communicate, set personal and collaborative learning goals, solve problems, and manage complex situations. The real-world context of the content and learning activities enables learners to make sense of people and places around them and in the wider world. Through developing this competency, learners also learn to reflect on their learning. Reflection is a major feature of *FIRST* LEGO League Explore SUBMERGED. Learning with and about others also enables children to develop empathy.

Being an active citizen
- Developing an understanding of, and acting on, the rights and responsibilities of myself and others
- Experiencing learning through democratic practices
- Recognising injustice and inequality and ways to take action
- Developing capacity to make choices and take action in favour of a sustainable future

Being creative
- Participating in and enjoying creative and cultural experiences
- Being curious
- Being imaginative
- Being innovative
- Using creative processes
- Exploring alternative ways of communicating

Being a digital learner
- Communicating and collaborating with others through digital technology
- Accessing, analysing, and managing content using digital technology
- Enabling content creation, problem-solving, and creativity using digital technology
- Interacting ethically, critically, and responsibly with digital technology



Being mathematical
- Understanding the usefulness and beauty of mathematics
- Thinking and communicating mathematically
- Solving problems and making sense of the world using mathematics
- Observing, estimating, predicting, and calculating
- Recognising relationships, trends, connections, and patterns
- Interpreting, processing, and evaluating information and data

Being an active learner
- Playing, learning, and working, both individually and with others
- Developing metacognitive skills and strategies
- Fostering and maintaining positive relationships
- Dealing with conflict
- Respecting difference
- Learning about others
- Caring for and showing empathy towards others

Being a communicator and using language
- Developing understanding and enjoyment of words and language
- Developing expressive language
- Reading for enjoyment and with critical understanding
- Writing for different purposes and for a variety of audiences
- Exploring and creating a variety of texts

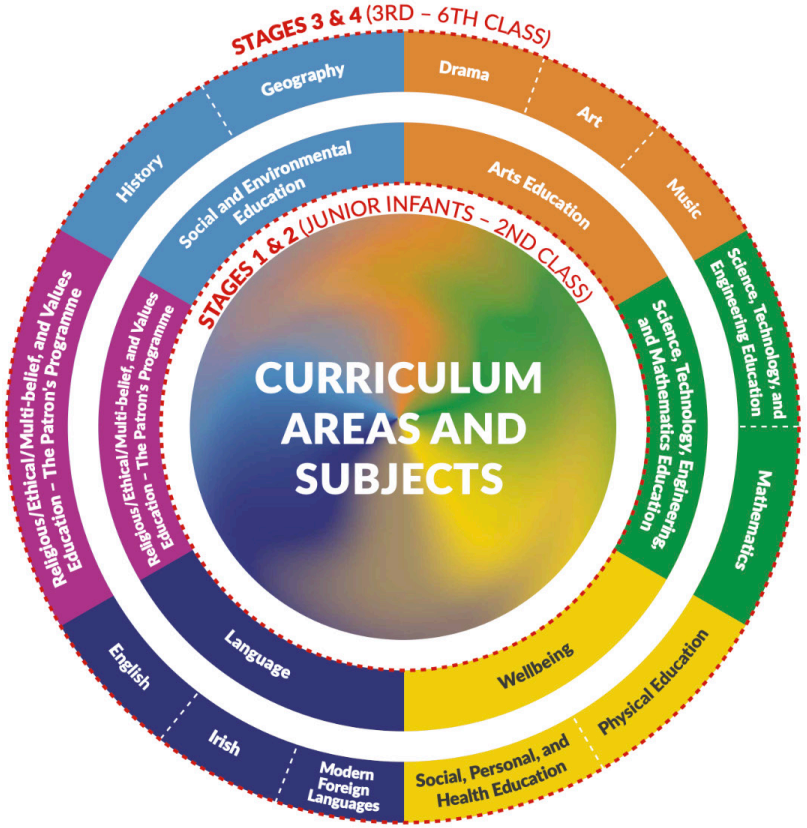
Being well
- Showing awareness of how to make good choices in relation to wellbeing
- Participating with growing confidence and skill in physical activity
- Being self-aware and resilient
- Acting responsibly and showing care towards self and others
- Being spiritual and having a sense of purpose and meaning
- Being persistent and flexible in solving problems
- Being able to assess risk and respond

Figure 5. The Seven Key Competencies of the new Primary Curriculum Framework.

Curriculum areas and subjects of the Primary Curriculum

The curriculum is presented in five broad curriculum areas:

1. Language
2. Science, Technology, Engineering, and Mathematics (STEM) Education
3. Wellbeing
4. Arts Education
5. Social and Environmental Education.



	Language	Science, Technology, Engineering and Mathematics Education	Wellbeing	Arts Education	Social and Environmental Education	Religious / Ethical / Multi-belief, and Values Education - The Patron's Programme
Stages 1 and 2 Junior Infants - 2nd Class	Language (Irish and English)	Science, Technology, Engineering and Mathematics Education	Wellbeing	Arts Education	Social and Environmental Education	Religious / Ethical / Multi-belief, and Values Education - The Patron's Programme
Stages 3 and 4 3rd - 6th Class	Irish English Modern Foreign Languages	Science, Technology and Engineering Mathematics	Social Personal and Health Education Physical Education	Drama Art Music	History Geography	Religious / Ethical / Multi-belief, and Values Education - The Patron's Programme

Concepts and approaches of computational thinking and coding

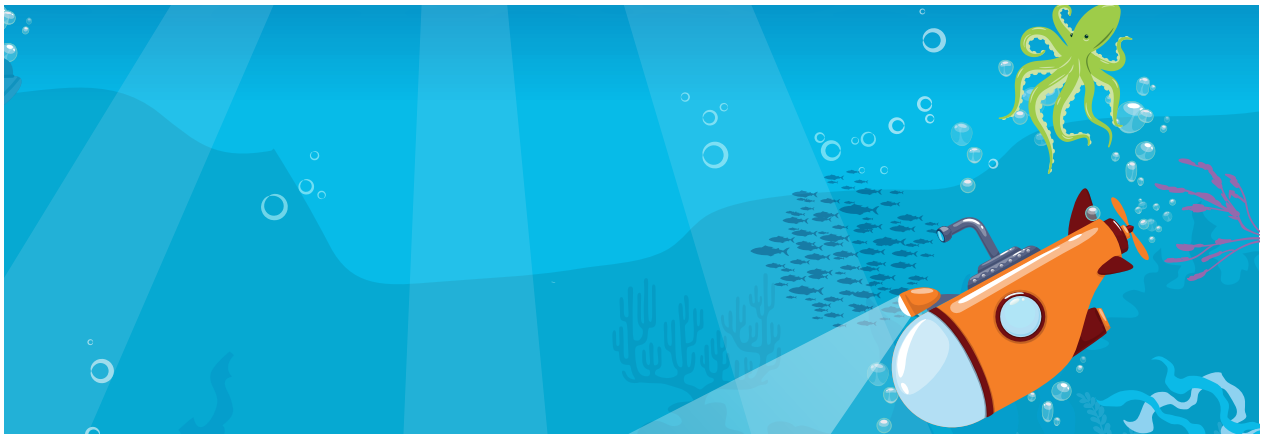
As discussed by Butler & Leahy (2022) the concept of computational thinking originates in the work of Seymour Papert (1980; 1991) when he introduced the 'idea of the computer being the children's machine that would allow them to develop procedural thinking through programming' (Dede, Mishra & Voogt, 2013, p. 2), enabling them to combine critical thinking with computing power as the foundation for innovating solutions to real-life problems (Tabesh, 2017). In the Irish context the NCCA has been investigating possible approaches to the introduction and development of computational thinking in primary schools (NCCA, 2016; 2017, Millwood et al., 2018). This can be seen in the recently published Draft Science, Technology and Engineering Education Specification (NCCA, 2024).

Computational thinking and coding are a key element of all SUBMERGED sessions. At the heart of these sessions is a process of testing and learning, whereby learners work logically by changing and testing one variable (or code block) at a time, and documenting this. In so doing, learners can reflect upon the process and debug (or fix) the code that may not be having the intended result. This process can be scaffolded by probing questions from the teacher. The intention is to help learners to think about the problem differently; *"I wonder if…", "how might you…", "have you considered…"*
Examples of guiding questions are provided in each session.

While engaging in coding and computational thinking it is important to assist learners in using the correct **terminology** to describe the concepts and approaches they are developing. Table 8 below details five concepts and approaches of computational thinking and coding which are developed across the *FIRST* LEGO League Explore SUBMERGED sessions.

Concept or Approach	Explanation	Example of the concept or approach in use
Algorithms	Making steps, rules, and/or instructions	Creating the code or programme within the LEGO App (SPIKE Essential or WeDo 2.0). Creating algorithms. Writing instructions
Debugging	Finding and fixing 'bugs' in a logical and methodical manner	Iteratively making small changes to the code or programme and testing the outcome in order to overcome a problem. Creating tests, evaluating programme outputs and statements
Decomposition	Breaking down into parts	Organising information, creating representations of relationships and systems in diagrams e.g. labelling the parts of a plant, creating a mindmap on a topic
Logic	Predicting and analysing	Evaluating for correctness
Tinkering	Trying things out	Creating systems and playing with 'variables'. Experimenting and playing with the code or program.

Table 8. Five Concepts and Approaches of Computational Thinking developed across the SUBMERGED sessions.



Other concepts and approaches of computational thinking and coding include:

- Pattern recognition - looking for similarities among and within problems
- Abstraction - focusing on the important information only, ignoring irrelevant detail
- Evaluation - making judgements
- Creating - planning, making and evaluating things
- Persevering - never giving up, being determined, resilient and tenacious
- Collaborating - working with others to ensure the best results

(Adapted from Millwood et al., 2018)

The Barefoot Computing curriculum (**www.barefootcomputing.org**), includes a useful graphic which summarises the key concepts and approaches of computational thinking and coding.

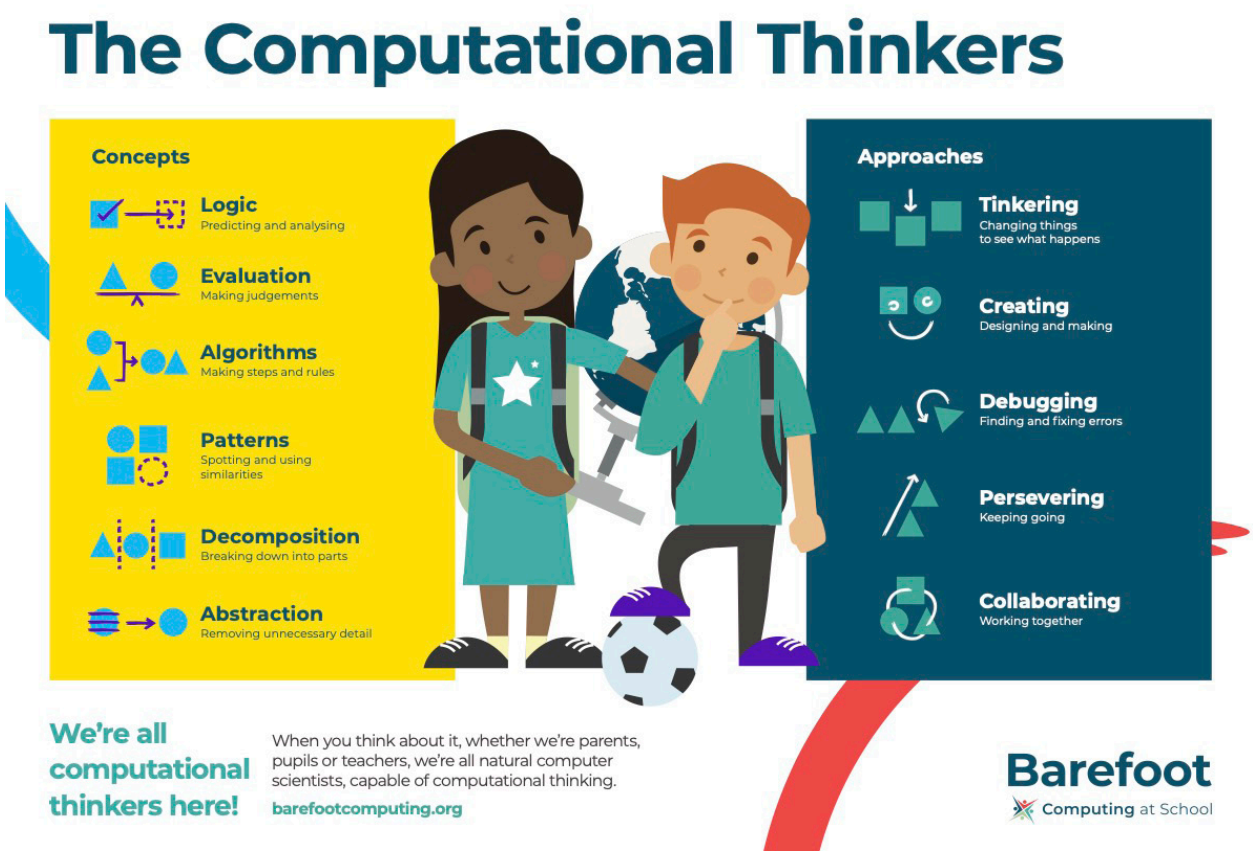


Figure 6. The Computational Thinker: Concepts and Approaches

What Does the Team Need?

LEGO® Education Set

LEGO® Education SPIKE™ Essential Set

Note: Other LEGO Education sets such as WeDo 2.0 are also allowed.

SUBMERGED℠ Explore Set

Each team will get one SUBMERGED℠ Explore set. Leave the LEGO® pieces in their bags until the sessions in which they are needed.

Two printed books contain the building instructions for the Explore model.

Electronic Device

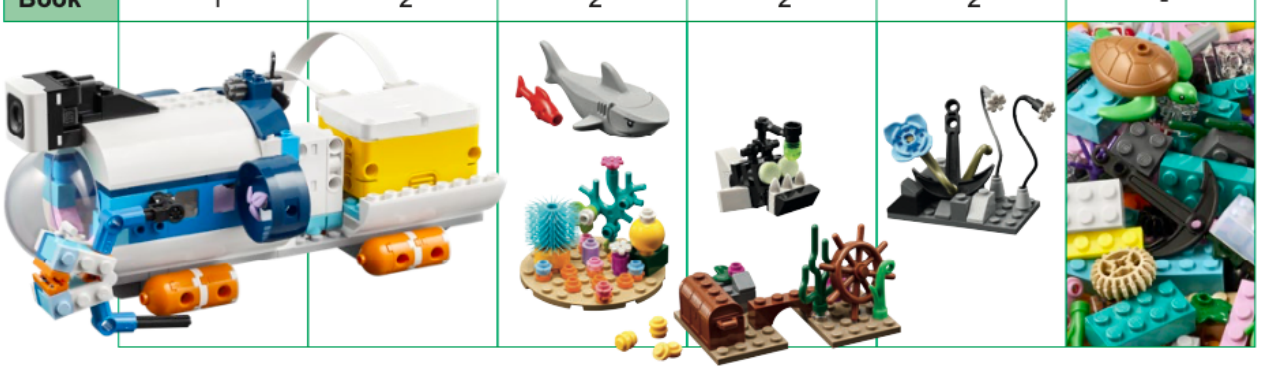
Your team will need a compatible Bluetooth-enabled device like a laptop, tablet, or computer. Scan the QR code to view system requirements and download software.

Scan here for system requirements and software download

Team Poster Supplies

Each team will need a large poster board and various art supplies and materials in Sessions 10-11.

	Submarine	Motor and Hub Pieces*	Sunlight Zone Pieces	Twilight Zone Pieces	Abyssal Zone Pieces	Prototyping Pieces
Bag	1, 2	3	4	5	6	7, 8, 9, 10, 11
Book	1	2	2	2	2	-



*The motor and hub are part of the SPIKE Essential set. Bag 3 contains bricks needed to attach these pieces to the submarine model in the Explore set.

Tip

- The prototyping pieces and baseplates are used throughout the sessions to build solutions to the design challenges.

Organisation of team

Learners will work together in teams of four to six using elements from a LEGO Education set (SPIKE Essential or WeDo 2.0) and a SUBMERGED Explore Set. They will collaborate and communicate to build, learn, and play together. Please refer to Figure 7 below for details of Team Roles. Learners should remain in the same teams for all sessions.

Team Roles

Here are sample team roles to use during the sessions. Everyone could experience each role multiple times throughout their *FIRST* LEGO League Explore experience.

Using roles helps the team function more efficiently and ensures that everyone on the team is engaged. Some roles, like the builder and coder, could be filled by multiple children during a session when the experience is designed for a pair of children.

Reporter
Captures the team's journey by taking pictures or video. This media can be used for the team poster.

Builder
Assembles the LEGO builds following the building instructions.

LEGO Element Finder
Locates the specific LEGO elements needed for each build step.

Team Captain
Shares team progress with facilitator. Ensures session tasks are completed.

Adult Facilitator
Guides the team through the sessions and their learning to achieve session outcomes.

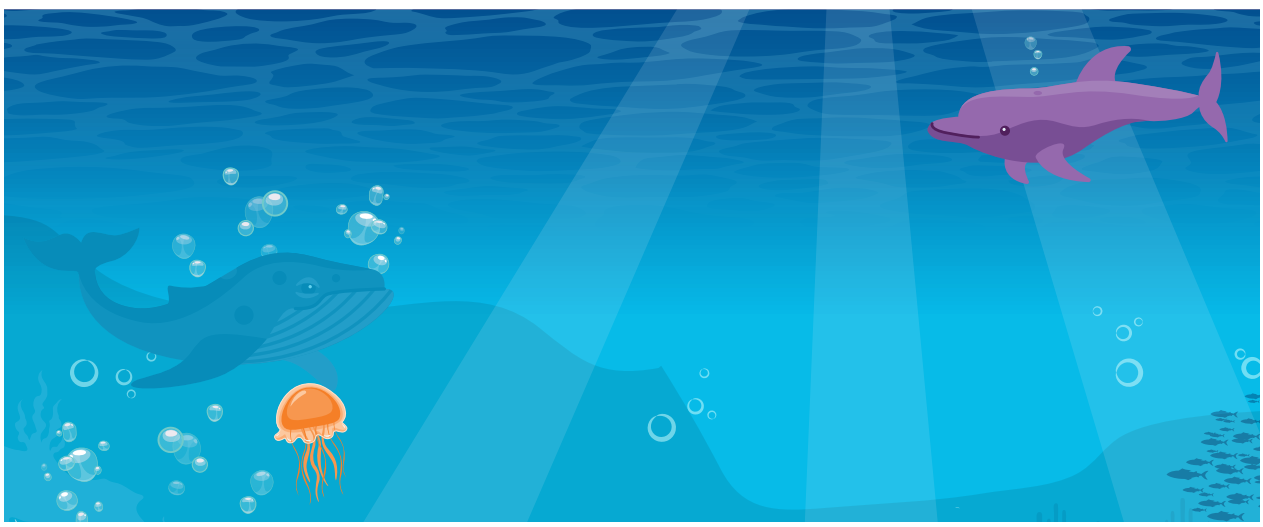
Material Manager
Gathers materials needed for session and returns materials at end of session.

Coder
Operates the device and creates the programs in the app.

Figure 7. Team Roles

Engaging with experts

There are opportunities to engage with experts over the course of the season through school visits, Zoom etc.



Managing equipment

Here are some recommendations on managing the *FIRST* LEGO League Explore SUBMERGED materials:

Before	Ongoing	After
If the sets have been previously used - each team checks that they are not missing any elements before completing their first session. This can be done by comparing the contents against the cover insert. Designate one LEGO Education Set (SPIKE Essential or WeDo 2.0) and SUBMERGED Explore Set per team. Where possible, label these to avoid confusion or swapping of sets.	A large lunchbox per team could be used to store the prototyping pieces between sessions. Any LEGO elements found on the floor could be placed in a box on the teacher's desk. Teams missing any elements can then check this box. Move all school bags and personal belongings of learners to the back of the room while completing sessions involving the LEGO materials. This is to avoid any elements accidentally falling into bags or pockets. After building the Explore models, store the printed books containing building instructions for future use.	After the Showcase Event: Each team checks that their LEGO Education Set (SPIKE Essential or WeDo 2.0) is not missing any elements. Disassemble the SUBMERGED models and place the pieces (and printed building instructions) into zip lock bags for future use. Prototyping pieces can be resealed into storage containers.

Session overview

fll.ie/submerged

Session 6: How marine biologists explore the sunlight zone

Purpose:
Learners will explore the work of a marine biologist in the ocean's sunlight zone.

Core values:

Discovery Teamwork Fun

Learning outcomes:
Learners will be enabled to
1. Develop an understanding of, and appreciation for, the work of a marine biologist
2. Build and code a LEGO robot
3. Experiment with cause and effect relationships using the motor and movement code blocks
4. Develop a deeper understanding of code by testing and adapting prototypes

Learners will build:
LEGO SPIKE Essential
- Lesson 1 - Boat Trip

LEGO WeDo 2.0
- Cooling Fan

Progress:
1 2 3 4 5 6 7 8 9 10 11 12

Resources
Per team:
- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device

Digital resources:
- What Is Marine Biology?
- How do you become a marine biologist?
- A Day In The Life
- David O'Sullivan

Each session follows the same format.

Purpose: The purpose of each session is provided.

Core Values: Each session will focus on a specific Core Values.

Learning outcomes: Learning outcomes for each session are provided. These are indicative learning outcomes and should be adapted to meet the needs of your learners.

Resources: This includes Team Resources, Digital Resources and any Printable Resources. All digital resources can be accessed via the link provided

Curriculum content

Subject	Strands	Strand units/ elements	Skills and concepts
Science	Living Things; Environmental awareness and care	Plant and animal life; Caring for the Environment	Questioning; Observing; Sorting and classifying; Designing and making
Geography	Human Environments; Natural Environments	People at work; Land, rivers and seas	A sense of place; a sense of space
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using

Curriculum content: This includes reference to (i) strand, (ii) strand units/ elements and (iii) skills and concepts.

Introduction

Resource(s):
- Video links
- Digital devices

Introduction

In this session, learners build on what they learned in the previous five sessions by exploring the work of marine biologists in the ocean's sunlight zone.

Teacher introduces the session by activating prior knowledge of the work of a marine biologist:
- *Does anyone know what a marine biologist does?*
- *Do we know any marine biologists?*
- *When we hear the word 'marine', could we infer what types of life the marine biologist studies?*
- *Where might marine biologists work? Explain*
- *What types of work might a marine biologist do? What makes you think this?*

Session introduction and development: Learning activities, resources, guiding questions and suggested time frame for each key activity provided. Digital resources are also linked throughout this section and will also be available online at

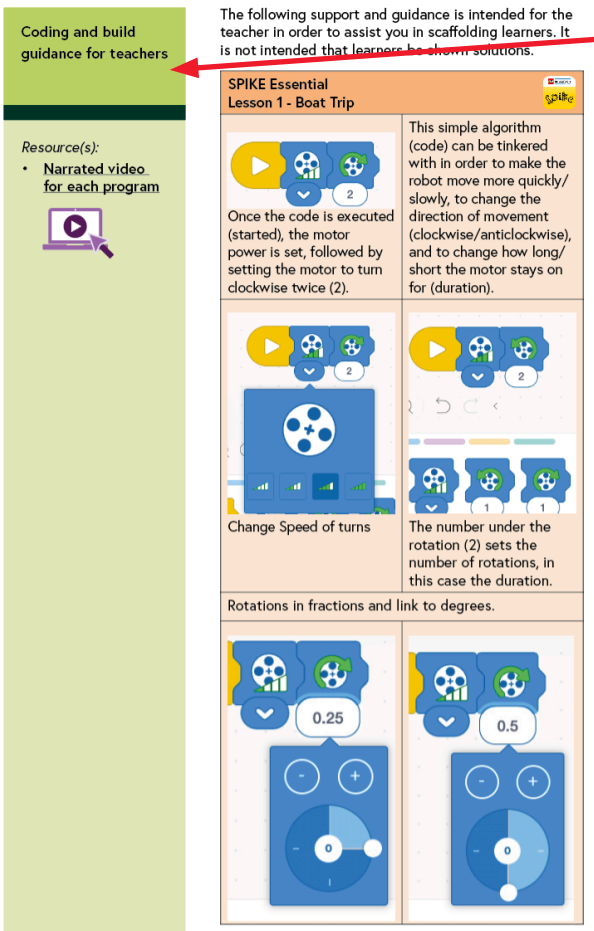
fll.ie/submerged

Icon to indicate visiting a website

Icon to indicate watching a video

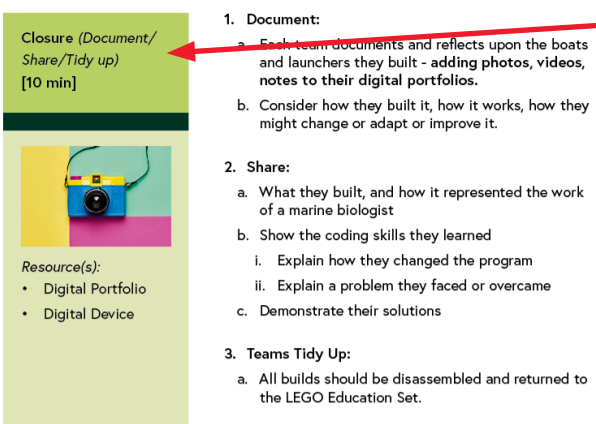
Resource icons:

Resources that require visiting a website or watching a video will have icons under them in the resource section to indicate that a link must be clicked on to access the resource.



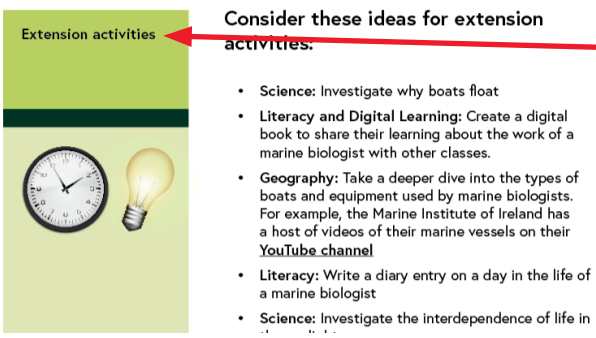
Coding and build:

Details of the build and code are provided. Teacher Guiding Questions and Important Points to Note will support the learners' development of computational thinking and coding skills.



Closure:

This is an important feature of every session as it allows learners time to reflect upon their new learnings and understandings. The portfolio or learning diary being kept will be invaluable when learners begin to design their Team Models. Further details and teacher guidance is provided in the next section.



Extension activities:

These highlight activities which develop the learners' skills and knowledge in a specific subject area within the context of *FIRST* LEGO League Explore SUBMERGED. These are optional but recommended extension activities.

Session closures: document, share, reflect

Every session ends with an opportunity for learners to document, share, and tidy up. This is a pivotal part of the Engineering Design Process as it enables learners to reflect and think about what they have learned through the session, in order to build upon this in future sessions.

These session closures have been designed to support learners as they work on their Team Model and Team Poster in the final sessions. By engaging fully with the session closures learners will have completed a lot of reflection in advance of the final sessions, which will make these more effective. For example, the builds and coding explored in earlier sessions should be documented and reflected upon so that learners can iterate and develop upon these for their Team Model.

Below is a general overview of what is intended in these session closures. Session-specific details are provided in the session guides that follow in Part B of this guide

Document

It is recommended that learners use digital devices and/or portfolio tools to document the **Engineering Design Process** while exploring the sessions in *FIRST* LEGO League Explore.

The process of documenting their progress and ideas can support the learners in **learning to be learners**, and aids in retention of skills and knowledge.

The use of digital devices and digital portfolio tools is also linked to the **Digital Learning Framework** and the Key Competency of **Being a Digital Learner** in the Primary Curriculum Framework.

Share

Teams are invited to share what they did during the session, including demonstrating their model and explaining how their code works. The focus of these sharing sessions is to enable learners to explain their thinking and use the correct vocabulary in their explanations. In the initial sessions the teacher may need to model the types of questions that could be asked. As the class progresses through the sessions, learners from other teams could be called upon to pose questions.

The sharing could be organised in many ways, two recommendations include:

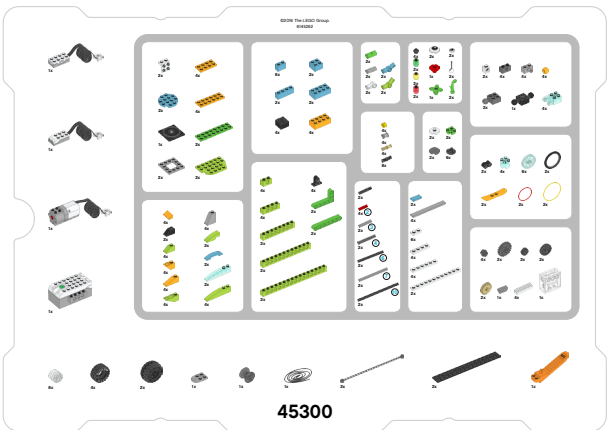
- The team who are sharing bring their LEGO model and digital device to the front of the class - option to connect to the digital display/ Interactive Whiteboard.
- The presenting team stays at their work area and all other learners physically move to this work station for the duration of the sharing.

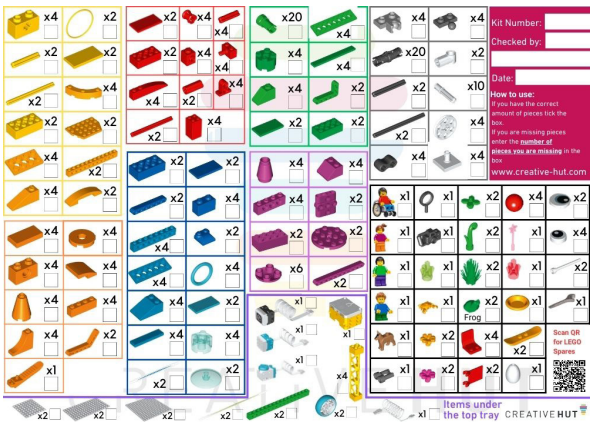
Tidy up

It is recommended that each team be assigned a specific LEGO Education Set (SPIKE Essential or WeDo 2.0) for the duration of *FIRST* LEGO League Explore.

It is important to build up an expectation of learners that each team deconstructs and replaces all parts into the correct section of their LEGO Education Set at the end of each session, if appropriate. This will facilitate the following sessions to run smoothly, and avoid the loss of required pieces.

As illustrated in the picture, the LEGO Education Materials (SPIKE Essential or WeDo 2.0) have specific sections for different categories of pieces, with these pictured on the stickers and on the cover insert.





WeDo 2.0 Element Overview

SPIKE Essential Element Overview

Don't forget to share your progress with us where possible through:

X.com (Twitter): *@FLLUK, @Learnit_Ireland, @scienceirel, @DCU_IoE/@DCU_SEIGS*

Instagram: *@TheIET, @creativehut.ie, @scienceireland, @dublincityuniversity*

And use the Hashtag: *#FLLIRE*

Further help and support to schools

Help and support is available to teachers and schools. The **Oide** and **Oide Technology in Education** are available to provide a range of supports to teachers and schools, including training, technical support, and ongoing sustained school support. Where available, sustained support is recommended as it provides for ongoing training and support to teachers engaged in *FIRST* LEGO League Explore.

> Oide Sustained School Support is a deeper form of teacher professional learning aimed at building internal capacity and enabling schools to drive and embed change as independent communities of learners. The support is provided over a period of time, as part of a deliberately planned process, involving the school and teachers working towards clear and agreed-upon goals. In this context, our advisors will support teachers to collaboratively reflect, identify strengths and needs before deciding on the best way forward for your school.
>
> (PDST, 2021)

Visit **oide.ie** for further information, and to request school support.

Help and support is also available from your local **Education Centre**. This support can include training sessions, cluster groups of schools and teachers, and the loan of equipment and devices. Visit their website for further information, including details of upcoming training events.

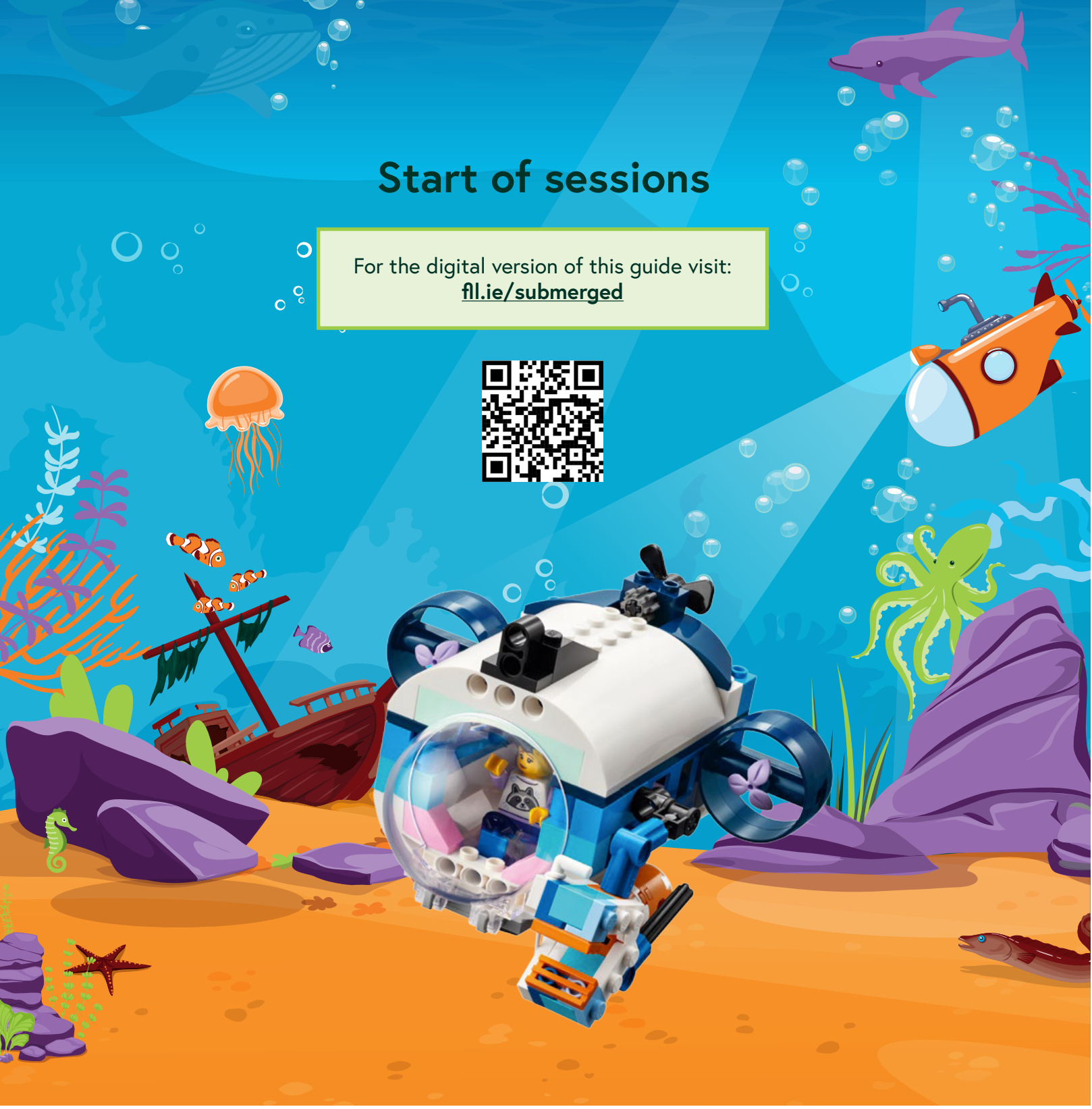
LEGO Education Support: For replacement parts, additional kits, workshops and teacher CPD visit our partners **creative-hut.ie**.

The Institution of Engineering and Technology

FIRST LEGO LEAGUE EXPLORE

Start of sessions

For the digital version of this guide visit:
fll.ie/submerged



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CREATIVE HUT

Science Foundation Ireland sfi For what's next

Session overview

Session 1: What are oceans? Where are oceans? Why are oceans important?

Learners will identify the locations of oceans on maps/ globes and investigate the ways in which oceans are important.

Page: 38

Session 2: Experiments to understand how oceans work

Learners will conduct three separate experiments to explore and demonstrate how the oceans work; focusing on the role of the ocean in the Water Cycle, the function of the ocean in regulating the Earth's temperature; and exploring properties of sea water.

Page: 44

Session 3: Ocean zones and habitats

Learners will be introduced to the different zones of the ocean and how different animals adapt to life at these depths.

Page: 50

Session 4: Threats to our oceans

Learners will explore the major threats to our oceans, identifying the causes, effects and possible solutions and actions.

Page: 56

Session 5: Developments in underwater navigation and exploration

Learners will develop an understanding of how humans navigate and explore the ocean and build an underwater vessel for this purpose.

Page: 60

Session 6: How marine biologists explore the sunlight zone

Learners will explore the work of a marine biologist in the ocean's sunlight zone.

Build: Cooling Fan OR Boat Trip

Page: 68

Session 7: How marine archaeologists explore the twilight zone

Learners will be introduced to the work of a marine archaeologist in the twilight zone. They will adapt and improve the submarine model by adding sensors and outputs.

Build 1: Spy Robot OR Animal Alarm
Build 2: Improve the submarine (motor & sensor)

Page: 80

Session 8: How oceanographers explore the abyssal zone

Learners will go even deeper to learn about the abyssal zone and the work of an oceanographer to explore it. Learners will modify an autonomous underwater vehicle (AUV).

Build: Milo the Science Rover OR Arctic Ride

Page: 92

Session 9: A closer look at marine life

Learners will investigate one marine animal to tie together the importance of oceans, the different ocean zones, marine careers, and how marine animals adapt to their environment and threats.

Build: representation of marine animal and their habitat

Page: 102

Session 10: Team Model and Poster

Learners will work in teams to create their Team Model and Poster which represent a unique way to share their team's ocean discoveries with others.

Page: 108

Session 11: Let's share - preparation for Showcase and Showcase Event

Learners will prepare to share their SUBMERGED Team Model and Poster at a Showcase Event.

Page: 120

Session 12: Let's reflect

Learners will reflect upon the SUBMERGED sessions, their Team Model and Poster, and their understanding of the importance of our oceans, as well as how and why people explore the oceans.

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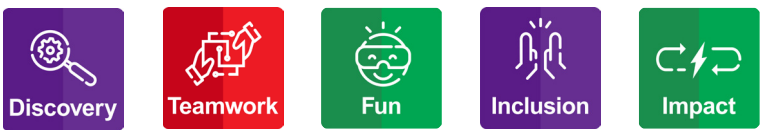
Session 1: What are oceans? Where are oceans? Why are oceans important?

Purpose:

Learners will identify the locations of oceans on maps/globes and investigate the ways in which oceans are important.

Core Values:



Learning outcomes:

Learners will be enabled to

1. Identify the seven oceans of the world and understand that all oceans are essentially one global ocean
2. Recognise and understand the different reasons why oceans are important
3. Appreciate the significance of oceans not only to humans but also the natural world

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- Real map of Ireland
- Class atlases
- Globes
- Blank maps of the world
- Activity sheet for each group (matching captions and images)
- A3 paper for each group
- Scissors and glue

Digital resources:

- Blue Planet trailer
- Activity sheet to match captions to images
- Oceans of the world website
- Printable world map

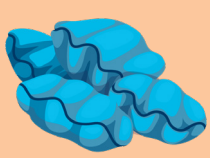
Curriculum content

Subject	Strands	Strand units/ elements	Skills and concepts
Geography	Natural Environment; Environmental Awareness and Care	Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment	Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)
Science	Environmental Awareness and Care; Living Things	Environmental Awareness; Caring for the Environment; Plants and Animals	Working as a Scientist Scientific Investigation Skills (Questioning, Hypothesising, Predicting, Investigating, Experimenting, Observing, Analysing, Recording, Communicating)

Introduction

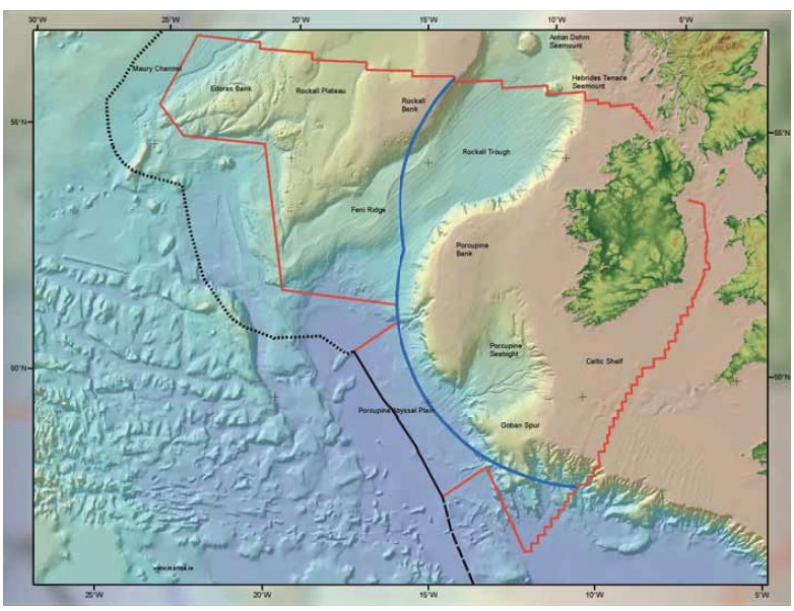
Resource(s):

- Real map of Ireland
- Class atlases
- Globes
- Blank maps of the world



What are the oceans?

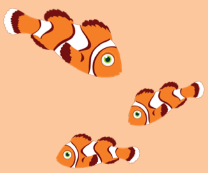
Teacher introduces the topic of oceans to the learners using the map below. Ireland's ocean territory extends far beyond the coastline and is over 10 times larger than its land. Teachers can use this map to introduce learners to the idea that there is much more for us to learn about Ireland and the world than the lands. We live on the 'Blue Planet' after all which is 70% covered in ocean!



Introduction [continued]

Resource(s):

- Video



Stimulus: Learners watch this **Video** of Ocean Life for stimulating discussion about what learners already know about oceans and what they would like to find out. Learners suggest some open-ended investigable questions relating to oceans.

Where are the oceans?

Teacher explains that an ocean is a large body of water between continents. There are 7 oceans *(i.e. pirates and sailors often refer to the 'Seven Seas').* These are the Arctic, North Atlantic, South Atlantic, North Pacific, South Pacific, Indian, and Southern oceans. *(The Southern Ocean is sometimes called Antarctic Ocean).*

Learners work in pairs to identify the locations of the 7 different oceans on Earth on their class atlases or globes. Teacher probes and challenges the learners to make observations and undertake map reading and also make speculations as to what the living conditions would be like in different oceans:

- *What is the ocean between Europe and North America?*
- *Which is the largest ocean?*
- *What line divides the North and South Pacific?*
- *Would the water be cooler or warmer near the equator?*
- *Which ocean do you think would be the coldest and why? (answer varies between Southern Ocean and Arctic Ocean)*

Introduction [continued]

Resource(s):

- Oceans of the world website
- Printable blank world map

Learners can work in pairs using this **oceans of the world website** to learn more about the oceans and to create their own map of the 7 oceans of the world using the blank world map template. **Link to printable blank world map**.

Learners should also note that the 7 oceans are not divided by any borders and that in reality the Earth has only one ocean! Learners should observe that oceans cover 70% of the Earth -most of the Earth is water which is why it is known as the "blue planet" (see image for discussion below)!

Development

Why are oceans important?

Teacher tells learners that oceans are important to all of us. Even if you live on land – like humans do – you wouldn't survive without the ocean!

Learners will work in groups with each group being given an **activity sheet to match captions to images**. Groups should also be given A3 paper and glue. Each group must divide the A3 paper into 6 sections (there are 6 main reasons that the oceans are important). Captions and images relating to the specific reason of importance should be glued in the same box on the A3 paper.

The 6 main reasons why oceans are important are: :

- *Oceans absorb carbon dioxide (CO_2) and produce Oxygen (O_2)*
- *Oceans are an important source of food*
- *Lots of jobs are linked to the oceans*
- *The oceans regulate weather and climate*
- *Oceans are crucial to the water cycle*
- *Oceans are a very important habitat for biodiversity*

Once the learners have completed this task in matching the correct captions and images to the correct reason of importance, the class can have a discussion about what they learned.

- *What have you learned so far?*
- *What did you find most surprising?*

Closure

Ranking and wrapping up

Learners can work in the same groups to rank the importance of each reason by numbering them 1-6 with 1 being Most Important and 6 being Least Important. The teacher can facilitate a discussion and challenge the learners on the rationale for their decisions.

The teacher should highlight the fact that there is no correct answer to the ranking activity but that it is clear that oceans are very important not only to humans but to the entire planet.

Teacher facilitates a cognitive closure on what the learners learned pertaining to oceans and what else they would like to find out.

Extension activities

Consider these ideas for extension activities:

- **Geography:** Playing **Ocean Battleships**
  - Learners use their knowledge of ocean names and locations as well as longitude and latitude coordinates to play the game Battleships in pairs
- **Science/Geography:** Consider watching **Blue Planet II** (by David Attenborough). Different topics can be viewed by scrolling to watch shorter clips that are labelled.

Printable worksheets for this session are available here: **https://fll.ie/submerged**

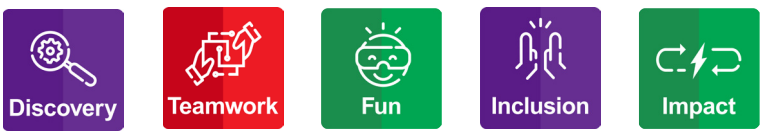
fll.ie/submerged

Session 2: Experiments to understand how oceans work

Purpose:

Learners will conduct three separate experiments to explore and demonstrate how the oceans work; focusing on the role of the ocean in the Water Cycle, the function of the ocean in regulating the Earth's temperature; and exploring properties of sea water.

Core Values:



Learning outcomes:

Learners will be enabled to

1. Appreciate the important role the oceans play in the Water Cycle
2. Understand how the ocean absorbs a large proportion of the rising temperature of the Earth
3. Recognise how salt water enables floating

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Experiment 1:

- Large Bowl, Cup, Salt, Clingfilm, Rubber band, Spoon

Experiment 2:

- 1 balloon full of air, 1 balloon full of water, lighter/matches *(for teacher demonstration purposes only)*

Experiment 3:

- 2 containers of equal size, Water, Salt, Plastic objects of equal size *(e.g. counters)*

Digital resources:

- Global warming demonstration video
- Sea water vs Salt water: What floats?
- Explore how waves are formed?
- Explore how oceans are formed and how they impact the climate

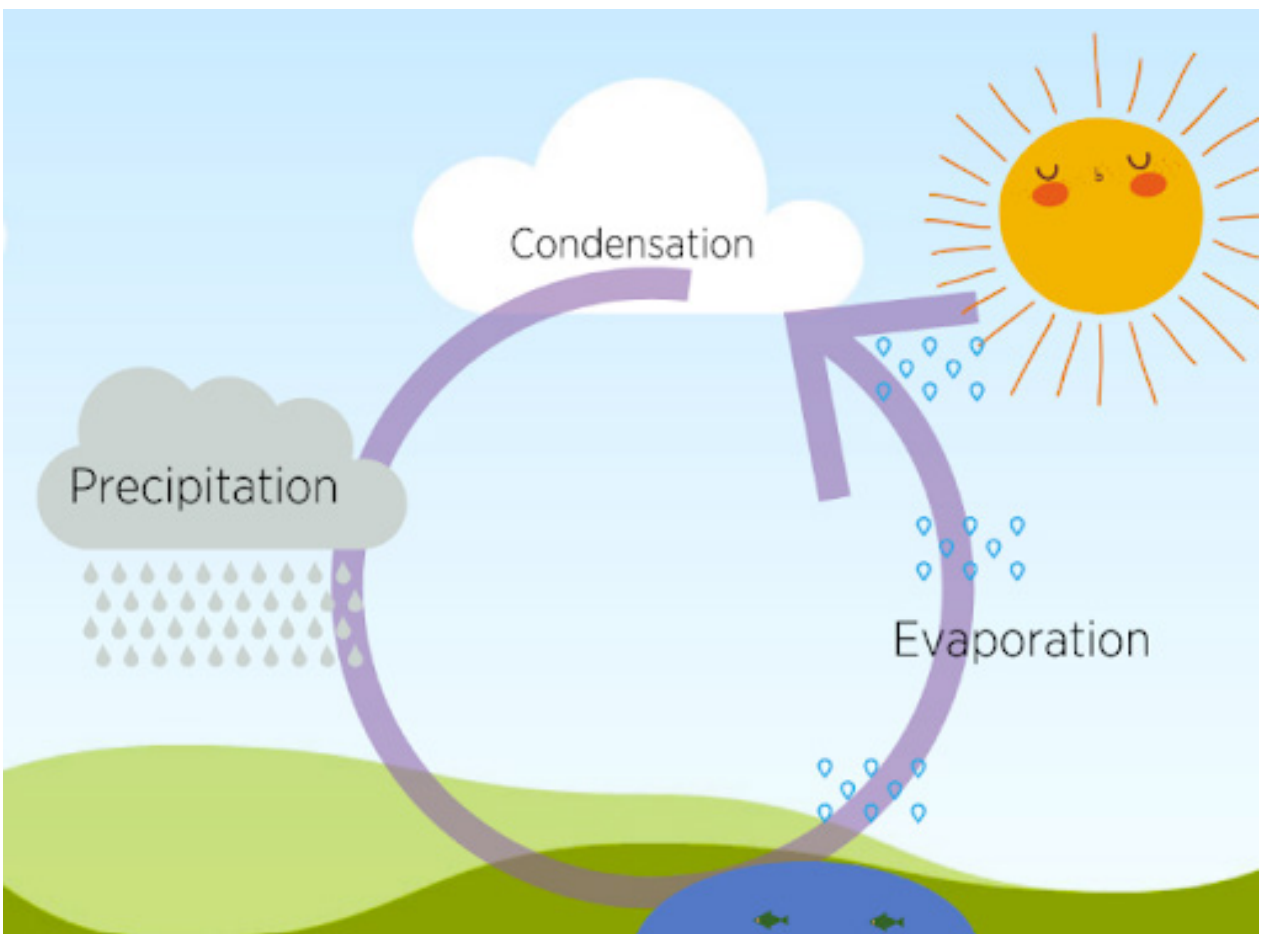
Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
Science	Environmental Awareness and Care; Living Things; Materials	Environmental Awareness; Caring for the Environment; Plants and Animals; Properties; Characteristics of Materials; Materials; Change	Working as a Scientist Scientific Investigation Skills (Questioning, Hypothesising, Predicting, Investigating, Experimenting, Observing, Analysing, Recording, Communicating)
Geography	Natural Environment; Environmental Awareness and Care	Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment	Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)

Experiment 1

Learner led experiment: The role of the ocean in the Water Cycle

86% of all precipitation (rain, snow and sleet) comes from water that has evaporated from the ocean.

Teacher introduces the idea of the Water Cycle by explaining that we use and recycle the same water on Earth for thousands of years. Teacher uses the image below to explain to the children that the Water Cycle entails three main stages (Evaporation, Condensation and Precipitation). Heat from the sun evaporates water from our oceans, lakes and rivers (evaporation). This water rises (like steam from a kettle) and condenses high in the sky as clouds of water vapour (condensation). The water vapour will later fall as rain or snow (precipitation). Animals and plants as well as humans benefit from this.



Experiment 1 [continued]

Resource(s):

- Large Bowl
- Cup
- Salt
- Clingfilm
- Rubber band
- Spoon
- Video

Learners can investigate how water from the ocean evaporates and condenses to form precipitation using the resources listed above.

1. Pour 150ml of warm water into a large bowl.
2. Stir 8 spoons of salt into the warm water until the salt dissolves.
3. Place an empty cup in the centre of the bowl.
4. Place cling film over the bowl and secure it with a rubber band.
5. Place a weight/coins on top of the clingfilm directly over the cup.
6. Put the bowl in a sunny place such as a windowsill and observe how the water evaporates, condenses as water droplets under the clingfilm and then drips into the empty cup.

Once all the saltwater has been evaporated, the clumps of salt will be left behind. Learners can taste the water from the cup to identify that this water does not contain any salt.

There is a **video** which also demonstrates this (note: begin video at 2:19).

Experiment 2

Resource(s):

- 1 balloon full of air
- 1 balloon full of water
- Lighter /Matches
- **Video**

Teacher demonstration: The role of the ocean in absorbing heat from the sun

The ocean helps to keep the Earth cool by absorbing the heat from the sun! Water can absorb much more heat than air can. Therefore, the oceans are absorbing a lot of Earth's increased temperatures due to climate change.

Teacher demonstrates this by conducting an experiment using an air balloon and a water balloon (the water balloon represents the ocean).

1. Hold the balloon full of air over the lighter. Learners can first predict what they think will happen. The air cannot absorb the heat and so the heat melts the rubber of the balloon, causing it to burst.
2. Hold the water balloon over the lighter. Again, learners can make predictions beforehand. The water absorbs the heat from the lighter (which represents the sun) and the balloon does not burst.

There is a short **video clip** to demonstrate this experiment.

Experiment 3

Resource(s):

- 2 containers of equal size
- Water
- Salt
- Plastic objects of equal size (e.g. counters)
- **Video**

Learner led experiment: How saltwater in the ocean enables floating

Water in the ocean is always salty. This makes it easier for objects to float as the water is more dense. To demonstrate this, learners can engage in the following experiment.

1. Fill two containers of equal size with equal amounts of water
2. Stir 8 spoons of salt into one container (until dissolved) and no salt into the other container (i.e. this is the control)
3. Add one plastic item into each container. Learners should make predictions beforehand and record results afterwards. A variety of items should be investigated.

There is a short **video clip** to demonstrate this experiment.

Extension activities

Consider these ideas for extension activities:

- **Science:** Explore How Waves are Formed with this **Video**
- **Science:** Explore how ocean currents are formed and how they impact our climate by doing this simple **experiment**

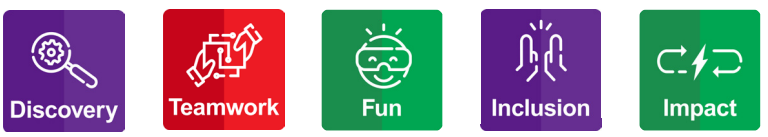
fll.ie/submerged

Session 3: Ocean zones and habitats

Purpose:

Learners will be introduced to the different zones of the ocean and how different animals adapt to life at these depths.

Core Values:



Learning outcomes:

Learners will be enabled to

1. Identify the different zones of the ocean (sunlight, twilight, midnight and abyssal)
2. Identify the characteristics and habitats of different marine animals
3. Appreciate how different elements of ocean life adapt to living in these different zones of the ocean
4. Recognise and appreciate the interconnected nature of sea life

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- Ocean zone activity sheet

Digital resources:

- Video on the ocean zones (2 min)
- Ocean zones website
- National Geographic Sea Life
- Brittannica Kids
- Galway Atlantaquaria
- Who eats who?
- Video: What animals live in the "midnight zone" of the deep sea?

Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
Science	Living Things	Plant and Animal Life	Investigating, Questioning, Hypothesising, Recording, Communicating
Geography	Natural Environment; Environmental Awareness and Care	Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment	Sense of place; Sense of space; Mapping Skills; Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using

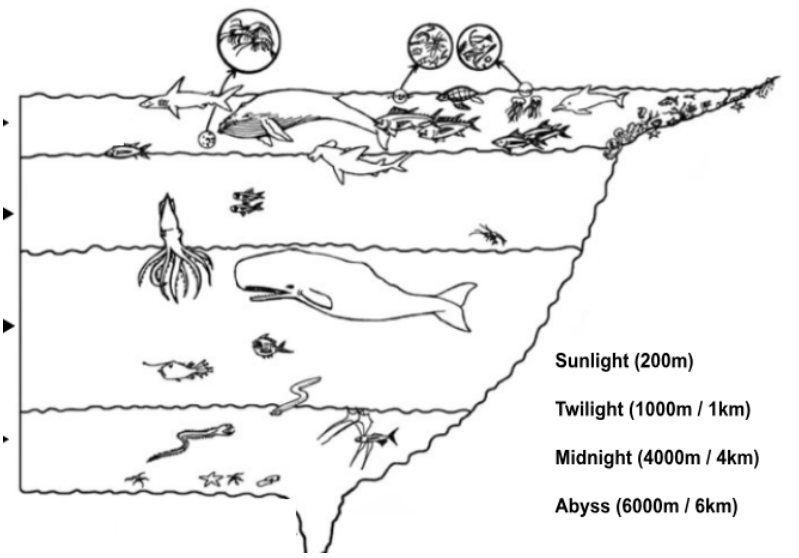
Introduction

Resource(s):

- Ocean zone activity sheet
- Video on the ocean zones
- Ocean zones website

Introducing the ocean zones

Teacher introduces the session by focusing on the 4 main ocean zones (sunlight, twilight, midnight and abyss). Teacher distributes an **ocean zone activity sheet** to the learners in pairs (an image from this activity sheet is displayed below). Learners watch the short 2min **video on the ocean zones** with the teacher pausing the view to allow the learners to make notes about each zone and label the correct zone while engaging with the video.



Development

Background

Only 5% of the ocean has been explored. Most plants and animals need sunlight to survive but in the Midnight and Abyss zones there is none. Sunlight reaches the Twilight zone but not enough for photosynthesis to occur. Animals that live at depth have adapted body systems to enable them to survive the dark and high pressures. For example the dumbo octopus has a flattened squishy body and gas inflated swim bladders, which they inflate to the same pressure as the water around them. Others use bioluminescence (a natural chemical reaction) to catch their prey.

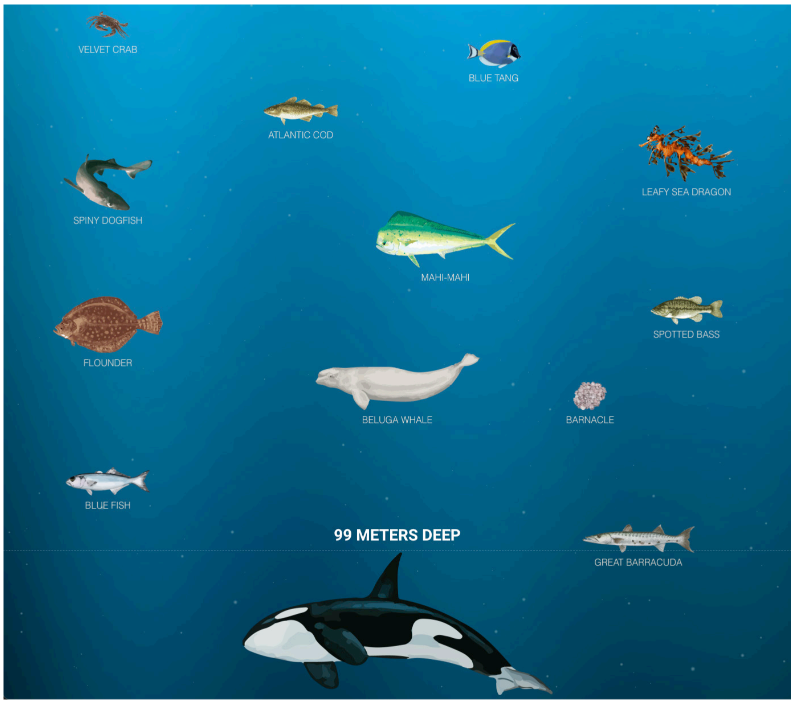
Development [continued]

Resource(s):

- [Video: What animals live in the "midnight zone" of the deep sea?]

Deep sea dive

In pairs, learners should use this **ocean zones website** to scroll down through the ocean zones from the sunlight all the way to the abyss and make notes on interesting animals that live at each zone.



Marine animal pair activity

Distribute a different marine animal to each learner/pair.

Marine animals could include: diatoms, dinoflagellates, orca, copepod, shrimp, seal, tuna, cod, octopus, krill, zooplankton, squid, crab, turtle, whale, dolphin, radiolaria, rotifera, silicoflagellates, sea spider, basket star, sea cucumber, sea worm, tripod fish.

Learners should be provided with an opportunity to investigate their marine animal. The following questions can be used to stimulate their investigation.

Key questions:

- *What zone does your marine animal live in?*
- *What do they feed on?*
- *Does any other marine animal eat them?*
- *How has your marine animal adapted to its environment?*
- *Is your marine animal endangered?*

The following websites can be used for the learners' investigation:

- **National Geographic Sea Life**
- **Brittannica Kids** - access provided by Scoilnet.ie
- Speak to an expert at **Galway Atlantaquaria**

Development [continued]

Present and attach the marine animals to the ocean zone

Learners present the findings of their investigation. They should then attach an image of the marine animal to the ocean zone as a classroom display. See samples in the images below (please note real life images of the marine animals should be used). This display can be referred to when completing the remainder of the sessions which focus on the different ocean zones.

Closure

Resource(s):

- Selection of marine animals
- Ball of string
- **Who eats who?**

Food chain: Who eats what?

In this activity learners stand in a circle and each learner is given a marine animal written on a piece of paper/ image of the animal. The above list (development section) of marine animals can be used. Humans can also be added.

One learner holds the end of a ball of string and passes it to another learner who they have a connection with on the food chain. Each learner must explain why. For instance the shark may be connected to the dolphin because sharks eat dolphins. The next learner (dolphin) then passes the ball of string to another member of the group. By the end of the activity, each learner should be holding a piece of string and a web will be created. The learners will then be asked 'what does this show?' The food web highlights the interconnected and interdependent nature of sea life.

For older classes learners can be introduced to terms primary producer, secondary producer, apex predator.

The following is a link to an online resource to assist with this learning activity: **Who Eats Who?**

Extension activities

Consider these ideas for extension activities:

- **Literacy:** Learners could write a report on their marine animal.
- **Science:** Learners can investigate each zone in depth. For instance, learners could watch this 4min **Video** on what lives in the Midnight Zone where Bruce Robinson (an ocean biologist) explains how he explores the midnight zone and how different animals have adapted to the conditions.

Printable worksheets for this session are available here: **https://fll.ie/submerged**

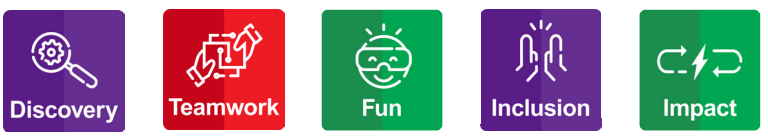
fll.ie/submerged

Session 4: Threats to our oceans

Purpose:

Learners will explore the major threats to our oceans, identifying the causes, effects and possible solutions and actions.

Core Values:



Learning outcomes:

Learners will be enabled to

1. List and explain the major threats to our oceans (acidification, rising temperatures, noise pollution, plastic/chemical pollution and overfishing)
2. Develop an understanding for the causes of these threats and the impacts they have on the human and natural world
3. Identify possible solutions to these threats including actions that they themselves can take

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- Paper/copybook and colouring pencils andor markers

Digital resources:

- Digital voting/response tool (e.g. Mentimeter, Sli.do)
- Webquest links for investigating threats to the ocean

Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
Geography	Natural Environment; Environmental Awareness and Care	Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment	Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)
Science	Environmental Awareness and Care; Living Things	Environmental Awareness; Caring for the Environment; Plants and Animals	Scientific Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using

Introduction

Introducing the threats to our oceans

Teacher introduces the topic (i.e. threats to the ocean) and what threats mean.

- *What does the word threat mean?*
- *Does anyone know of any threats to our oceans?*

Teacher explains that the learners will be investigating threats to the ocean using online links and videos and focusing on the **causes, effects and possible solutions and actions** to assuage these threats.

Development

Resource(s):

- **Webquest links for investigating threats to the ocean**

Investigating threats to our oceans

Divide the learners into groups of 4 or 5. Assign each group a "Threat to the Ocean" to research [i.e. plastic/ chemical pollution, overfishing, noise pollution, rising temperatures and acidification].

Each group must design a presentation about their investigation (e.g. a digital product/poster/ presentation/document) which presents their learning pertaining to the Threat under the headings of Causes, Effects and Solutions. This could include photos, videos, maps, voice recordings, drawings, or any other media that best explains what they have learned.

Each group then shares what they have learned about that Threat to the Oceans with the rest of the class. Sources of information for each Threat to the Ocean can be found **here**. Website articles can be viewed on digital devices (tablets/laptops).

Teacher as a facilitator circulates the class and aids groups and learners as appropriate using the key questions below.

- *What is the cause of noise pollution?*
- *How does rising temperature in the ocean impact sea life?*
- *What solutions can you think of in relation to this threat?*

Note to teacher:

Depending on the class level and ability, you might choose to not use the jigsaw approach but instead to investigate one of these Threats to the Ocean as a whole class activity for one entire session.

All groups could investigate the same threat and discuss the main findings under Causes, Effects and Solutions. Other threats could then be investigated collectively in proceeding sessions.

Discussion

Discussing causes, effects and solutions and identifying appropriate action!

Whole class discussion on what the class has learned and understood about different threats to the ocean and focusing on the correct terminology/vocabulary (e.g. acidification).

The learners should have a brief discussion and synopsis about each threat focusing on the Causes, Effects and then suggesting appropriate Solutions.

Teachers should guide the learners towards identifying any actions that they themselves can take (individually or collectively as a class/school) to assuage any of these threats (e.g. only buying Certified Sustainable Seafood to prevent overfishing).

Extension activities

Consider these ideas for extension activities:

- **Science:** investigate the impacts of oil spills from tankers on the ocean following these simple **experiments** and demonstration videos **here** and **here**
- **Taking Action through Geography and Science:** learners could take inspiration from work done by **Cappabue NS** and conduct work with the Green Schools Committee to identify 3 actions that the school could take to protect the ocean/raise awareness of these issues facing our ocean.
- **Science and Geography:** Case study investigation of how one of these threats are being addressed/ resolved -such as **Ways To Reduce Ocean Acidification**

Printable worksheets for this session are available here: **https://fll.ie/submerged**

fll.ie/submerged

Session 5: Developments in underwater navigation and exploration

Purpose:

Learners will develop an understanding of how humans navigate and explore the ocean and build an underwater vessel for this purpose.

Core Values:

Discovery | Teamwork | Fun | Inclusion | Impact

Learning outcomes:

Learners will be enabled to

1. Consider the challenges of exploring inaccessible parts of our oceans
2. Learn about underwater vessels such as submarines and the contribution that Irish engineer John Philip Holland made to their development
3. Design and build a submarine that could navigate and explore aspects of the ocean

Learners will build:

- Submarine from the Explore set

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

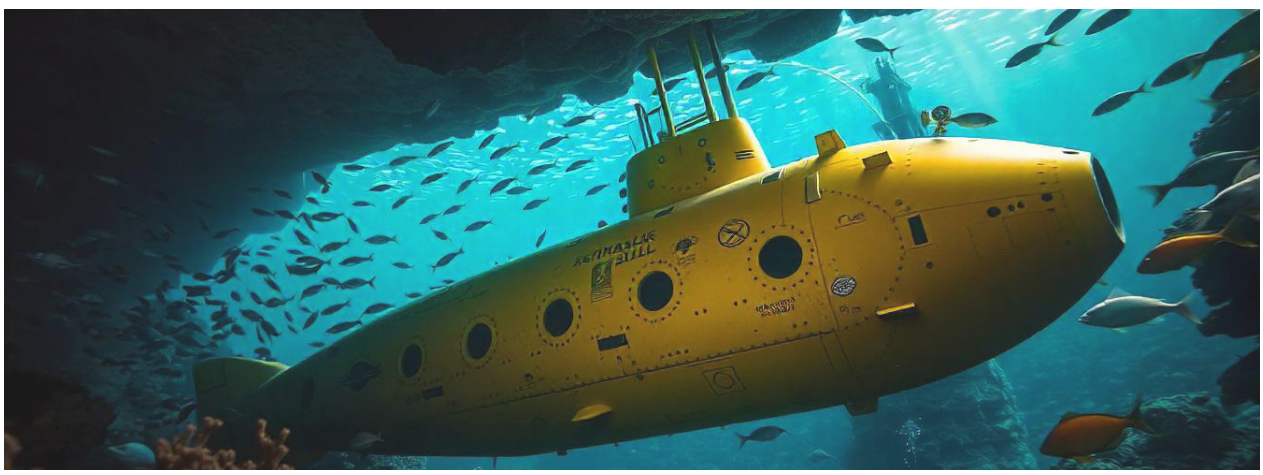
Per team:

- Paper/copybook and colouring pencils and/or markers; art materials (optional)
- SUBMERGED Explore Kit Bags 1 & 2
- Build Instructions (Book 1)

Digital resources:

- **What is a submarine?** *(0:00 - 2:22 mins)*
- **JP Holland - Irish engineer** *(1:22 - 4:10 mins)*
- **Canva**
- **Book Creator**

Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
History	Continuity and change over time	Transport	Time and chronology; Change and continuity
Geography	Natural Environment; Environmental Awareness and Care	Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment	Geographical Investigation Skills (Questioning, Hypothesising, Investigating, Observing, Analysing, Recording, Communicating)
Literacy	Oral Language; Writing	Communicating	Communicating; Understanding; Exploring and using



Introduction

Resource(s):

- Images from previous sessions

Challenges to exploring our oceans

Teacher introduces the topic (i.e. exploration of our oceans) by reminding learners of the different aspects of our oceans learned about so far (e.g., what oceans are, where they are located, ocean zones, habitats, and threats).

Exploring our oceans can be difficult. Use the following question to guide learners in a short discussion:

- *What do you think are some of the challenges of exploring the deepest parts of the ocean? (i.e. darkness, high pressure and cold temperatures).*
- *Can anyone think of a type of underwater vessel that could help humans to explore the deep ocean? How do you think it works? What makes such a vessel so useful?*

.

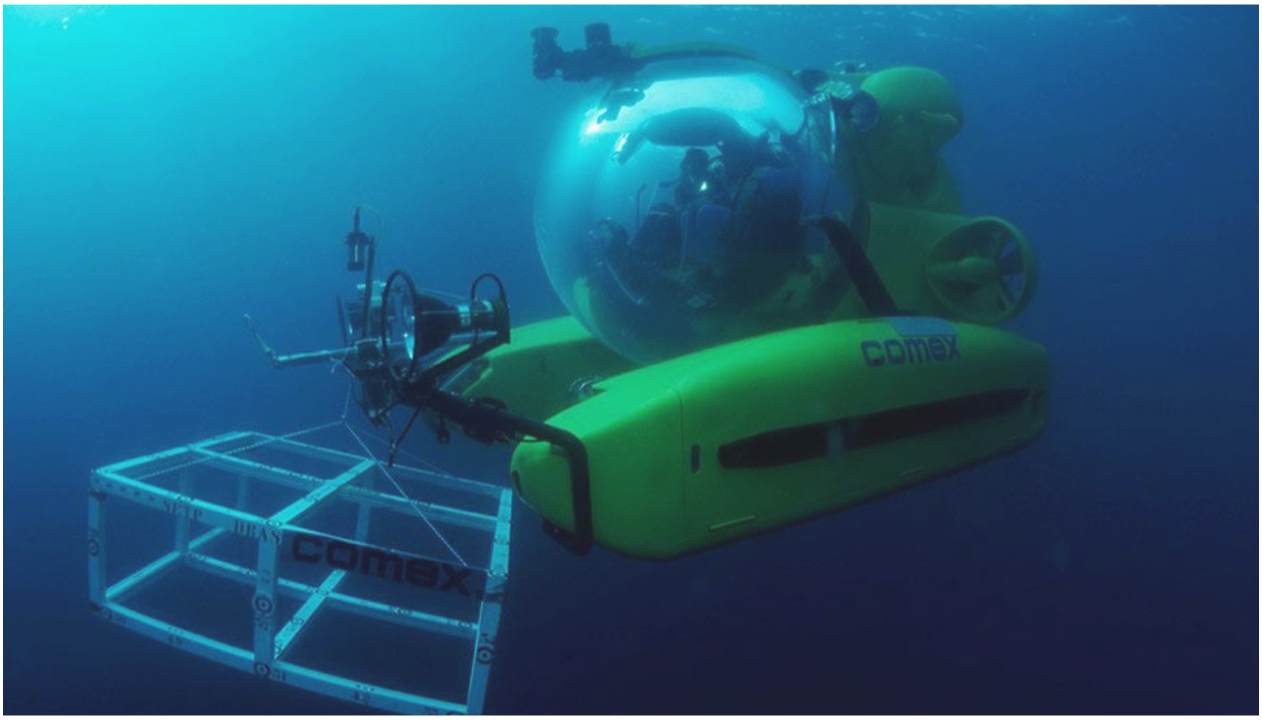
Introduction [continued]

The deepest depth a diver has swum at was 318m.

Whereas the oceans' deepest points lie at around 11km deep.

At this depth the pressure from the water is 1,100 atmospheres.

This is the same as an elephant standing on your little toe.



Development

Resource(s):

- **What is a submarine?** (*0:00 - 2:22 mins)*
- **JP Holland - Irish engineer** (*1:22 - 4:10 mins)*

- **Printable: JP Holland Factfile**
- SUBMERGED Explore Kit Bags 1 and 2
- Build instructions (book 1)

Vessels for underwater navigation

Video 1: What is a submarine?

At this stage of the session, learners will be introduced to submarines.

Before watching the video, the following guiding questions could be used:

- *What is a submarine and what is it used for?*
- *What can a submarine do that a diver cannot do?*

Watch the first part of the video clip: 0:00-2:22 mins and use these follow up questions:

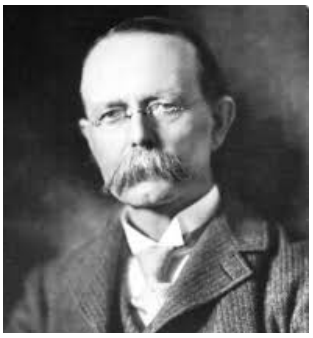
- *What more did you learn about submarines from the video clip?*
- *How do they work?*
- *If you were able to travel in a submarine, what would you want to discover in the ocean?*

Note to teacher:

This video continues by discussing other inventors, however it is recommended to stop it at 2:22 to avoid confusion.

Video 2: John Philip Holland, Irish engineer / inventor (1841-1914)

John Philip Holland was an Irish engineer who developed the first submarine to be formally commissioned by the US Navy. Watch this **video clip** (1:22 - 4:10) to learn a little more about John Philip Holland, where he came from and how he developed his designs before they were formally commissioned.



Following the video, encourage learners to discuss what they found interesting about JP Holland's life. The infographic on the next page provides some learner-friendly details of JP Holland's life and achievements.

JOHN PHILIP HOLLAND

(1841-1914)

1. Inventor of the modern submarine

John Philip Holland is famous for inventing the first modern submarine, a special underwater boat that could travel like a fish!

2. Ireland to America

He was born in Ireland on February 24, 1841 in the coastguard's residence in Liscannor, Co. Clare. As a child, he loved learning about science and building things. When he grew up, John moved to the United States, where he continued to work on his dream of creating a submarine to travel the oceans of the world.

3. Holland VI

His most famous submarine, called the Holland VI, took its first dive in 1898, in New York Harbour and was acclaimed a success. It could travel both on the surface and underwater, using a special engine. It carried a crew of fifteen, and had a torpedo tube in the bow.

4. First Submarine, US Navy

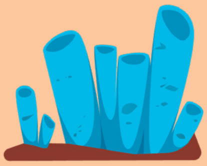
After some modifications to the Holland VI, the U.S. Navy bought it in late 1900. This submarine became the first one used by the US Navy, starting a new era in naval technology.

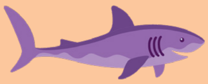
5.Legacy

John Philip Holland from Liscannor died on August 12, 1914. He is buried in Totowa, New Jersey, less than one mile from where he launched his first submarine. Thanks to him, submarines are now used all over the world. His inventions helped make travel and exploration underwater possible!

Reference: Clare County Library

Development [continued]



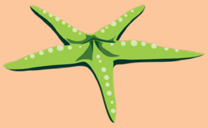


Build a team submarine, inspired by JP Holland

Imagine your team has been asked to help John Philip Holland build a submarine using his designs. What would you need to consider? Let's explore!

- Hand out the SUBMERGED Explore Kit Bags 1 & 2 and build instructions (book 1)
- Explain that the submarine design was inspired by John Philip Holland.
- Guide students to work in teams to build their submarines using the provided kits.
- Encourage them to think about the different parts and functions of their submarines

Share



Let's share and imagine!

The teacher invites teams to talk about their submarines.

- *What are the different parts and what they might be used for? What might their submarine do or discover on one of its expeditions? (e.g., locate a sunken ship, discover new species, map the ocean floor)*
- *How do the team designs differ from JP Holland's designs?*
- *Why do submarine designs need to evolve over time?*
- *Are there any technologies today that weren't available to JP Holland? How might they have altered his designs and his thinking?*

(Include the document/share cycle here - or intro of portfolio to document and reflect upon their progress.)

Share [continued]

Note to teacher:

Today, vessels for underwater navigation have many different kinds of uses.

Please keep your team submarine model assembled so that it can be used again, or modified to learn more about underwater navigation and exploration in future sessions.

Closure/Extension

Resource(s):

- Canva
- Book Creator

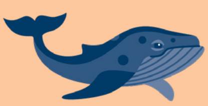
Next, ask learners to imagine they were working with JP Holland around 1900. Their task is to persuade the US Naval authorities that JP's submarine is worth buying and developing further. Ask learners to create a poster/brochure to do this.

Learners could include - a persuasive title, 1-2 drawings of the submarine and its features/functions. Ideas for future developments of the submarine could also be included, along with some details about JP Holland, engineer (e.g. born in Ireland in 1841; moved to the United States; was a schoolteacher before becoming an engineer; was fascinated with underwater navigation).

Encourage learners to be as imaginative (and persuasive!) as possible.

This activity could be done using art materials or alternatively, digital tools such as Canva or Book Creator offer many multi-media options too (e.g. text, image, voice recordings etc). Learners' work could form or contribute to a class display.

Additional useful links for background information can be found in the extension activities section.



Closure/Extension [continued]

Taken from *The Phoenix*, Clare Champion, Friday August 9, 1996

The 'Holland 1' Submarine

Extension activities

Consider these ideas for extension activities:

- **History:** learn more about the development of the modern submarine by visiting some of the following reliable sources:
  - Clare People: John P Holland: **link**
  - Britannica profile on the Irish inventor of the modern submarine: **link**
  - Short Irish Times article on John Philip Holland and his invention of the submarine: **link**
  - Short RTE Radio recording after the death of John Philip Holland (3:53): **link**
    [note to teachers, references to Fenians may need to be explained]
- **History, Literacy, Geography, Science:**
  This scoilnet.ie learning path could be adapted and used with a class to learn more about what submarines are, how they work, and an experiment to create a submarine
  - **scoilnet.ie**
  - Direct link to simple science experiment: **link**

Printable worksheets for this session are available here: **https://fll.ie/submerged**

fll.ie/submerged

Session 6: How marine biologists explore the sunlight zone

Purpose:

Learners will explore the work of a marine biologist in the ocean's sunlight zone.

Core Values:

Learning outcomes:

Learners will be enabled to

1. Develop an understanding of, and appreciation for, the work of a marine biologist
2. Build and code a LEGO robot
3. Experiment with cause and effect relationships using the motor and movement code blocks
4. Develop a deeper understanding of code by testing and adapting prototypes

Learners will build:

LEGO SPIKE Essential

- Lesson 1 - Boat Trip

LEGO WeDo 2.0

- Cooling Fan

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device

Digital resources:

- What Is Marine Biology?
- How do you become a marine biologist?
- A Day In The Life
- David O'Sullivan

Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
Science	Living Things; Environmental awareness and care	Plant and animal life; Caring for the Environment	Questioning; Observing; Sorting and classifying; Designing and making
Geography	Human Environments; Natural Environments	People at work; Land, rivers and seas	A sense of place; a sense of space
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using

Introduction

Resource(s):

- Video links
- Digital devices

Introduction

In this session, learners build on what they learned in the previous five sessions by exploring the work of marine biologists in the ocean's sunlight zone.

Teacher introduces the session by activating prior knowledge of the work of a marine biologist:

- *Does anyone know what a marine biologist does?*
- *Do we know any marine biologists?*
- *When we hear the word 'marine', could we infer what types of life the marine biologist studies?*
- *Where might marine biologists work? Explain*
- *What types of work might a marine biologist do? What makes you think this?*

Introduction [continued]

The following video resources, and guiding questions, can be used to introduce the work of a marine biologist:

> **Teacher Tip**
>
> If time is limited, it is recommended that the second and third videos (Rachel and Adrian's stories) be prioritised

- **What Is Marine Biology?**
  1:47 - this video is aimed at younger learners, but provides a useful explanation of marine biology.
  - *How would you explain biology?*
  - *How would you explain marine biology?*
  - *Could you give examples of animals a marine biologist would be interested in?*

- **How do you become a marine biologist?**
  4:38 - BBC Earth video where a marine biologist (Rachel) explains how to become a marine biologist. This video includes a host of videos and images of the work of a marine biologist, and explains the different types of work marine biologists conduct from 1:32 - 2:15.
  - *What types of places do marine biologists work?*
  - *Which are you most interested in, and why?*
  - *What was your favourite part of Rachel's video?*

Introduction [continued]

- **A Day In The Life**
  2:06 - Marine Scientist (Adrian) explains his daily work designing experiments to grow food in the oceans. This video includes videos and images, and highlights a very different type of work compared to the previous video.
  - *What type of work does Adrian do?*
  - *How does Adrian's work differ from Rachel's?*
  - *Do you think Adrian's work is important? Why (not)?*
- **David O'Sullivan**
  1:23 - Marine Institute of Ireland animated video where the work of marine biologist and geoscientist (David) is introduced. It includes images of the Irish ship, Celtic Voyager, and images of mapping around the coast of Ireland.
  - *Where does David do a lot of his work?*
  - *What types of things does David do in his job?*
  - *Did anything surprise you?*

Following engagement with some of these media resources divide learners into pairs or small groups and instruct them to develop an explanation for what a marine biologist does, and what questions they might have for a marine biologist.

Marine biology

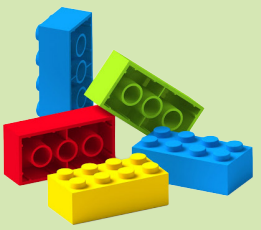
Marine biology is the study of life in the ocean.

A marine biologist studies ocean ecosystems and ocean life. Their focus may be on large animals like whales and dolphins, small organisms like plankton and algae, or plant life like seaweed. Marine biologists help to identify whether species are in danger or if they are changing their behaviours due to threats such as increased temperature.

As an extension, learners could examine the following weblinks to further develop their understanding of the work of a marine biologist:

- **American Museum of Natural History**
- **UK National Marine Aquarium**

Development
(Build)



Classroom organisation:

- Divide learners into groups of four or fewer while using LEGO materials.

Teams are building boats, but these materials should not be placed in water.

Resource(s):

- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device

LEGO builds

If your class is new to coding, you could have them complete the tutorial activities in the LEGO Education SPIKE Essential or WeDo 2.0 software.

Remind the class that like Rachel, Adrian and David explained in their videos, many marine biologists need a boat to get to the sunlight zone and study the life contained there. In the next part of this session we are going to use LEGO elements to build and code a boat, and a way of launching it out into the ocean. This way, the marine biologist will be able to get to work in the sunlight zone.

Purpose of the builds:

- To introduce learners to the LEGO® Education SPIKE Essential or WeDo 2.0 software and block-based coding.
- To introduce the 'motor' block and explore what happens when the power of the motor is changed.
- Learners modify their boat and launcher, and change the program to launch it.

Teacher tip

Dependent on the class it may be beneficial to explicitly revise or pre-teach the following mathematical concepts:

- Clockwise and anti-clockwise
- Fractions of a circle: half, ½, 0.5; quarter, ¼, 0.25
- 5th & 6th: Degrees : 360° 180° 90°

Build a boat and launcher: [approximately 30min]

1. In teams, learners engage with the LEGO Education classroom project dependent on which kit they have
2. Complete challenge activities

Development [continued]

SPIKE Essential
Lesson 1 - Boat Trip

Learners follow detailed instructions to build and code the 'Boat Trip'.

Once the basic build has been completed, set the following tasks which challenge them to explore how the coding for the boat launcher works and how it can be changed.

The white base plate holding the smart hub can be moved back to allow the boat to be 'launched' right and left.

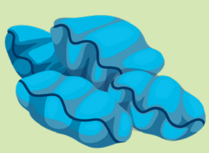
Make the purple arm

a. Turn clockwise
b. Turn anti-clockwise
c. Move quicker/slower
d. Push the boat out as far as possible
e. Push the boat out as short a distance as possible
f. Move a half turn (180°)
g. Move a quarter turn (90°)

Development [continued]

Resource(s):

- WeDo Cooling Fan



WeDo 2.0
Cooling Fan

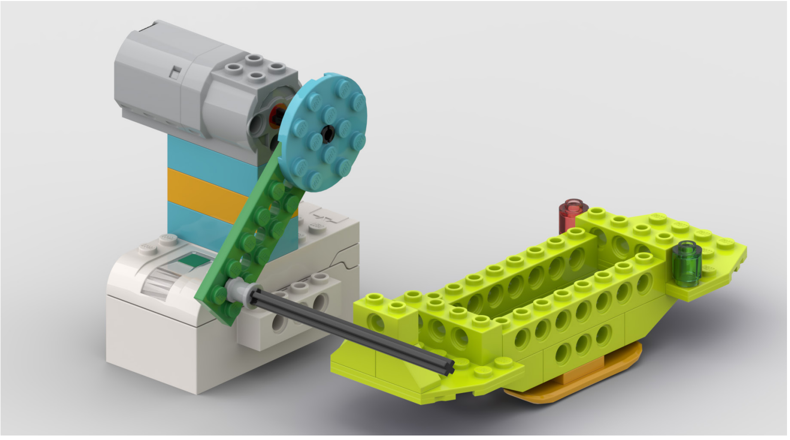
Learners follow detailed instructions to build and code the Cooling Fan.

Once the basic build has been completed, modify the build to turn the Cooling Fan into a boat launcher.
Then, build a boat that is tall enough to be pushed by the boat launcher.

Next, set the following tasks which challenge them to explore how the coding works and how it can be changed.

Make the boat launcher:

a. Turn clockwise
b. Turn anti-clockwise
c. Move quicker/slower
d. Push the boat out as far as possible
e. Push the boat out as short a distance as possible
f. Move a half turn (180°)
g. Move a quarter turn (90°)



Development [continued]

Now that learners have built a boat and boat launcher, remind them of the different types of work completed by marine biologists like Rachel, Adrian and John. Think about where they worked, what equipment they were using in their videos, what types of living things they investigated.

Instruct each team to decide what type of marine biology their team will be conducting, and modify their boat to do this.

Guiding questions:

- *What type of marine biology will your team conduct?*
- *Will this take place in the water, under the water?*
- *Will it involve travelling long distances?*
- *Will this take place in the water? Under the water?*
- *What types of equipment will be needed? Will there be a lab on board? Will there be a need for scuba equipment?*

Teams modify their boat model to represent the marine biology being undertaken by their team.

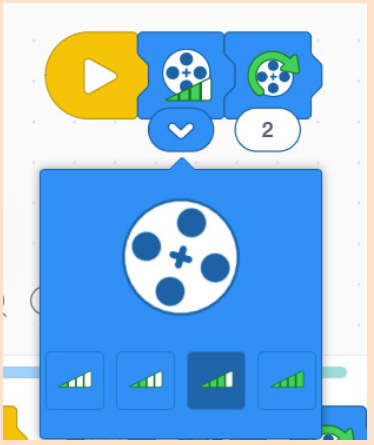
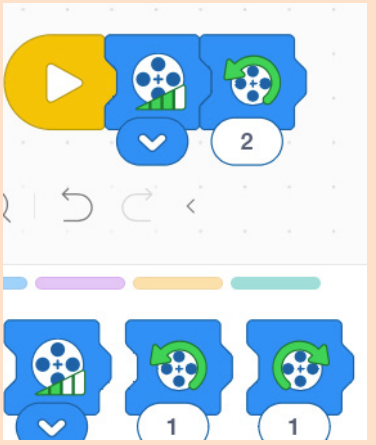
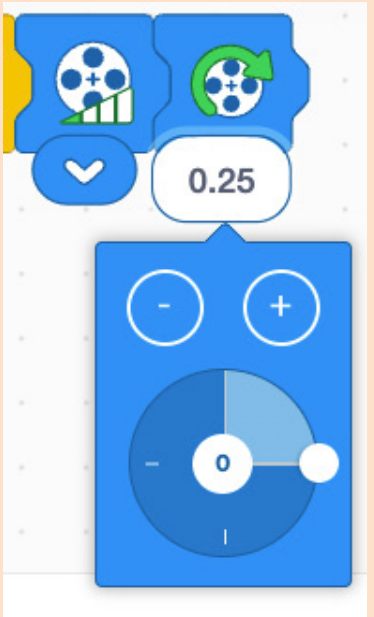
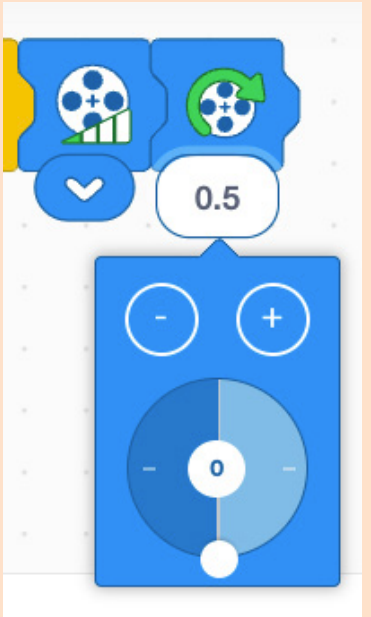
Teams could be invited to share their modified boats and launchers, and explain how they work (e.g. the program/code).

Coding and build guidance for teachers

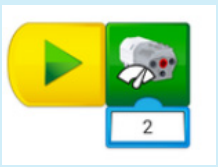
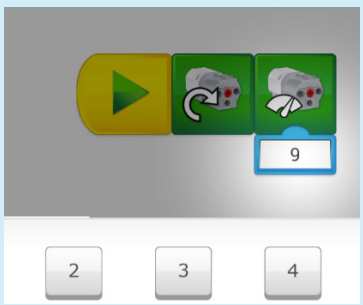
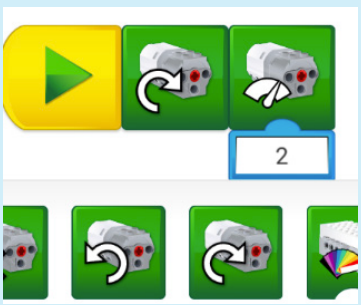
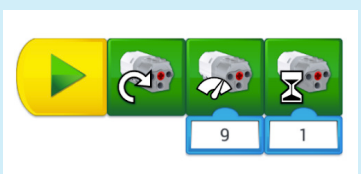
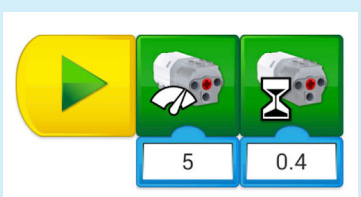
Resource(s):

- Narrated video for each program

The following support and guidance is intended for the teacher in order to assist you in scaffolding learners. It is not intended that learners be shown solutions.

SPIKE Essential **Lesson 1 - Boat Trip**	
 Once the code is executed (started), the motor power is set, followed by setting the motor to turn clockwise twice (2).	This simple algorithm (code) can be tinkered with in order to make the robot move more quickly/ slowly, to change the direction of movement (clockwise/anticlockwise), and to change how long/ short the motor stays on for (duration).
 Change Speed of turns	 The number under the rotation (2) sets the number of rotations, in this case the duration.
Rotations in fractions and link to degrees.	
	

Coding and build guidance for teachers

WeDo 2.0 Cooling Fan	
 Once the code is executed (started), this robot will turn on the motor at a power of two (2), which will cause the fan to begin moving.	This simple algorithm (code) can be tinkered with in order to make the robot move more quickly/ slowly, to change the direction of movement (clockwise/anticlockwise), and to change how long/ short the motor stays on for (duration).
 Change Speed	  The number under the hourglass is the number of seconds the motor will run.
To get the WeDo cooling fan to make a half or quarter rotation the learners can be asked to think about making it turn more slowly (adjust speed) and for less or more time (duration). The image on the right is one possible solution of a program which has the fan turn one full rotation.	

Guiding questions:

- *Can you change the direction the robot turns?*
- *I wonder what might happen if you change the number under the motor block?*
- *Can you see any blocks that might make the robot stay running for longer?*
- *What is the fastest you can set the robot to turn?*

Closure *(Document/ Share/Tidy up)*
[10 min]

Resource(s):

- Digital Portfolio
- Digital Device

1. **Document:**
   a. Each team documents and reflects upon the boats and launchers they built - **adding photos, videos, notes to their digital portfolios.**
   b. Consider how they built it, how it works, how they might change or adapt or improve it.

2. **Share:**
   a. What they built, and how it represented the work of a marine biologist
   b. Show the coding skills they learned
      i. Explain how they changed the program
      ii. Explain a problem they faced or overcame
   c. Demonstrate their solutions

3. **Teams Tidy Up:**
   a. All builds should be disassembled and returned to the LEGO Education Set.

Extension activities

Consider these ideas for extension activities:

- **Science:** Investigate why boats float
- **Literacy and Digital Learning:** Create a digital book to share their learning about the work of a marine biologist with other classes.
- **Geography:** Take a deeper dive into the types of boats and equipment used by marine biologists. For example, the Marine Institute of Ireland has a host of videos of their marine vessels on their YouTube channel
- **Literacy:** Write a diary entry on a day in the life of a marine biologist
- **Science:** Investigate the interdependence of life in the sunlight zone

fll.ie/submerged

Session 7: How marine archaeologists explore the twilight zone

Purpose:

Learners will be introduced to the work of a marine archaeologist in the twilight zone. They will adapt and improve the submarine model by adding sensors and outputs.

Core Values:

Discovery | Teamwork | Fun | Inclusion | Impact

Learning outcomes:

Learners will be enabled to

1. Develop initial understandings of the work of a marine archaeologist
2. Build the LEGO model from the lesson and explore the use of lights and sensors
3. Identify how sensors are used by marine archaeologists to identify items of interest in the twilight zone of the ocean
4. Apply their understanding of sensors and if/then statements to improve the submarine model

Learners will build:

Build 1:

LEGO SPIKE Essential

- Lesson 2 - Animal Alarm

LEGO WeDo 2.0

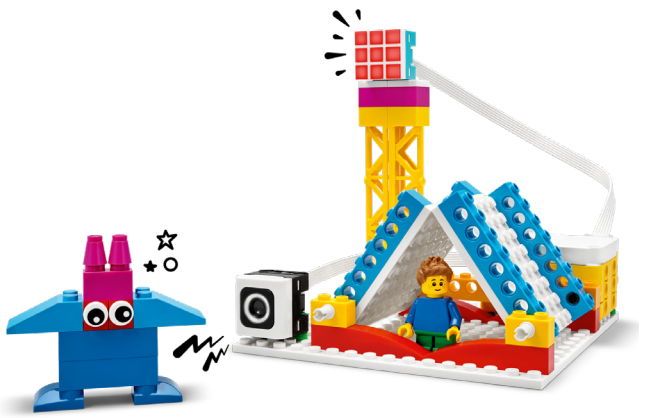
- Spy Robot

Build 2:

Improving the submarine (motor & sensor)

Progress:

1 2 3 4 5 6 7 8 9 10 11 12



Resources

Per team:

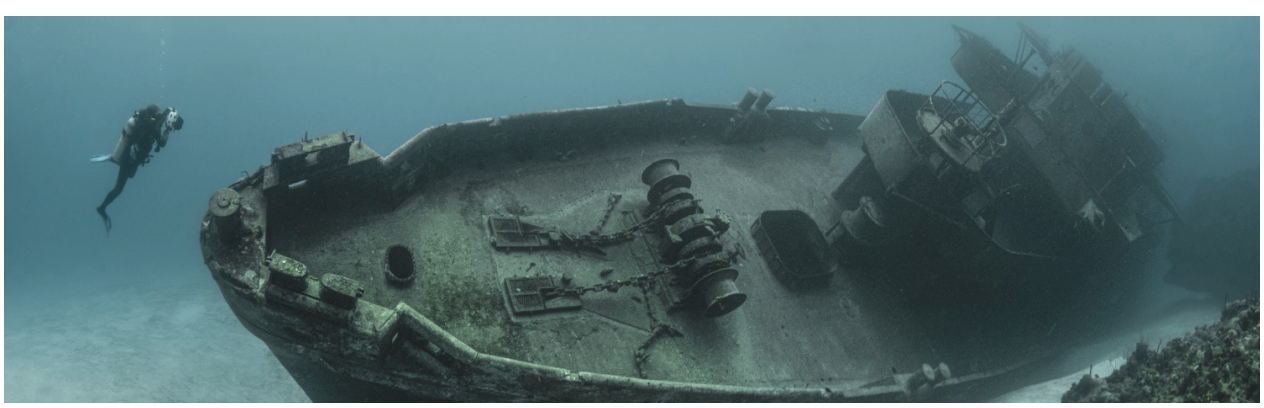
- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device
- LEGO SUBMERGED Submarine (already built)
- LEGO SUBMERGED Explore Set
- SUBMERGED Explore Kit Bag 3
- Build Instructions (Book 2 or **WeDo instructions**)

Digital resources:

- **What is Maritime Archaeology?**
- **Curious about careers**
- **Joe MagRaollaigh reports on shipwrecks off the Irish coast**
- **Wreck Diving at Malin Head**
- **Deep wrecks of Malin Head**

Curriculum content

Subject	Strands	Strand units/ elements	Skills and concepts
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using
Geography	Human Environments	People at Work	Analysing; recording and communicating; predicting
History	Life, Society Work and Culture in the Past; Continuity and Change over Time	Life during World War II; Transport	Change and continuity; cause and effect; using evidence; synthesis and communication; empathy
Maths	Number; Shape and Space	Fractions; Decimals; 2D / 3D shapes; Lines and angles	Applying and problem-solving; Communicating and expressing; Integrating and connecting; Reasoning; Implementing



Resource(s):

- Digital devices
- **Link to discussion images**

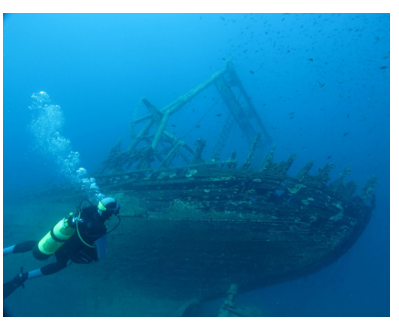
Introduction

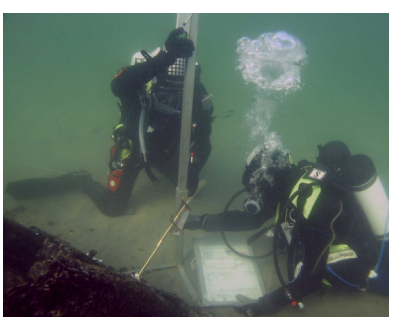
In this session, learners learn about the work of marine archaeologists in the ocean's twilight zone. They then build and code technology similar to that used by marine archaeologists when exploring for ancient artefacts in the ocean's twilight zone.

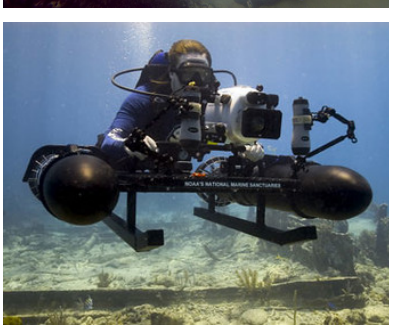
Teacher introduces the session by activating prior knowledge of this part of the ocean - the twilight zone:

- *From Session 3, can anyone remember anything about the Twilight Zone?*
- *Why is this part of the ocean called the Twilight Zone?*
- *What kind of animals live there?*
- *Why/how do you think they can survive there?*

Teacher displays the following **images** to prompt discussion. This could be done as a whole class, with the images displayed on the teacher's IWB, or in small groups using print outs or digital versions of the images on student devices, etc.







- What is happening in these photos? What makes you say this?
- What do you think these people work as?
- What are they studying? Why do you think this?

Introduction [continued]

Resource(s):

- Video links

Teacher then explains that in this session we will explore the work of a marine archaeologist. The following questions could be used to activate prior knowledge:

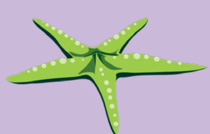
- *Does anyone know what a marine archaeologist does?*
- *Do we know any marine archaeologists?*
- *Where might marine archaeologists work? Explain*
- *What types of work might a marine archaeologist do? What makes you think this?*
- *How might the work of an archaeologist and a marine archaeologist differ? How might it be similar? Explain why you think this*

The following video resources, and guiding questions, can be used to introduce and explore the work of a marine (or underwater) archaeologist. If time is limited, it is suggested to prioritise the first two videos:

- **What is maritime archaeology?**
  1 minute - in this very short video a marine archaeologist (Jim) gives a very general explanation of marine archaeology. He draws strong connections to the importance of the ocean in our daily lives, and how human artefacts found under the sea can help us learn about our history.

- **Curious about careers**
  2 minutes - In this video a child interviews a marine archaeologist (Melanie) about her work. This is all explained in very child-friendly language.
  - *After listening to Melanie, what types of work does a marine archaeologist do? Did any of this surprise you?*
  - *What types of 'clues to human history' did you see in the video?*
  - *How do marine archaeologists find the shipwrecks and items they study? What types of technology are used? (Ans: remote sensing equipment. This will be the focus of the LEGO build)*

- **Joe MagRaollaigh reports on shipwrecks off the Irish coast**
  2:35 - video from RTE News which includes images and video of shipwrecks around the coast of Ireland.
  - *Did anything in that video surprise you? Why?*
  - *What types of things did they find under the sea off the coast of Ireland?*
  - *Could there be more shipwrecks that have not yet been found? What other types of things could be found in the twilight zone?*



Introduction [continued]

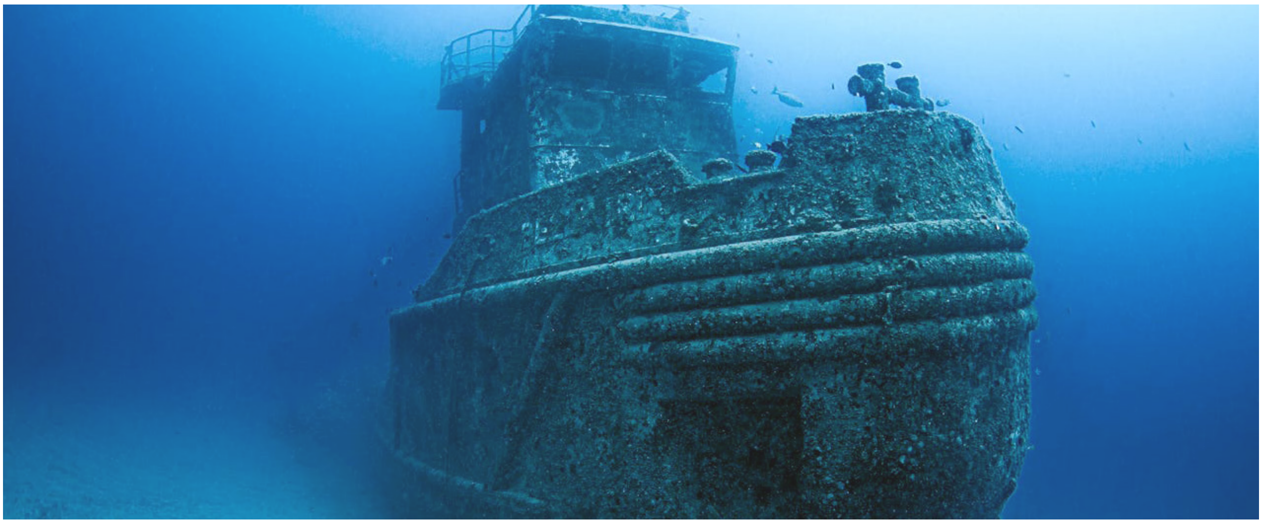
- Wreck Diving at Malin Head
  6:42

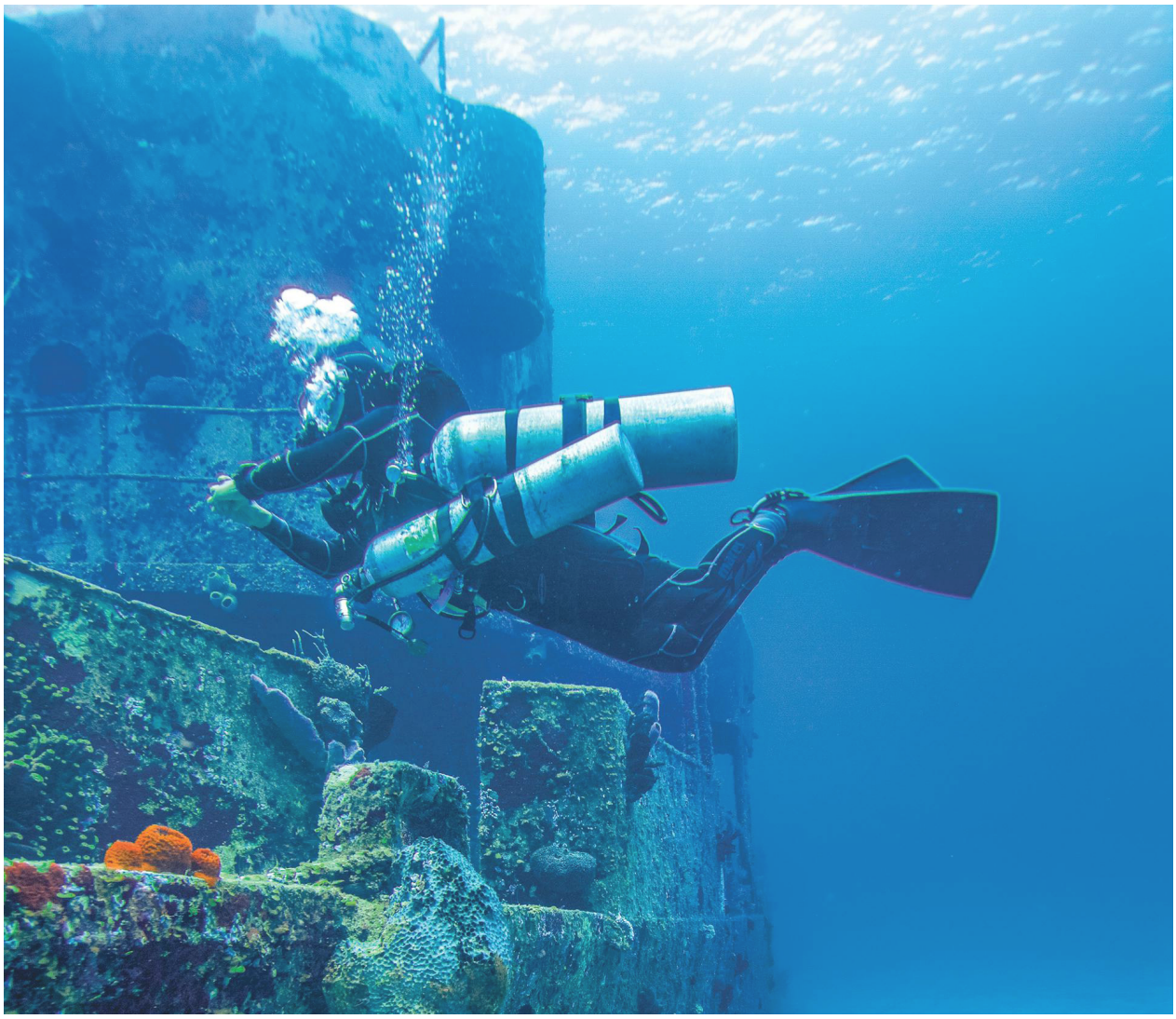
- Deep wrecks of Malin Head
  12:11 - divided into chapters. Two videos of divers exploring shipwrecks off the coast of Donegal, including SS Justicia, HMS Audacious, SS Laurentic, German UBoat U-2511. Sections of these videos could be used to enable learners to imagine what it could be like to be a marine archaeologist working in the twilight zone off the coast of Ireland.

Marine archaeologist

A marine archaeologist explores how humans have interacted with the oceans in the past. They can teach us a lot about the history of the oceans.

See the Extension Activities at the end of this session for further ideas relating to how marine archaeologists work as historians.





Development
(Build)

Sensor and improving the submarine

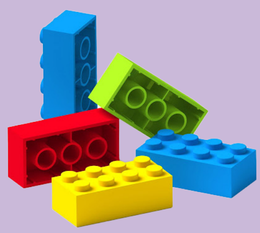
Remind the class that marine archaeologists use technology to help them identify and record items of interest, like shipwrecks, in the twilight zone.

In the next part of this session we are going to work on two LEGO builds. The first will help us learn how to use a sensor to 'see' what we might not be able to. Then, in the second we will help our marine archaeologists by modifying the submarine we built in Session 5 so that it can move and alert us when it senses something worth investigating.

Purpose of the builds:

- To introduce the sensor and sensor code block.
- Explore how the sensor and sensor code block function.
- Tinker with, and build upon the sensor code to add sound, light to their submarine.

Development [continued]

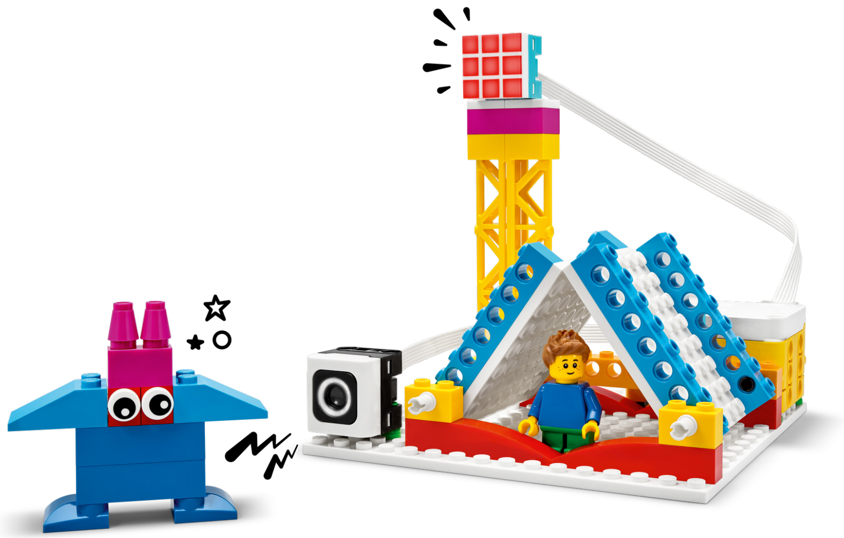


Resource(s):

- SUBMERGED Explore Kit Bag 3
- Build Instructions (Book 2 or WeDo 2.0 instructions)
- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device

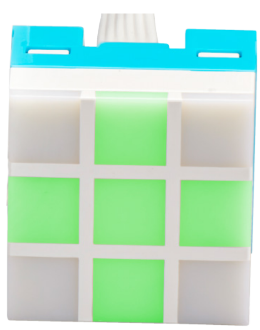
Sensor build: [approximately 20min]

1. In teams, learners engage with the LEGO Education classroom project:
   a. SPIKE Essential - Lesson 2 - Animal Alarm
   b. WeDo 2.0 - Spy Robot
2. Learners follow detailed instructions to build and code the Animal Alarm OR Spy Robot.
3. Encourage learners to complete challenge tasks below.



SPIKE Essential
Animal Alarm challenge tasks

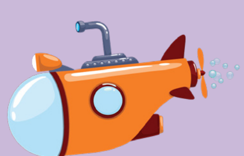
1. Change the colours displayed by the colour light matrix connected to the hub.
2. Create a 'pixel' image on the colour light matrix (e.g. smile for safe, frown for alarm)
3. Add sound so that when the alarm is activated a sound is also played.
4. Record and add a learner-recorded sound to play when the sensor is triggered.
5. Write an algorithm that plays a noise and flashes a light when the sensor is activated.
6. Discuss why it is beneficial to have the sensor provide both visual and audio alerts.



Development [continued]

Resource(s):

- WeDo Instructions



WeDo 2.0
Spy Robot Challenge Tasks

1. Change the sound played when the alarm is activated
2. Record and add a learner-recorded sound to play when the sensor is triggered.
3. Code the robot to flash a coloured light on the hub when the sensor is activated
4. Change the colour displayed by the hub
5. Write an algorithm (code) that plays a noise and flashes a light when the sensor is activated.
6. Discuss why it is beneficial to have the sensor provide both visual and audio alerts.

Build 2: Improving the submarine [~20min]

1. In teams, learners use the building instructions in Book 2 (or in the separate WeDo 2.0 instructions) to improve their submarine by attaching the sensor, motor, and hub.
2. Learners use the basic program (code) provided to motorise their submarine. The aim is that by adding the motor, the submarine's propeller will spin. By modifying the basic program provided, the propeller can turn clockwise or counterclockwise, causing the submarine to move forwards or backwards.
3. Once a team has the basic program working, assign the following challenges. Change the program so that your submarine will do the following:
   a. When an object is detected, the submarine flashes a light, to notify the marine archaeologist.
   b. When an object is detected, the submarine plays a sound, to notify the marine archaeologist.
   c. When an object is detected, the submarine flashes a light and plays a sound, to notify the marine archaeologist.
   d. SPIKE Essential only:
      i. When the sensor detects a black or grey object, the propeller spins quickly to back away.
      ii. When the sensor detects a blue or yellow object, the propeller spins slowly to move in and get a closer look.
4. Invite teams to share, and explain how they coded their submarine model.

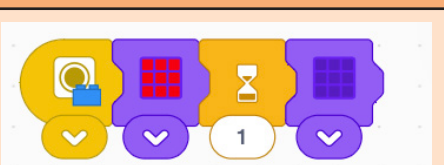
Coding and build guidance for teachers

Resource(s):

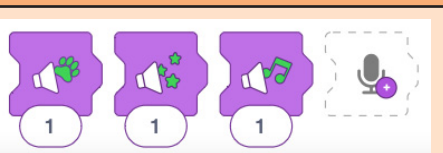
- **Narrated video for each program**

The overall build and code are very similar, however the different sets use different sensors:

- The LEGO WeDo 2.0 Set uses a **motion** sensor.
  - The motion sensor detects changes in distance from an object within its range in three different ways:
    - Object moving closer
    - Object moving farther away
    - Object changing position
  - e.g. a robot can be programmed to react after something moves within range of its sensor
- The SPIKE Essential Set uses a **colour** sensor.
  - The Colour sensor can be programmed to detect a specific colour and then react to this.
  - e.g. a robot can be programmed to react after a specific colour is detected within range of its sensor

WeDo 2.0 Classroom Project: **Spy Robot**	SPIKE Essential: **Lesson 2 - Animal Alarm**
	
Once the code is executed (started), this robot will wait until the sensor senses motion. It will then start playing an audio file (sound 1).	Once the colour sensor recognises the target colour (blue), the colour light matrix will display a 3x3 grid of red lights. After 1 second has passed, the colour light matrix will not display any lights.

This simple algorithm (code) can be tinkered with in order to make the 'alarm' more effective by including both lights and sound. The additional code blocks for lights in WeDo 2.0 and sound in SPIKE Essential are shown below.

WeDo 2.0	SPIKE Essential
	

Coding and build guidance for teachers

Guiding questions:

- *Can you change the sound the robot makes?*
- *I wonder what might happen if you change the number under the music block?*
- *Can you see any blocks that might make the robot turn on a light?*
- *Can you change the colour of the light?*
- *Can you make the robot play a sound and flash a light one after the other?*
- *I wonder if you could change the order of sound and light?*

Teacher tip:

If using the LEGO WeDo 2.0 Set - remember that the sound comes from the digital device, not from the hub. Learners may need to turn up the volume on the device.

Closure (Document/ Share/Tidy up)

Resources:

- Digital portfolio
- Digital device

Document:

1. Each team documents and reflects upon their improved submarine - adding photos, videos, notes to their digital portfolios
2. Consider how they built it, how it works, how they might change or adapt or improve it

Share:

1. What they built, and how it represented the work of a marine biologist
2. Show the coding skills they learned
   a. Explain how they changed the program
   b. Explain a problem they faced or overcame
3. Demonstrate their solutions

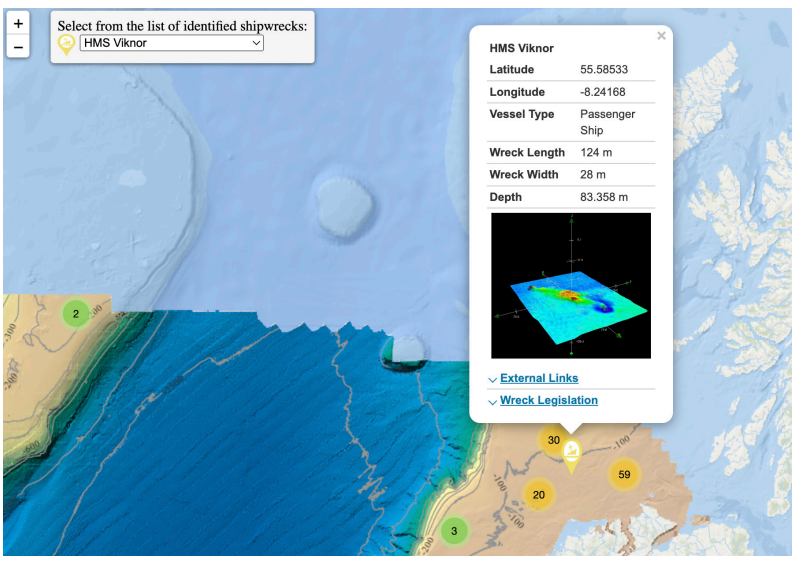
Teams tidy up:

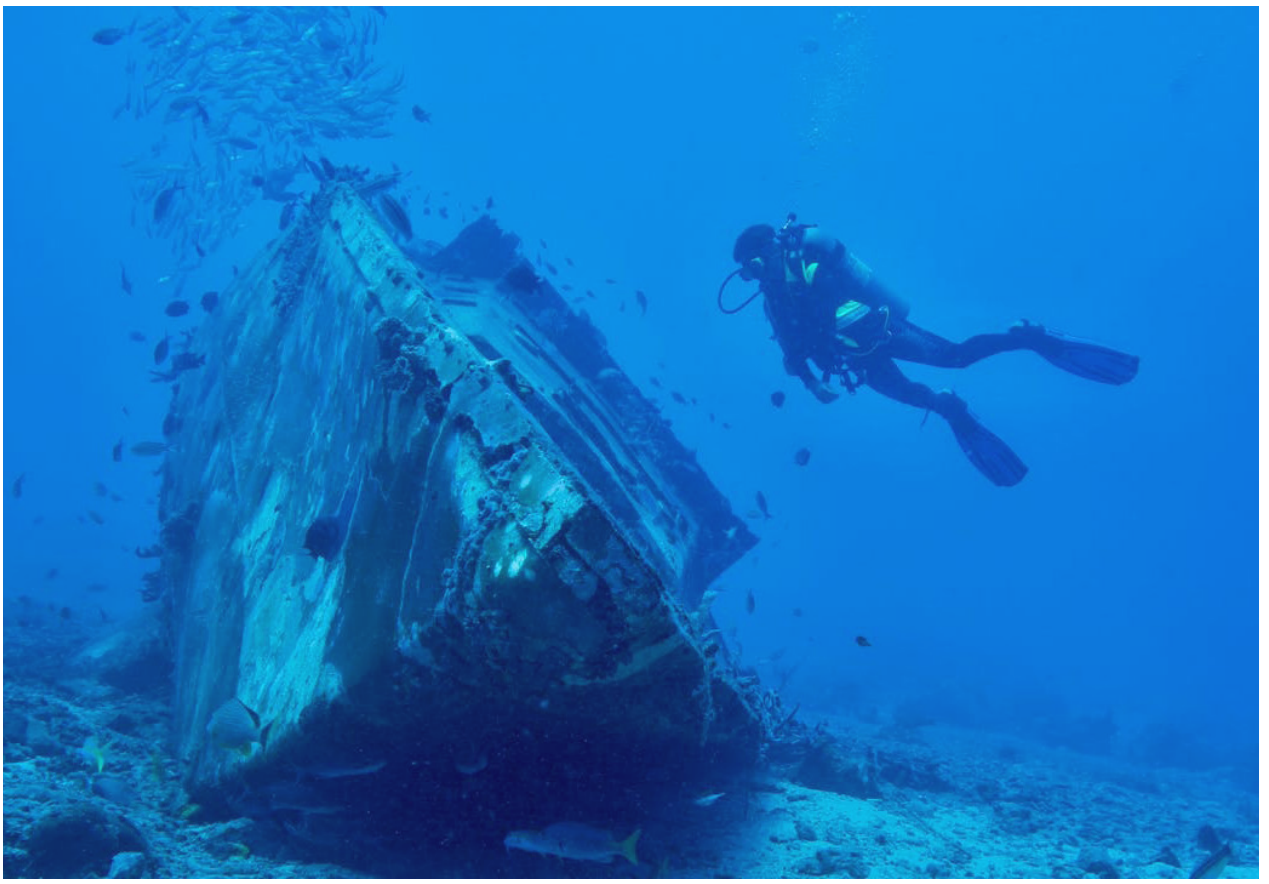
1. The submarine should be left assembled
2. Remove the hub, sensor pieces, and motor from the submarine and return them to the LEGO Education Set (SPIKE Essential or WeDo 2.0)
3. All other prototyping pieces should be taken apart and returned to storage

Extension activities

Consider these ideas for extension activities:

- **Science:** Investigate how the sensors used in the LEGO builds work by conducting experiments relating to light and sound (e.g. investigating how sound travels).
- **History:** Take a deeper dive into the shipwrecks around Ireland by exploring some of the resources provided by the Marine Institute:
  - **www.infomar.ie/** scroll down to find an interactive map of shipwrecks in Irish waters
  - Your class could use their skills as historians to learn more about one or more of these shipwrecks





Extension activities [continued]

- Investigate a more well known shipwreck:
  - Sir Ernest Shackleton's ship Endurance was found at the bottom of the Weddell Sea, and has been examined by marine archaeologists. Information, images and video at this **BBC link**
  - The Titanic is one of the most famous shipwrecks. Consider some of the learning activities on the **Scoilnet.ie** theme page for the Titanic
- After learning more about one or more shipwrecks, your class could apply their knowledge and understanding in literacy and drama activities:
  - Freeze-frame of moments upon the investigated ship
  - Interview with passengers and/or members of the crew (written/dramatised/podcast).
- Share their learning about the work of marine archaeologists by creating a greenscreen video where they are 'exploring a shipwreck' - see **Appendix 1** for a beginner's guide to using Green Screen visual effects.

fll.ie/submerged

Session 8: How oceanographers explore the abyssal zone

Purpose:

Learners will go even deeper to learn about the abyssal zone and the work of an oceanographer to explore it. Learners will modify an autonomous underwater vehicle (AUV).

Core Values:

Discovery | Teamwork | Fun | Inclusion | Impact | Innovation

Learning outcomes:

Learners will be enabled to

1. Identify some basic characteristics of the abyssal zone
2. Learn about the methods and technologies oceanographers use to explore the abyssal zone
3. Build and code a mobile LEGO robot that enables further experimentation with motor direction and motor speed
4. Modify the build to represent an underwater vehicle (AUV) capable of exploring the abyssal zone

Learners will build:

LEGO SPIKE Essential

- Lesson 3 - Arctic Ride

LEGO WeDo 2.0

- Milo the Science Rover

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device
- LEGO SUBMERGED Submarine (already built)

Digital resources:

- The Deepest Part of the Ocean (4 min)
- Meet Katy Croff Bell (2:30 min)

Curriculum content

Subject	Strands	Strand units/ elements	Skills and concepts
Science	Living Things; Energy and Forces	Plant and animal life; Forces	Questioning; Observing; Sorting and classifying; Designing and making
Geography	Human Environments; Natural Environments; Environmental Awareness and Care	People at Work; Lands, Rivers and Seas; Environmental Awareness; Caring for the Environment	Analysing; recording and communicating; predicting
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using

Oceanography

Oceanography is the study of the ocean. It applies chemistry, geology, meteorology, biology, and other branches of science to the study of the ocean. Oceanographers study the ocean, marine plants and animals, as well as the rocks and minerals that lie beneath the sea bed.

Introduction

In this session, learners are introduced to some basic characteristics of the ocean's abyssal zone and how an oceanographer works to explore it.

Teacher introduces the session by activating prior knowledge of the deepest part of the ocean - the abyssal zone:

- *What do you think the deepest part of the ocean might be like?*
- *Does anyone know what this zone is called?*
- *What kind of animals might live there?*
- *Why/how do you think they can survive there?*

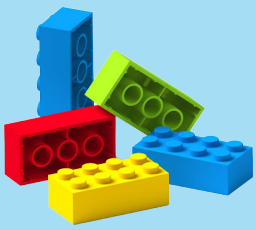
Meet **Katy Croff Bell** - Oceanographer

This short **NatGeo Kids video** (2:30 min) introduces learners to Katy Croff Bell and her work as an oceanographer.

Following the video, use the following questions to enable learners to further describe the work of an oceanographer:

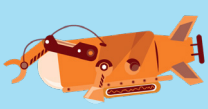
- *What aspects of the ocean does an oceanographer explore?*
- *Why is this important work?*
- *What kinds of vehicles do they use?*
- *How do these vehicles work?*
- *Do the vehicles have any special features or technologies?*
- *Where does all the new information go? Who helps Katy to share this information? How do they share it?*
- *What kinds of challenges might Katy and the team meet during their work?*

Development
(Build)



Resource(s):

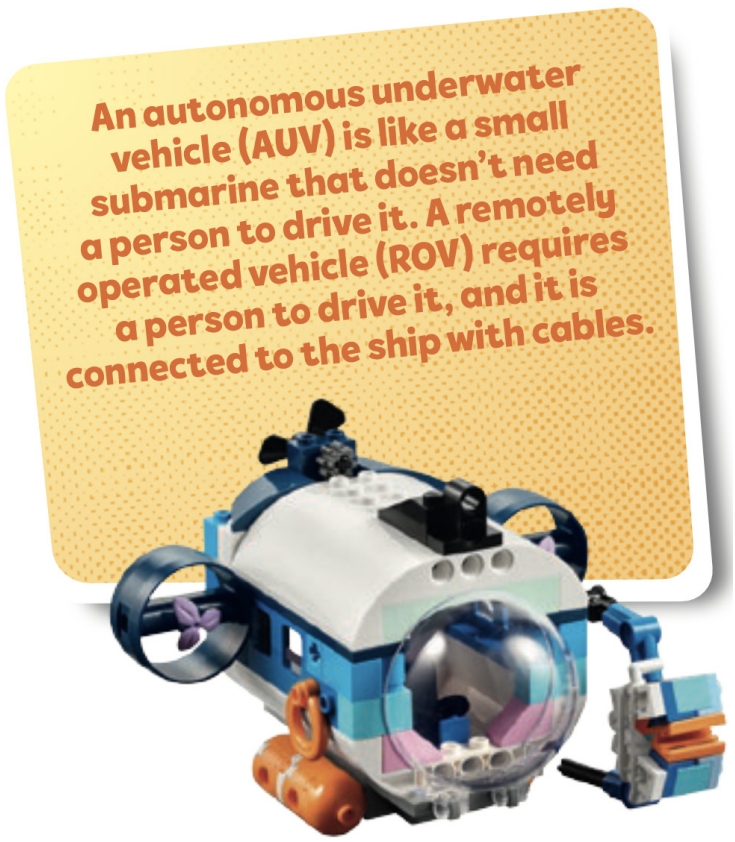
- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital Device



LEGO Autonomous Vehicle / Remotely Operated Vehicle

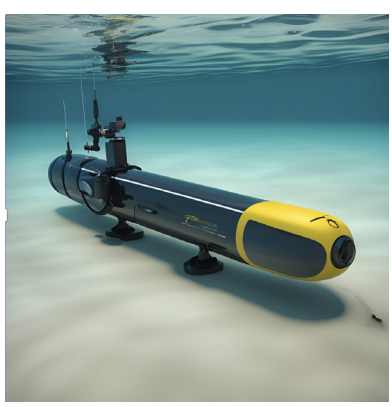
Remind the class that in their work to study the ocean, Katy and her team often have to use Remotely Operated Vehicles (ROV). This helps them to access the deepest parts of the ocean that people cannot reach, for example in the abyssal zone.

Other oceanographers may use underwater vehicles that are not connected to a boat or ship. These are called Autonomous Underwater Vehicles (AUV).

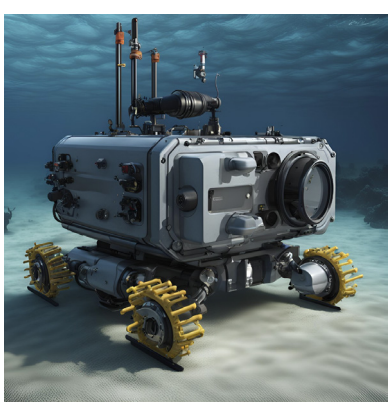


Ask learners to imagine they are going to help Katy and her team with their exploratory work. To do so, they need to build and code a robot to represent an AUV that moves remotely to gather evidence and data from the ocean.

These images may inspire learners:



Autonomous Underwater Vehicle



Remotely Operated (underwater) Vehicle

Development
(Build)
[continued]

Resource(s):

- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- Digital device
- **Narrated video for each program**

Purpose of the builds:

- To apply their developing understanding of engineering and coding in building and adapting a LEGO vehicle.
- To reinforce learner understanding and experience of using and coding sensors.

Build a motorised LEGO vehicle: [~30min]

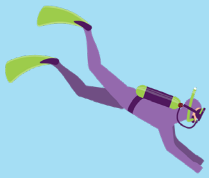
1. In teams, learners engage with the LEGO Education classroom project:
   a. SPIKE Essential - Lesson 3 - Snowmobile
   b. WeDo 2.0 - Milo the Science Rover
2. Learners follow detailed instructions to build and code the Snowmobile or Milo the Science Rover
3. Encourage learners to modify the code in order to complete challenge tasks

SPIKE Essential
Arctic Ride challenge tasks

1. Make the vehicle move forwards and backwards
2. Make the vehicle turn left and / or right.
3. Change the speed. What do you observe?
4. Change direction and / or duration of distance travelled.
5. Add a sensor to the LEGO vehicle and complete the following tasks (reinforce from Session 7):
   a. Code their vehicle to stop at an icon on the SUBMERGED mat.
   b. Record and add a learner-recorded sound to play when the sensor is triggered.
   c. Write an algorithm that plays a noise and flashes a light when the sensor is activated.
6. Remind learners from a previous session (7) why it is beneficial to have the sensor provide both visual and audio alerts.
7. Using the LEGO Submerged submarine, can you modify the build in some way that might help Katy and her team with their explorations?

*Other adaptations of their choosing (a copybook can be used for planning code changes)

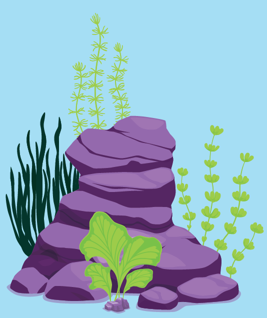
Development
(Build)
[continued]



WeDo 2.0
Milo the Science Rover challenge tasks

1. Make Milo move forwards and backwards
2. Make the vehicle turn left and / or right. (Milo is unable to turn without modifications to its design)
3. Change the speed. What do you observe?
4. Change direction and / or duration of distance travelled.
5. Use a sensor with Milo and complete the following tasks (covered in Session 7):
    a. Code Milo to flash a coloured light on the hub when the sensor is activated
    b. Change the colour displayed by the hub
    c. Write an algorithm (code) that plays a noise and flashes a light when the sensor is activated.
6. Remind learners from a previous session (7) why it is beneficial to have the sensor provide both visual and audio alerts.
7. Using the LEGO Submerged submarine, can you modify the build in some way that might help Katy and her team with their explorations?

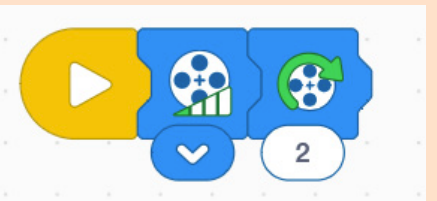
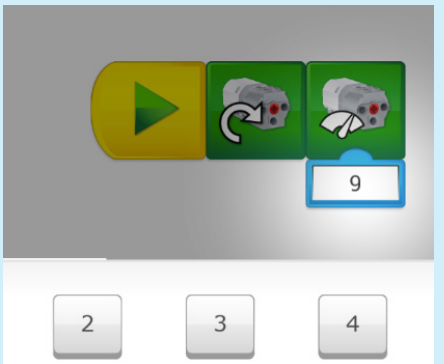
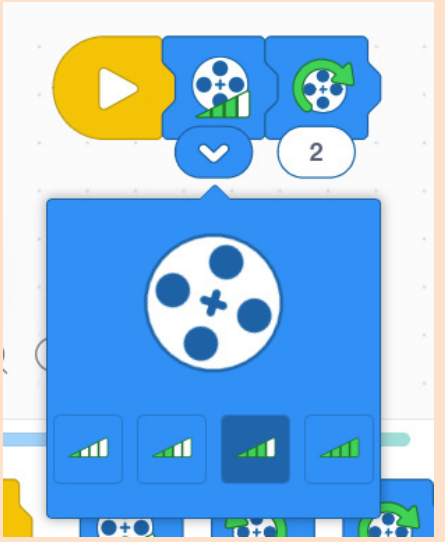
*Other adaptations of their choosing (a copybook can be used for planning code changes)

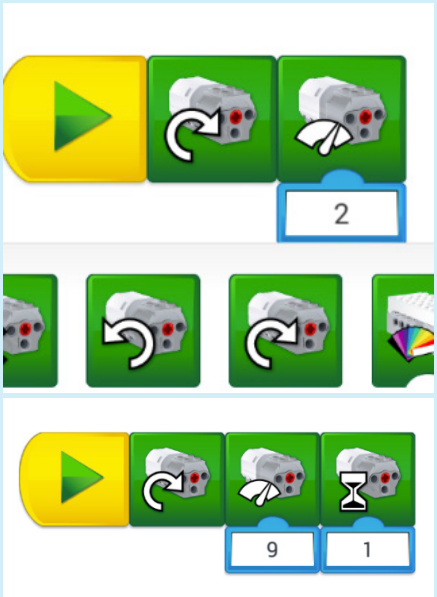
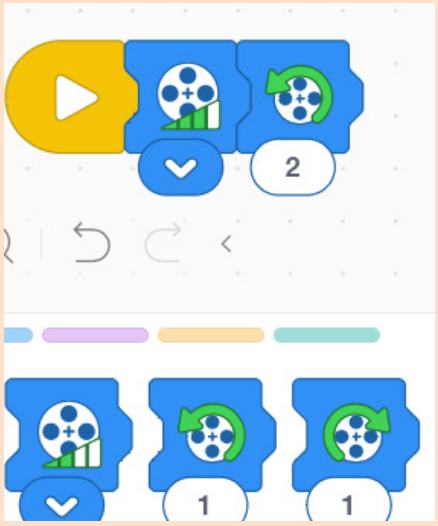


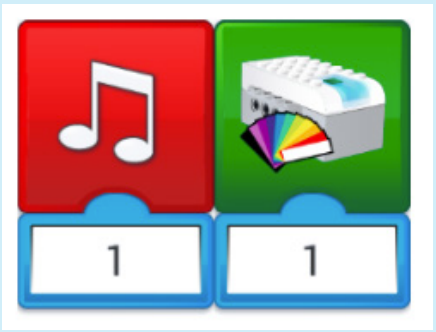
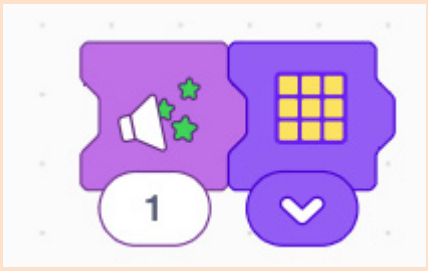
Coding and build guidance for teachers

Resources:

- Narrated video for each program

LEGO Education WeDo 2.0 classroom project: **Milo the Science Rover**	LEGO Education SPIKE Essential **Lesson 3 - Arctic Ride**
	
This program begins by setting the motor power at '8'. It then sets the rotation of the motor, clockwise, to move forward. The motor will run for a duration of '2' seconds before stopping.	This program begins by setting the motor power. It then sets the rotation of the motor, clockwise, to move forward. The motor will make two full rotations. Links could be made to each rotation equalling 360 degrees.
This simple algorithm (code) can be tinkered with in order to make the model move more quickly/slowly, to change the direction of movement (clockwise/anticlockwise), and to change how long/short the motor stays on for (duration).	
Change speed	
 The motor power can be increased or decreased	

Change direction and duration	
 The number under the hourglass is the number of seconds the motor will run.	 The number under the rotation (2) sets the number of rotations, in this case the duration.

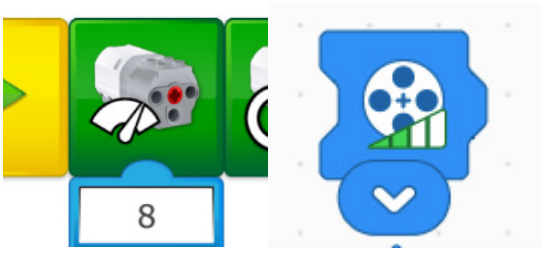
The algorithm could be further adapted to add use of sensors and sound and/or lights. See the coding and build guidance in Session 7 and/or the SPIKE/WeDo app for further support and examples.	
	

Guiding questions:

- *Can you tinker with the code in order to make the vehicle run for longer?*
- *Can you change the code to make the vehicle move faster?*
- *I wonder what might happen if you change the number under the motor or duration blocks?*
- *Can you see any blocks that might make the vehicle change direction? (change the rotation from clockwise to anticlockwise)*
- *I wonder if you could make the vehicle play a sound and/or flash a light to warn that it is about to move?*
- *I wonder if you could change the order of sound and light?*

Teacher tip:

If using the LEGO WeDo 2.0 Set - remember that the sound comes from the digital device, not from the hub. Learners may need to turn up the volume on the device.



The number under this block sets the power of the motor. Encourage learners to test what happens when this number is changed. Does the robot move faster/slower?

Learners could build upon the code learnt in previous builds:

- The motion sensor or colour sensor could be used to start or stop the robot.
- A sound could be played or a light could flash when the code begins or ends. This idea could link to the reversing warning noise that is a feature on most newer models of cars.

LEGO WeDo 2.0 - Make a turn

Milo the Science Rover is not mechanically capable of turning due to its design. The purpose of this challenge task is to encourage learners to consider the design of a robotic model and any limitations it may face.

Closure (Document/ Share/Tidy up)

Resources:

- Digital portfolio
- Digital device

Document:

1. Each team documents and reflects upon the vehicles they built - **adding photos, videos, notes to their digital portfolios**.
2. Consider how they built it, how it works, how they might change or adapt or improve it.

Share:

1. What they built, and how it could help an oceanographer in their work.
2. Show the coding skills they learned
   a. Explain how they changed the program
   b. Explain a problem they faced or overcame
3. Demonstrate their solutions

Teams tidy up:
All builds should be disassembled and returned to the LEGO Education Set.

Extension activities

Consider these ideas for extension activities:

Science investigation
Investigate water pressure

Enhanced coding challenge
Autonomous Navigation: Task students with programming their robots to navigate a complex underwater maze, simulating an abyssal zone exploration mission. This maze could be created using arts and crafts materials, or other readily available objects (e.g. uni-fix cubes, textbooks, etc.)

Collaborative mini Projects / Presentations
Group Research: Assign small groups to research e.g. different aspects of oceanography or e.g. a threat to marine animals.
Presentations: Each group presents their findings to the class, incorporating visual aids such as posters, slideshows, or 3D models.

Children's books found **here**

To learn more about the Deepest part of the ocean, and the work of oceanographers, consider using the following **video** and prompt questions.

(0:00 - 3:30) Part 1 - Introducing the deepest part of the ocean (The Mariana Trench) - Abyssal Zone

Play the video. Following viewing this part, learners can discuss what they discovered. The following questions may guide this stage of the session:

- *List 3-4 characteristics of the abyssal zone*
- *Name 3-4 deep marine animals you heard about in the video*
- *What have they all got in common? Why is this important for their survival?*
- *How do you think we learn about these marine animals?*

(3:30 - 4:05) Part 2 - Brief introduction into exploring the deepest part of the ocean - the work of an oceanographer.

Play the video. Following viewing this part, learners can discuss what they imagine the work of an oceanographer might involve. The following questions may guide this stage of the session:

- *What is an oceanographer?*
- *What kind of work might an oceanographer do?*
- *Why might this work be important?*
- *How do they go about this work?*

fll.ie/submerged

Session 9: A closer look at marine life

Purpose:

Learners will investigate one marine animal to tie together the importance of oceans, the different ocean zones, marine careers, and how marine animals adapt to their environment and threats.

Core Values:

Discovery | Teamwork | Fun | Inclusion | Impact

Learning outcomes:

Learners will be enabled to

1. Develop understandings of a marine animal, including its habitat and how it has adapted to this environment
2. Represent their knowledge and understanding of a marine animal and its habitat using LEGO
3. Identify threats facing a marine animal, and propose solutions to these threats

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- IWB/board
- Materials for learners to create a list or mind map: digital device/ paper/whiteboard
- Digital Device
- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- SUBMERGED Submarine (already built)
- SUBMERGED Prototyping pieces
- SUBMERGED Ocean Zone models - Bags 5, 6, 7
- **Printout worksheet**

Digital resources:

- Useful apps for creating lists or mind maps:
  - Freeform; Explain Everything; Canva; Book Creator; Notes; Google Slides
- Green Sea Turtle resources:
  - **Marine wildlife protection**
  - **Overview of the sea turtle**
  - **Britannica Kids - Sea turtle**
  - **Green sea turtle facts**
  - **Plastic threatens sea turtles**
  - **Endangered ocean species**
- Deep-sea animal resources:
  - **BBC Blue Planet video** (8min)
  - **PBS 8 Deep Sea animals** (3min)

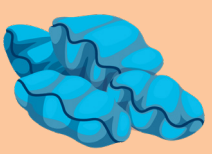
Curriculum content

Subject	Strands	Strand units/ elements	Skills and concepts
Science	Living Things Environmental awareness and care	Plant and animal life Caring for the Environment	Questioning; Observing; Sorting and classifying; Designing and making
Geography	Human Environments; Natural Environments; Environmental awareness and care	People at work; Land, rivers and seas; Caring for the Environment	Geographical Investigation Skills: questioning, hypothesising, observing, recording and communicating
Literacy	Oral Language	Communicating	Communicating; Understanding; Exploring and using
SPHE	Myself and others; Myself and the wider world	My friends and other people; Relating to others; Developing citizenship	Communication; Co-operation; Decision-making

Introduction

Resource(s):

- IWB/board
- Materials for learners to create a list or mind map: digital device/ paper/whiteboard



Revisiting ocean zones, marine careers, marine animals and threats

Explain to the class that this session ties together all of what we've learnt and explored in SUBMERGED so far.

Begin by dividing the class into teams, and explaining that we are going to begin by thinking about everything we've learnt about so far, and any big questions we might still have. On the IWB/board write up three titles:

- *Ocean zones*
- *Marine careers*
- *Marine animals and threats*

Ask the children to discuss these topics in their SUBMERGED teams. Instruct teams to record what they know about these topics, and any questions they may still have. This could be recorded on a digital device/ paper/whiteboard, and could take the form of a list, mind map, etc.

You may prefer to ask teams to discuss all three topics, or divide the topics across the class.

After a suitable amount of time has passed, invite teams to share what they have discussed. This could be documented on the teacher's IWB/board.

The following guiding questions could be used to scaffold this discussion:

- *What types of marine animals live in each zone?*
- *How have these marine animals had to adapt to survive in these zones?*
- *How would you explain what a marine biologist/ archaeologist/oceanographer does?*
- *How does their work help us to learn more about oceans and marine life?*
- *What types of technology do they use to help them?*
- *How has the threat of noise pollution/pastic pollution/rising temperature/acidification/overfishing impacted marine animals?*
- *Are there any ways we could help these marine animals?*

Development

Resource(s):

- **Printout worksheet**
- Digital Device
- LEGO Education Set (SPIKE Essential or WeDo 2.0)
- SUBMERGED Submarine (already built)
- SUBMERGED Ocean Zone models - Bags 5, 6, 7
- SUBMERGED Prototyping pieces

Diving deeper: Examining one marine animal

Having activated prior knowledge, the remainder of this session turns to examining one marine animal. In their teams, children are tasked with exploring:

1. The Ocean Zone and Habitat of the marine animal
2. How that animal has adapted to life in the zone
3. The issues/threats that the animal faces
4. Using LEGO build a representation of the marine animal and their habitat
5. Suggest ways of helping that ocean animal in relation to the issues it faces

This **printout worksheet** could be useful to focus learners' investigations. This learning activity could be facilitated in a few ways, below are three suggestions:

1. All teams examine the same marine animal, (see the example for Green Sea Turtle resources below)
2. Teams select any marine animal of their choosing
3. Teams are assigned an Ocean Zone, and select any marine animal from this zone.

Teacher tips:

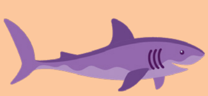
1. Learners could refer to the resource they created during Session 3
2. The representation of the marine animal and their habitat could be supported by using the LEGO models for each zone in bags 5 - 7.
3. Teams could be encouraged to examine a less commonly known marine animal. There are a wide variety of interesting and strange marine animals which have adapted to life in the deepest and darkest parts of the ocean:
   a. **BBC Blue Planet video** (8min)
   b. **PBS 8 Deep Sea animals** (3min)

Development [continued]

Other suggested endangered marine life:

- Coral reefs
- North atlantic right whale
- Sea otter
- Manatee
- Vaquita porpoise
- Blue whale

Further information can be found at the following **link**



Option A: Investigating the green sea turtle:

The following reliable sources of information could be shared with groups to inform and support their exploration of the green sea turtle:

- **Marine wildlife protection**
- **Overview of the sea turtle**
- **Britannica Kids - Sea turtle**
- **Green sea turtle facts**
- **Plastic threatens sea turtles**

Option B: Investigating their own ocean animal:

If selecting their own marine animal, teams could be directed to the following reliable sources of information:

- **Britannica School**
- **National Geographic Kids**

Explain to the class that they will have a set amount of time (e.g. 20min) to explore their marine animal, and to create a representation of their marine animal and their habitat. After this time they will be invited to share with the class.

While teams investigate their marine animal, circulate around the class providing challenge and/or support where necessary. The emphasis here is upon critical thinking, as opposed to creating a fact-file. Children are encouraged to explore and begin to understand how marine animals are impacted by their habitat, and the threats they face. The different marine careers, and technological advancements help us to learn more about these marine animals, and try to protect them from threats.

Closure (Document/ Share/Tidy up)

Resource(s):

- Digital portfolio
- Digital device

Document:

Each team documents the representation of their marine animal and habitat

Share:

1. What they built, and how it represented their marine animal, its habitat, and the threats it faces
2. Explain how the animal has adapted to life in the zone
3. Explain the issues and threats faced by that animal
4. Suggest ways to overcome the threats and issues faced by that animal

Teams tidy up:

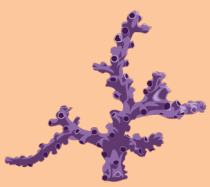
1. If used, the submarine should be left assembled
2. All other prototyping pieces should be taken apart and returned to storage

Extension activities

Consider these ideas for extension activities:

Additional video resources to support understanding of threats to specific marine animals:

- **Impact of noise pollution on whales and dolphins**
- Impact of ocean plastic pollution on turtles
  - **How ocean plastic threatens sea turtles**
  - **Sea turtles and plastic pollution**
- Impact of rising ocean temperature on coral reefs
  - **The devastating truth about coral reefs**
  - **Rising ocean temperatures are "cooking" coral reefs**
- Impact of ocean acidification on shellfish
  - **What is ocean acidification?**
  - **Ocean acidification and lobsters**
- Impact of overfishing on fish stocks
  - **Ocean alert: Overfishing**
  - **Endangered sharks**



Session 10: Team Model and Poster

Purpose:

Learners will work in teams to create their Team Model and Poster which represent a unique way to share their team's ocean discoveries with others.

Core Values:

Team Model requirements:

1. Include motorised parts and sensors (at least one)
2. Use LEGO coding (SPIKE/WeDo 2.0 app)
3. Should fit on a table, be sturdy and be easily transportable (to be brought to Showcase Event)
4. There is **no** requirement to use the SUBMERGED Mat, or to include the submarine model. If using the submarine model, it is encouraged that it be adapted.

Be advised that the time required for creating a Team Model and Poster will vary by class level and experience. On average this session may take approximately three hours.

Team Poster requirements:

Divided into **three sections** which describe the team's journey throughout the sessions:

1. Explore - focused on their newfound knowledge and understandings of our oceans, including e.g. its importance, contemporary challenges to oceans and oceanic life, how and why people explore the oceans.
2. Create and test - focused upon their builds and coding
   a. Previous builds: how these helped develop understanding of coding and computational thinking
   b. Team Model: what this represents, and how they achieved this
   c. How they tested and improved their build and code
3. Share - Supporting information relating to their ocean discoveries.
   For example: contemporary challenges, oceanic life, careers related to ocean discoveries, tools and technologies that enable ocean exploration.

Progress:

Learning outcomes:

Learners will be enabled to

Team Model:

1. Discuss knowledge and understanding of how and why people explore the oceans.
2. Work collaboratively to build and code a Team Model that represents a unique way to share their team's ocean discoveries with others.
3. Collaboratively design and label a Team Model.

Team Poster:

1. Work collaboratively to plan and design a Team Poster which describes their team's journey through the sessions and supports their Team Model.
2. Communicate the purpose of their Team Model, specifically: how it represents a unique way to share their team's ocean discoveries with others.

Learners will build:

- Each team will build a LEGO model of their own design which includes motorised parts and sensors (at least one).

Resources

Per team:

- Materials for planning design: digital tool (e.g. Book Creator/ Canva/Slides/Powerpoint, etc.) or paper/copy
- LEGO Education set (SPIKE Essential or WeDo 2.0)
- SUBMERGED Explore set (optional)
- SUBMERGED mat (optional)
- Prototyping pieces (from SUBMERGED set)
- Digital Device
- Digital poster software (e.g. Canva, Slides, **piktochart**)
    - OR poster board
- Digital portfolio which includes reflections, photos and videos of their building, coding and computational thinking to date
- Markers/crayons/colouring pencils

Optional:

- The Team Model can use extra LEGO bricks, minifigures, baseplates and other LEGO elements in addition to the LEGO Education Set and SUBMERGED Set.
- Additional multimedia resources can also be used to support their project (e.g. video, presentation, interactive materials).

Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
Mathematics	Shape and space; Measures	2-D shapes; 3-D shapes; Time	Applying and problem-solving; Communicating and expressing; Integrating and connecting; Reasoning; Implementing
Science	Energy and Forces; Materials	Forces; Properties and characteristics of materials	Design and make
Literacy	Oral Language Writing	Communicating	Communicating; Understanding; Exploring and using
Visual Arts	Construction; Drawing	Making constructions; Making drawings	An awareness of line; An awareness of form; An awareness of space
SPHE	Myself and others; Myself and the wider world	My friends and other people; Relating to others; Developing citizenship	Communication; Co-operation; Decision-making

Introduction

Resource(s):

Introduction

1. Teacher introduces the session by reflecting on the SUBMERGED project to date. Suggested questions to scaffold this discussion:
   a. What have we learnt about our oceans?
   b. What makes our oceans important?
   c. What challenges or problems facing ocean life did we learn about? Can you explain why these are problems we should try to solve?
   d. Which of the ocean zones was your favourite, and explain why?
   e. What types of jobs or careers relating to exploring ocean life did we learn about? Could you explain to your partner what that job involved? Which would you like to do most, and why?
   f. What types of technology did the marine biologist/marine archaeologist/oceanographer/etc use that allowed them to explore the ocean?
2. Follow this by asking learners what they would they like to share with others (e.g. other classes, parents, family, wider school community)?

Introduction [continued]

3. Next ask the class to think about the LEGO builds and code they encountered.
   a. What have they built?
   b. What types of coding blocks do they know how to use? (e.g. motor, sensor)
   c. What types of things could they program their LEGO robot to do? (e.g. sound, colour, movement)
   d. Were there any ways they could program their LEGO robot to react to motion (e.g. sensor)?
4. Finally, explain to learners that they are now going to use all that they have learnt through the SUBMERGED sessions in order to create a Team Model "that represents a unique way to share your team's ocean discoveries with others"

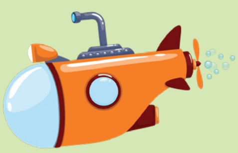
Note to teacher:

The SUBMERGED theme is intentionally deep, and allows for learner agency in selecting a project topic, or problem they would like to try to solve. The following are some general ideas for projects, presented in order of increasing complexity and challenge:

- Representing their understanding of an ocean zone and the marine animals present in this zone by creating a motorised habitat
- Creating a motorised Team Model which represents the work of an ocean career (e.g. marine biologist, marine archaeologist) in a given ocean zone
- Prototyping a new technology which could assist in exploring the ocean (e.g. a new vessel/tool to improve exploration of the Abyssal zone)
- Identifying a problem facing a specific marine creature, and designing a Team Model which represents a way of solving this problem (e.g. addressing the challenge of artificial light upon the life cycle of green sea turtles)
- Representing a solution to a real-world problem which involves the ocean (e.g. sustainable marine food production under climate change)

These ideas are provided to support teachers in guiding teams, and are not intended as a 'project menu'.

Introduction
[continued]



Team Model requirements:

1. Include motorised parts and sensors (at least one)
2. Use LEGO coding (SPIKE/WeDo 2.0 app)
3. Should fit on a table, be sturdy and be easily transportable (to be brought to showcase)
4. There is no requirement to use the SUBMERGED mat, or to include the submarine model. If using the submarine model, it is encouraged that it be adapted.

Team Poster requirements:

Divided into **three sections** which describe the team's journey throughout the sessions:

1. Explore - focused on their newfound knowledge and understandings of our oceans, including e.g. its importance, contemporary challenges to oceans and oceanic life, how and why people explore the oceans.
2. Create and test - focused upon their builds and coding
    a. Previous builds: how these helped develop understanding of coding and computational thinking
    b. Team Model : what this represents, and how they achieved this
    c. How they tested and improved their build and code
3. Share - Supporting information relating to their ocean discoveries.
    For example: contemporary challenges, oceanic life, careers related to ocean discoveries, tools and technologies that enable ocean exploration.

Posters could be created physically or digitally; creativity is encouraged. For example, could a team create a presentation, greenscreen video, or podcast instead of a traditional poster?

Development
(Build)

Resource(s):

- LEGO Education set
- SUBMERGED set
- Additional LEGO pieces
- Digital device
- Digital portfolio (reflections, photos and videos of previous builds and code)
- A4 paper or relevant copybook for planning

The focus for the remainder of this session is on the creation of a Team Model & Poster. It is likely that teams will work at different paces and require different levels of support and scaffolding.

Some groups may need to complete their discussion or plan for their Team Model, others may be ready to begin iteratively building their Team Model.

Some teams may elect to focus on the Team Model first, followed by the Team Poster. Others may work on both simultaneously. There is no 'correct' approach or order.

Team Model:

In teams, learners build the design using the prototyping pieces and any other LEGO elements available. Learners ensure that their Team Model meets the Team Model requirements:

1. Include motorised parts and sensors (at least one)
2. Use LEGO coding (SPIKE/WeDo 2.0 app)
3. Should fit on a table, be sturdy and be easily transportable (for future Showcase Event to share and communicate ideas)
4. Teams are encouraged to take inspiration from the builds encountered so far in order to develop an original motorised part in their model.
5. Remind teams to document their progress as they go as this will be used on their Team Poster.

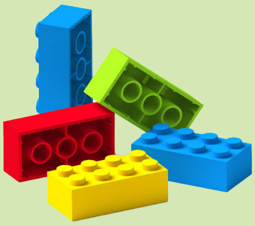
Make Team Poster:

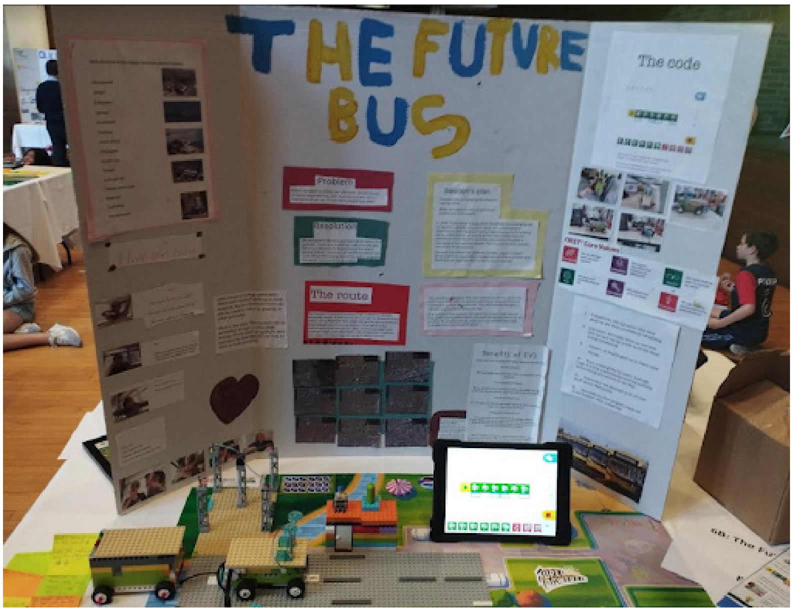
Alongside building their Team Model, teams are tasked with creating a Team Poster which supports their Team Model in sharing their passion in creative and captivating ways. Team Posters should meet the requirements listed at the beginning of this session.

Suggested headings include:

1. **Team name:** Each poster should include the Team Name.
2. **Our model:** Include a detailed drawing of the Team Model, including explanation of how they decided upon their model, and how this changed over time (iteration).
3. **Our coding program:** What programme did the team use for their model? Can you add this here?
4. **Core Values:** Provide examples of how your team has used the Core Values throughout the sessions.
5. **Our passion/interest/hobby:** information to support their Team Model

Development [continued]





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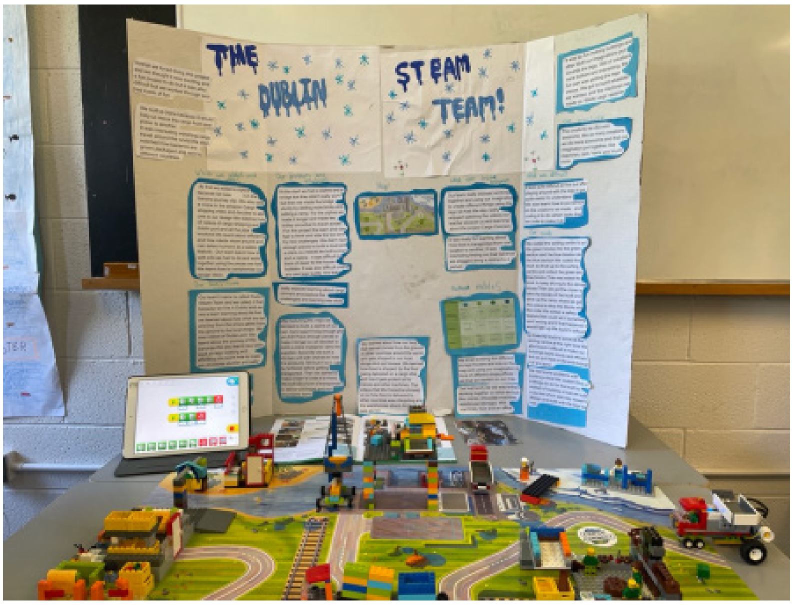

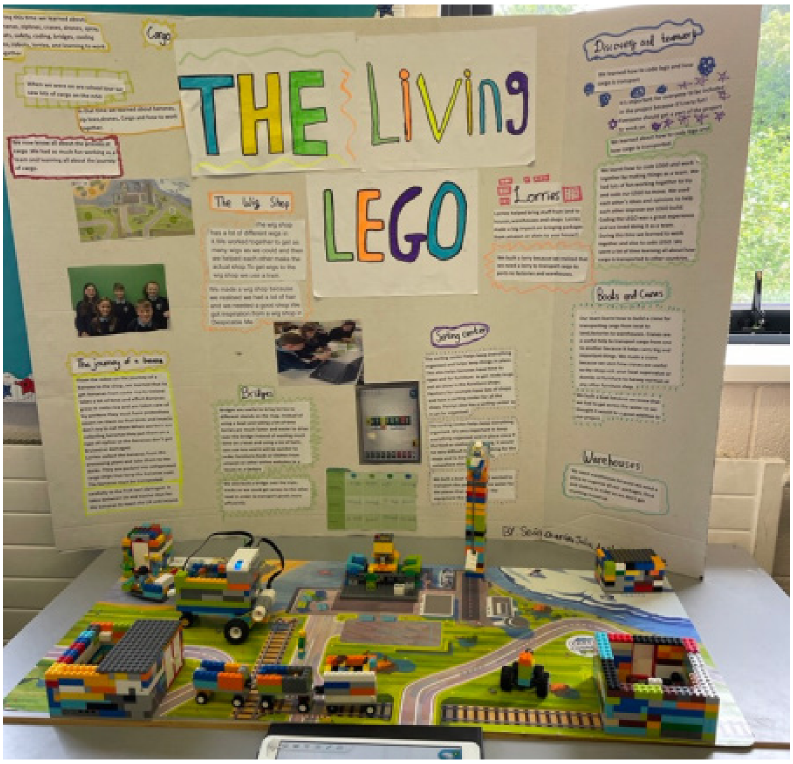

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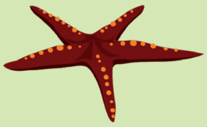


-- Suggested break between sessions --

Following completion of Team Models and Team Posters:

Evaluate: Encourage the learners to reflect on their build with their team: How does their Team Model share their passion, hobby or interest in creative and captivating ways?

1. What part of your model is motorised, and how have you coded this?
2. What sensors have you used, and how do they improve your model?
3. What other things would you like to add?
4. What are the strengths and the weaknesses of your design? (particularly structural - is the model sturdy enough to be moved)
5. What will your model teach, show or demonstrate about your ocean discoveries?

The following **checklist of questions** can support assessment while teams share their models and run their code:

1. Is power running continually?
   a. Does it start/stop - is there a pattern?
2. Is there a motorised part?
   a. What does it represent?
   b. Does it work as intended?
3. Are sensors used?
   a. For what purpose?
   b. Does it work as intended?
4. Does it make a sound?
   a. Is this sound linked to motion or as a safety feature?
   b. Could self-recorded sound be used?
5. Are there any flashing lights?
   a. What do these lights symbolise or represent?
6. Could ideas from other teams be adapted to improve your team's model?

Closure (Document/ Share/Tidy up)
[20 min]

Resource(s):

- Digital portfolio
- Digital device

Document:

Each team documents and reflects upon their builds - adding to their digital portfolios etc.

Share:

1. Teams share their completed Team Models and posters with the class
2. Teams demonstrate and explain how their Team Model and Poster ***"represents a unique way to share your team's ocean discoveries with others"***.
3. Teams explain the program and how sensors and motors are used as part of their build.

Teams tidy up:

1. The Team Model will remain assembled from this point forward until the event and should be placed in the designated storage space.
2. Any unused pieces should be returned to the correct box and stored - this includes LEGO Education set, prototyping pieces, and any LEGO elements supplied by learners.

Coding and build guidance for teachers

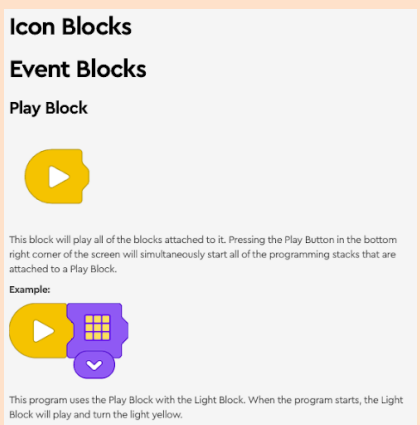
There is no specific code or build in this session.

The programs encountered to date should be adapted and innovated upon. Further assistance and guidance can be found below.

The LEGO WeDo 2.0 app includes a **program library** and **build library** which demonstrates ways in which learners could build and code their model in order to achieve different outcomes.

This can be accessed by clicking on the 'lightbulb' icon in the top left of the app

The SPIKE Essential app **help section** (bottom left corner of the app) includes a helpful detailed explanation for each of the Icon Blocks used to create code.



Coding and build guidance for teachers

Teacher questioning and scaffolding will assist teams in creating innovative models. The more learners are questioned, the more they will be encouraged to think about the what/how/why of their prototypes/ models that represent their ideas. The following Guiding Questions could be adapted to support your class.

Guiding questions:

- *What part of your model could you motorise?*
- *What would you like it to do? How can you motorise it to do this?*
- *What sensors could you use? How might these sensors be used?*
- *Could we test and improve this?*
- *How does your model share your passion in a creative way?*
- *I wonder if you could make use of skills you've encountered in other builds? Could your digital portfolio have ideas you could build on?*
- *Could your model make use of light and/or sound?*
- *Could you tinker with your code in order to make it work faster/slower?*
- *Could your model play an original sound? How could you record your own original sounds?*
- *I wonder if you could change the order of sound and light?*
- *Have you spoken to other teams to see how their model and code works?*
- *Could you learn from any of the other teams?*

Important points to note

As each class is unique, please decide upon the best way of grouping learners.

If learners are allowed to bring in LEGO elements, it is advised that either:

- Any LEGO elements contributed will become part of the class materials and not be returned.
- A clear record is kept of what a learner contributed so that it can be returned following completion of the project.

The teams will apply coding concepts throughout these sessions to create their programs.

As all teams will include learners of differing abilities, these sessions should be **differentiated** as required.

Extension activities

Consider these ideas for extension activities:

- Aided by media captured during these sessions (images, video, etc.), learners write instructions on how to build their Team Model.
- In teams, learners record a short podcast based upon their experience creating their Team Model. The podcast can be created using an appropriate digital tool (Spotify for Podcasters, **Vocaroo**, etc). Suggested content: what part of their model is motorised, how a sensor is used, how these were coded, the individual input of each team member, etc.

Session 11: Let's share - Preparation for showcase and Showcase Event

Purpose:

Learners will prepare to share their SUBMERGED project at a Showcase Event.

Core Values:

Final Showcase Event

The capstone to *FIRST* LEGO League Explore is a Final Showcase Event where teams can present their models and posters to other learners.

Schools and teachers may also opt for a Final Showcase Event within their own school where members of the school community are invited to learn about the solutions proposed by each team.

However the class decides to share their projects and solutions, it is important that all learners get a chance to both present their work, and examine the work of other teams. This is to enable deeper reflection and learning.

Learning outcomes:

Learners will be enabled to

1. Communicate the purpose of their Team Model and Poster at a Final Showcase Event - how it shares their passion in a captivating and creative way
2. Discuss their knowledge and understanding of the SUBMERGED theme

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- LEGO build
- Digital device *(tablet, laptop)*
- Poster *(physical or digital, see Session 10 for details)*

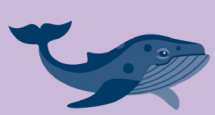
Digital resources:

- **Reviewing sheet and questions** for Final Showcase Event
- **Showcase peer review sheet**

Curriculum content

Subject	Strands	Strand units/ elements	Skills and concepts
Literacy	Oral Language Writing	Communicating	Communicating; Understanding; Exploring and using
Visual Arts	Construction; Drawing	Making constructions; Making drawings	An awareness of form; An awareness of space

Introduction
[10 min]



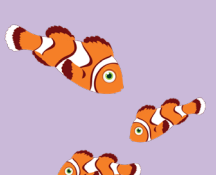
1. Explain the Final Showcase Event where the learners will showcase their LEGO builds and posters.
2. The key purpose of these events is for learners to share their projects and learn from others. There is an equal focus on sharing the what/why/how of their project, as there is on learning from the projects of others.

Development

1. Explain to learners that they will have three main jobs at the Showcase Event
   a. Share their Team Model and Team Poster, and be able to explain them.
   b. Answer peer review questions.
   c. Speak to other teams and learn about their models and posters.
2. Share the peer review prompts with learners and begin a discussion around what each question refers to, how might they be answered, etc.
   a. Allow time for teams to discuss potential answers to the peer review questions.
3. In teams, learners decide who will present each section of the poster.
   a. Learners review their Team Model and ensure that their code works. Learners decide who will present the Team Model.
   b. In teams, learners discuss what they have learnt throughout the SUBMERGED sessions. Learners should be prepared to share what they have learned at the Final Showcase Event.
   c. Pair teams up so that each team can practise their presentations with other learners.
   d. The sample reviewing sheet and reviewing questions can be used to support the learners during this session.

The *FIRST* LEGO League Explore team have prepared review questions and self-assessment checklists to assist teams in preparing for their final howcase event. These can be accessed via the **digital resource section**.

The prompt questions in the concept cartoon below could be used to further scaffold teams in their preparations.



Closure (Document/ Share/Tidy up)

Resources:

- Digital portfolio
- Digital device

Share:

1. Reflection and assessment (self and peer) of presentations

Teams tidy up:

1. Ensure Team Models and Team Posters are stored and ready to be transported to the event.
2. Ensure all devices are fully charged.

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Session 12: Let's reflect

Purpose:

Learners will reflect upon the SUBMERGED sessions, their Team Model and Poster, and their understanding of the importance of our oceans, as well as how and why people explore the oceans

Core Values:

Learning outcomes:

Learners will be enabled to

1. Describe their team's journey throughout the SUBMERGED sessions
2. Discuss their knowledge and understanding of the SUBMERGED theme

Progress:

1 2 3 4 5 6 7 8 9 10 11 12

Resources

Per team:

- Team Model
- Digital device (tablet, laptop)
- Team Poster

Digital resources:

- Reflection prompt questions

Curriculum content			
Subject	**Strands**	**Strand units/ elements**	**Skills and concepts**
Literacy	Oral Language Writing	Communicating	Communicating; Understanding; Exploring and using
Visual Arts	Construction; Drawing	Making constructions; Making drawings	An awareness of form; An awareness of space

Revisiting SUBMERGED

Revisiting SUBMERGED

1. Ask the class to think about their recent Showcase Event. The following prompts could be completed as an oral discussion, think-pair-share, etc.
   a. What did they enjoy most?
   b. Find the most challenging?
   c. Learn from other teams?

2. Now that we have built Team Models, created Team Posters, and shared our passions at a Final Showcase Event, it is time to reflect on all that we have achieved and learned along the way.

Meta reflection

Resources:

- Digital devices
- Prompt questions to display on IWB

The following prompt questions should be considered by learners following engagement with SUBMERGED.

These might be discussed orally, in small groups or teams, or independently using a device/paper.

1. What are three things you learnt about oceans and marine life?
2. What is one thing that you learnt about yourself through completing the SUBMERGED project?
3. What part of SUBMERGED stands out for you? (Your favourite session, build, code?)
4. What have you learnt about coding and computational thinking?
5. What will you do differently now as a result of SUBMERGED?
6. Can you think of an example of when you demonstrated the *FIRST* Core Value of: Teamwork, Inclusion, Innovation, Fun, Discovery, Impact?
7. What would you like to do with your LEGO Education set next?
8. What other real-life issues could we explore through the engineering design process?

Individual/Group Activity:

Following discussion, learners could be tasked with one of the following activities to further their reflection. The finished products could then be shared with the school community.

Record a short video diary of their experiences of SUBMERGED

Make an audio recording or podcast

Write a short diary entry and type or photograph this for inclusion in their digital portfolio.

Audit equipment

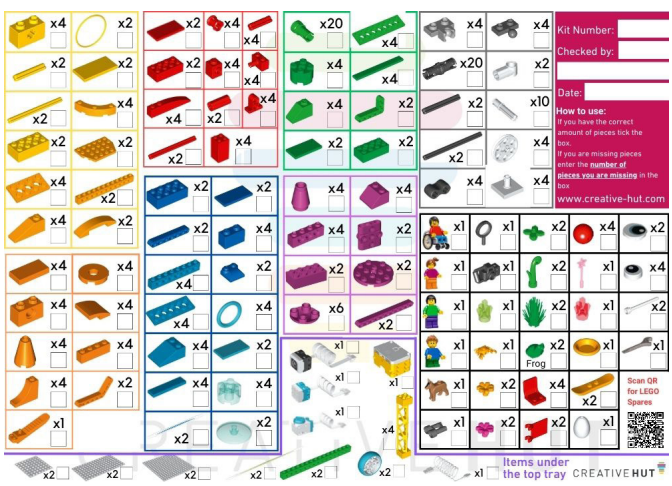
Resources:

- Audit sheets

Any final photos or videos of the Team Model should be taken as the final part of this project is to disassemble and audit the LEGO Education equipment.

All LEGO Education equipment should be disassembled and returned to its correct place.

All elements from the SPIKE Essential or WeDo 2.0 boxes should be returned and audited using the audit sheet. (Find audit sheets at: **fll.ie/submerged**)



If any elements have been lost, replacements can be ordered from: **https://www.lego.com/en-ie/pick-and-build/pick-a-brick**

All LEGO elements from the SUBMERGED Explore Set should be disassembled and returned to suitable containers (e.g. ziplock bags) for use by a future class. It is highly advised that the Explore models (e.g. submarine) be disassembled into separate bags for future use.

Any LEGO elements belonging to learners can be disassembled and returned to them at this point.

References:

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