Myanmar Pre-service Teacher Education Programme

Year 3 Semester 2

EDU3116
Curriculum and Pedagogy Studies: Science

Primary School Specialisation Track

Teacher Educator Guide

PREFACE

The Pre-service Teacher Education Curriculum consists of several components: the curriculum framework, syllabi, Student Teacher Textbooks, and Teacher Educator Guides. This curriculum for the four-year Pre-service Teacher Education Programme was designed and structured to align with the Basic Education Curriculum and to equip student teachers with the competencies needed to teach effectively in Myanmar's primary and middle school classrooms. It is based on a Teacher Competency Standards Framework (TCSF) which articulates the expectations for what a teacher should know and be able to do in the classroom.

The curriculum follows a spiral curriculum approach which means that throughout the four years, student teachers return to familiar concepts, each time deepening their knowledge and understanding. To achieve this, the four-year Pre-service Teacher Education programme is divided into two cycles. The first cycle (Years 1 and 2) is repeated at a deeper level in the second cycle (Years 3 and 4) to enable student teachers to return to ideas, experiment with them, and share with their peers a wider range of practices in the classroom, with the option to follow up on specific aspects of their teaching at a deeper level.

The curriculum structure provides an integrated approach where teaching of subject knowledge and understanding educational theories are learnt through a supportive learning process of relevant preparation and practical application and experience. The focus is, therefore, not just on subject content, but also on the skills and attitudes needed to effectively apply their knowledge, skills, and attitudes in teaching and learning situations, with specific age groups. As the focus is on all components of a 'competency' – knowledge, skills, attitudes and their effective application – it is referred to as a competency-based curriculum.

Accordingly, a competency-based curriculum is learner-centred and adaptive to the changing needs of students, teachers, and society. Where new concepts are learnt, they are then applied and reflected on:

1. Learn (plan what and how to teach);
2. Apply (practise teaching and learning behaviours); and
3. Reflect (evaluate teaching practice).

Beyond the Pre-service Teacher Education programme coursework, it is intended that student teacher graduates will be able to take and apply this cycle of 'learn, apply, and reflect' to their own teaching to effectively facilitate the learning and development of Myanmar's next generation.

The curriculum development was supported by the Strengthening Pre-service Teacher Education in Myanmar project, with technical assistance from the United Nations Educational, Scientific and Cultural Organization (UNESCO) and financial contribution from the Government of Finland.

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HOW TO USE THIS GUIDE

Who will use this Science Teacher Educator Guide?

This Teacher Educator Guide has been designed to help you facilitate student teachers' learning of Year 3 Science. It is addressed to you, as the teacher educator, and should be used in tandem with the Student Teacher Textbook as you teach Science. This Teacher Educator Guide contains step-by-step instructions to help you guide the student teachers in your class towards achieving the learning outcomes for each unit and lesson in the Student Teacher Textbook.

When and where does Year 3 Science take place?

A total of 60 teaching periods (Semester 1: 36 teaching periods; Semester 2: 24 teaching periods) are allotted for Year 3 Science of the four-year Education Degree College programme. Classes will be held on the Education Degree College campus.

What is included in the Year 3 Science Teacher Educator Guide?

The organisation and content of both Science Student Teacher Textbook and Teacher Educator Guide align with Science subject syllabus of the four-year Education Degree College programme.

Year 3 Science contains the following topics:

- Methodology
- Biology
- Chemistry
- Physics.

The Teacher Educator Guide follows the same structure as the Student Teacher Textbook. For each unit and lesson, there are **expected learning outcomes** and **competencies** that indicate what student teachers should know and be able to do by the end of the unit.

For each lesson, the Teacher Educator Guide includes:

Competencies gained: This list of competencies highlights the teacher competencies from the Teacher Competency Standards Framework (TCSF) that are focused on in that lesson.

Time: This is the total teaching minutes and number of 50-minute class periods allocated for the lesson as per the syllabus.

Learning strategies: This is an overview of all the learning strategies used during the suggested lesson learning activities.

Assessment approaches: This is an overview of all the assessment approaches suggested to be used before, during and after the lesson learning activities.

Preparation needed: This can include guidance on what you need to know about the topic and references to subject knowledge resources; technology preparation; links to other subjects; room organisation; time management; and reference to expected answers.

Resources needed: This can include printed media, flipchart paper, coloured paper, marker pens, URLs, video clips, low/no cost resources, and practical equipment.

Learning activities: Each lesson includes a variety of suggested learning activities designed to help student teachers achieve the expected learning outcomes within the allotted time. Each lesson should begin by activating the student teachers' prior knowledge or fostering interest in the subject. Learning activities are varied and in line with competency-based approaches to teaching and learning.

Facilitator's notes: These instruction boxes are included as an occasional 'safety net' at key points during the lesson, reminding you to quickly check that the lesson is flowing in the direction as planned, and to check if there are any points to emphasise to ensure that student teachers are learning effectively before moving forward.

Assessment: This comes at the end of each activity. It is an explanation or recap as to how each activity can be assessed formatively in order to assess success and inform future teaching. Instructions for facilitating various types of assessment are included in the *Toolbox for assessment approaches.*

Possible student teachers' responses: These are responses that you may get from the student teachers from each learning activity's assessment.

Check student teachers' understanding: This is the lesson plenary. At the end of the lesson, revisit the learning outcomes and TCSF competencies, and briefly assess the extent to which they have been achieved. Summarise the competencies and how they were addressed by the lesson content. Explicitly remind student teachers what they have studied and how they did so.

Extended learning activities: Some lessons in this guide include ideas on ways to adapt the learning activities to provide additional stimulus for student teachers to deepen their learning. These extended learning activities emphasise the benefits of flexibility in learning to respond to diverse needs and interests of student teachers. It is not mandatory to complete these learning activities during the class period.

Differentiated learning activities: Some lessons in this guide include ideas on ways to adapt the learning activities by considering different learning needs and interests of student teachers towards attaining the learning outcomes and TCSF competencies. These differentiated learning activities emphasise inclusive and flexible practice in teaching and learning. It is not mandatory to complete these learning activities during class period.

For each sub-unit, the Teacher Educator Guide includes:

Expected student teachers' responses for the review questions in TB: A box at the end of each sub-unit gives you the answers to the review questions in the Student Teacher Textbook. This section exists to support your knowledge as a teacher educator and enables you to support your student teachers by confirming the answers to the questions in their Student Teacher Textbook. It is NOT part of the lesson.

Each unit of the Teacher Educator Guide ends with a **Unit Summary**, which includes:

Key messages: This is a summary of the unit, including a reminder of the key points that student teachers should take from the unit.

Unit reflection: This section is part of the student teachers' self-study material and is included in the Student Teacher Textbook. It is duplicated here to inform you of its content. Your only task here is to remind the student teachers to read it. It does not form part of any lesson. It provides the student teachers with reflection points or questions relating to the learning in the unit.

Further reading: Suggestions for additional resources are listed according to the relevant unit. You can use these resources to learn more about the topic yourself or encourage student teachers to look these up in the library, on the internet, or in your Education Degree College's e-library.

Please note that the learning activities in the Student Teacher Textbook are designed for individual self-study. At times, these individual learning activities may be incorporated into the learning activities outlined in this guide. You may also wish to assign the learning activities in the Student Teacher Textbook for homework or encourage student teachers to do them at their own pace.

While this Teacher Educator Guide contains detailed learning activities to help you plan and deliver lessons, the instructions in this guide are only suggestions. The student teachers in your classroom will have different characteristics and learning needs. As their teacher educator, you are encouraged to come up with your own

learning activities which suit these needs, interests, and ability levels. You should feel free to change and adapt the lessons as much, or as little, as needed.

What is a competency-based curriculum?

The Student Teacher Textbooks and Teacher Educator Guides for all Education Degree College programmes follow a competency-based approach. This is outlined in the Education Degree College Curriculum Framework for the four-year degree and is based on the Myanmar Teacher Competency Standards Framework (TCSF). A competency-based approach means that the teacher education curriculum does not just focus on subject content. Rather, it emphasises the development of knowledge, skills, and attitudes and their application in real-life contexts. Competency-based curriculums are learner-centred and adaptive to the evolving needs of learners, teachers, and society.

The following elements are integrated throughout this Teacher Educator Guide, in line with a competency-based approach to teacher education:[1]

- **Contextualisation:** The learning content and learning activities are based on the Myanmar context to ensure that student teachers can relate what they learn to daily life.

- **Flipped classroom:** This pedagogical concept and method replaces the standard lecture-in-class format with opportunities for student teachers to review, discuss, and investigate module content with the teacher educators in class. Student teachers are typically expected to read the learning materials before class at their own pace. Classroom time is then used to deepen understanding through discussion with peers and problem-solving activities facilitated by you, the teacher educator.

- **Collaborative learning:** This educational approach involves groups of student teachers working together to solve a problem or complete a task. Learning occurs through active engagement among peers, either face-to-face or online. The main characteristics of collaborative learning are: a common task or activity, small group learning, co-operative behaviour, interdependence, and individual responsibility and accountability.[2]

1 Adapted from *the Glossary of curriculum terminology* (UNESCO-International Bureau of Education, 2013).
2 Lejenue's Collaborative Learning for Educational Achievement. (1999).

- **Problem-solving:** This involves the act of defining a problem; determining the cause of the problem; identifying, prioritising and selecting alternatives for a solution; and implementing a solution. The learning content and activities included in this Teacher Educator Guide provide opportunities for student teachers to apply their problem-solving skills as appropriate.

Course rationale and description

This course will prepare student teachers with the competencies required to teach the Science subject through modelling the values and attitudes promoted in the basic education curriculum for the types of citizens and society Myanmar envisions to create. Through this course, student teachers will develop essential skills such as science process skills, critical thinking skills, creative and problem-solving skills, questioning skills and collaborative skills. After attaining these skills, they will then be able to apply them with their primary school students in their classrooms and facilitate primary school students' interest and learning of Science. The student teachers will also be equipped with competencies to develop and implement well-designed lessons by linking them with daily life experiences. In addition, student teachers can plan and use various assessment practices integrated with learning activities to check primary school students' understanding and provide feedback. In this course, both subject and pedagogical content knowledge are integrated in the learning of various topics including living things, matter, energy, earth and space, and the environment. With reference to the Education Degree College Curriculum Framework, in Years 1 and 2, student teachers are expected to develop their fundamental knowledge of Science and basic pedagogical knowledge and competencies for teaching Science. In Years 3 and 4, they will further strengthen deeper understanding of Science subject knowledge and gain a more systematic grasp of the effective implementation of Science curriculum, instruction and assessment.

Basic Education Curriculum objectives

This subject, Science, is included in the pre-service Education Degree College (EDC) curriculum to ensure that teachers are prepared to teach the Science curriculum as defined for basic education in Myanmar. Primary school teachers will learn to achieve academic standard equivalent to KG and primary school level in order to ensure a strong subject proficiency foundation for being effective teachers for primary school students (Education College Curriculum Framework, 2019).

The objectives of Basic Education Curriculum are as follows:

a. Ensure every school-age child learns until the completion of Basic Education;
b. Generate critical thinking skills in students, progressively throughout their primary education and are hence, equipped with five strengths;
c. Engage students to become responsible and accountable individuals who abide by the laws in compliance with civic, democracy and human rights standards;
d. Cultivate students with appreciation to open-mindedness, curiosity, innovation and cooperation;
e. Strengthen 'union spirit' by allowing students to appreciate and preserve the languages, literatures, cultures, arts, traditional customs and historical heritage of all national ethnic groups and hence, evolve as citizens capable to pass on those valuable assets;
f. Give rise to students who appreciate and conserve natural environment, and involve in the dissemination of knowledge and skills in respect to sustainable development;
g. Enable the quality environment for education in conformity with international standards, and strengthen the quality of learning and teaching process by integrating technology in line with today's needs;
h. Promote sound body and sportsmanship through participation in sports and physical education activities, and school health activities;
i. Develop foundational knowledge for higher education, with inclusive to technical and vocational education; and
j. Empower to become global citizens who embrace diversity as individual or group, respect and value equality, and are armed with fundamental knowledge of peace to practise in their daily lives.

Learning objectives for primary school students for Science subject:

- To be able to recognise the importance of science in their surroundings through engagement in fun activities.
- To be familiar with and develop affection for the natural environment.
- To have acquired a curiosity and willingness to explore the natural environment.
- To gain basic science knowledge through scientific investigations.
- To develop the basic science process skills like observing, comparing, measuring, relating and controlling conditions.

- To take the awareness of experimental hazards.
- To be able to apply the basic principles of science in daily-life.
- To appreciate advantages of science for human beings.

Teacher competencies in focus for Science

This section identifies key competencies from the Myanmar Teacher Competency Standards Framework (TCSF) specifically relevant for this subject. These teacher competencies give an overall compass for what student teachers should know and be able to do when graduating from this course. This overall teacher competencies links to the specific learning outcomes expected by Science strands as outlined in the syllabus.

Table A. Teacher competencies in focus: Year 3 Science, Primary school specialisation track

Competency standard	Minimum requirements	Indicators
A1: Know how students learn	A1.1 Demonstrate understanding of how students learn relevant to their age and developmental stage	A1.1.2 Prepare learning activities to align with students' level of cognitive, linguistic, social, emotional and physical development
	A1.2 Demonstrate understanding of how different teaching methods can meet students' individual learning needs	A1.2.2 Identify focused and sequenced learning activities to assist students to link new concepts with their prior knowledge and experiences
A2: Know appropriate use of educational technologies	A2.1 Demonstrate understanding of appropriate use of a variety of teaching and learning strategies and resources	A2.1.1 Plan learning experiences that provide opportunities for student interaction, inquiry, problem-solving and creativity
A4: Know the Curriculum	A4.1 Demonstrate understanding of the structure, content and expected learning outcomes of the basic education curriculum	A4.1.1 Describe key concepts, content, learning objectives and outcomes of the primary curriculum for the subjects and grade level/s taught
A5: Know the subject content	A5.1 Demonstrate understanding of the subject matter to teach the assigned subject/s for the specified grade level/s	A5.1.1 Describe the key concepts, skills, techniques and applications for the subjects covered in the grade levels taught A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills A5.1.3 Describe approaches used to promote learning in key areas of literacy, numeracy, science and social studies for the grade levels taught and linked to real life

Competency standard	Minimum requirements	Indicators
	A5.2 Demonstrate understanding of how to vary delivery of subject content to meet students' learning needs and the learning context	A5.2.1 Describe ways to contextualise learning activities for the age, language, ability and culture of students to develop understanding of subject related principles, ideas and concepts A5.2.2 Explain how lessons are contextualised to include localised information and examples related to the subject content, concepts and themes
B1: Teach curriculum content using various teaching strategies	B1.1 Demonstrate capacity to teach subject-related concepts and content clearly and engagingly	B1.1.1 Clearly explains the curriculum content and intended learning outcomes
	B1.2 Demonstrate capacity to apply educational technologies and different strategies for teaching and learning	B1.2.3 Create opportunities for students to investigate subject related content and concepts through practical activities
	B1.3. Demonstrate good lesson planning and preparation in line with students' learning ability and experience	B1.3.1 Plan and structure lesson to ensure all of the lesson time is used effectively
B2: Assess, monitor and report on students' learning	B2.1 Demonstrate capacity to monitor and assess student learning	B2.1.1 Use assessment techniques as part of lessons to support students to achieve learning outcomes
B3: Create a supportive and safe learning environment for students	B3.1 Demonstrate capacity to create a safe and effective learning environment for all students	B3.1.2 Encourage students to interact with each other and, to work both independently and in teams B3.1.3 Model and promote good health and safety practices to ensure students' wellbeing and safety within the classroom and school B3.1.4 Follow regulations regarding health and safety (administration of medication, CPR and First Aid training, fire and disaster drills, abuse and neglect, communicable disease)

Source: Myanmar Teacher Competency Standards Framework (TCSF) - Beginning Teachers, 2020, pp. 79 – 110

Teaching young adult learners

The student teachers in your classroom are young adult learners. As such, evidence suggests that they will learn best when:

- The course content is related to their prior knowledge and experiences;
- There are opportunities for them to be active in their learning, both in and outside the classroom; and
- They are asked to develop their critical thinking and social skills and to take ownership of their own learning.

The different types of content delivery and learning strategies proposed in this Teacher Educator Guide are based on the following 'good practice' principles of teaching adult learners:

1. **Keep it relevant.** Adults tend to be goal-oriented and practical. They want to understand how what they are learning will be important in their daily lives. This means that it is important to have clearly defined goals and objectives for what student teachers will accomplish in a lesson, and why. Student teachers need to see the relevance of what they are learning for their future jobs as teachers. You can tell them explicitly what they are learning or how individual learning activities will be useful to them as teachers.
2. **Recognise your student teachers' backgrounds.** Your student teachers are coming to you with at least 18 years of life experience. The content of your course should reflect the level of education that they have completed and the realities of their daily lives. Adult learners need to be shown respect by valuing the experience and knowledge that they bring to the class. In your lessons, you can look for places where student teachers can draw on their real-life experiences and prior knowledge to help them understand and connect to a topic.
3. **Encourage exploration.** As adult learners, your student teachers are capable of learning on their own and being self-directed. Activities that require problem-solving and collaboration can help your student teachers to connect deeply and meaningfully with the lesson content. To do this, look for ways to actively involve your student teachers through discussion groups, real-life practice and opportunities to teach others. It may help to think of yourself as a *facilitator* of learning, rather than a teacher. You can encourage the student teachers in your classes to take ownership of their learning by finding out what is interesting to them and encouraging them to pursue these things.

Guidelines for inclusive and equitable classroom practices

Inclusion is the act of ensuring that all persons are free from discrimination of any kind and enjoy equal rights. In terms of inclusion in education, a child should be able to enjoy their right to education, regardless of their gender, language, ethnicity, religion, disability, socioeconomic status and geographic location, as set forth in the 1990 UN Convention on the Rights of the Child. The vision of the Ministry of Education (MoE) is to ensure significant advancement towards adhering to the terms of the UN Convention. Its aim is also the achievement of the Sustainable Development Goal for

Education, namely: *SDG Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.*

The achievement of SDG Goal 4 can be realised through the creation of inclusive, learner-friendly environments at all levels of the Education Degree College. While teacher educators can model inclusive and equitable classroom practices to their student teachers, administrators can also contribute by creating mission and/or vision statements and policies that celebrate inclusion, including a policy against discrimination.

As a teacher educator, actively promoting inclusion and gender equality in the classroom is an essential element of your teaching. Facilitating a safe and positive environment and atmosphere where all student teachers feel that their contributions are equally valued, and have equal access to learning, requires you to be mindful of the teaching and learning strategies and resources you use.

It is your responsibility not only to ensure your student teachers have equal access to learning, but also to ensure that they understand and value the importance of inclusion and gender equality and take that knowledge with them into their own teaching practice. The skills, knowledge, values and attitudes developed in the classroom with regards to creating inclusive, learner-friendly environments, either implicitly or explicitly, can have a long-lasting impact on the future behaviour of your student teachers.

General strategies to facilitate an inclusive classroom

Teachers, as facilitators, are responsible for creating high quality, inclusive learning environments where all students are supported to experience success in their learning.

- Think about each student teacher and consider the barriers they may experience because of their gender, disability, religion, ethnicity, language, geographical context, and socio-economic situation.
- Be aware of your own biases and reflect on your actions and teaching strategies.
- Ensure that all genders are represented and recognised, be aware not to reinforce gender stereotypes.
- Be sensitive to the marginalisation of different ethnic or religious groups experienced or continue to experience.

- Be aware that student teachers from ethno-linguistic groups who may not be as confident in using the language of instruction in the school. Use terms that all students would be familiar with and check for understanding throughout the lesson. If needed, provide translations of key documents and materials for all student teachers.
- Recognise and acknowledge different religious practices and try to represent all in the class and not have a bias towards the most predominant culture or religion in the population.
- Ensure that activities and examples are accessible to student teachers from all socio-economic groups and can all participate. Use local examples relevant to the locality and materials that are easy to acquire, low-cost and are readily available.
- Provide accommodations and adapt lessons for student teachers with disabilities.
- Make sure you present the key learning points of the lesson through visual, auditory and if possible tactile cues – respond to different learning styles.
- Be flexible and offer a variety of activities for different student teachers to explore the same learning competencies and learning outcomes.
- Have high expectations of all student teachers and focus on helping each of them achieve the learning outcomes.

Ensure gender inclusivity in the classroom

Gender stereotypes are often inadvertently reinforced in the classroom through the use of language, pedagogical approaches and resources that support the preconceived culturally expected norms, roles, and responsibilities of women and men. By promoting a gender-inclusive environment in the classroom, you can support both male and female student teachers in building a healthy understanding of gender equality and further mainstreaming of this gender-sensitive and inclusive practice into basic education classrooms.

- Ensure that there is equal representation of male and female voices, names, quotes and examples.
- Ensure that illustration examples do not reinforce any existing stereotypes.
- Use equitable and gender-inclusive language and ensure that your student teachers do likewise.
- Help and encourage your students to be gender aware, highlight any perceived gender-biased attitudes and encourage your student teachers to reflect on their own actions.

- Ensure that you interact equally with male and female student teachers, addressing and engaging them both to the same degree in your teaching, across different subjects. For example, when asking questions, asking for volunteers, selecting activity leaders, giving compliments, giving eye contacts, or even remembering the names of student teachers.
- Arrange the classroom setting in a gender-sensitive and equal manner, in terms of classroom decorations, seating arrangement, and group formation/ division.

Specific guidelines to adapt a lesson according to the different needs of your student teachers

Types of situations	Guidelines
Student teachers not interested in lesson topic	Make relevant connections between topic and their lives
	Show them practical applications of topic
	Use examples related to their interests
	Include games and activities which require the student teachers to collaborate together on the lesson content
Unmotivated student teachers to engage in activities	Provide choices within the classroom
	Increase opportunities for peer-based learning
	Ensure learning tasks are at an appropriate level of difficulty
Student teachers reluctant to participate in class	Provide options for participation
	Be flexible in expectations for participation among peer partners/small groups
	Encourage and support the participation of quieter student teachers
Student teachers who may finish their work more quickly	Develop and prepare extension activities
Student teachers who may take longer time to complete the tasks	Allow more time to complete work if they need it
Student teachers who respond better to visual input (including learners with hearing impairments)	Use objects/pictures, colour-coded information for visual organisation
Student teachers who respond better to auditory input (including learners with visual impairments)	Use lecture or discussion-based learning, peer-based activities, audiobooks, text-to-speech software
Student teachers with learning or attention challenges	Use small chunk of information, frequent repetitions, multiple examples, concrete learning experiences, actual demonstration, hands-on learning
Student teachers who learn better kinaesthetically	Use hands-on learning, touching objects, tactile graphics, frequent movement, project-based learning
Culturally diverse student teachers	Use culturally relevant materials and instructional methods
Student teachers with disabilities	Group them with student teachers who can offer support and assistance, not with those who are facing difficulties

Types of situations	Guidelines
Student teachers with hearing impairments	Ask them to sit near the front of the room
	Make sure that they can see your lips to be engaged through lip-reading
	Provide written representations of what is being communicated
Student teachers with visual impairments	Ask them to sit near the whiteboard/chalkboard
	Use large-print materials with the contrast enhanced
	Provide instructions verbally as well as visually
	Provide a variety of engaging activities engaging other senses
Student teachers who prefer expressing themselves through printed words (including students with speech difficulty)	Use journalling, fill in the blank activities, essays, stories or poems
Student teachers who are verbally expressive (including students having writing difficulties)	Include discussions in class or "reporting back" to questions
Student teachers who communicate best with drawings, diagrams (including students with speech or writing challenges)	Use visuals, poster making or other artistic formats
Student teachers who express themselves better through demonstration and movement	Use drama/skit, body movements, building models
Student teachers who need time to think before responding (including second-language learners)	Provide time for them to construct responses before sharing with you or their classmates
Student teachers who have limited mobility	If movement is required, adjust the lesson to include variations that allow the student teachers to demonstrate knowledge by using other parts of their body or wheelchair movement.
	Have them demonstrate the competency using a written or oral description
Student teachers with complex physical disabilities	Use of scribe to support writing
Student teachers with learning/ organisational challenges	Encourage peer support
	Use sentence-starters in writing, word banks, pictures, to-do-lists, task checklists

Inclusive, quality assessment to enhance learning

Traditional assessment strategies create barriers for many students. Inclusive assessment allows student teachers to maximise access to learning opportunities, but also considers their individual differences and contributes to improving the quality of education.

- Use formative assessments frequently. Use the data that you get from formative assessments to influence instructional decisions.

- Design and adapt tests so that they are accessible to all student teachers.
- Ensure that all instructions are clear and easy to understand, questions are at the reading level of all students, and diagrams are clear and easy to read.
- Allow student teachers with disabilities to be supported by providing assistance in writing down their answers or understanding the questions as needed (this can be a student teacher from another year group or class or a designated teaching assistant).
- Use assessment rubrics with benchmarks towards the learning goal, using a rating scale such as 'not yet evident', 'beginning', 'developing' and 'independent'. The benchmarks can be adjusted depending on the lesson or individual learning goals. Other alternatives include checklists, personal feedback, student self-assessment, portfolio with selecting highlights and areas for improvement.
- Ensure that there is more than one way for you to check understanding in a lesson. Provide several options for student teachers to express learning through a variety of assessment tasks.

Accommodations for student teachers who may experience barriers in participating in assessment tasks

Types of accommodations	Ideas
Accommodations in presentation	Provide oral reading of the assessment (either by recorded voice or adult reader)
	Use large print for the assessments
	Provide audio amplification to aid in listening (hearing aids of speakers)
	Use computerised screen readers of text
Accommodations in response	Use a computer or a scribe to help with answering of questions
	Circle answers directly in the text booklet rather than a separate book
	Use organisational devices (calculators, organisers, spell checkers, dictionaries)
Accommodations in setting	Administrate the test in a separate place to minimise distraction
	Test in a small group
	Adjust lighting in a room (more or less light for students who need it)
	Provide noise buffers (headphones, ear plugs, earphones)
Accommodations in timing	Extend time to complete a test
	Allow multiple or frequent breaks
	Change the order of a test (e.g., provide easier subjects first to decrease anxiety)
	Test over multiple days rather than one day

Enhance inclusive teaching through reflective practice

You should constantly reflect on your teaching practice to ensure that you are providing quality education that is accessible and engaging for all of your student teachers, regardless of their background. After every lesson, think about these questions for your reflection:

1. Teaching is planned with all student teachers in mind.

- Do lesson activities take account of student teachers' interests and experiences?
- Are varied teaching strategies and methods used?
- Do the student teachers understand the purposes of lesson activities?
- Does the lesson plan support the achievement of intended learning outcomes?
- What works well and what does not work well for whom? Is there a better way to teach the subject?
- Have I anticipated different learning styles, preferences, abilities, and needs of student teachers and designed activities to cater to their needs?
- How have I considered student teachers' understanding and prior knowledge? How have I adapted my lesson to scaffold understanding and address a range of needs?

2. Lessons encourage the participation of all student teachers.

- Are all student teachers, regardless of gender, addressed by their name equally?
- Are there locally, culturally, and personally relevant materials that engage the interest of the student teachers?
- Do student teachers feel they are able to speak during lessons?

3. Student teachers are actively involved in their own learning.

- Are student teachers encouraged to take responsibility for their own learning?
- Does the classroom environment encourage independent learning?
- Have I designed the lesson to allow student teachers an element of choice in how they learn?

4. Student teachers are encouraged to support one another's learning.

- Do seating arrangements encourage student teachers to interact?
- Are student teachers sometimes expected to work in pairs or groups?
- Do student teachers help one another to achieve the goals of lessons?

5. Support is provided when student teachers experience difficulties.

- Am I watching out for student teachers experiencing difficulties?
- Do students feel able to ask for help?

6. Positive learning behaviour is based on mutual respect.

- Are there established rules for taking turns to speak and listen?
- Do student teachers feel that their voice is being equally heard?
- Are bullying, gender stereotyping and discriminatory biases discouraged?

7. Student teachers feel that they have somebody to speak to when they are worried or upset.

- Are the concerns of all student teachers listened to, regardless of background?
- Do I make myself available for student teachers to talk with me privately?
- Have I created an encouraging and positive learning environment?

8. Assessment contributes to the achievement of all student teachers

- Have I used assessment to encourage learning?
- Are the assessment techniques inclusive and accessible for all student teachers?
- Are all student teachers actually learning what they are supposed to?
- Are student teachers given constructive feedback on their work?
- Have I supported student teachers for tests or examinations according to their individual needs?
- Do I ensure that diversity is respected, even within one united formal assessment system?

Toolbox for teaching and learning strategies

This Teacher Educator Guide includes suggested learning activities for each lesson in the Student Teacher Textbook. These learning activities are intended to help support you as you plan your lessons, but they do not dictate what you must do to help student teachers develop the desired knowledge, skills and attitudes for each lesson. On the contrary, you are encouraged to come up with the lesson activities that will best help the student teachers in your classroom to learn, given their unique backgrounds and needs.

Many of the learning activities listed below are used in this Teacher Educator Guide. You can also use this list to help you plan, or further adapt, your lessons. This is not an exhaustive list of teaching and learning strategies. You may wish to brainstorm additional teaching strategies by visiting http://www.theteachertoolkit.com/index.php/tool/all-tools or other similar websites.

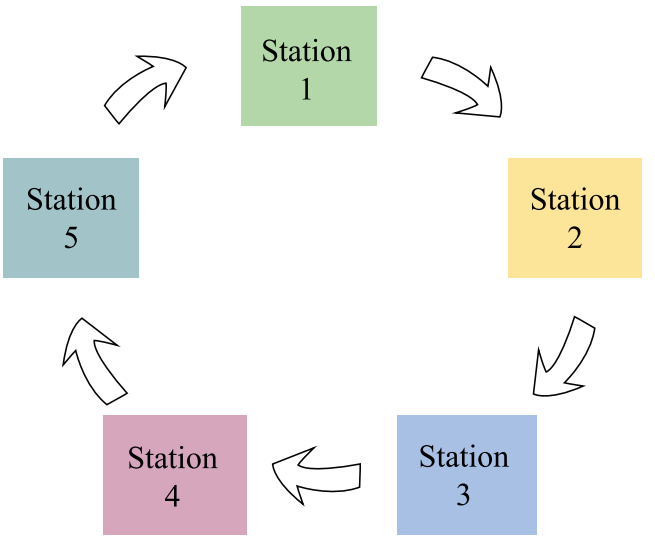
Assignments: The assignments that you give to student teachers might include formal written essays, portfolios and reflection journals. They also might be smaller, developmental tasks – for example, a short homework assignment answering questions about a reading. Assignments can help student teachers to review previously taught materials. They can also help student teachers prepare for future learning – for example, you might assign student teachers to read the Student Teacher Textbook content in advance of the next lesson.

Case studies: Working through case studies can help student teachers to develop their problem-solving and critical thinking skills as they must apply what they are learning to a scenario or story (the 'case'). To complete a case study, student teachers first read the scenario and then discuss and answer one or more open-ended questions about the scenario. Case studies often require student teachers to propose solutions to the problem presented in the scenario.

Directed activities: These are activities set by you, as the teacher educator, but carried out by the student teacher independently. For example, a directed activity might be for a student teacher to interview a basic education teacher during their Practicum school placement, or to independently research a specific teaching method. Directed activities are typically followed up in tutorials, seminars or workshops which provide an opportunity for student teachers to share about what they have learnt and to learn from their peers.

Gallery walk: In a gallery walk, student teachers work in groups to answer questions or complete a task on poster paper at various stations. They then rotate stations and add comments, questions, or further content to the poster at that station.

You can also use a version of the gallery walk to display student teachers' work. In this type of gallery walk, posters created during individual, or group work are displayed around the room. Student teachers then circulate at their own pace to either simply view the posters, or to add their questions or comments to the poster.

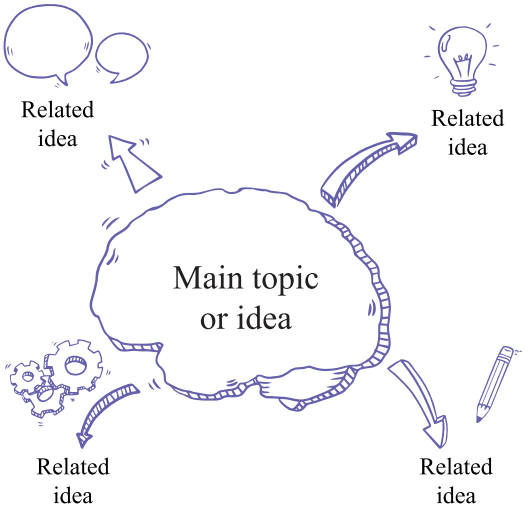


Graphic organisers: Graphic organisers are a simple and effective tool to help student teachers brainstorm and organise their thoughts and ideas in a way that makes it easier for them to understand. Graphic organisers can be used in any lesson for brainstorming, planning, problem-solving or decision-making.

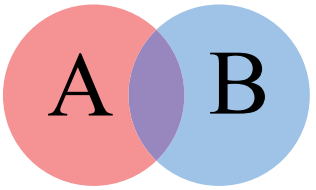
Some of the most popular graphic organisers that you will see in your Teacher Educator Guides include:

- **Concept map (also called a mind map):** Concept maps, or mind maps, can be used to visually show the relationships between concepts or ideas. They are useful for brainstorming and also organising information. Concept maps can be organised in different ways and with different levels of complexity but

most start with broad topics first, connected to sub-topics (or more specific concepts) to form a web of connecting ideas. The diagram below shows a very simple concept map.



- **Venn diagram:** Venn diagrams can be used to compare and contrast at least two different things or ideas (A and B). In the Venn diagram below, the overlapped area represents the characteristics belonging to both A and B and the two areas without overlap are for listing the characteristics that belong only to A and those that belong only to B.



- **KWL chart:** KWL charts can help student teachers organise information before, during and after a unit or a lesson. They can be used to engage students in a new topic, activate prior knowledge, share unit objectives and monitor student teachers' learning. KWL charts can be completed as a small group, whole class or by an individual. Before the lesson or unit, student teachers should fill in the first two columns about what they already know and what they want to know. After the lesson or unit, they can fill in the column about what they have learnt.

K What I **K**now	**W** What I **W**ant to know	**L** What I **L**earnt

- **T-chart:** T-charts can help student teachers examine two facets of a topic; for example, the advantages and disadvantages, or facts versus opinions.

Heading 1	**Heading 2**

Group work: Group work refers to any time you ask student teachers to cooperatively work together in groups on a task (for example, see the Jigsaw activity below). Group work can help motivate student teachers and encourage active learning. It requires student teachers to practise key critical thinking, communication and decision-making skills. Student teachers can work in groups to answer questions, create a presentation, write a lesson plan, analyse a case study, and conduct a role-play and many more learning activities. You may wish to assign roles to group members – for example, recorder, presenter and team leader – to make sure that everyone is involved in the task.

Jigsaw: In a jigsaw activity, small groups of student teachers become experts on one component of a topic and then 'teach' that component to their peers. This gives student teachers the opportunity to work with others and to see different points of view. The jigsaw technique is especially effective because each student teacher is responsible for another's learning, and student teachers come to realise that each group member has something important to contribute to the group. In a jigsaw, student teachers must

practise using many important skills, including communication, problem-solving and critical thinking.

Lecture: Lectures are largely one-way communication between you, as a teacher educator, and a group of student teachers. They can be useful for delivering straightforward new content. Even when giving a lecture, you can involve student teachers more actively by pausing to ask and respond to questions, or by asking a student teacher to reflect or comment on the topic.

Micro-teaching: During a micro-teaching experience, a student teacher, or a small group of student teachers, teaches their peers all or part of a lesson. They then receive feedback on the mini-lesson and reflect on the experience in order to develop practical skills and apply their learning. Micro-teaching is an important opportunity to prepare for the Practicum Lesson Study and school placements. It can also provide a chance to focus on specific core teacher practices; for example, asking open-ended questions or giving students positive feedback.

Modelling: Modelling is an instructional strategy in which the teacher demonstrates a new concept or approach, and students learn by observing. As a teacher educator, you may choose to demonstrate a learning activity or teaching strategy, rather than simply telling the student teachers about it – this is modelling.

Modelling may also be followed by a discussion about how you presented the activity or strategy and what impact that had on the student teachers as learners. This can highlight the role of modelling in teaching and encourage student teachers to reflect on how they might use modelling in their own teaching in the future.

Observation: Student teachers can observe a peer or expert teacher teaching, then participate in structured, reflective discussion to make sense of what was observed. You may also observe a student teacher teaching all or part of a lesson and then follow this with a discussion to explore and develop the student teachers' thinking and practice. This strategy is an excellent opportunity to make links between theory and practice, and to support student teachers in making accurate assessments of their progress.

Practicals: Practicals can include demonstrations by you as teacher educator (for example, showing how to conduct a science experiment) and those led by,

or involving, student teachers (for example, having student teachers complete a mathematical investigation and associated worksheet). This strategy can help student teachers to understand how different activities can help students learn. Practicals can also encourage student teachers to connect theory to their developing practice as teachers.

QR Codes: QR codes are a mobile friendly way to enter web addresses or check out links of specific information. Instead of clicking on links, a collection of small black squares, known as a QR code, is scanned.

First, student teachers will need to use their smartphone to download a QR code scanner or reader from the iOS Apple Store or Google Play, using mobile data or available internet connection. After downloading the scanner, connected students can hold up their phone, point their camera, scan the code and be directed to a given location. Teachers should be encouraged to use these codes in their own classrooms and know how to generate them easily and quickly.

These QR codes can be a great tool used for the flipped classroom approach, allowing student teachers to easily access links, websites, and download worksheets. You can also use them in warm up activities, assessments, surveys, and other learning activities to include VLE in the classroom.

Please note that you and your student teachers will need mobile data or internet connection for the scanner to work.

Reading groups: A reading group is a small group session focused on the analysis and interpretation of a text, most commonly an academic paper. The paper is usually issued in advance and student teachers are expected to be familiar with its contents before attending the reading group. One student teacher may be asked to present the paper to the group, followed by a discussion to which all student teachers contribute. This strategy helps to familiarise students with academic writing as well as with the ideas within papers. Discussions may focus on the content, presentation or the methodology of the papers presented.

Role-playing: Role-play is a technique that allows student teachers to explore realistic situations as they interact with people and scenarios in a simulated way to try different strategies. This can allow student teachers to work through common challenges, or specific aspects of teaching, in a safe and supportive environment.

Self-study: In a self-study, student teachers must take responsibility for their own learning, with you as a guide. This strategy can supplement face-to-face and Education Degree College-based learning and is important to help frame, supplement, and consolidate new learning. Self-study can take a number of forms, such as reading around topic areas and action planning. Self-study includes time to think about specific areas of education.

Seminars: Seminars are small group sessions where questions can be explored, and views can be debated and analysed. Students usually complete preparatory work or reading before the seminar. While you would lead the seminar as a teacher educator, all student teachers are expected to contribute to discussions. Seminars can be good for developing student teachers' deeper thinking about content with which they are already familiar.

Think-pair-share: Think-pair-share is a simple and collaborative strategy where learners work together to solve a problem or answer a question. To use think-pair-share in your class, you can follow these three steps:

1. Think: Begin by asking a specific question about the text. Ask student teachers to 'think' about what they know or have learnt about the topic.
2. Pair: Each student teacher should pair up with a classmate, or with a small group.
3. Share: With their partner or small group, student teachers should share and discuss their thinking about the question. You can then expand this time of sharing into a whole class discussion about the topic.

Tutorials: Tutorials are one-on-one or small group sessions between you and a student teacher. Tutorials allow for personalised, detailed discussion and exploration of ideas. They may have a pastoral or academic focus and may be used to support student teachers who are struggling with specific academic content, or who have missed out on an in-class learning experience.

Virtual Learning Environment (VLE): This widely-used tool is a teaching strategy to supplement and support learning and self-study. In VLE, activities, study skills and website links are shared with student teachers, and different tools are used to explore understanding, such as wikis, forums and blogs. An e-library is available for student teachers to access teaching and learning resources.

Workshops: Workshops are group sessions in which student teachers engage with new content and skills in order to develop their understanding and practice. This strategy often incorporates a great deal of collaboration and discussion as well as more lecture 'teaching' by you, as teacher educator. Workshops allow for detailed discussions about a topic and for student teachers to practise applying what they are learning.

Toolbox for assessment approaches

There are many different ways you can monitor student teachers' learning before, during, and after a lesson. This Teacher Educator Guide includes many of these assessment approaches. Remember that providing feedback, either written or verbally, is an important part of formative assessment. Your feedback is what will help student teachers to learn and improve on future tasks. You can think of formative assessment as a chance for student teachers to practise before the summative assessment, where they will be asked to show what they have learnt through a larger test, exam or project.

Some of the most popular assessment methods you will see in this Teacher Educator Guide include:

Demonstration: In a demonstration, you may ask a student teacher to show you – or demonstrate – a skill that they have been learning. For example, you may ask a student teacher to demonstrate a dance technique, a step in a science experiment, or a movement in physical education. By observing the demonstration, you can monitor student teacher progress and provide suggestions for improvement. As with all formative assessment approaches, the feedback you provide on the student teacher's demonstration is what will help him or her to improve.

Homework assignments: Checking student teachers' homework assignments, which may include tasks such as reading and answering questions or looking up additional

information, is a good way to monitor if they are on the right track. Depending on the homework assignment, you may wish to discuss answers as a class, check for completion, or collect and provide written feedback.

Journal log/ reflection papers: These are a detailed log of student teachers' thoughts and feelings about their professional development and growth. The journal log and reflection papers are intended to help student teachers think deeply about their own learning by reflecting on their progress towards becoming a teacher. The process of consciously reflecting on their learning will help student teachers make connections between the content they learnt in a subject and other subjects, solve problems that come up, and learn from their experiences. Teacher educators may provide advice to student teachers on the areas to focus on when preparing the journal logs and reflection papers.

Observation: Informal observation – by circulating the room, listening to groups discuss, and making eye contact – is a good way to get a general sense of whether student teachers understand the material. More formal observation would involve using a checklist or criteria that you are looking for in a student teacher's answers or presentation. You can then provide feedback on the basis of what you have observed.

Peer-assessment: If you ask student teachers to evaluate or judge, the work of their peers, this is called peer-assessment. You will need to have the appropriate peer-assessment tools – either a rubric or a checklist – so that student teachers can provide feedback to their classmates based on established criteria. When student teachers observe each other during micro-teaching and complete an observation sheet, this is a form of peer-assessment.

Presentation: A presentation may be similar to a demonstration but often involves more preparation on the part of the student teachers. Asking groups or individuals to present their work – perhaps at the end of the lesson – is an excellent opportunity to check for understanding, correct any misconceptions and provide feedback.

Projects: Projects are completed by each student teacher, either individually or collaboratively in a group. This is to demonstrate their understanding in the subject content knowledge and their competencies gained through designing, planning and developing projects. Student teachers work on a project over a certain period of time to investigate a topic or a real-life issue. Teacher educators are requested

to provide instructions on completing the projects, including the rubrics of the assessment.

Question and answer: Asking student teachers both closed-ended and open-ended questions is a good way to monitor whether student teachers understand the material. During question and answer sessions, be sure to call on a variety of student teachers for their responses. While you may want to use some closed-ended questions (with one correct answer) to check understanding, you will be able to foster better and deeper discussions through open-ended questions, which have more than one right answer and generally require more thinking on the part of the student teachers.

Quiz: You may wish to use a short quiz to test the knowledge of your student teachers. Quizzes can be graded in class as a whole class activity, or you may wish to collect and check the quizzes outside of class. Quizzes can also be seen as a way to 'practise' for a summative test or exam.

Self-assessment: In a self-assessment, student teachers evaluate their own strengths and weaknesses. This process can help them to understand their own gaps in skills or knowledge and to create a plan to address these gaps. Self-assessments are good ways to encourage student teachers to take ownership of their own learning and development. As in peer-assessment, student teachers will need some coaching to understand the assessment criteria and how to apply them to their own work or skill sets.

Written examinations: Written examinations are conducted usually at the end of each semester to test the basic subject content specific knowledge and reflection of related pedagogy discussed during the course.

General tips for facilitating a lesson

Some of the teaching and learning strategies suggested here and throughout this Teacher Educator Guide may be new to you. If so, it is recommended that you spend some time carefully planning out how you will use them in your lessons so that student teachers can achieve the desired learning outcomes.

The following are some additional general tips that you can implement to help your student teachers learn.

Before teaching a class, you may wish to do the following:

- Choose a small amount of content to deliver. Keep in mind that in a given 50-minute class period, you generally do not want more than one-third of the class period should be focused on content delivery. This will enable there to be enough time for student teachers to practise their skills and deepen their understanding of the topic.
- Note down the key points you think are most important for your student teachers to learn from the lesson content. You can refer to these as you deliver the content to the class to make sure you discuss these key points.
- Make sure you are clear on how you will carry out the content delivery and the learning activities. Refer to the suggestions in this guide and discuss with other teacher educators, if needed. Always feel free to change the suggested steps so that the lesson activities work well for your specific classroom situation.
- For each learning activity, prepare clear written instructions for your student teachers describing, step-by-step, how to do the activity. The instructions could be displayed on a presentation slide, printed on a handout or written on the board. Make sure the instructions are large enough to be read by all student teachers.
- You may want to practise explaining the instructions verbally, going slowly and step-by-step. This will help you be ready to explain the instructions to your student teachers before the activity, so they will understand what to do. You can practise the explanation with a friend or colleague ahead of time and then ask them what needs to be explained more clearly.
- If time allows, prepare to model of what student teachers are expected to do during the activity. This might involve one or two teacher educators doing a short role-play, pretending they are the student teachers doing the activity. This will enable student teachers to *see* exactly what they should be doing.
- If student teachers are expected to produce something at the end of an activity, you may wish to prepare an example, or 'end product,' to show student teachers what they should be aiming to create during the activity.

During class, just before the content delivery or any learning activity, if applicable, it may be helpful to:

- Distribute any materials or learning supplies that student teachers will need to carry out tasks you will ask them to do. Make good use of the e-library to

request student teachers to access necessary teaching and learning materials online as appropriate.
- Provide clear verbal and written instructions to student teachers about any task you would like them to do as you deliver the content.
- Model what the student teachers should do using a short role-play.
- Show the example end product to student teachers that you prepared before class.
- Ask one or more student teachers to repeat back to the class how to do the activity, using their own words, to make sure they understand the instructions.
- Tell student teachers how long they have to complete the activity.

Throughout the class, it may be helpful to:

- Look for any signs that suggest whether the student teachers understand the content you are delivering or the task they are working on. If you suspect certain points may be difficult for student teachers to understand, consider explaining the information in a different way or breaking down the information into smaller, more manageable pieces.
- Walk around to all parts of the classroom to:
  - Ensure all student teachers are on task;
  - Answer questions student teachers have;
  - Ensure student teachers have all the materials needed to do the activity; and
  - Assess student teachers' understanding by observing whether they are carrying out the activity as instructed.
- Encourage student teachers to ask questions.
- If you detect a misunderstanding, either talk directly to the student teacher to clarify, or if the whole class may benefit from the clarification, call the attention of all student teachers and explain to everyone.
- Check for **Facilitator's notes** instruction boxes for points to emphasise and to ensure that student teachers are learning effectively before moving forward.

At the end of class, it may be helpful to:

- Consider following the suggested ways to "Check student teachers' understanding" at the end of each lesson. This is an opportunity to summarise the lesson and to briefly assess the student teachers' achievement of the learning outcomes and understanding of how the lesson addressed the Teacher Competency Standards Framework (TCSF).

- Assess student teachers' understanding by asking them to share a point from the content you delivered that they thought was particularly interesting, or that surprised them.
- Encourage student teachers to ask questions and provide comments on what you have just taught them.
- Ask one or two student teachers to share what they produced during the activity. If the activity was not designed to produce an end product, ask one or two student teachers to describe what they learnt from the activity.
- After student teachers share their work or their thoughts, choose one or two aspects of what they shared to emphasise to the class. The point you choose to emphasise should be key points that you would like all student teachers to learn and remember from the activity.

As a teacher educator, you have an important role to play in creating a classroom where all student teachers feel free to ask questions, share their reflections, and practise teaching in a safe supportive environment. It is your feedback and support that will help them grow into teachers who can foster the holistic development and learning of Myanmar's children and youth.

Table B. Year 3 Semester 2 Science, Primary school specialisation track content map

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
5. Methodology II	5.1. Formative Assessment	5.1.1. Formative assessment strategies (Grade 1/2)	• Identify inclusive strategies to provide formative assessment and feedback to students in Grade 1/2 • Justify the importance of formative assessment in the Science curriculum	B2.1	B2.1.1	1
	5.2. Summative Assessment	5.2.1. Summative assessment strategies (Grade 1/2)	• Describe a variety of summative assessment approaches for Primary school Science Grade 1/2 • Critique these practices from an inclusion perspective	B2.1	B2.1.1	1

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
	5.3. Lesson Plans and Lesson Designing	5.3.1. Collaborative learning in Science	• Identify different pedagogical strategies for group learning in Science that are suitable for a Grade 1/2 class • Discuss how a good Primary Science lesson plan could be taught through grouping • Explain how intellectual understanding, abilities, and skills, communication, cooperative, and teamwork skills, and personal growth among students of diverse ability and social levels can be developed in Grade 1/2 through collaborative learning	B1.2 B1.3	B1.2.3 B1.3.1	1
		5.3.2. Teaching and learning materials	• Collaboratively design one teaching resource to support collaborative learning in a Grade 1/2 class, to support specific learning objectives	B1.2 B1.3	B1.2.3 B1.3.1	1
6. Biology II	6.1. Function	6.1.1. Plant nutrition	• Classify types of organisms (autotroph/ heterotroph based on plant nutritive function including saprophytes, parasites, and so on) • Identify the needs of plants • Collaboratively design an explanation of the conditions necessary for photosynthesis suitable for a Grade 1/2 class	A5.1	A5.1.1	1

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
		6.1.2. Animals' needs to survive	• Explain physiological needs of animals and humans • Describe the basic needs for animals to survive including differences between the requirements of carnivores, herbivores, and omnivores	A5.1	A5.1.1 A5.1.3	1
		6.1.3. Digestive system	• Explain the functions of the human digestive system and identify the structures that carry out these functions using illustrations	A1.2 A5.1	A1.2.2 A5.1.1 A5.1.2	1
		6.1.4. Practical: Digestive system	• Draw, label, and describe the structures and functions of the digestive system in vertebrates • Compare and contrast the different digestive systems of animals such as fish and mammals • Create a chart or model of the human digestive system suitable as a teaching resource for a Grade 1/2 class (viva voce)	A1.2 A5.1 B3.1	A1.2.2 A5.1.1 A5.1.2 B3.1.3 B3.1.4	2
	6.2. Environment	6.2.1. Environmental factors causing changes in surroundings	• Consider the factors causing seasonal changes in different environments • Identify and relate effects of weather and seasonal conditions in the community and human beings	A5.1	A5.1.1 A5.1.2	1

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
7. Chemistry II	7.1. Environmental Chemistry in Society	7.1.1. Types and formation of solutions	• Compare and contrast different types of solutions • Identify the components in a solution • Examine the process by which solutions form and their properties	A5.1	A5.1.1	1
		7.1.2. Solutions and solubility	• Determine the concentration of a solution • Define solubility and explain how it is affected by various factors • Describe the application of solubility product principle in the qualitative analysis of a solution	A5.1	A5.1.1	1
		7.1.3. Properties of solutions, colloids and suspensions	• Explain how certain chemical reactions are relevant in everyday life and work • Perform stoichiometric calculations involving reactions in solution, including precipitation reactions • Describe properties of colloids, suspensions, and solutions with examples • Apply understanding of the properties of colloids, suspensions, and solutions to distinguish between them	A5.1	A5.1.1 A5.1.2	1

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
		7.1.4. Importance of Chemistry in daily life	• Appreciate the central role of Chemistry in our society • Explain why Chemistry is an integral activity for addressing social, economic, and environmental problems • Develop a teaching resource suitable for a Grade 1/2 class that outlines phenomena in our everyday lives from a scientific perspective	A5.2	A5.2.2	1
		7.1.5. Examples of Chemistry in daily life	• Develop a critical approach towards the presence of chemicals in our daily life • Provide effective examples demonstrating the power of Chemistry in daily life	A5.1 A5.2 B3.1	A5.1.1 A5.2.2 B3.1.3	1
		7.1.6. Integrating the concept of Chemistry in daily life	• List chemicals that are used in daily life • Find and exchange information to give chemical explanations of some everyday facts • Give opinion about the uses of chemical substances in daily products • Identify chemical hazard labels	A5.1 A5.2	A5.1.1 A5.2.2	1

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
8. Physics II	8.1. Force and Movement	8.1.1. Forms of forces	• Classify the forms of forces and conduct an experiment designed for a Grade 1/2 class that shows types of forces • Examine the relationship between force, mass, and acceleration based on Newton's law of motion • Explain the difference between mass and weight with the effect of gravity on objects	A5.1	A5.1.1 A5.1.2	1
		8.1.2. Pressure: Sinking and floating	• Define density • Compare the densities of various substances • Use Archimedes' principle to explain why objects sink or float, giving examples from daily life	A5.1	A5.1.1	1
	8.2. Waves: Light	8.2.1. Nature of light	• Explain how the properties of materials affect the behaviour of light, including shadow formation • Describe the difference between the laws of refraction and reflection with real-life examples • Explain absorption of light using examples from everyday life	A5.1	A5.1.1 A5.1.2	2

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
			• Design a learning activity for a Grade 1/2 class that identifies and classifies sources of light • Use diagrams to show the path of light as it contacts concave and convex lenses • Describe the application of refraction of light in the context of the human eye			
	8.3. Heat Energy	8.3.1. Thermal expansion of substances	• Identify that thermal energy is an internal energy of matter • Examine linear, area, and volume expansion using the coefficient of thermal expansion • Develop a simple explanation suitable for a Grade 1/2 class that explains some of the everyday applications and consequences of thermal expansion	A5.1	A5.1.1 A5.1.2	1
	8.4. Electricity and Magnetism	8.4.1. Electric force and electric field	• Explain electric charges and their properties • Describe the difference between electric force and electric fields and distinguish their units • Apply Coulomb's law to quantify the force between charged particles	A5.1	A5.1.1 A5.1.2 A5.1.3	1

Units	Sub-units	Lessons	Learning outcomes	TCSF		Periods
				Minimum requirements	Indicators	
		8.4.2. Electromagnetism	• Perform a demonstration suitable for a Grade 1/2 class that demonstrates the magnetic effect of electric current • Explain how alterations to the solenoid would change its magnetic field • Discuss the uses of electromagnets	A5.1	A5.1.1 A5.1.2	1
	8.5. Earth and Space	8.5.1. Solar system	• Collaboratively construct a model of the features of the solar system suitable as a teaching resource for a Grade 1/2 class, including planets, dwarf planets, moons, asteroids, comets, and meteors • Explore the differences in the major planets of the solar system including orbital and rotational periods • Explain the methods used to explore the solar system and how we benefit from satellite technology	A5.1	A5.1.1 A5.1.2	1
Total number of periods						**24**

Unit 5

Methodology II

In this unit, student teachers will learn that assessment is an integral part of the Primary teaching and learning model. They will explore types of assessments and the nature of collaborative work. Student teachers will design and develop activities that are engaging and appropriate for students in a Primary classroom.

Expected learning outcomes

By the end of this unit, student teachers will be able to:

- Identify inclusive strategies to provide formative assessment and feedback to students in Grade 1/2;
- Justify the importance of formative assessment in the Science curriculum;
- Describe a variety of summative assessment approaches for Primary school Science Grade 1/2;
- Critique these practices from an inclusion perspective;
- Identify different pedagogical strategies for group learning in Science that are suitable for a Grade 1/2 class;
- Discuss how a good Primary Science lesson plan could be taught through grouping;
- Explain how intellectual understanding, abilities, and skills, communication, cooperative, and teamwork skills, and personal growth among students of diverse ability and social levels can be developed in Grade 1/2 through collaborative learning; and
- Collaboratively design one teaching resource to support collaborative learning in a Grade 1/2 class, to support specific learning objectives.

Competencies gained

B1.2 Demonstrate capacity to apply educational technologies and different strategies for teaching and learning

B1.3 Demonstrate good lesson planning and preparation in line with students' learning ability and experience

B2.1 Demonstrate capacity to monitor and assess student learning

5.1. Formative Assessment

In this sub-unit, student teachers will investigate the meaning of assessment in Science education, with a focus on formative assessment.

5.1.1. Formative assessment strategies (Grade 1/2)

In this lesson, student teachers will investigate formative assessment strategies.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Identify inclusive strategies to provide formative assessment and feedback to students in Grade 1/2; and
- Justify the importance of formative assessment in the Science curriculum.

Competency gained

B2.1.1 Use assessment techniques as part of lessons to support students to achieve learning outcomes

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Investigation: Assessment

Learning activity 2. Analysis: Formative assessment

Assessment approaches: Questioning, reviewing student work

Preparation needed

Read the Science Student Teacher Textbook Lesson 5.1.1.

Resources needed

Learning activity 1. Student Teacher Textbook

Learning activity 2. Student Teacher Textbook

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class and groups of 3

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge of assessment.

1. Introduce the concept of assessment by asking the student teachers about their experiences of assessment. This might be in another learning institution or maybe in a workplace.
2. Ask the student teachers to express their experiences using the Y-chart.

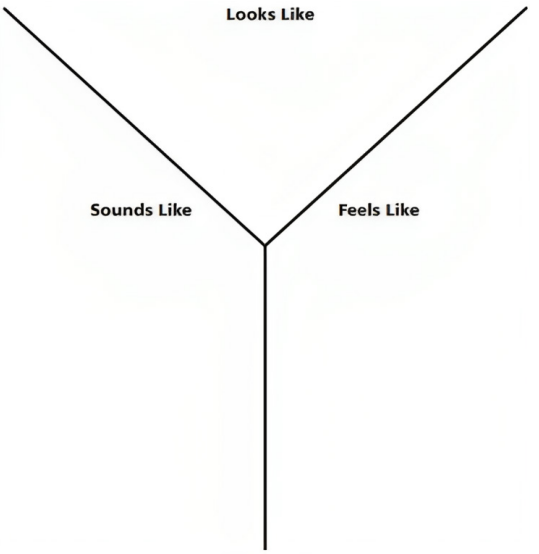


Figure. Y-chart

3. Direct the student teachers to form groups of 3 and have them combine the categories so that a group expression of the experiences is presented.
4. Have groups present what the group experience looks like, sounds like, and feels like to the class.
5. Engage student teachers in a discussion about the similarities of their experiences.

Learning activity 1. Investigation: Assessment

Time	20 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to investigate the purpose of assessment.

The title of the learning activity is *Assessment for what?* This question is the focus of this learning activity as student teachers should be working towards answering this question.

1. Form groups of 2, and then ask the student teacher groups to discuss the exam system that was introduced in Myanmar in the 2017-18 academic year.

Facilitator's notes

You may encourage student teachers to discuss the extent to which the new exam system is more inclusive for students.

2. Ask the groups to reflect on the Y-chart from the introduction and compare their experiences with the current exam-test system.
3. Refer students to Figure 5.3 in the textbook and ask the groups to discuss the three purposes of assessment for learning, assessment of learning, and assessment as learning.
4. Ask the groups to revisit the current assessment practice in Myanmar. Ask them to use the descriptions of the different purposes of assessment, and then compare assessment practices with these three different purposes.
5. Invite the groups to report back to the class and have the class discuss these ideas. These three purposes of assessment will cause some cognitive conflict for student teachers. The system they have been exposed to is the basis of their experience of assessment. Reflecting on the purpose of assessment and the system as it currently stands is a strategy to open spaces for thinking and discussion about assessment.
6. Direct the student teachers to apply these principles to the Grade 1/2 cohort and refer the groups to the concept cartoon (Figure 5.4).
7. Ask the groups to explain the Science knowledge to which the cartoon refers. Answer: The concept is condensation where water vapour is condensing on the glass.

Facilitator's notes

Some student teachers are likely to find this concept difficult due to their Science experience.

8. Ask the student teachers to consider what Grade 1/2 students might say about the cartoon. Ask the student teachers to suggest how they might modify this for the younger student cohort.
9. Ask the groups to discuss how they might use this cartoon in assessment for learning. Assessment for learning is about seeking what students already know. The cartoon strategy provides an opportunity to uncover student knowledge about condensation, through group discussion.
10. Ask the student teacher groups to suggest how the cartoon might be used to design an investigation or a series of investigations that might confirm or reject the ideas expressed in the cartoon. The idea that the cartoon is expressing invalid ideas will challenge some student teachers. Their experiences of Science have not provided opportunities to question and wonder. Again, this is a cognitive challenge to open a space for thinking and discussion.

Assessment

Ask the groups to report to the class about how they might use the cartoon to confirm or reject the ideas expressed in the cartoon. Use a class discussion to bring together the student teachers' ideas.

Possible student teachers' responses

The possible responses are infinite, as student teachers have constructed their ideas. However, there are some key points that might be useful.

Any investigation that is suggested should involve some sort of an experiment. This is not mandatory.

The students should have progressed through the following logical steps, using an if-then approach:

- The assumption is that the ideas expressed in the cartoon are correct.
- So, the logic of this assumption allows the use of the if-then statement – for example, if the water gets out through holes in the glass, then what is the evidence that will confirm this idea?
- The experiment should try to confirm the existence of holes and water leaking out.

- If the evidence does not support holes in the glass, then the assumption is invalid and not supported.
- This is science in action.

Learning activity 2. Analysis: Formative assessment

Time	20 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to investigate formative assessment.

1. Direct the student teachers to form pairs.
2. Ask the pairs to discuss formative assessment, and then direct class discussion by referring to the starter questions:
   - What do you consider to be the clear goals of a learning activity?
   - What does 'inclusive for all learners' mean?
   - What does this look like in the classroom?
   - How can you help students learn better?
   - What evidence do you need to allow you to help students learn better?
3. Ask the pairs whether the goals for the learning activity are clearly defined. Then reflect on their previous answer about goals.

Facilitator's notes

Suggest to the groups to revisit the previous answer and modify the ideas.

4. Ask the student teachers to explain how forces relate to kites. Again, this is a cognitive challenge as it is most likely that the student teachers' experience with the Science content knowledge of forces has only been from a textbook.
5. Direct the student teachers to the scenario and ask them to discuss Figure 5.5, Student A's work sample. The discussion should focus on what is in the figure and their interpretations, as this is the result of a learning activity.

6. Encourage the pairs to generate feedback for the student that will motivate the student and improve the student's work. The groups need to decide what the student has done well and what is missing. Direct the student teachers to the criteria on which the student was assessed.
7. Ask the groups to suggest how they might assist the student to complete the missing aspects of the task submission.
8. Ask how the student teachers might use peer assessment to support Student A.

Assessment

Engage the class in a discussion about the meaning of formative assessment.

Possible student teachers' responses

There are infinite responses in the discussion as proposed. The significant points are around the new experiences and the possible cognitive conflict that these experiences have produced.

Some points include:

- Formative assessment is designed to help students achieve their goals.
- Learning activities are designed to provide opportunities for students to demonstrate what they know and can do, which means providing students with clear statements about what they are expected to demonstrate and how they are expected to represent their work.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers if there are questions, they are finding difficult;
- Reinforce concepts if needed;

- Have student teachers share the answers to the questions and check for student teachers who need support to derive the correct answer;
- Ask the student teachers the question: "Assessment for what?"; and
- Encourage the student teachers to express their ideas and develop a consensus.

It could be useful in the context of answering this question to have student teachers reflect on their original experiences of assessment. The question could be asked of the student teachers: *"Is the current exam-test system meeting the needs of assessment?"*

Expected student teachers' responses for the review questions in TB

Question 1: What is the purpose of assessment in Primary Science?

Answer: *The purpose of assessment has three aspects: assessment for learning, assessment as learning, and assessment of learning. These three aspects require students and teachers to understand what evidence is required for the demonstration of learning. Through the teaching and learning processes, teachers provide opportunities for students to demonstrate what they know and can do in an ongoing manner.*

Question 2: How does the 5Es model an evidence-based approach to teaching and learning in Science?

Answer: *This model supports active student engagement, uncovering the prior knowledge of students. It also encourages posing questions, participating in hands-on experiences, and conducting exploratory and formal investigations so that students can develop explanations about scientific phenomena.*

In this model, primary students are given opportunities to represent and re-represent their developing understanding using literacy skills. To this end, primary students are actively engaged in the learning process. The model presents multiple opportunities to collect evidence of student learning over the engage, explore, explain, elaborate and evaluate phases.

Question 3: What are characteristics of formative assessment?

Answer: *Assessment for learning is referred to as formative assessment. Formative assessment:*

- *Reflects a view of learning in which assessment helps students learn better, rather than just achieve a better mark;*
- *Involves formal and informal assessment activities as part of learning and informs the planning of future learning;*
- *Includes clear goals for the learning activity or task;*
- *Provides effective feedback that motivates the learner and can lead to improvement;*
- *Reflects a belief that all students can improve;*
- *Encourages self-assessment and peer assessment as part of the regular classroom routines; and*
- *Is inclusive of all learners.*

5.2. Summative Assessment

In this sub-unit, student teachers will investigate summative assessment.

5.2.1. Summative assessment strategies (Grade 1/2)

In this lesson, student teachers will investigate summative assessment.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Describe a variety of summative assessment approaches for Primary school Science Grade 1/2; and
- Critique these practices from an inclusion perspective.

Competency gained

B2.1.1 Use assessment techniques as part of lessons to support students to achieve learning outcomes

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Analysis: Evidence of learning

Learning activity 2. Construction: Judgements

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 5.2.1.

Resources needed

Introduction. Nil (other than Student Teacher Textbook and pen)

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge.

1. Ask the student teachers to reflect on the purpose of assessment.
2. Direct the student teachers to write two examples of classroom practice that could be considered assessment for learning and two examples of practices that are not considered assessment for learning.

3. Invite student teachers to engage with the class by presenting their examples. The ensuing discussion should be managed so that individual thoughts and ideas expressed are positive and supportive. This is the point of formative assessment.

Learning activity 1. Analysis: Evidence of learning

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to investigate and make decisions about evidence of learning.

1. Direct the student teachers to form groups of 3.
2. Ask the groups to define the term *evidence* and then provide some examples of student demonstration that might be considered evidence of learning.
   The idea of evidence of learning is problematic, because it is not necessarily a number out of 100. The idea of classrooms engaging in activities that provide opportunities for students to demonstrate what they know and can do is all about learning. What students do is the demonstration. What the teacher does is to observe, question, and support students to produce evidence of their work of a standard that can be graded.
3. Ask the student teachers to suggest the purpose of summative assessment.
4. Ask the student teachers to consider the scenario in Learning activity 1 and analyse Figure 5.6. (Cleaning water investigation).
5. Ask the groups to discuss the cleaning water activity and ask them to suggest what evidence would indicate a successful completion of the task.

Facilitator's notes

Suggest to the groups that they could consider a measure of the cleanliness of the water, the quality of the cooperation of the students in a group, or demonstration that students understand the filtration process.

6. Invite groups to present their ideas about assessment of learning for the cleaning water activity.
7. Ask the student teachers to describe the modifications that might be needed for Grades 1 and 2. Invite volunteers to share their ideas.
8. Refer the groups to the 'Planning and conducting investigations' section in the textbook. Refer students to Tables 5.1. and 5.2. These tables will require explanation, as the student teachers will not have prior exposure to the use of defined criteria that link evidence with student performance in a particular task.

   The tables present a description of each criterion that is being assessed. The descriptions are in Levels 1, 2, and 3. Allow groups to discuss the meaning of each of the criteria (description of the evidence: what students demonstrate).
9. Ask the student teachers to discuss these tables. Ask them to suggest what the difference is between Level 1 and Level 3 for the criteria PC1: 'Suggest ways to plan and conduct investigations to find answers to questions.
10. Encourage a class discussion on the meaning of the criteria in each of the levels. You might ask the class: *"What would a student in a class be doing if they were working at Level 1 in the PC1 criteria?"*
11. Encourage the groups to discuss the meaning of criteria PC2 and PC3. This discussion should focus on what the demonstration of these criteria looks like for a student in the classroom. The groups should then use their discussion to produce feedback to a student on Level 1 (PC2 and PC3) that will encourage improvement to Level 3.
12. Refer the groups to Table 5.2 and ask the groups to create their own evidence descriptors in the blank spaces.

    Possible answer:

Table 5.2. Process and analyse (PA) levels of achievement – Completed

PA1: Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends		
Level 1	**Level 2**	**Level 3**
Follows simple procedures to use provided tables and simple column graphs.	Uses provided tables and simple column graphs to organise their data and identify patterns in data.	Independently constructs tables and simple column graphs to organise data.
PA2: Compare results with predictions, suggesting possible reasons for findings		
Level 1	**Level 2**	**Level 3**
Suggests reasons for findings that are obvious and follow explicitly from evidence.	Suggests explanations for observations and compares their findings with their predictions.	Applies scientific concepts and knowledge, and constructs claims based on evidence to explain findings and compare findings with predictions.

Discuss these ideas with the class.

13. Refer the groups to Table 5.3 and explain the nature of the student profile. The criteria column lists the criteria, and the levels column indicates the level at which the student has demonstrated achievement.
14. Direct the student teachers in their groups to analyse the student profile and describe the positives in the student's achievement and areas for improvement.
15. Refer the student teachers to Table 5.4 and explain that this table is a descriptor of levels of achievement in Science understanding for a Grade 2 water unit. Ask the student teachers what the Primary students need to demonstrate.
16. Refer the student teachers to Table 5.5, which describes the levels of achievement for planning and conducting investigations in Grade 2.
17. Ask the student teacher groups to compare Table 5.1 and Table 5.5 and identify how they are similar and how they are different.

Assessment

Ask the groups to present their understanding of an outcome, criteria, and descriptor. This might be easily done via a visualisation.

Possible student teachers' responses

Possible answer for Table 5.2 is provided in the activity.

The relationship between outcome, criteria, and descriptor are hierarchical. The outcome defines – at a high level – what the students need to be able to know and do. The criteria describe specific aspects of the outcome. The criteria are then described in achievement levels. These levels use descriptors to indicate the level at which a student has demonstrated the criteria.

Learning activity 2. Construction: Judgements

Time	20 minutes
Class organisation	Groups

Purpose

The purpose of this learning activity is for student teachers to make judgements about student work.

1. Refer the groups to Scenario 1, the electric circuit task. Allow the groups to discuss the task and point the student teachers to Table 5.6. Explain that this table presents the content that the students are required to demonstrate.
   This content is labelled 'Science understanding', using the symbol SU. There are several criteria in the understanding of electricity. In this activity, the student teachers will focus on:
   - SU 1: Electrical energy can be transferred and transformed in electrical circuits.
   - SU 2: Communicate ideas, explanations and processes using scientific representations.

   Remind students of the relationship between outcomes, criteria, and descriptors.
2. Ask the student teachers to work in groups to analyse Figures 5.7. and 5.8. Then discuss the similarities and differences between the samples of work. These samples of work are the result of a summative task.
3. Ask the student teachers to discuss the evidence presented in the work samples. Refer the student teachers to Table 5.6, and then ask the groups to grade the samples of work from Student X and Student Y.
   The grading process requires the groups to discuss the evidence provided and match it to the achievement level descriptors from Table 5.6. This task is conceptually challenging, and the student teachers will need to discuss the nature of the evidence and the alignment with the level descriptor.

4. Introduce Scenario 2, investigating water. Ask the groups to analyse the sample of student work presented in Figure 5.9. Direct the groups to use the level descriptors in Table 5.6 to determine a level of achievement.

Assessment

Provide an opportunity for the groups to present their grading. You might even suggest they use the profile format that was presented in Table 5.3.

Possible student teachers' responses

At this stage of the student teachers' development, the actual grading profile is not overly important. The focus is the process of trying to match evidence with a descriptor.

The groups should be able to determine that Student X's sample is of a lower standard than Student Y's sample. Student X's sample provides no indication that the student understands anything about a circuit or electrons flowing. Student Y demonstrates a knowledge of the devices, such as the electric motor being used as a fan. These are just some examples of the sorts of differences that the student teachers should present.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson, ask the student teachers to complete the mind map using the terms presented in Figure 5.10 in the Student Teacher Textbook.

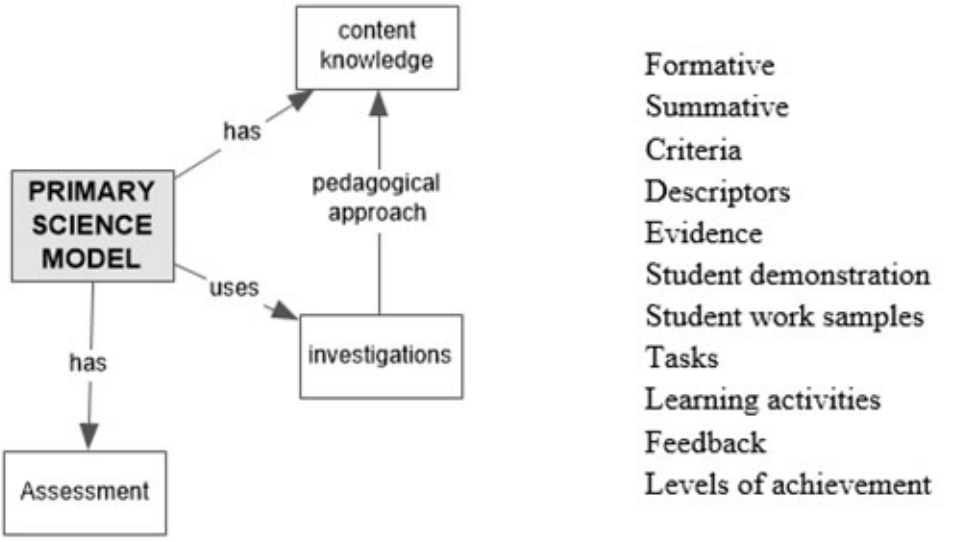


Figure 5.10. Incomplete mind map

Expected student teachers' responses for the review questions in TB

Question 1: What is the purpose of summative assessment?

Answer: *Assessment of learning assists teachers in using evidence of student learning to assess achievement against outcomes and standards. Assessment of learning:*

- *Is used to plan future learning goals and pathways for students;*
- *Provides evidence of achievement to the wider community, including parents, educators, and the students themselves; and*
- *Provides a transparent interpretation across all audiences.*

Question 2: Provide examples of standard descriptors for a selected criterion at three different standards.

Answer: *Learning outcome/criterion: Suggest ways to plan and conduct investigations to find answers to questions.*

Standards descriptors:

- *L1: Suggests ways to conduct investigations.*
- *L2: Discusses ways to conduct investigations.*
- *L3: Demonstrates a detailed understanding of how they can conduct Science investigations to respond to questions.*

5.3. Lesson Plans and Lesson Designing

In this sub-unit, student teachers will investigate collaborative learning and development of teaching and learning materials for Primary Science.

5.3.1. Collaborative learning in Science

In this lesson, student teachers will investigate collaborative learning in Science.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Identify different pedagogical strategies for group learning in Science that are suitable for a Grade 1/2 class;
- Discuss how a good Primary Science lesson plan could be taught through grouping; and
- Explain how intellectual understanding, abilities, and skills, communication, cooperative, and teamwork skills and personal growth among students of diverse ability and social levels can be developed in Grade 1/2 through collaborative learning.

Competencies gained

B1.2.3 Create opportunities for students to investigate subject-related content and concepts through practical activities

B1.3.1 Plan and structure lesson to ensure all of the lesson time is used effectively

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Collaboration: Learning in Science

Learning activity 2. Collaboration: 5Es

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 5.3.1.

Resources needed

Introduction. Nil (other than Student Teacher Textbook and pen)

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge of collaborative learning.

1. Ask the student teachers to reflect on their experiences of working in teams. Explain that the term 'working in teams' or 'teamwork' means collaborative work. In an education context, this means collaborative learning.
2. Ask the student teachers to use the Y-chart (Figure 5.11 in Student Teacher Textbook) to categorise their experiences.

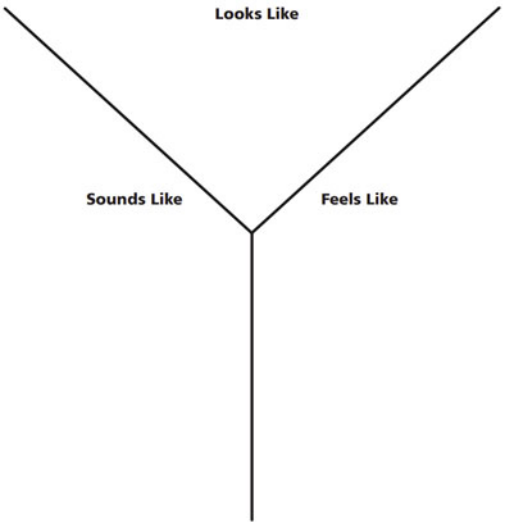


Figure 5.11. Y-chart

3. Invite student teachers to present their experiences. Ask a student teacher to present 'looks like' experiences, choose another student to present 'sounds like', and then choose yet another student to present 'feels like'.

   The aim of the strategy is to develop a class consensus on their experiences.

Learning activity 1. Collaboration: Learning in Science

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to investigate collaborative learning in Science.

1. Introduce student teachers to the idea of specific roles for team members (collaborative learning group members). Make sure the use of collaborative learning group members is prominent.
2. Direct the class to form groups of 3, and then have them discuss the meaning of the group roles manager, speaker, and director.

Facilitator's notes

Suggest to the groups to consider additional roles for a collaborative learning group in a Science investigation. Invite the groups to identify additions to the roles already stated.

3. Invite the groups to discuss team roles and direct them to develop a list of team roles that would be necessary in performing a collaborative learning investigation in Science.
4. Invite the groups to design a badge for each role from their list, which would be easily visible by the teacher so they might monitor team member activity.
5. Working collaboratively requires the team members to reflect on their collaborative performance. Refer the groups to Figure 5.12 and explain the use of Plus/Delta and action to work on for the next learning activity.
6. Invite the groups to discuss how they might use the Plus/Delta template to reflect on cooperative learning.
7. Invite the groups to discuss the Six Thinking Hats strategy presented in Figure 5.13. Explain that these roles represent ways of thinking and provide a structure for diversity to be represented in discussions of problems and possible solutions.

8. Invite the groups to consider the particulate pollution problem. Then ask them to use the Six Thinking Hats strategy to suggest a solution to the problem.
9. Invite the groups to present their solutions.

Assessment

Ask student teachers to comment on the purpose of collaborative learning, with specific mention of including all students in the learning process.

Possible student teachers' responses

In their responses, student teachers should mention the concepts of positive interdependence, promotive interaction, and individual/group accountability. These concepts are important for self-esteem, motivation, and inclusion.

Learning activity 2. Collaboration: 5Es

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to develop an understanding of the place of collaborative work in Science.

1. Refer the student teachers to the scenario and Table 5.7. Explain the relationship between the 5Es model and the scenario. The 5Es teaching and learning model is compatible with the Primary Science model.
2. Ask the student teachers to discuss what is meant by the explore phase and how it relates to an investigation. Remind the student teachers of the importance of placing collaborative learning activities in the context of school students' everyday life.
3. Ask the groups to describe a context for the focus question: What kinds of things use materials that soak up a lot of water? This focus question provides an opportunity for students in class to investigate the absorbency of materials.

4. Ask the student teachers to form a collaborative investigation team. You might suggest using the six hats strategy, because the manager, speaker, and director team roles are not appropriate, as there was no actual investigation occurring.
5. Direct the student teachers to decide on the variables and methodology they will use. Remind them that the fair test experimental design procedures can be found in the Student Teacher Textbook in Lesson 1.2.2.
6. Provide opportunities for the groups to present their investigations. Remember to encourage class discussion and provide positive feedback.
7. Ask the groups to reflect on their collaborative learning using the Plus/Delta template.

Assessment

Ask the groups to present their reflections using the Plus/Delta template, with a particular focus on what the cooperative learning team will focus on in the next collaborative activity.

Possible student teachers' responses

Responses will be varied. Groups will use the 'fair test' from their textbook Lesson 1.2.2 to design an investigation to test the absorbency of different materials.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to present a visualisation that demonstrates the important aspects of collaborative learning in Science.

5.3.2. Teaching and learning materials

In this lesson, student teachers will understand the initial process of planning teaching and learning materials.

Expected learning outcome

By the end of this lesson, student teachers will be able to:

- Collaboratively design one teaching resource to support collaborative learning in a Grade 1/2 class, to support specific learning objectives.

Competencies gained

B1.2.3 Create opportunities for students to investigate subject-related content and concepts through practical activities

B1.3.1 Plan and structure lesson to ensure all the lesson time is used effectively

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Investigation: Lesson planning

Learning activity 2. Construction: Planning using the 5Es model

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Science Student Teacher Textbook Lesson 5.3.2.

Resources needed

Introduction. Nil (other than Student Teacher Textbook and pen)

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise prior knowledge of planning an activity.

1. Ask the student teachers to reflect on the concept of planning an activity. Suggest that there must be a beginning, activity, resources, and an end.
2. Ask the student teachers to consider a journey they might have undertaken recently.
3. Direct the class to prepare a flow chart that describes the planning for the journey (not the journey itself).
4. Provide an opportunity for the class to describe their preparation flow chart.
5. Remind the class that planning any activity is often considered a linear process. Suggest that planning cooperative learning activities may not be as

linear as they might expect. Student teachers might experience difficulties around the knowledge of the content of Primary Science and the types of collaborative learning experiences appropriate for particular year levels.

Learning activity 1. Investigation: Lesson planning

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to investigate lesson-planning processes.

1. Explain to the class that the topic *matter* is made up of many sub-topics in Primary Science. The sub-topic *materials* are the focus of the planning exercise in Learning activity 1.
2. Explain that the sub-topic materials have two outcomes:
   - Everyday materials can be physically changed in a variety of ways.
   - Different materials can be combined for a particular purpose.

   Remind the student teachers that the focus year levels for this activity are Years 1 and 2.
3. Direct the class to form groups of 3.
4. Ask the groups to develop ideas for activities that might be used as collaborative learning investigations for materials. Use the following examples:
   - Example activity 1: Organise Primary students to explore the local environment to observe a variety of materials and describe the ways in which the materials are used.
   - Example activity 2: Provide opportunities for Primary students to identify materials such as paper that can be changed and remade or recycled into new objects.
5. Direct the groups to collaboratively produce a list of learning activities that could develop students' understanding of materials. These activities can be for both outcomes and/or either one.
6. Ask the groups to develop a shared understanding of what the activity might look like and the resources that might be necessary.

7. Refer the student teachers to Table 5.8, the 5Es elaborations. Provide opportunities and assistance for the groups to discuss the elaborations. The aim of the discussion is to decide which of the activities would be best suited for a particular 'E': engage, explore, explain, elaborate, or evaluate.
8. Direct the groups to sort and categorise their activities using the 5Es phases. This collaborative work will help the student teachers understand the meaning of the 5Es model and its relationship to activities that Primary school students can do.

Facilitator's notes

Suggest to the groups to discuss and modify activities to fit the description of a particular 'E'.

9. Introduce the groups to the student skills criteria for Grade 1 and Grade 2. Ask them to discuss how these criteria might be relevant to their investigations.
10. Encourage the groups to share their collaborative learning activities. This sharing could be managed by nominating a particular E (engage) and asking groups to share each of the activities. Then do the same process for the other of the other 5Es phases.

Assessment

Point out to the class that the class is a diverse group of students with diverse backgrounds and a variety of knowledge and skills. The collaborative learning approach to understanding complex processes and knowledge has been demonstrated in the class.

Possible student teachers' responses

Examples were provided to scaffold student work:

- Example activity 1: Organise Primary students to explore the local environment to observe a variety of materials and describe the ways in which the materials are used.

- Example activity 2: Provide opportunities for Primary students to identify materials such as paper that can be changed and remade or recycled into new objects.

Use class discussion to reflect on the diversity of learning activities presented by the groups.

Learning activity 2. Construction: Planning using the 5Es model

Time	20 minutes
Class organisation	Groups of 3 (same groups as Learning activity 1)

Purpose

The purpose of this learning activity is for student teachers to use a backward planning design to sequence learning activities.

1. Explain the importance of starting the planning process with what the primary students need to be able to know and do.
2. For most students, this is counterintuitive. If the point of teaching and learning is to provide opportunities for primary students to achieve to the best of their abilities, then the activities and their sequence must be based on what the students know and can do.
3. Introduce the groups to the backward planning template (Table 5.9). Ask groups to discuss the questions that are presented in each of the sections of the template.
4. These questions are guides to help student teachers in their development of a sequence of activities that could be used in a Primary Science teaching and learning situation.
5. Direct the groups to collaboratively use their developed activities from Learning activity 1 to populate the template.

Facilitator's notes

Suggest to the groups to modify the language in the activities to match the questions in the template.

6. Encourage the presentation of the group work. Allow peers to critique and groups to amend where necessary. Ensure that the critique is positive feedback to motivate group members to improve.

Assessment

Encourage the class to reflect on the process of activity development, alignment with outcomes, and the use of the 5Es teaching and learning model. This is an open discussion where all points of view are valid and supported.

Possible student teachers' responses

Responses will be varied – groups will use the activities from Learning activity 1 to populate the backward planning template.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to explain how the backward planning document they have produced supports the understanding of the teaching and learning process; and
- Direct an open discussion with the class.

Expected student teachers' responses for the review questions in TB

Question 1: Why are collaborative learning activities important in learning?

Answer: *Collaborative learning has been shown to develop higher-level thinking skills in students and boost their confidence and self-esteem. Collaborative learning activities maximise the inclusion of a diverse range of learners, while improving social and interpersonal skills. Students learn how to work with various types of learners and develop their leadership skills. All students have knowledge and skills about a variety of topics. Collaborative learning provides an opportunity for a diverse range of inputs to any learning activity.*

Question 2: Why is it important to think about feedback opportunities in lesson planning?

Answer: *Feedback is essential in guiding primary students in their learning journey. Feedback provides the essential information about what and how to do better.*

Unit Summary

Key messages

- Assessment for learning, assessment as learning, and assessment of learning support students to demonstrate what they know and can do.
- Student demonstrations of knowledge and skills provide evidence of learning.
- Collaborative learning supports learning.
- The 5Es is a teaching and learning model that supports science learning.

Unit reflection

Create a visualisation (graphic) that demonstrates the relationship between the key messages and the key terms.

Further reading

Lesson Plans and Lesson Designing

Assessing science in the primary classroom. STEM Learning. https://www.stem.org.uk/resources/collection/3244/assessing-Science-Primary-classroom

Australian Academy of Science. *Primary connections: Linking science with literacy.* https://www.primaryconnections.org.au

Australian Academy of Science. (2021). *Science by doing.* https://www.sciencebydoing.edu.au

Skamp, K., & Preston, C. (2020). *Teaching primary science constructively* (7th ed.). Cengage.

VanTassel, N. (2023). *Formative assessment for NGSS science classrooms*. iExploreScience. https://iexploreScience.com/2019/01/23/formative-assessments-for-the-ngss

Unit 6

Biology II

In this unit, student teachers will explore the diversity of ways that living things function. They will investigate the nutritional functions of plants with a focus on photosynthetic requirements and study the different ecological relationships of plants. Student teachers will explore the physiological needs of animals, including humans, and investigate how animal functions differ based on these needs.

Student teachers will use practical learning activities to study the functions of the human digestive system and create ways to demonstrate the structures and functions of the digestive system, including developing resources suitable for Grade 1/2 students. Student teachers will explore seasonal changes and consider the impact that seasonal changes can have on the living things in the environment.

Expected learning outcomes

By the end of this unit, student teachers will be able to:

- Classify types of organisms (autotroph/heterotroph based on plant nutritive function including saprophytes, parasites, and so on);
- Identify the needs of plants;
- Collaboratively design an explanation of the conditions necessary for photosynthesis suitable for a Grade 1/2 class;
- Explain physiological needs of animals and humans;
- Describe the basic needs for animals to survive including differences between the requirements of carnivores, herbivores, and omnivores;
- Explain the functions of the human digestive system and identify the structures that carry out these functions using illustrations;
- Draw, label, and describe the structures and functions of the digestive system in vertebrates;
- Compare and contrast the different digestive systems of animals such as fish and mammals;

- Create a chart or model of the human digestive system suitable as a teaching resource for a Grade 1/2 class (viva voce);
- Consider the factors causing seasonal changes in different environments; and
- Identify and relate effects of weather and seasonal conditions in the community and human beings.

Competencies gained

A1.2 Demonstrate understanding of how different teaching methods can meet students' individual learning needs

A5.1 Demonstrate understanding of the subject matter to teach the assigned subject/s for the specified grade level/s

B3.1 Demonstrate capacity to create a safe and effective learning environment for all students

6.1. Function

In this sub-unit, student teachers will focus on the different physiological requirements of plants and animals based on their functional needs. Student teachers will explore the nutritional requirements of organisms and classify types of living things according to their nutritional needs. Student teachers will continue to develop ways of working scientifically through practical learning activities, creating models, and collaborative learning activities. Student teachers will also use the content knowledge in this sub-unit to develop teaching and learning resources suitable for use in a Grade 1/2 classroom.

6.1.1. Plant nutrition

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Classify types of organisms (autotroph/heterotroph based on plant nutritive function including saprophytes, parasites, and so on);
- Identify the needs of plants; and
- Collaboratively design an explanation of the conditions necessary for photosynthesis suitable for a Grade 1/2 class.

Competency gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Group work: Photosynthesis

Learning activity 2. Gallery walk: Heterotrophic plants

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Write relevant learning outcomes on board.

Have resources available for research task.

Resources needed

Learning activity 1. Whiteboard markers, small plant in pot

Learning activity 2. Chart paper, coloured markers, Internet access, textbooks, information sheets, sticky tack

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Group work: Photosynthesis

Time	25 minutes
Class organisation	Individual, pairs, groups, and whole class

Purpose

The purpose of this learning activity is for student teachers to consider the factors that affect photosynthesis and design an explanation suitable for a Grade 1/2 class.

1. Outline the learning outcomes for the lesson:
   - Classify types of organisms (autotroph/heterotroph based on plant nutritive function including saprophytes, parasites, and so on);
   - Identify the needs of plants; and
   - Collaboratively design an explanation of the conditions necessary for photosynthesis suitable for a Grade 1/2 class.
2. Place the pot plant in the front of the class so that the student teachers can see it. Remind the student teachers that plants have five basic needs to grow and survive. Ask the student teachers what the pot plant needs to be able to grow.
3. As student teachers contribute ideas, write the ideas on the whiteboard or on chart paper so that all the student teachers can see.
4. With each need, ask why the plant needs that factor and how it helps the plant grow and survive. Ask guiding questions such as: "How does this plant get food?", "What does it need to be able to make food?", "Why is this plant in a pot with soil?", "What is in the soil that helps plants grow?", "What else would we need to give this plant to make sure it grows?" and so on.
5. Facilitate the class discussion until all five needs and the main functions have been shared:
   - Air (carbon dioxide for photosynthesis); student teachers may also identify that there is water vapour in air, although this is not the main source of water for most plants
   - Water (in soil to transport nutrients and for photosynthesis)
   - Light (energy for photosynthesis, heat for optimal temperature)
   - Nutrients (in soil or fertiliser for many plant functions)
   - Space (for roots to spread in the soil and to access light).
6. Ask the student teachers if they can remember the formula for photosynthesis. Write the formula on the board.

7. Explain that some of the basic needs of plants affect the rate at which a plant can perform photosynthesis.
8. Direct the student teachers to the background information and Table 6.1 in the Student Teacher Textbook.
9. Explain that the student teachers need to consider each factor in the table and give a reason that explains how each factor affects photosynthesis.
10. Explain that after student teachers have given their reasons independently, they will each share their responses with another student teacher. The student teachers should continue to develop their explanations from the discussion. Explain that after they have shared with another student teacher, they will share their explanations with the class.
11. Direct student teachers to work independently for a few minutes to write an explanation.
12. Then direct each student teacher to join with another student teacher and share their explanations.
13. Once all the student teachers have recorded and shared their explanations with another student teacher, ask the pairs of student teachers to share their responses with the class (correct responses given in Table 6.1).
14. Ask student teachers for learning activities that are engaging for Grade 1/2 students.

Facilitator's notes

Encourage the student teachers to consider teaching and learning strategies such as songs, rhymes, mnemonics, stories, and so on.

15. Explain that each pair of student teachers will join with another pair to design an explanation of the conditions necessary for photosynthesis that is suitable for a Grade 1/2 class.
16. Direct the student teachers to form groups of 4 and develop their explanations for a Grade 1/2 class.
17. Tell the student teachers that there is space in Box 6.1 of the Student Teacher Textbook to record the explanation. There are some questions in the Student Teacher Textbook that can be used to guide the development of an explanation.

Assessment

Check student teachers' understanding of the factors affecting photosynthesis as they think-pair-share explanations and record these in Table 6.1. Listen to student teachers' conversations and correct any misconceptions.

Observe the explanations that student teachers develop for a Grade 1/2 class. Check that the language is appropriate and that the activities are inclusive or can be modified for students with special learning needs.

Possible student teachers' responses

Table 6.1. Factors that affect photosynthesis – Completed

Factor affecting photosynthesis	Explanation
1. Light	Increasing the light intensity increases the rate of photosynthesis. However, the intensity of light is at maximum, after which other factors, such as chlorophyll damage, will prevent further photosynthesis from occurring. Without enough light, a plant cannot carry out photosynthesis very quickly – even if there is plenty of water and carbon dioxide and a suitable temperature.
2. Air	If the concentration of carbon dioxide in the air increases, the rate of photosynthesis will increase. As carbon dioxide is normally present in the atmosphere at very low concentrations (about 0.04%), increasing the concentration of carbon dioxide causes a rapid rise in the rate of photosynthesis. The reaction will reach a maximum rate of fixation where no further increase in photosynthesis will occur, even if more carbon dioxide becomes available
3. Temperature	The chemical reactions that combine carbon dioxide and water to produce glucose are controlled by enzymes. As with any other enzyme-controlled reaction, the rate of photosynthesis is affected by temperature. At low temperatures, the rate of photosynthesis is limited by the number of molecular collisions between enzymes and substrates. At high temperatures, enzymes are destroyed by heat and the reaction will no longer proceed.

Student teachers' responses for the explanation of photosynthesis will vary. Ensure the language is appropriate for a Grade 1/2 class and the explanation is suitable for the age group.

Learning activity 2. Gallery walk: Heterotrophic plants

Time	20 minutes
Class organisation	Groups of 3-4

Purpose

The purpose of this learning activity is for student teachers to investigate heterotrophic plants and share their learnings in a gallery walk.

1. Explain to the student teachers that not all plants obtain their energy through photosynthesis.
2. Explain that plants that cannot make their own food must obtain their nutrients from other sources.
3. Tell the student teachers that in this learning activity they will work in small groups to investigate one type of heterotrophic plant and create a poster about that type of plant.
4. Explain that after the student teachers have completed their posters, the posters will be displayed in the classroom so that the other groups can learn about other types of heterotrophic plants.
5. Assign groups of student teachers to a type of plant, with 3-4 student teachers in each group.
6. The types of plants that student teachers should investigate are:
    - Parasitic plants
    - Saprophytes
    - Symbionts
    - Epiphytes
    - Insectivorous plants.
7. Provide the student teachers with resources such as textbooks, Internet access, information sheets, and so on to investigate the plant types.
8. Give the student teachers about 10 minutes to complete the posters. Allow 10 minutes at the end of the learning activity for the gallery walk.

Assessment

This learning activity provides an opportunity to evaluate student teachers' understanding of heterotrophic plants as well as to observe their research skills. Observe the posters for scientific accuracy. As the student teachers research the plant types, ask questions about the sources of information they are using. Ask whether student teachers think the sources of information are reliable. Ensure student teachers are using scientific sources of information.

Possible student teachers' responses

Responses will vary depending on the type of heterotrophic plant the group researched.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers to share something interesting they learnt today; and
- Ask student teachers how they could include that information in a Grade 1/2 classroom.

6.1.2. Animals' needs to survive

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Explain physiological needs of animals and humans; and
- Describe the basic needs for animals to survive including differences between the requirements of carnivores, herbivores, and omnivores.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques, and applications for the subjects covered in the grade levels taught

A5.1.3 Describe approaches used to promote learning in key areas of literacy, numeracy, science and social studies for the grade levels taught and linked to real life

Time: One period of 50 minutes

Learning strategies

Learning activity 1. T-chart: Needs of plants and animals

Learning activity 2. Research: How animals obtain energy

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Read the learning activities and find resources for research task.

Resources needed

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Research resources such as Internet access, textbooks, information sheets, and magazines

This period is structured as follows:

Learning activity 1	15 minutes
Learning activity 2	30 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. T-chart: Needs of plants and animals

Time	15 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to understand the basic needs of animals, including humans, and compare these with the needs of plants.

1. Ask the student teachers to recall the basic needs of plants from the previous lesson. Write these on the board or on chart paper as they are recalled; air, water, nutrients, space, light (energy).
2. Ask the student teachers which of these are also needs of animals.
3. Ask the student teachers if animals have other needs. Ask guiding questions to ensure the student teachers conclude that animals need shelter in addition to air, water, nutrients, and energy.
4. Explain to the student teachers that they have a comparison chart (T-chart) in the textbook. The student teachers will work in pairs to consider the needs of animals and how these are different to the needs of plants.
5. Direct the student teachers to work in pairs to complete the T-chart.

6. As the student teachers work to complete the table, ask guiding questions such as:
   - What is the energy source for plants?
   - Do animals use this as an energy source?
   - What do animals use as an energy source?
   - Why do animals need shelter?
   - How is this different to a plant's requirement for space?
   - How is it the same?

Assessment

Check student teachers' responses in the T-chart. Listen to their discussions. Support student teachers' understanding by asking guiding questions and correcting any misconceptions.

Possible student teachers' responses

Table 6.3. T-chart – Needs of animals and plants – Completed

	Function in animals	How is this different from plants?
Air	All animals must obtain oxygen to survive. Land-dwelling species receive oxygen from the air, which they inhale directly into their lungs. Aquatic organisms take oxygen from water through their gills.	Plants use carbon dioxide from the air for photosynthesis. Plants use oxygen from the air in respiration.
Water	Animals obtain water through food and drink. All chemical reactions in an animal's body take place in water. Water also functions in excretion of waste, regulating body temperature, and transporting food.	Plants take in most of their water through their roots. In plants, nutrients are transported to cells in water.
Energy	Food provides energy for animals, for growth, reproduction, metabolism, maintaining body temperature, and cellular functions.	Most plants obtain energy from the sun. Plants use energy in photosynthesis to make food for plant functions.
Nutrients	Animals obtain nutrients from the external environment through food and drink. Nutrients provide materials needed for normal structure and function.	Plants take in nutrients as liquid (nutrients dissolved in water and transported to the plant).
Shelter	Shelter helps to maintain required body temperature, protects animals from weather and predators, and provides a place to raise offspring.	Some plants grow in environments that provide shelter from weather. Shelter is generally not a requirement for plants to survive.

Learning activity 2. Research: How animals obtain energy

Time	30 minutes
Class organisation	Groups of 3-4

Purpose

The purpose of this learning activity is for student teachers to investigate the different ways that animals obtain energy.

1. Ask the student teachers if all animals obtain energy from the same sources. Ask the student teachers to brainstorm some energy sources for animals. Write ideas on the board as they are suggested.
2. Ask guiding questions such as:
   - What did you eat for breakfast?
   - Do all animals eat this type of food?
   - Do you have a pet? What does your pet eat?
   - How are animals classified based on what they eat?
   - What do we call animals that eat only plant matter? (Herbivores, producers)
   - What do we call animals that eat only meat? (Carnivores, predators)
   - What do we call animals that eat both plant matter and meat? (Omnivores)
3. Explain that the terms *producer*, *consumer*, and *predator* describe an animal's relationship to other organisms in an ecosystem. The terms *herbivore*, *carnivore*, and *omnivore* describe the dietary requirements of an animal.
4. Ask the student teachers to give examples of animals that are herbivores, carnivores, or omnivores.
5. Explain that in this research task, the student teachers will work in small groups to investigate an herbivore, carnivore, and omnivore native to Myanmar.
6. Tell the student teachers to use the resources provided to identify one of each type of animal. Explain that the student teachers should complete Table 6.4.
7. There are some questions in the Student Teacher Textbook that the student teachers should try to answer about each animal they choose to research.

Assessment

Listen to student teachers as they research native animals of Myanmar. Assist with sourcing information if required. Check the information student teachers record in the table for accuracy.

Possible student teachers' responses

Student teachers' responses will vary depending on the animals selected.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers to share something about the animals from their research; and
- Ask whether there are any common features, or what features might be common to these groups of animals.

Often herbivores will have flattened teeth to grind tough plant matter into more digestible particles and carnivores will have sharp teeth to tear meat; omnivores (like humans) have a combination. However, ensure that the student teachers know these are generalisations and there are some animals that cannot be classified based on their teeth.

6.1.3. Digestive system

Expected learning outcome

By the end of this lesson, student teachers will be able to:

- Explain the functions of the human digestive system and identify the structures that carry out these functions using illustrations.

Competencies gained

A1.2.2 Identify focused and sequenced learning activities to assist students to link new concepts with their prior knowledge and experiences

A5.1.1 Describe key concepts, skills, techniques, and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples, and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Model: Digestive system

Learning activity 2. Pairs: Structures and functions of the digestive system

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Purchase materials for digestive system model.

Resources needed

Learning activity 1. Chart paper, sticky tape, marker pens, different coloured balls of wool, scissors, measuring tape

Learning activity 2. Marker pens

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Model: Digestive system

Time	25 minutes
Class organisation	Pairs and whole class

Purpose

The purpose of this learning activity is for student teachers to construct a model of the digestive system.

1. Remind the student teachers that in the previous lesson they learnt about the different diets that animals may have, and how the digestive systems and other features of animals differ based on these diets.
2. Explain to the student teachers that they are going to work in pairs to construct a model of the human digestive system.
3. Explain that you will provide guiding information to help the class construct their models simultaneously.
4. Provide each pair of student teachers with a large sheet of chart paper (or several sheets that they can tape together), a ball of wool, scissors, tape, and marker pens.
5. Explain that each pair of student teachers will make a model of their digestive

system by measuring and cutting the wool to represent the different structures of the digestive system.

6. Direct each pair of student teachers to create an outline of one of their bodies. They can do this by taping together pieces of chart paper, placing the paper on the floor, and lying on top of the paper. The other student teacher can then draw an outline of the body. The outline should extend from the head to the upper thigh.
7. Explain that the student teacher who has provided the outline will be the person whose digestive system is modelled. The other student teacher will measure and cut representative lengths of wool to construct the model.
8. Ask the student teachers where the digestive system begins. The student teachers should recall that digestion starts at the mouth. The student teachers should label the mouth on the body outline.
9. Tell the student teachers that the length of the mouth is from the lips to the back of the jaw (under the chin). Direct the student teachers to stretch a length of wool from the mouth to the underneath of the jaw. The student teachers should cut the wool at this length, measure how long it is using the measuring tape, and record the measurement. Student teachers should then tape the wool onto the body outline in the correct location.
10. Ask each pair to exchange wool with another pair of student teachers so that they have a different coloured wool for the next section of the digestive system.
11. Continue to do this for the rest of the digestive system, ensuring that the body outline is labelled and the measurements of the lengths of wool are recorded for each component of the digestive system. Ensure that the student teachers exchange colours of wool after each component.
12. Continue to direct the student teachers to make the measurements and add them to the body outline as follows:
    - Oesophagus: Back of the jaw to just below the ribcage
    - Stomach: The length of the stomach is the distance of a hand span from the tip of the thumb to the tip of the little finger
    - Small intestine: The small intestine is folded inside the body, and it is approximately four times the height of a person (height × 4), so the wool will need to be coiled up
    - Large intestine: Approximately the same length as the height of the person (1 × height), also coiled into position.
13. Facilitate a class discussion about the length of the digestive system. Ask questions such as:

- How long is your digestive system?
- How does the length of your digestive system compare to your height?
- Why do you think your digestive system is so long?
- How do you think length helps digestion?

Assessment

Observe student teachers as they construct their models of the digestive system. Listen to the responses to the discussion questions and guide the discussion to build student teachers' understanding about the digestive system.

Possible student teachers' responses

The length of the digestive system should be approximately 9m, but this is variable. The student teachers will need to add the measurements of each component together. It should be about five times the height of the person. The digestive system is long to allow time and space to break down food, absorb nutrients, and absorb water.

Learning activity 2. Pairs: Structures and functions of the digestive system

Time	20 minutes
Class organisation	Pairs and whole class

Purpose

The purpose of this learning activity is for student teachers to identify the structures of the digestive system and explain their functions.

1. Explain to the student teachers that they will continue to use their models of the digestive system to identify the structures and their functions in digestion.
2. Direct the student teachers to the list of structures of the digestive system in Table 6.5 in the textbook.
3. Explain that the student teachers should draw these structures onto their model. For example, the student teachers should draw an illustration of the stomach around the length of wool that represents the stomach.

4. Explain that some of the structures have not yet been included in the model.
5. Direct the student teachers to draw these structures onto their models and write a brief explanation of the function of each of the structures listed.

Facilitator's notes

Explain that the student teachers can use the Internet or resources provided to find information for their models and illustrations.

Once the student teachers have completed their models, student teachers may wish to take photos using their mobile phones or other devices to record their work and the information.

Assessment

Observe the location of the structures of the digestive system and the functions that student teachers annotate on their models. Correct any misunderstandings and help student teachers to locate information if required.

Possible student teachers' responses

Table 6.5. Structures of the digestive system and their functions – Completed

Structures of the digestive system	Function in animals
Mouth	Ingests food. Chews and mixes food. Begins chemical breakdown of carbohydrates.
Tongue	Moves food around the mouth. Pushes food into the pharynx.
Salivary glands	Secretes saliva. Moistens food, lubricates the oral cavity. Contains enzymes and proteins to begin chemical digestion of food.
Pharynx	Propels food from the oral cavity to the oesophagus.
Oesophagus	Propels food to the stomach.

Structures of the digestive system	Function in animals
Stomach	Mix and churn food with gastric juices to form chyme. Begins chemical breakdown of proteins. Releases food into the duodenum as chyme. Absorbs some fat-soluble substances.
Small intestine	Mix chyme with digestive juices. Propels food at a rate slow enough for digestion and absorption. Absorbs breakdown products of carbohydrates, proteins, lipids, and nucleic acids, along with vitamins, minerals, and water. Performs physical digestion via segmentation.
Large intestine	Further breaks down food residues. Absorbs most residual water, electrolytes, and vitamins produced by enteric bacteria. Propels faeces toward rectum.
Rectum	Resorption of electrolytes from the faeces. Holds faeces until evacuation.
Anus	Controls the expulsion of faeces from the rectum.
Liver	Produces bile salts, which emulsify lipids, aiding their digestion and absorption.
Gallbladder	Stores, concentrates, and releases bile.
Pancreas	Produces digestive enzymes and bicarbonate. Helps neutralise acidic chyme and provide optimal environment for enzymatic activity.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers to reflect on the learning outcome for the lesson (explain the functions of the human digestive system and identify the structures that carry out these functions using illustrations);
- Ask for student teachers to indicate how well they have achieved this learning outcome; and

- Ask if student teachers have further questions.

If there are simple questions, you – or other student teachers – can directly respond to them. If the questions are more complex, you might like to make a note and inform the student teachers that you will respond to these questions in the next lessons.

6.1.4. Practical: Digestive system

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Draw, label, and describe the structures and functions of the digestive system in vertebrates;
- Compare and contrast the different digestive systems of animals such as fish and mammals; and
- Create a chart or model of the human digestive system suitable as a teaching resource for a Grade 1/2 class (viva voce).

Competencies gained

A1.2.2 Identify focused and sequenced learning activities to assist students to link new concepts with their prior knowledge and experiences

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples, and exercises to support student learning of subject content and skills

B3.1.3 Model and promote good health and safety practices to ensure students' wellbeing and safety within the classroom and school

B3.1.4 Follow regulations regarding health and safety (administration of medication, CPR and First Aid training, fire and disaster drills, abuse and neglect, communicable disease)

Time: Two periods of 50 minutes

Learning strategies

Learning activity 1. Practical: Digestive system

Learning activity 2. Think-pair-share: Comparing digestive systems

Learning activity 3. Group work: Create a teaching resource for a Grade 1/2 class

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Purchase materials as listed in resources needed.

Resources needed

Learning activity 1. Breakfast cereal, lemon juice, zip-lock plastic bags, water, measuring spoons and cups, wide-mouth straws, scissors, plastic cups, food colouring, cardboard tubes (e.g., inside of a paper towel roll), stockings, disposable gloves, buckets

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

Learning activity 3. Dried beans or beads, wool, straws, cardboard tubes, playdough

Period 1

Practical: Digestive system

This period is structured as follows:

Learning activity 1	45 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Practical: Digestive system

Time	45 minutes
Class organisation	Groups of about 4 student teachers

Purpose

The purpose of this learning activity is for student teachers to investigate what happens to food as it passes through the digestive system.

1. Remind the student teachers that, in the last lesson, they constructed a model of the human digestive system and identified the functions of components of the digestive system.
2. Explain that, in this lesson, the student teachers will further investigate the functions of the digestive system through a practical learning activity.
3. Tell the student teachers that the equipment and method for the practical activity are in the Student Teacher Textbook.
4. Instruct the student teachers to quietly read through the activity so that they know what they need to do.
5. Once the student teachers have finished reading the method, ask if there are any questions. Address any questions from the student teachers.
6. Ensure the student teachers are aware that this can be a messy investigation and that they need to be careful of slip hazards.
7. Distribute the equipment to the student teachers and divide the class into groups, with about 4 student teachers per group.
8. Direct the student teachers to work through the learning activity.
9. Monitor the student teachers as they work and ensure they are working safely.

Assessment

Listen to student teachers' conversations as they complete the practical. Check for understanding as student teachers complete their drawings of the digestive system. Ensure the student teachers include a description of what was used to model each digestive system structure and how it demonstrates the function of the component of the digestive system.

Possible student teachers' responses

Student teachers should include the following information in their figures.

Table. Information for inclusion in labelled drawing for Figure 6.2

Structure	What was used to model this?	How does this model the function of this structure?
Mouth	Zip-lock bag	Can be enclosed or opened to add food. Breaks food down into smaller particles (chewing).
Saliva	Water	Helps break down food to begin digestion. Adds moisture.
Oesophagus	Straw	Tube that passes food from the mouth to the stomach.
Stomach	Zip-lock bag	Food is churned to represent the mechanical digestion.
Gastric acid	Lemon juice	Chemical digestion of food.
Gastric fluids	Water	Enzymes and fluid to digest food.
Small intestine	Cardboard tube	Moves food from the stomach to the large intestine. Absorbs nutrients.
Digestive enzymes and chemicals	Food colouring	Digestive juices from the liver, pancreas, and gallbladder.
Large intestine	Stockings	Water and nutrients move out into the circulation.
Anus	Hole in stocking	Waste material passes out.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson, ask student teachers questions to check for understanding:

- Is gravity necessary for digestion? (No, the muscular movements of the oesophagus push the food down.);
- What are the advantages of the stomach having an acidic environment? (It kills much of the foreign material, such as microbes and provides the correct environment for enzymes to work.);
- Where does most of the mechanical digestion take place? (Mouth and stomach.); and
- Where does most of the chemical digestion take place? (Mouth, stomach, and small intestine.).

Period 2

Practical: Digestive system

This period is structured as follows:

Learning activity 2	20 minutes
Learning activity 3	25 minutes
Check student teachers' understanding	5 minutes

Learning activity 2. Think-pair-share: Comparing digestive systems

Time	20 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to compare and contrast the digestive systems of different vertebrates.

1. Explain that the last lessons have focused mostly on the digestive system of humans.
2. Explain that the digestive systems of many other vertebrates have similar structures and functions to the human digestive system.

3. Direct the student teachers to Figure 6.3 in the Student Teacher Textbook.
4. Explain that this figure shows the digestive systems of humans and some other vertebrates.
5. Explain that the student teachers will have a few minutes to identify and label the structures of the digestive systems. Ask the student teachers to look for similarities and differences as they label the diagrams.
6. Explain that the student teachers have some background information about different digestive systems in the Student Teacher Textbook.
7. Direct the student teachers to read the background information in the textbook.
8. Explain that there are some questions in the textbook for student teachers to consider. Explain that you will facilitate a think-pair-share activity using the questions.
9. Ask the student teachers the first question: "*What similarities did you notice between the digestive systems?*"
10. Direct the student teachers to think about the question and then share their thoughts with another student teacher. Then ask the student teachers to share their ideas with the class.
11. Repeat this for the remaining questions:
    - What differences did you notice between the digestive systems?
    - Why do you think these differences exist?
    - What influence do you think diet and habitat might have on the digestive systems of these animals?
    - Can you see a pattern in the complexity of the digestive systems of these animals?
12. Address any misconceptions as the student teachers share their understanding of the digestive systems.

Assessment

Listen to student teachers' responses to the questions to check for understanding.

Possible student teachers' responses

Student teachers' responses will vary. Guide their understanding to identify that the digestive systems increase in complexity with organisms that are more evolved (higher class). Some structures are similar (e.g., stomach, intestines) but may carry out different stages of the digestive process. Some processes (e.g., chemical and mechanical) are similar across many organisms but may differ in the structure where

the process takes place (e.g., mechanical breakdown of food between humans and birds).

Learning activity 3. Group work: Create a teaching resource for a Grade 1/2 class

Time	25 minutes
Class organisation	Groups of 3-4

Purpose

The purpose of this learning activity is for student teachers to create a model or chart of the human digestive system suitable as a teaching resource for a Grade 1/2 class.

1. Ask the student teachers if they can recall the objectives of the Primary Science curriculum for Grades 1-5.
2. Write any responses on the board. Prompt the student teachers by asking questions such as:
   - What do we want students in a Primary classroom to learn about Science?
   - What do we want them to experience?
   - How can we make Science relevant for Primary students?
3. Write any student teacher responses on the board, and then read the objectives of the Primary curriculum to remind the student teachers:
   - To be able to recognise the importance of Science in their surroundings through engagement in activities with fun.
   - To be familiar with and develop affection for the natural environment.
   - To have acquired a curiosity and willingness to explore the natural environment.
   - To be able to gain scientific knowledge through scientific investigation.
   - To have developed the basic Science process skills like observing, comparing, measuring, relating, identifying, reasoning, and changing condition.
   - To create the awareness of experimental hazards.
   - To be able to apply the basic principles of Science in daily life.
   - To appreciate advantages of Science for human beings.
4. Explain that the student teachers will work in groups with other student teachers to create a teaching resource suitable for a Grade 1/2 class. Explain

that the student teachers should create a model or a chart to explain digestion.

5. Inform student teachers that they will have about 15 minutes to develop their teaching resource. (It does not need to be polished.) Explain that there are some questions that they may want to consider in the development of their resource.
6. Explain that the student teachers will then briefly explain their resources to the class and explain how they have structured the resources to be suitable for a Grade 1/2 class.
7. Divide the class into groups of about 3-4 student teachers and provide them with chart paper and markers. Have other resources available for use if needed (e.g., dried beans or beads, wool, straws, cardboard tubes, playdough).
8. Direct the student teachers to commence working with their groups to develop the teaching resources.
9. Allow time at the end of the learning activity for student teachers to share their resource ideas with the rest of the class.

Assessment

Observe the resources as they are developed. Remind groups to consider the age and ability level of the students in a Grade 1/2 class.

Possible student teachers' responses

Responses will vary depending on the resources developed. Check for accuracy of information and suitability of the resources for Early Years learners.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to reflect on the resources they have developed;
- Ask the student teachers whether the resources are inclusive and accessible to all students; and

- Ask how the activities can be modified for students with special needs, especially, in this case, students with visual impairment.

Expected student teachers' responses for the review questions in TB

Question 1: Choose one type of heterotrophic plant. How does this type of plant obtain nutrients? Give an example of a plant of this type.

Answer:

Parasitic plant: *A plant that obtains some or all of its nutritional requirements from another living plant; usually obtains nutrients through modified roots that can penetrate other plants to obtain nutrients.*

Saprophyte: *Obtains nutrients from decaying organic matter by secreting enzymes to break down the food so that it can be absorbed by the plant.*

Symbiont: *Obtains nutrients, such as nitrogen, from bacteria or fungi in the soil.*

Epiphyte: *Grows on another plant for structural support and obtains nutrients from air, rain, other water sources, or debris.*

Insectivorous plant: *A carnivorous plant that obtains nutrients by eating insects.*

Examples will vary.

Question 2: Compare mechanical and chemical digestion, giving an example of each from the human digestive system.

Answer: *Both are processes that occur in the digestive system to process food, absorb nutrients and water, and excrete waste products. Mechanical digestion involves physical movement to break down food. It does not change the chemical nature of the food. Examples include chewing, tongue movements, and churning in the stomach. Chemical digestion involves the breakdown of complex food molecules into smaller molecules with the aid of chemical agents secreted into the digestive system. Examples include amylase in saliva, digestive acids in the stomach, pancreatic enzymes, and bile secreted by the liver to break down fats.*

Question 3: What are the organs that are part of the digestive system but not in the direct path of food? How do these function as part of the digestive process?

Answer:

Pancreas: *Produces enzymes that are released into the small intestine; proteases digest proteins, amylase digests starch, nucleases digest nucleic acids; also secretes hormones such as insulin and glucagon, which regulate the concentration of blood sugar.*

Liver: *Synthesises bile that breaks down fats into fatty acids; stores nutrients such as vitamins and iron; detoxifies some molecules.*

Gallbladder: *Stores bile produced by the liver; releases bile into the small intestine to break down fats into fatty acids.*

6.2. Environment

In this sub-unit, student teachers will investigate why Earth experiences seasonal changes and why these are different depending on geographical location on Earth. They will explore the different ways that weather and seasons are described, and the impact that seasonal and weather changes can have in the community and on the environment.

6.2.1. Environmental factors causing changes in surroundings

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Consider the factors causing seasonal changes in different environments; and
- Identify and relate effects of weather and seasonal conditions in the community and human beings.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Concept mapping: Weather and seasons

Learning activity 2. Think-pair-share: Impact of seasonal changes

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Read the lessons in advance.

Write the learning objectives on the board.

Resources needed

Learning activity 1. Marker pens and chart paper

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	15 minutes
Check student teachers' understanding	10 minutes

Learning activity 1. Concept mapping: Weather and seasons

Time	25 minutes
Class organisation	Groups of about 4

Purpose

The purpose of this learning activity is for student teachers to consider the factors that affect daily and seasonal weather conditions.

1. Write the learning objectives for the lesson on the board.
2. Ask the student teachers if they can recall what causes seasonal changes. Student teachers should recall that seasonal changes are caused by the tilt of Earth on its axis and Earth's rotation around the sun.
3. Explain to the student teachers that they have a diagram in Figure 6.4 that shows Earth's pattern of movement around the sun.
4. Direct the student teachers to write a short description of the seasons in each hemisphere at each of the four positions shown in the figure.

Facilitator's notes

Student teachers can discuss the diagrams in pairs if they wish.

5. Once the student teachers have completed the descriptions, ask how seasonal changes are described. Record the student teachers' suggestions on the board or on chart paper as suggestions are made.
6. Prompt student teachers' ideas by asking questions such as:
   - What is the weather like outside today?
   - Do you ever look up a weather forecast?
   - What information do you find when you look for weather information?
   - What season are we in today?
   - What do you like about this season?
   - What are the seasons of myanmar?
7. Direct the student teachers to Figure 6.5. Explain that this is the information from a weather site.
8. Ask the student teachers: "*What other information is given about the weather or seasons on the website?*"
9. Explain to the student teachers that they will work in small groups to brainstorm and construct a concept map of weather and seasons.
10. Provide the student teachers with chart paper and marker pens.
11. Divide the student teachers into groups of about 4.

12. Explain that the student teachers should link concepts of weather and seasons on the concept map with an explanation of how they are related. For example, dry season can be connected with precipitation by explaining that precipitation is low. However, precipitation should also be connected with other seasons and the explanation given on the line connecting the two concepts.

Assessment

Observe the concept maps as they are developed. Listen to student teachers' conversations about how weather changes daily and seasonally.

Possible student teachers' responses

Explanations about the seasonal changes shown in Figure 6.4 should include information such as:

> Around June 22, the northern hemisphere is angled towards the sun and receives the most direct radiation and the most energy. This is the start of astronomical summer in the northern hemisphere and winter in the southern hemisphere. Six months later, in December, the Earth has completed half a revolution around the sun. The northern hemisphere is now angled away from the sun and receives less energy than the southern hemisphere; this is the beginning of winter in the northern hemisphere and summer in the southern hemisphere.

Ensure concept maps include information about:

- Precipitation (annual rainfall patterns)
- Temperature (actual and real feel)
- Humidity
- Wind (strength and direction)
- Cloud (cover and type)
- Atmospheric pressure
- Daylight hours/night-time hours.

Learning activity 2. Think-pair-share: Impact of seasonal changes

Time	15 minutes
Class organisation	Individual, pairs, and whole class

Purpose

The purpose of this learning activity is for student teachers to identify and relate the effects of weather and seasonal conditions in the environment.

1. Explain that the weather and seasons affect many aspects of daily life.
2. Direct the student teachers to Table 6.6 in the textbook.
3. Explain that the student teachers will have time to consider how weather and the seasons affect the aspects listed in the table.
4. Direct the student teachers to describe the impacts of seasonal and weather changes in the table.
5. If guiding questions are needed, ask questions such as:
   - How do animal behaviours change with the weather or seasons?
   - How do human behaviours change?
   - Do shelters or clothing change with the seasons?
   - Do the patterns of movement change for some animals?
   - Why do they make these changes?
   - What happens to plants as seasons change?
   - When are crops planted and harvested?
   - Do we always have the same foods available to eat?
   - How do animals change their behaviour with less food to eat?
   - How does human health change with weather and seasons?
   - Why can aspects of health change?
   - Why is light important to humans and animals?
   - What celebrations do you know of that relate to changes in weather or season?
   - At what time of year are particular celebrations held?
6. Direct the student teachers to work in pairs and share their understandings. The student teachers should add to the information in their tables as they share ideas.
7. Facilitate a class discussion and ask student teachers to contribute their understandings to the discussion.

Assessment

Listen to student teachers' conversations about how weather and seasonal changes impact aspects of daily life.

Possible student teachers' responses

Table 6.6. Impact of changes in weather and seasons – Completed

Aspect	Description of the impact of weather and seasonal changes on this aspect
Animal behaviours (including humans)	Describe changes in behaviour, shelter, patterns of movement, clothing, and so on. Some animals migrate or hibernate in cold weather. Shelters are constructed to protect from weather and climate (wet, cold, heat) such as shade cloths outside in public areas or schools, heating in houses, or animals burrowing underground to shelter from heat. Humans dress according to the weather and climate – warm hats, scarves, shoes, blankets, and so on in cold weather; raincoats and umbrellas in wet seasons.
Vegetation	Describe the changes to plants and the impact of this on animals, including humans. Trees may be deciduous. Seasons when plants bear fruit can be connected to light and warmth. The spread of seeds and the reproduction of plants vary with seasons. The availability of produce for consumption by humans and other animals is seasonal. There is less food in winter and other cold-weather times.
Health	Consider the impact on aspects of health, disease and pests. Often pests will be more prolific in warmer months (e.g., mosquitoes and insects that can affect crops). Seasonal affective disorder can affect people in winter if they are not exposed to enough light. Infections spread more easily in some seasons (e.g., cold weather).
Traditional practices	When do cultural celebrations occur in Myanmar? Are these connected with the time of the year or harvests? Cultural practices can be connected with changes in seasons or particular times of the year, such as the Tazaungdaing Festival that marks the end of the rainy season. Agricultural practices such as controlled burning, planting, and harvesting are done seasonally.

Check student teachers' understanding

Time	10 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers what impact climate change will potentially have on the aspects of daily life they have just discussed;
- Ask questions to gauge student teachers' understanding of the impact of climate change on the environment, food production, animal habitats, health, water availability, and extreme weather events (floods, bushfires, and so on); and
- Ask student teachers to discuss how their role as a teacher can help build students' understanding of these concepts.

Expected student teachers' responses for the review questions in TB

Question 1: Using illustrations, describe why Earth experiences different seasons.

Answer: *Student teachers should be able to draw an image similar to Figure 6.4 that shows the rotation of Earth around the sun on a tilted axis. This means that the amount of sunlight reaching Earth is different in different locations, depending on the position relative to the sun.*

When the northern hemisphere is tilted towards the sun, it is warmer (summer). At the same time, the southern part of the Earth is tilted away from the sun and it is cooler (winter). As the Earth orbits the sun, the tilt of the Earth means that the northern hemisphere receives less sun and the southern hemisphere gradually receives more sunlight.

Question 2: List and explain three environmental factors that are measured and reported that indicate particular weather or seasonal conditions.

Answer:

- *Precipitation (annual rainfall patterns)*
- *Temperature (actual and real feel)*
- *Humidity*
- *Wind (strength and direction)*
- *Cloud (cover and type)*
- *Atmospheric pressure*
- *Daylight hours/night-time hours.*

Question 3: How do climate and weather patterns affect agriculture?

Answer: *Precipitation determines the types of crops that can grow in an area. Temperature and temperature variability affect the types of plants that can grow, when they fruit, and when they should be planted and harvested. Seasonal variation influences when crops should be planted. Temperature affects pest populations that can damage crops. Seasonal extremes such as monsoon season or extremely hot or cold seasons affect plant and animal agriculture.*

Unit Summary

Key messages

- Plants need water, air, nutrients, space, and light (energy) to grow and survive.
- Plants can be autotrophs (make their own food from sunlight) or heterotrophs (obtain food or nutrients from sources other than the sun).
- Animals need air, water, energy, nutrients, and shelter to physiologically survive.
- Animals can be herbivores, carnivores, or omnivores.
- The digestive system functions to break down food into small molecules to provide the body with energy and nutrients.
- The digestive system consists of a number of organs and structures that have a range of functions in breaking down food.
- There are similarities between the digestive systems of all vertebrates.
- Seasonal changes on earth are a result of earth's tilt on its axis and orbit around the sun.
- Weather and seasons differ in different geographical locations on earth and change during earth's orbit of the sun.
- The effects of weather and seasons impact aspects of community and the environment, including agriculture.

Unit reflection

Student teachers should reflect on their learnings from the unit as they begin to prepare to teach these scientific concepts in a Primary school classroom.

Student teachers should identify the learning strategies that they think will be effective in teaching these scientific concepts in a Primary school classroom.

Student teachers should think of ways to contextualise the content to the local Myanmar environment. Student teachers should consider why it is important to contextualise the scientific knowledge to a local context.

Student teachers should draw a concept map to link the different concepts of 'function' from this unit and suggest every day and real-life examples that will be relevant to Grade 1/2 students.

Further reading

Function

Animal nutrition and the digestive system. (2021, March 6). General Biology (Boundless). LibreTexts. https://bio.libretexts.org/@go/page/12626

Module 21. The digestive system: Invertebrates and vertebrate digestive systems. (n.d.). Biology for Majors II. Lumen. https://courses.lumenlearning.com/wm-biology2/chapter/invertebrates-and-vertebrate-digestive-systems

Soil and plant nutrition: Nutritional requirements of plants. (n.d.). Lumen Boundless Biology. https://courses.lumenlearning.com/boundless-biology/chapter/nutritional-requirements-of-plants

Environment

Weather. (2012, October 9). National Geographic Society. https://www.nationalgeographic.org/encyclopedia/weather

Unit 7

Chemistry II

In this unit, student teachers will investigate the place of Chemistry in their everyday lives.

Expected learning outcomes

By the end of this unit, student teachers will be able to:

- Compare and contrast different types of solutions;
- Identify the components in a solution;
- Examine the process by which solutions form and their properties;
- Determine the concentration of a solution;
- Define solubility and explain how it is affected by various factors;
- Describe the application of solubility product principle in the qualitative analysis of a solution;
- Explain how certain chemical reactions are relevant in everyday life and work;
- Perform stoichiometric calculations involving reactions in solution, including precipitation reactions;
- Describe properties of colloids, suspensions, and solutions with examples;
- Apply understanding of the properties of colloids, suspensions, and solutions to distinguish between them;
- Appreciate the central role of Chemistry in our society;
- Explain why Chemistry is an integral activity for addressing social, economic, and environmental problems;
- Develop a teaching resource suitable for a Grade 1/2 class that outlines phenomena in our everyday lives from a scientific perspective;
- Develop a critical approach towards the presence of chemicals in our daily life;
- Provide effective examples demonstrating the power of Chemistry in daily life;

- List chemicals that are used in daily life;
- Find and exchange information to give chemical explanations of some everyday facts;
- Give opinion about the uses of chemical substances in daily products; and
- Identify chemical hazard labels.

Competencies gained

A5.1 Demonstrate understanding of the subject matter to teach the assigned subject/s for the specified grade level/s

A5.2 Demonstrate understanding of how to vary delivery of subject content to meet students' learning needs and the learning context

B3.1 Demonstrate capacity to create a safe and effective learning environment for all students

7.1. Environmental Chemistry in Society

In this sub-unit, student teachers will investigate solutions, colloids, and suspensions in solutions. Student teachers will also learn about the importance of Chemistry to everyday life.

7.1.1. Types and formation of solutions

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Compare and contrast different types of solutions;
- Identify the components in a solution; and
- Examine the process by which solutions form and their properties.

Competency gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Visualisation: Solutions

Learning activity 2. Challenging misconceptions: Solutions

Assessment approaches: Questioning, reviewing student work

Preparation needed

Read the Science Student Teacher Textbook Lesson 7.1.1.

Resources needed

Learning activity 1. Student Teacher Textbook

Learning activity 2. Student Teacher Textbook

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class and groups of 3

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge of the particle nature of matter.

1. Ask the student teachers to imagine they have shrunk down to the size of a water molecule and are in a glass of river water. Encourage the student teachers to discuss that they see, feel, and hear.
2. Form groups of 3 and ask group members to use the Y-chart to combine the group's ideas.

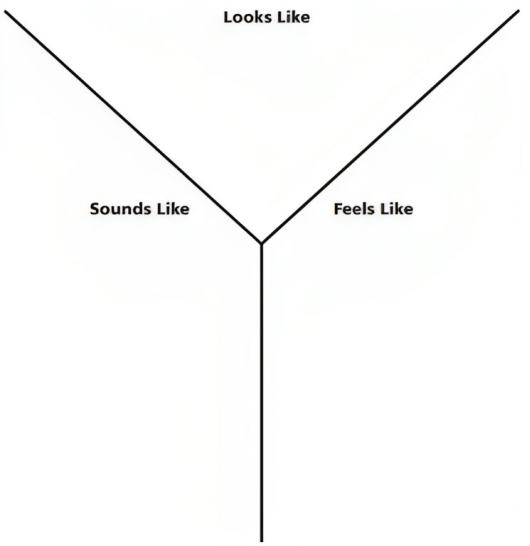


Figure. Y-chart

3. Provide an opportunity for groups to present their ideas.

Learning activity 1. Visualisation: Solutions

Time	20 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to investigate the properties of solutions.

1. Introduce the concept of solutions, using the imagination exercise in the introduction. This imagination exercise provides an opportunity for students to conceptualise what is in a glass of river water.
2. Highlight the variety of particles that could be in a glass of water. Encourage the student teachers to use their group Y-charts to list the possible components of the river water.
3. Explain the definition of a solution to the student teachers. Student teachers will have difficulty with the concept, as the definition encompasses gas-gas

solutions and solid-solid solutions. Use the examples in the following table to help clarify student teachers' understanding:

Table. Examples of solutions

Solution type	Example
Gas-gas	Air
Gas-liquid	Carbon dioxide in soda
Gas-solid	Hydrogen gas in palladium metal
Liquid-liquid	Unleaded petrol
Solid-liquid	Sugar in water
Liquid-solid	Mercury dental amalgam
Solid-solid	Sterling silver

1. Explain the definitions of solute and solvent to the student teachers. Use air as an example: it is made up of 78% nitrogen, 20% oxygen, 0.03% carbon dioxide, and some water vapour and other gases.
2. Ask the students what phases of matter are presented in the air solution. Then ask, *"What is the solvent?*"
3. Refer the student teachers to Figure 7.2 and remind the student teachers of their Y-charts and the particle nature of matter. Explain that this figure is a glass of water and that the circles are molecules of water.
4. Ask the student teachers to describe what happens to the glass of water when sugar is added.
5. Seek responses from the class.
6. Direct the student teachers to draw a diagram of the sugar-water solution, using Figure 7.2 as the starter.
7. Encourage the groups to share their ideas. The drawings should show particles of water and some particles of sugar, which should be evenly dispersed throughout the drawing.
8. This technique of requiring students to represent their ideas as a drawing provides feedback to the students and the instructor about the quality of their understanding.
9. Ask the student teachers to draw the air solution. Again, this is about getting students to visualise the particle nature of a solution. The particles in the drawings should be in the ratio expressed earlier and equally dispersed throughout the drawing.

10. Explain that brass is a metal alloy and a solid-solid solution. Brass has 32% zinc, and the rest is made up of copper. Ask the student teachers what the solvent is in the brass alloy. Then direct students to draw a diagram that represents the brass alloy.
11. Explain the concept of concentration and how it is measured (including the units). Then, using the diagram in Figure 7.2, ask the student teachers to draw a diagram that represents a dilute solution and then a concentrated solution. The drawings should show the comparison between dilute and concentrated, represented by the number of solute particles.

Assessment

Encourage student teachers to share their drawings and ask them to discuss the similarities and differences.

Invite the student teachers to comment on the use of drawings to represent their ideas of Science concepts and as a feedback mechanism to check their understanding.

Possible student teachers' responses

Figure 7.2 serves as a starter for student drawings.

Learning activity 2. Challenging misconceptions: Solutions

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to design investigations to challenge student ideas about solutions.

1. Review the concept of misconception found in Lesson 1.2.2. Remind the student teachers that all Primary students have misconceptions about everyday phenomena. These misconceptions often lead to misunderstanding of Science theories about everyday phenomena.

2. Ask the student teachers to form groups of 3.
3. Remind the student teachers of the fair test investigation strategy from Lesson 1.2.2, and then ask the groups to discuss the planning of an investigation using: question format, identification of variables (Table 7.1), and the planning template (Table 7.2).
4. Direct the groups to the concept cartoon (Figure 7.3).
5. Ask the groups to discuss the meaning of each avatar's comment in the cartoon. Also point out the focus question and ask the student teachers to collaboratively discuss the students in the cartoon in relation to the focus question: 'Where does the sugar go?'.
6. Ask the groups to collaboratively choose one of the comments from the cartoon, and then design an experiment and investigation that will confirm or challenge their chosen comment.
7. To focus discussion, suggest that the groups assume that their chosen comment is in fact correct. This provides an opportunity to discuss the type of evidence that would prove the comment correct. The groups can then plan an experimental investigation on the assumption of correctness. The evidence produced from the experimental investigation will either confirm the assumption of correctness or reject the assumption of correctness.
8. Direct the student teachers to share their experimental investigation planning and provide an opportunity for positive feedback from other groups.

Facilitator's notes

Encourage groups to modify their plans for their experimental investigation in the light of peer feedback.

Assessment

Ask student teacher groups to present the experimental investigation to other groups to check the relationship between the avatar statement/question and investigation question.

Possible student teachers' responses

There are many possible responses. The recognition of relationship between the avatar statement/question and the variables tested is the key *cause and effect* aspect of this activity.

Some possibilities include:

- Avatar A: 'It melts into the tea or coffee'. If you melt some sugar, the melting point is 186°C. The water of a cup of tea or coffee is between 80°C and 100°C. So, the sugar cannot melt. The assumption is not valid.
- Avatar B: 'Can I get the sugar back?'. If the water is evaporated, then the sugar is left in the cup. The 'yes' assumption is valid.
- Avatar C: 'You might if you strained it.' If you pour the water through a filter paper or a strainer of various sizes, the water will still taste sweet: the sugar has not been removed. The straining assumption is not valid.
- Avatar D: 'It disappears quicker if you stir it fast.' If you add sugar to the cup and time how long it takes to disappear, then repeat with one stir, then repeat with two stirs and so on, this will produce data to test this idea. This assumption is valid.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to create a summary of solutions using Figure 7.4 in the textbook.

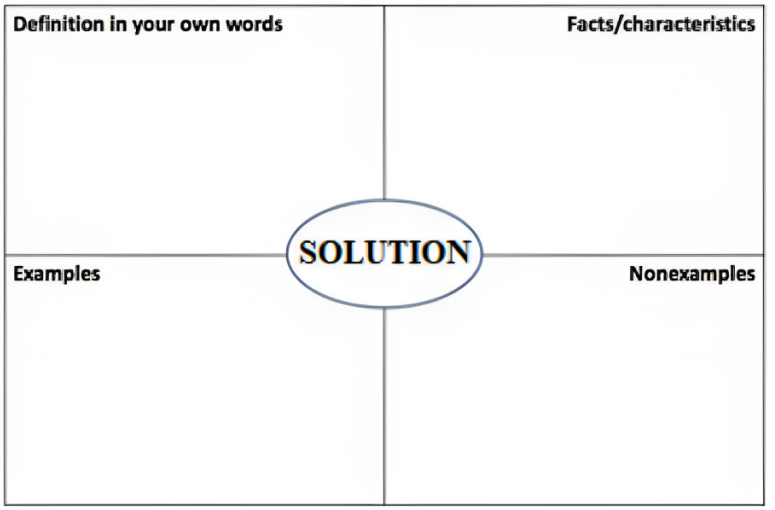


Figure 7.4. Solution summary

Some ideas that should be present in the summary include:

- Melting and dissolving are not the same.
- In melting, only one substance is involved and the liquid and solid are the same material; heat is needed for melting to occur.
- Dissolving involves two materials; the resulting solution is a mixture of both.
- The dissolved substance is still present in the solution even though it cannot be seen unless the solute is coloured.

7.1.2. Solutions and solubility

In this lesson, student teachers will investigate the concept of solubility.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Determine the concentration of a solution;
- Define solubility and explain how it is affected by various factors; and
- Describe the application of solubility product principle in the qualitative analysis of a solution.

Competency gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Data investigation: Solubility factors

Learning activity 2. Mathematisation: Measures of concentration

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 7.1.2.

Resources needed

Introduction. Bag of coloured balls or Styrofoam spheres

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge of solutions.

1. Ask the student teachers to review their drawings of solutions.
2. Introduce the coloured balls or Styrofoam spheres to the student teachers. The balls are a model for the particle nature of matter.
3. Direct the class to model the dissolving of solid-liquid.
4. Ask the class to model 'insoluble' using the balls.
5. Highlight that the particle nature of matter explains the experimental evidence of dissolving and solutions.

Learning activity 1. Data Investigation: Solubility factors

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to investigate factors that affect solubility.

1. Introduce the concept of a solubility curve by referring the class to Figure 7.5.
2. Explain the Y axis, the X axis, and the meaning of the graph. The student teachers might need some assistance with the names of the salts. There is an expectation that the language of Chemistry is understood, and student teachers should be able to name the salts in the graph.
3. Form the class into groups of 3.
4. Ask the groups to discuss the general relationship between the solubility of salts and the temperature. Seek responses from the groups. The groups should be able to recognise that there is a relationship between solubility and temperature. They should articulate the increasing solubility that occurs with increasing temperature. This is a proportional relationship. Point out that not all salts behave the same. Cerium sulphate does not behave like any other salt.
5. Refer the student teachers to Figure 7.6. Ask the groups to discuss the dissolving of sodium chloride.
6. Using the balls or Styrofoam spheres, ask the groups to create a model of the process of sodium ions and chloride ions being surrounded by water molecules. Direct the groups to role-play their models.
7. Remind the student teachers of the electrostatic attraction between the polar molecule water and the positive charge of sodium, and the negative charge of chloride. It is important that the groups demonstrate an understanding of opposite charges attracting each other (electrostatic attraction).
8. Mention that the dissolving reaction is endothermic, where energy from the solvent is used to break bonds. This means that the dissolved ions surrounded by water molecules are at a lower energy than the ionic solid that was dissolved.

9. Refer groups to the molecular explanation of dissolving and ask the groups to suggest why solubility increases as temperature increases. You may need to remind the student teachers that raising the temperature of the solution increases the kinetic energy of the molecules.
   Kinetic energy is the energy of movement, so the motion of the molecules increases. This increase in motion breaks the ionic bonds at a greater rate, therefore making it easier for the ions to be surrounded by water.
10. Ask the groups to discuss Figure 7.7. This graph represents the solubility of gases in a solvent (water). Direct the groups to determine the general rule between solubility of gases and the temperature. Again, there is a relationship presented in this graph, but the relationship is an inverse proportion relationship. The groups should be able to determine the general rule that solubility decreases as temperature increases.
11. Ask the groups, reminding them of the increasing kinetic energy of the molecules, to suggest why this relationship is different to the ionic solid-liquid rule.
12. Ask the groups to determine the reason for fish kills in the pre-monsoon season. The groups need to use the relationship of solubility of gases and temperature to determine that as the temperature rises, the amount of oxygen in the water decreases. You might suggest the groups determine, using the graph, the percent decrease between 20°C and 40°C.
13. Refer the student teachers to the graph in Figure 7.8. Ask the groups to determine the relationship between vapour pressure and the concentration of the dissolved gas. You may need to remind the student teachers that the vapour pressure is the pressure of the gas at the gas-liquid interface. The relationship is proportional: vapour pressure is directly proportional to the concentration of gas in the solvent.
14. Ask the groups to calculate the slope of the line and then write the equation for this relationship. Remind students of slope of the line (m) = $y_2 – y_1 / x_2 – x_1$, and that they can use the graph to find these values.
   Answer: m = (360 – 119) / (0.3 – 0.1) = 1205
15. Ask the groups to use the slope of the line they have calculated to write the equation for the relationship between pressure and concentration of gases dissolved in the solution.
   Answer: y = 1205x, vapour pressure = 1205 concentration of gas.
   This equation in symbols is P = 1205C.

16. The equation determined is a mathematical model for the relationship between pressure and the concentration of gases dissolved in a solution. Explain to the student teachers that this relationship was experimentally determined by the English chemist William Henry in 1803.
    Henry's law states that at a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the vapour pressure of the gas at equilibrium within the liquid.
    This law does not work with gases at very high pressures.
    Henry's law is expressed as $S_g = KP_g$, where S_g is the solubility of the gas, K is the Henry's law constant for the gas in that solvent, and P_g is the pressure of the gas above the liquid.
17. Refer the student teachers to the graph in Figure 7.9. Explain that this graph describes the relationship between pressure, volume, and depth in the ocean and is used by scuba divers to keep them safe.
18. Ask the groups why the pressure depth draft begins at 1 atm rather than 0.
    Answer: The pressure at sea level sphere is 1 atm.
19. Ask the groups to determine the depth when the pressure is 4 atm.
    Answer: 30 m.
20. Inform the student teachers that nitrogen gas at 1 atm and 25°C contains 6.8×10^{-4} mol/L. Then, ask the students to calculate how many moles of nitrogen are dissolved at the depth of 4 atm.
    Answer: 2.7×10^{-3} mol/L.

Assessment

You can check for understanding by using a different context for the same concept. Astronauts in space are surrounded by zero pressure and their spacesuits are pressurised to maintain an environment that sustains life.

Ask the groups of student teachers to explain what will happen to an astronaut if their spacesuit gets a hole in it. Encourage discussion and invite groups to present their ideas.

Correct student teachers' responses

A spacesuit that has a hole will rapidly lose pressure, which is known as rapid decompression. Henry's law suggests that low pressure means less gas dissolved in the body. This means that a rapid decompression situation, like opening a carbonated drink quickly, will cause all the gas in the body to turn into bubbles. In essence, this means the fluid in the body is boiling. This boiling is not heat-related; it is bubbles in the fluids of the body.

Learning activity 2. Mathematisation: Measures of concentration

Time	20 minutes
Class organisation	Groups

Purpose

The purpose of this learning activity is for student teachers to calculate the concentration of solutions.

1. Explain to the class that the concentration of solute in a solvent can be measured using a variety of methods. The methods include:
   - Mass/mass percent
   - Mass/volume percent
   - Volume/volume percent
   - Molarity
   - Mole fraction
   - Parts per million.
2. Ask the class to discuss products they have in their home and the labels that describe the concentration of the chemicals in the products. For example, most products have 'active ingredients'. These are the chemicals that 'do the job' claimed on the product label.
   The contents of a skincare product example might be useful as a discussion starter:
   - Water (aqua)
   - Decyl glucoside (cleansing)
   - Glycerin (hydration/skin replenishing)

- Sodium cocoamphoacetate (cleansing)
- Lauryl glucoside (cleansing)
- Xanthan gum (texture-enhancing)
- Coco-glucoside (cleansing)
- Glucose (hydration)
- Sodium cocoyl glutamate (cleansing)
- Sodium lauryl glucose carboxylate (cleansing)
- Glyceryl oleate (texture-enhancing)
- Aloe barbadensis leaf juice (hydration/skin-soothing)
- Carrageenan (texture-enhancing)
- Sodium phytate (stabiliser)
- Citric acid (ph adjuster)
- Ethylhexylglycerin (preservative)
- Phenoxyethanol (preservative)
- Potassium sorbate (preservative).

In this example, the function of each chemical is defined by the 'job' it does in the skincare product. The labels on most skincare products have no concentration information. Other products, like drain cleaners, often have the concentrations of the active ingredients. Drain cleaner (solid form) has 20% weight/weight of sodium hydroxide as the active ingredient.

3. Introduce mass/mass % (m/m %) and work the example on the board.
4. Direct the student teachers to calculate the w/w % concentration of a solution of 250mg of sodium bicarbonate that is dissolved in 5g of water.
   Solution:
   250mg of sodium bicarbonate = 0.25g
   Solution weight = wt water + wt solute = 5 + 0.25 = 5.25
   m/m % = (g of solute / g of solvent) x 100 = (0.25 / 5.25) x 100 = 4.76%
5. Check answers and use groups to assist with issues in answers.
6. Introduce mass/volume % (m/v %) and work the example on the board.
7. Direct the student teachers to calculate the m/v % concentration of 250mL of aqueous sodium chloride solution containing 5g of sodium chloride. (Note: the volume of the solute is ignored is these calculations.)
   Solution:
   Check units: weight in g, and volume in mL.
   mass/volume % = (g of solute / mL of solution) x 100 = (5 / 250) x 100 = 2.0%
8. Introduce the groups to volume/volume % (v/v %), and then direct the student teachers to calculate the v/v % of solution containing 45mL of ethanol and 100mL of water.

Solution:
mL solution = volume solute + volume solvent = 45 + 100 = 145mL
v/v % = (mL of solute / mL of solution) x 100 = (45 / 145) x 100 = 31.03%

9. Introduce parts per million (ppm) as a concentration measurement often used in environmental chemistry for describing the concentration of environmental contaminants in water quality analysis.
   Ppm is used to express very dilute solution concentrations of weight/weight (w/w) or weight/volume (w/v) concentrations. Using ppm avoids the use of scientific notation.
10. Then, work through the weight/volume example, highlighting the units.
11. Ask the student teachers to calculate the concentration of NaCl in ppm of a 150mL sodium chloride solution that contains 0.0025g of NaCl.
    Solution:
    1ppm = 1mg/L
    ∴ 0.0025g NaCl = 2.5mg NaCl, 150mL solution = 0.15L
    ppm = 2.5/0.15 = 16.6ppm
12. Direct the student teachers to calculate the mass (in milligrams) of potassium nitrate if present in 0.25kg of a 500ppm aqueous solution of KNO_3 solution.
    Solution:
    1ppm = 1mg/kg = 1μg/g for weight/weight ppm calculations
    ∴ mg solute = ppm x kg = 500 x 0.25 = 125mg

Assessment

Check answers and use peers to correct mistakes.

Correct student teachers' responses

Solutions are provided.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to use the summary templates (Figure 7.10) to compare properties of solid-liquid and gas-liquid solutions; and
- Ensure the student teachers draw some molecular model diagrams in their summaries.

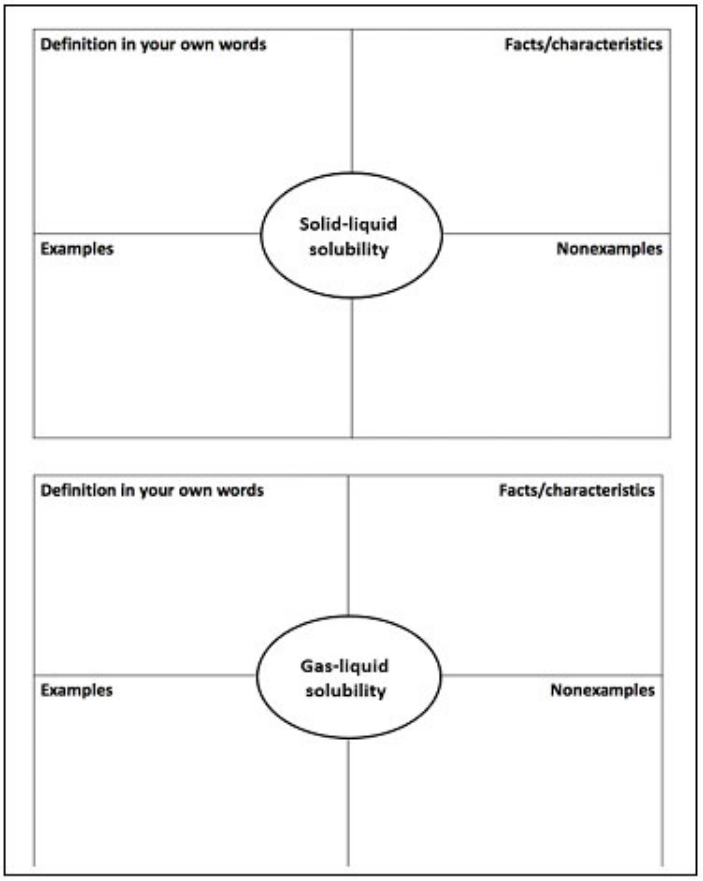


Figure 7.10. Summary templates

Student teachers will use their own words and examples. There is no defined correct answer, but the following key points should be included in their summaries:

- Temperature effects of solubility
- Pressure effects of solubility

- Concentrations are measured in various ways
- Molecular model of ionic solid dissolving
- Molecular model of gases dissolving, and vapour pressure.

7.1.3. Properties of solutions, colloids, and suspensions

In this lesson, student teachers will understand the properties of solutions, colloids, and suspensions.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Explain how certain chemical reactions are relevant in everyday life and work;
- Perform stoichiometric calculations involving reactions in solution, including precipitation reactions;
- Describe properties of colloids, suspensions, and solutions with examples; and
- Apply understanding of the properties of colloids, suspensions, and solutions to distinguish between them.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Investigation analysis: Colloids, suspensions, and solutions

Learning activity 2. Mathematisation: Solution stoichiometry

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 7.1.3.

Resources needed

Introduction. Bottle of river or lake water, bottle of drinking water

Learning activity 1. Student Teacher Textbook

Learning activity 2. Student Teacher Textbook

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge of solutions.

1. Refer student teachers to Lesson 7.1.3 in the textbook.
2. Ask the student teachers to present their summary templates from the last lesson. Encourage feedback from peers in the class. Remind them that positive critique and suggestions for improvement are essential in learning.
3. Ask the student teachers to recall the appearance of local rivers and lakes.
4. Engage the student teachers in a discussion about what might be in the water. The colour and turbidity are good starting points in such a discussion.
5. Ask the student teachers to speculate on what they think might be in a container of river water. Use a bottle of river or lake water and a bottle of drinking water as a prompt for comparison.
6. Encourage the class to make suggestions about what might be contained in each of the water samples.

Learning activity 1. Investigation analysis: Colloids, suspensions, and solutions

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to understand the difference between a solution, a colloid, and a suspension.

1. Introduce the concept of colloids, suspensions, and solutions as mixtures that contain particles of different sizes.

2. Ask the student teachers to describe a nanometre, a micrometre, and a metre. Student teachers should be able to convert nanometres, micrometres, and metres.
3. Present this conversion technique table to assist the class in conceptualising the conversions:

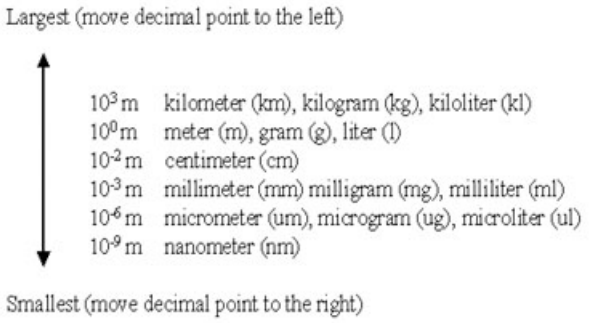


Figure. Conversion technique

4. Introduce Table 7.3 as a description of the particle sizes in solutions, colloids, and suspensions. This categorisation is based on particle size, and the size of the particles provides evidence for the categories in the table.
5. Refer the student teachers to their groups and ask them to analyse Figure 7.11. Remind the class of their suggestions about what might be in river or lake water and ask them to amend their ideas considering the particles presented in Figure 7.11.
6. The particle size defines not only the characteristics of solutions, colloids and suspensions, but also the separation techniques for each of these.
7. Form groups of 3. Refer the groups to Figure 7.12 and ask them to interpret the figure.
8. Ask the groups to draw the direction of the fluid flow in Figure 7.12. Ask them to suggest what the size of the holes in the filter paper would be if the solute particles are 120 micrometres in diameter.
9. Ask the groups to suggest what particles would be present in the filtrate. Seek group feedback and encourage discussions. The listed particles would need to be smaller than the diameter of the holes in the filter paper.
10. Introduce the concept of the semipermeable membrane as a specialised filter with very small holes.

11. Refer the groups to Figure 7.13. Then ask the groups to decide what the pore sizes of the semipermeable membrane would need to be, in order to remove the colloid solution of bacteria from the river water. Figure 7.11 presents bacteria at one micrometre. Therefore, the pore size would need to be less than one micrometre.
12. Introduce the concept of centrifugation as a means to separate the smaller particles in colloid solutions. This technique uses mass, shape, and size. Continue the scenario by asking students to use centrifugation on the filtrate from the semipermeable membrane. The particles in the filtrate include atoms and small molecules, proteins and large molecules, viruses, and dissolved ions.
13. Ask the groups to decide what particles would be in the pellet at the bottom of the tube. They would most likely be large protein molecules and viruses. The ions and small molecules would most likely be in the supernatant.
14. Ask the groups to decide how they might remove the ions and small molecules from the supernatant. The easiest technique is to evaporate the water using heat, leaving behind the ions and small molecules.

Assessment

Ask the groups to describe how the particle sizes of solutions, colloids, and suspensions are used in water treatment to provide clean drinking water.

Correct student teachers' responses

Student teachers should be able to describe the various techniques (e.g., coarse filtering using filter paper, fine filtering using semipermeable membranes, centrifugation) and describe what particles are removed.

Learning activity 2. Mathematisation: Solution stoichiometry

Time	20 minutes
Class organisation	Groups

Purpose

The purpose of this learning activity is for student teachers to determine the amounts of reactants and products in an aqueous solution.

1. Remind the student teachers that the equation of a chemical reaction depicts the compounds reacting (these are the reactants) and the products being formed (these are the products). The equations must be balanced to maintain the laws of conservation of matter. Balanced equations provide an opportunity to calculate the amounts, in moles or grams, of reactants used up and products produced.
2. Remind the class that in balancing equations, we are referring to moles rather than grams. The confusion about moles and grams is common.
3. As an example, explain the calculation of the concentration of sodium and chloride ions in a solution.
4. Ask the student teachers to work with their groups to calculate the concentration of barium and chloride ions when 50g of barium chloride is added to a volumetric flask and then filled to the 2L mark with deionised water. (Barium chloride MW = 208.23g/mole.)
   Solution:

   Balanced equation $BaCl_{2(s)} \rightarrow Ba^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$

   Mole ratio $BaCl_2 : Ba^{2+} : Cl^{-}_{(aq)}$

   Mole ratio 1:2

   $BaCl_2$ moles = g(solute) / MW = 50 / 208.23 = 0.24

   Using mole ratio, moles $BaCl_2$ moles = Ba^{2+} moles = 0.24, Cl^- = 2 x Ba^{2+} moles = 0.48

   [ ] = moles/L, $[Ba^{2+}] = 0.24 / 2 = 0.12M$, $[Cl^-] = 0.48 / 2 = 0.24M$

Facilitator's note

Remind the groups of the variety of methods for expressing concentrations in solutions.

5. Ask the student teachers to calculate the amount (moles) of solute present in 125mL of a 0.864 M solution.

Solution:
Check units
125mL = 0.125L
[solute] = moles/litres
$\therefore$ moles = [solute] x litres = 0.864 x 0.125 = 0.108 moles

6. Ask the student teachers to calculate the volume of barium nitrate solution (0.280 M) required to precipitate all the sulphate ion from 25.0mL of aluminium sulphate (0.350 M) as barium sulphate.
   Solution:
   Equation: $Al_2 (SO_4)_3 + 3Ba (NO_3)_2 \rightarrow 3BaSO_4 + 2Al (NO_3)_3$
   Mole ratio of reactants: 1 mol: 3 mol
   $\therefore$ equation factor = 3
   As both the concentration and volume of the aluminium sulphate are given, it is the known or standard solution. The volume of the barium nitrate solution of known concentration is the unknown quantity.
   Check units: $25mL = 25.0 \times 10^{-3}$ L
   Moles of aluminium sulphate in 25.0mL of solution = $M \times V = 0.350 \times 25.0 \times 10^{-3} = 8.750 \times 10^{-3}$ mol
   As the equation factor = 3,
   moles of sulphate = $3 \times 8.750 \times 10^{-3}$ mol = 2.625×10^{-2} mol
   moles of barium needed = moles of sulphate = 2.625×10^{-2} mol (ratio 1:1)
   concentration of barium nitrate = 0.280 M
   M = moles/L $\therefore$ volume (L) = mole/M = $2.625 \times 10^{-2}/0.280 = 9.38 \times 10^{-2}$ L or 93.8 mL
7. Explain that the alcohol content of various alcoholic beverages is quoted on their labels as v/v%, which means the number of mL of pure ethanol per 100mL of the beverage. Light-strength beer is 3.5 v/v%.
8. Ask the student teachers to calculate the molar concentration of ethanol in light-strength beer. The density of ethanol at 25°C = 0.785g/mL. $MW_{(ethanol)}$ = 46.07g/mole.
   Solution:
   Light beer v/v % = 3.5 = 3.50mL of ethanol/100mL of beer
   density = mass/volume
   $\therefore$ mass ethanol = density × volume = 0.785 × 3.5 = 2.75g
   Check units
   2.75g in 100mL = 27.5g in 1L
   moles ethanol = mass / MW = 27.5 / 46.07 = 0.59
   [ethanol] = moles / volume (L) = 0.59 / 1 = 0.59

Assessment

Check calculations and answers.

Correct student teachers' responses

Solutions are provided in the learning activity.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to design a flow chart that they could use to separate suspended particles, colloid particles, and ions dissolved in a water sample;
- Tell the student teachers that Figure 7.16. In their textbook provides a 'starter'; and
- Explain that they can use the starter or redesign the flow chart for their needs.

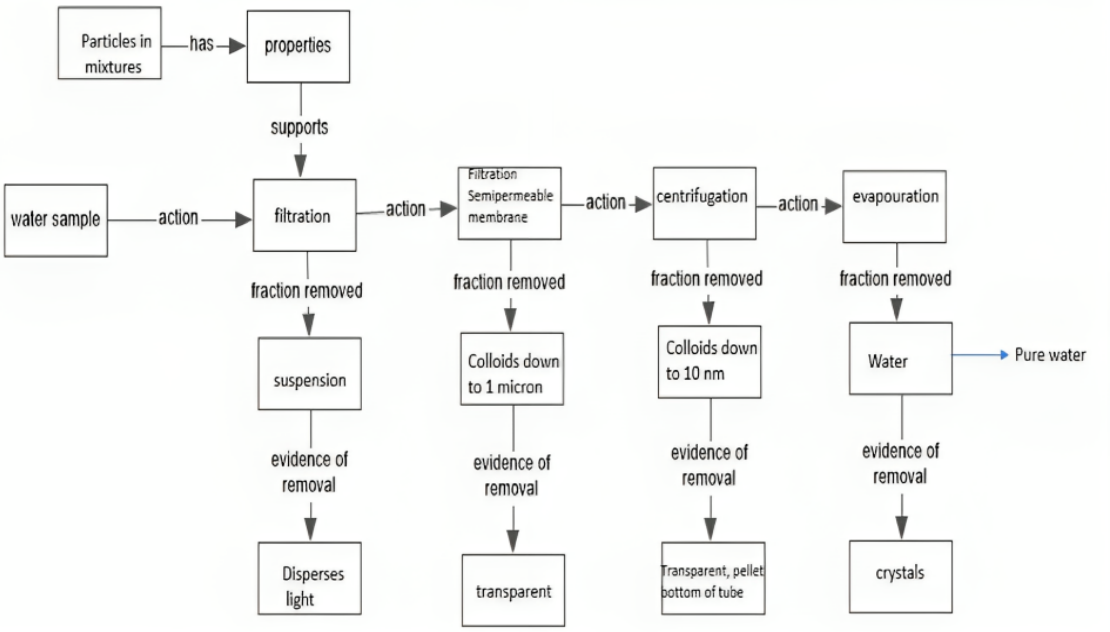


Figure 7.16. Initial flow chart – Completed

The suggested response is a guide only, as each student teacher will organise their mind map as a reflection of their learning.

7.1.4. Importance of Chemistry in daily life

In this lesson, student teachers will develop an understanding of the importance of Chemistry in daily life.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Appreciate the central role of Chemistry in our society;
- Explain why Chemistry is an integral activity for addressing social, economic, and environmental problems; and
- Develop a teaching resource suitable for a Grade 1/2 class that outlines phenomena in our everyday lives from a scientific perspective.

Competency gained

A5.2.2 Explain how lessons are contextualised to include localised information and examples related to the subject content, concepts and themes

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Concept development: Chemistry all around

Learning activity 2. Interpretation: Material world

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 7.1.4.

Resources needed

Introduction. Nil (other than Student Teacher Textbook and pen)

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class and groups of 3

Purpose

The purpose of this learning activity is for student teachers to recognise their prior knowledge of chemicals in the home.

1. Refer the student teachers to Lesson 7.1.4 in the textbook.
2. Ask the class to explain the definition of a chemical.
3. Form groups of 3, and then ask the groups to develop a group definition of a chemical. Invite groups to share their definitions.
4. Ask each student teacher to write 10 examples of chemicals they have in their home. Then ask each group to develop a combined list of 10 chemicals they have in their homes.
5. Invite groups to present their definitions and chemical examples. The aim is to gain an understanding of the prior knowledge that the student teachers

have about chemicals. Often, people do not recognise the chemicals used for cleaning and everyday uses as chemicals. Highlight this point with the student teachers.

Learning activity 1. Concept development: Chemistry all around

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to recognise chemicals and chemical reactions in their everyday lives.

1. Introduce the concept of Chemistry being a part of everyday life.
2. Refer the student teachers to Figure 7.17. Ask the student teachers to add the examples from their group's list to the mind map in Figure 7.17.
3. It is likely that many of the examples from the group activity in the introduction focused on food and health, and possibly agriculture. Ask the groups to discuss the categories from Figure 7.17 and add examples to the mind map.
4. Introduce the student teachers to the concept of macroscale-nanoscale-symbolic. Explain that Chemistry has always been problematic because all observations are in the macroscale, where the particle nature of matter that explains these observations is unseen. This is why in previous lessons we have used balls and drawings to model the nanoscale.
5. Explain that Chemistry has its own language. This language is known as the symbolic aspect of Chemistry. Refer the student teachers to Figure 7.18 and highlight the relationship between the macroscale, nanoscale, and symbolic aspects of Chemistry.
6. Use the example of combustion when burning fuel to cook a meal. Explaining this example brings a real-world explanation to the macroscale, symbolic, and nanoscale aspects of burning fuel to cook food.
7. Allow groups to discuss the example and invite student teachers to ask questions of these three aspects.
8. Ask the groups to consider what concepts a Grade 1/2 primary student might need to know about burning fuel to cook food.

9. Then ask the groups to decide what sort of evidence of understanding these primary students could present. Ask what they, as a teacher of primary students, would want those students to be able to do and how they would demonstrate it.
10. Direct the groups to use one of their everyday chemical examples and decide on the macroscale, nanoscale, and symbolic aspects of this example.
11. Direct the groups to complete Table 7.4 in their textbook when they have decided on macroscale, nanoscale, and symbolic aspects. (See possible student teachers' responses).
12. Considering the aspects, the groups have determined, ask the groups to decide what aspects they would require a Grade 1/2 primary student to know.
13. Direct the groups to suggest the experimental investigative learning activities that might be used to help Primary students understand the nanoscale aspects of the everyday example.

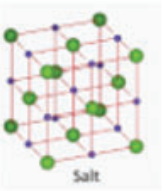
Assessment

Invite groups to present their everyday examples and what a Grade 1/2 primary student is required to know. Then invite groups to share the experimental investigative learning activities.

Possible student teachers' responses

The following table uses salt dissolving in water as an example that will assist student teachers to visualise the task.

Table 7.4. Everyday example – Completed

Everyday example	Macroscale-symbolic-nanoscale		
	Macroscale (Observable aspects)	**Symbolic (Symbols and icons)**	**Nanoscale (Unseen/Theoretical)**
Salt dissolves in water 	• See the salt added • Salt disappears • The salt is still there I can taste it • The water does not change in vloume • The density of the water changes	• Sodium chloride/ salt/ NaCl • Sodium ions Na • Chloride ions Cl • Water H_2O • Sodium Na • Chloride Cl • Hydrogen H • Oxygen O • Electric charge + and – • Density = mass/ volume  	• Particle nature of matter • Ionic solid structures • Atomic structures • Electronegativity • Molecules • Water molecules • Polar molecules • Charge based attraction and repulsion • Ionic bonding and bond strength • Covalent bonding • Hydrogen bonding 

Learning activity 2. Interpretation: Material world

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to design a learning resource that will assist students in their understanding of the chemical concept of materials.

1. Introduce the concept of materials and explain that everyday materials are made of chemicals and that they can be natural or processed. At a Grade 1/2 level, natural and processed materials mean the students should understand they have a range of physical properties that can influence their use.
2. Ask the groups to decide what the macroscopic, nanoscale, and symbolic aspects of natural and processed materials are that would be relevant to Grade 1/2 primary students.
3. Direct the groups to Figure 7.19 and ask the groups to discuss the mind map. This mind map provides a starting place for student teachers to consider the physical properties of materials that might be used in an experimental investigation based in macroscale experimental observations.
4. Encourage groups to add other ideas to the mind map to better represent their ideas and discussions.
5. Direct the groups to choose a physical property and decide the macroscale, nanoscale, and symbolic aspects of their chosen property.
6. Suggest to the groups they also consider the types of materials that are relevant to primary students in Grade 1/2. It is important for the student teachers to realise that these materials could be used to experimentally investigate the relationship between the properties and uses of the materials.
7. Expand this concept of experimental investigation, materials, and their properties by using the example presented in Figure 7.20. Encourage the groups to discuss the use of bamboo and other materials to make a bridge and point out that this is an experimental investigation looking at different materials and testing the tensile strength of these materials.
8. Ask the groups to design an experimental investigation learning activity using the fair test, which Primary students can perform using the physical property and the materials already identified. Remind the student teachers of the fair test protocol they used in Unit 5.

Assessment

Invite groups to share their investigations and explain the demonstration of the relationship between the material and the property. Encourage groups to specifically mention variables and what will be measured.

Possible student teachers' responses

The choice of investigations is wide-ranging considering that there are many physical properties that could be selected, and types of materials. Student teachers should demonstrate the relationship between the use and the property, and the material. Some examples include:

- Density: what materials float and sink? Measuring weight and volume to calculate the density.
- Thermal insulation: what materials are best at keeping a cup of coffee or tea hot? Measuring the temperature and changing the materials.

Check student teachers' understanding

Time	5 minutes
Class organisation	Groups

At the end of the lesson:

- Ask the student teachers to discuss the activities with their peers, and develop the activities using the feedback from their peers;
- Mention that the developed activities should be of a quality that they can be used in a primary school; and
- Facilitate a discussion about how the developed activity makes chemistry relevant to a primary student's everyday experiences.

7.1.5. Examples of Chemistry in daily life

In this lesson, student teachers will investigate examples of Chemistry in everyday life.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Develop a critical approach towards the presence of chemicals in our daily life; and
- Provide effective examples demonstrating the power of Chemistry in daily life.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.2.2 Explain how lessons are contextualised to include localised information and examples related to the subject content, concepts and themes

B3.1.3 Model and promote good health and safety practices to ensure students' wellbeing and safety within the classroom and school

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Data analysis: Drinking water quality

Learning activity 2. Application: Water quality

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 7.1.5.

Resources needed

Introduction. Nil (other than Student Teacher Textbook and pen)

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise prior knowledge of water as a solvent.

1. Refer the student teachers to Lesson 7.1.5 in the textbook.
2. Discuss with the class the importance of clean drinking water for their health and the health of their families.
3. Ask the student teachers how they know that a glass of drinking water is safe to drink even if it looks clear.

4. Invite student teachers to discuss their ideas.
5. Discuss with the class what might be dissolved in the water and what colloids might be in the water.
6. Explain that Chemistry is used extensively to decide if water is safe to drink.

Learning activity 1. Data analysis: Drinking water quality

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to analyse data to determine the quality of the water.

1. Explain to the class the need for safe drinking water for health, and that the quality of water is defined by a set of standards and guidelines which are internationally and nationally determined. Myanmar's current draft standard is found in Table 7.7.
2. Form groups of 3 and invite the groups to study the reference standards outlined in Table 7.7. The table presents a list of chemicals and their concentrations that are the maximum levels recommended in health guidelines.
3. Explain the parameters for water testing to the class. These parameters are all based on Chemistry, even though some use biological methods to test bacteria. These biological methods are based in Chemistry.
4. Introduce the scenario where datasets from water quality testing have been collected and analysed from Hlaing River Basin and the Doke Hta Waddy River Basin.
5. Refer the groups to the maps of the survey areas in Figures 7.21 and 7.22 Encourage the groups to discuss the maps, and then refer groups to the datasets in Tables 7.5 and 7.6.
6. Encourage discussion of the results. Point out rainy season and dry season data for each of the study areas.
7. Ask the groups to compare the data for each study area and then use the reference standards found in Table 7.7 to decide if the water is drinkable.
8. Ensure that the groups present evidence that justifies their decisions.

Assessment

Encourage groups to present their justifications of water quality for drinking. Ensure that discussions are positive, and all student teachers are involved.

Possible student teachers' responses

Hlaing River Basin

BOD and COD

Dry season: not fit for domestic use (standard B2).

Rainy season: fit for use if treated.

Other parameters

Rainy season: Coliform bacteria (total): unfit for domestic use.

The data suggests that for both seasons, Kokkowa and Wataya are not fit for domestic use.

Doke Hta Waddy River Basin

BOD and COD

Dry season: not fit for domestic use.

Rainy season: fit for use if treated.

Other parameters

Rainy season: Coliform bacteria (total), turbidity: unfit for domestic use.

The data suggests that for both seasons, Doke Hta Waddy River 1 and Intake Ayeyarwady River are not fit for domestic use.

Learning activity 2. Application: Water quality

Time	20 minutes
Class organisation	Groups of 3 (same groups as Learning activity 1)

Purpose

The purpose of this learning activity is for student teachers to use selective precipitation to determine unknown contaminants in water.

1. Review with the class the concepts of solubility, particularly the mechanisms for ionic salts dissolving in water. Make the point that water is a universal solvent, and many believe water is the fountain of life. This suggests that without water, there will be no living things on Earth.
   This suggestion is correlated with current investigations on Mars, which suggest Mars had water but now the water is gone and there appears to be no living things on Mars. However, Science is about answering questions, and current missions to Mars are looking for evidence of living things.
2. Remind the class that not all salts are soluble. These salts are known as insoluble. The solubility of any salt is experimentally determined.
   A mathematical model of solubility has been developed that compares the concentration of the reactants (ionic solids) to the products (ions in solution). This mathematical model determines the solubility product (K_{sp}) and is a measure of an ionic solid at 25°C. The larger the solubility product, the more ions in a solution; therefore, the solubility is high. A small-solubility product indicates very few ions in a solution: insoluble.
3. Refer groups to Table 7.8 and encourage them to discuss the structure of the table. The ionic solids are grouped by anions: halides, sulphides, sulphates, nitrates, phosphates, and hydroxides as examples of a wide range of anions found in ionic solids.
4. Ask the groups to decide which ionic solids are most soluble. This should be achieved through ranking the ionic solids. Some groups may need assistance from other groups to determine the meaning of the scientific notation. The ranking process will give the student teachers an opportunity to conceptualise the scientific notation related to the ionic solids.

5. Direct the student teachers to use their rankings to identify which anions form the ionic solids that are the most soluble (nitrates). Direct the student teachers to also identify the cations that are the most soluble (sodium potassium).
6. Explain to the class that the different solubility of ionic solids can be used as a technique to identify unknown ions in water samples. For example, if sulphuric acid was added to a sample of water that contained aluminium ions, the product of the reaction would be aluminium sulphate.
   The solubility product of aluminium sulphate is 9.84×10^{-21}. This solubility product is very small and indicates that aluminium sulphate is insoluble, and it will form a precipitate at the bottom of the test tube. A precipitate is a solid and, in this case, will be aluminium sulphate.
   This experimental technique indicates that aluminium cations are present in the water. In this reaction, the sulphuric acid is called the precipitating agent.
7. Use the scenario of silver cations and the precipitating agent NaCl to precipitate silver chloride as another example. Introduce the student teachers to another method of precipitating silver out of a solution: bubbling hydrogen sulphide into the water sample to precipitate the silver cations.
8. Ask the student teachers why they would use hydrogen sulphide as a precipitating agent.
   Answer: the solubility product of silver sulphide is much higher, indicating a more complete precipitation of silver cations.
9. Ask the class what other cations can be precipitated using hydrogen sulphide. The answer to this question is found in Table 7.8 in the K_{sp} values.
   Answer: lead and copper cations.
10. Refer the student teachers to Figure 7.23 and explain that the mind map is a summary of selective precipitation reactions with a variety of cations found in water. Encourage the groups to discuss the groupings of the cations and the precipitating agents. Use the example of hydrochloric acid as a precipitating agent and ask the student teachers to indicate which cations are precipitated.
11. Introduce the scenario, explaining that a 100mL sample of water came from an area downstream of the silver, lead, and zinc mine site. Explain that as a group, they have been asked to test the water for the presence of the following cations: cadmium, chromium, and manganese.
12. Ask the groups to decide what precipitating agents they would use and write the equation for the precipitate of chromium.
    Answer: $Cr^{3+} + OH^{-} \rightarrow Cr(OH)_3$
13. Ask the student teachers to calculate the concentration of chromium cations (mg/L) if the sample of chromium hydroxide precipitate was found to

weigh 0.012g. The molecular weight of $Cr(OH)_3$ = 103g/mole, and the atomic weight of chromium = 51.9.

Solution:

Moles $Cr(OH)_3$ = g/MW = 0.012/103 = 1.16×10^{-4} = moles of Cr^{3+}

weight of Cr^{3+} = moles x AW = $1.16 \times 10^{-4} \times 51.9 = 0.006g = 6.0mg$

$[Cr^{3+}]$ = mg/L = 6.0/0.1 = 60mg/L

14. Ask the students if the water is safe to drink if the recommended safe level of chromium ions is 0.19mg/L.

Assessment

Check student teachers' answers.

Direct the student teachers to discuss the concept of selective precipitation as an analytical technique. Encourage the student teachers to use the reference Table 7.7 and the selective precipitation Figure 7.23 to match some of the cations from the reference table and suggest the appropriate precipitation agents.

Possible student teachers' responses

Answers are presented in the learning activity.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask the student teachers to create a visualisation that demonstrates the linking of Chemistry to their everyday experiences.

There is no definitive answer for this, as it is each student teacher's meaning-making exercise. These will be shared in the next lesson.

7.1.6. Integrating the concept of Chemistry in daily life

In this lesson, student teachers will integrate Chemistry into their understanding of daily life.

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- List chemicals that are used in daily life;
- Find and exchange information to give chemical explanations of some everyday facts;
- Give opinion about the uses of chemical substances in daily products; and
- Identify chemical hazard labels.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.2.2 Explain how lessons are contextualised to include localised information and examples related to the subject content, concepts and themes

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Visualisation: Amphipathic molecules

Learning activity 2. Interpretation: Chemical hazards

Assessment approaches: Questioning, observation, peer and whole class discussion, peer and self-assessment, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 7.1.6.

Resources needed

Introduction. Nil (other than Student Teacher Textbook and pen)

Learning activity 1. 600mL clear plastic water bottle (1 per group), water, detergent, cooking oil, spherical balloons (2 per group), long balloons (2 per group)

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Introduction/Explicit teaching	5 minutes
Learning activity 1	20 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	5 minutes
Class organisation	Whole class

Purpose

The purpose of this learning activity is for student teachers to recognise prior knowledge of everyday products at home.

1. Encourage groups to share their visualisations from the previous lessons.
2. Provide opportunities for the student teachers to interact between groups to review each other's visualisations. Remind the groups that feedback and peer interaction is essential for learning.

Learning activity 1. Visualisation: Amphipathic molecules

Time	20 minutes
Class organisation	Groups of 3

Purpose

The purpose of this learning activity is for student teachers to understand the importance of amphipathic molecules to their everyday lives.

1. Ask the class what laundry detergent, cosmetics, toothpaste, shampoo, dishwashing liquid, soap, hormones in their bodies, and pharmaceutical drugs have in common. Encourage the class and groups of 3 to discuss what these chemicals have in common.
2. Invite the class to present their ideas.
3. Introduce the concept by using a clear, plastic water bottle that is three quarters full of water. Have student teachers add 20mL of cooking oil. Student teachers will draw a diagram of their observations. Ask the groups if the oil has dissolved.
4. Ask the student teachers to shake the bottle and then leave it for five minutes, observe the changes, and then draw the result. Ask the student teachers if the oil has dissolved.
5. Direct the student teachers to add between 2mL and 5mL of detergent to the bottle and ask again if it will dissolve. Ask the groups to report their observations and comment on the effect of the detergent (variable) on the oil and water system.
6. Explain that the oil-water-detergent is a colloid where the oil has been emulsified with the adding of the detergent. The detergent has created colloid dispersion of the oil in the water. This is the macroscale observation to understand what is happening in the oil-water-detergent colloid. There is a need to go to the nanoscale.
7. Explain that the oil is made up of long chained carbon and hydrogen atoms. Explain that they are not polar, and they have no attraction to water whatsoever. They are known as hydrophobic. Remind the student teachers of the nanoscale mechanism of dissolving: electrostatic attraction between ions and water. Molecules that have electrostatic attraction or form hydrogen bonds with water are known as hydrophilic (liking water).

8. Explain that the variable – detergent – allowed the formation of the colloid, which dissolved in water.
9. Introduce dishwashing liquid as an amphipathic molecule. This molecule has a nanoscale structure with a polar end (hydrophilic) and a nonpolar end (hydrophobic).
10. Refer the student teachers to Figure 7.24. The figure indicates a polar head due to the presence of oxygen and nitrogen atoms in the molecule. Ask the student teachers to circle on Figure 7.24 the atoms responsible for the polar end. Point out that they are isolated at one end of this very large molecule.
11. The nonpolar end contains only carbon and hydrogen atoms that are hydrophobic and only mix with hydrophobic compounds. Refer the student teachers to Figure 7.25. Invite groups to discuss this figure as it is a model of oil and water and detergent.
    The detergent is depicted as surrounding the oil, with the hydrophobic tails mixing with the oil and the hydrophilic ends of the detergent mixing with the water.
12. Inform the student teachers that oil surrounded by detergent is dissolved as a colloid, and that these structures are called micelles. Direct the student teachers to discuss the electron micrograph presented in Figure 7.26.
13. Ask the student teachers to predict the diameter of the micelle presented in image (c) in Figure 7.26. Ask the student groups if the diameter of the micelle is in the size range of a colloid dispersion.
14. Invite groups to make their own amphipathic molecule using a spherical balloon and a long balloon, as depicted in Figure 7.27. Then direct the groups to design and perform a role-play to model micelle formation. The groups will need to decide on what will represent the oil.
15. Provide an opportunity for the student teachers to present their role-plays. Ensure that the oil is centred in the middle of the micelle.
16. Inform the student teachers that cell membranes separate two water environments. Outside the cell is a water environment and inside the cell is a water environment; the membrane keeps these two worlds apart. Most cell membranes are made of an amphipathic molecule known as a phospholipid, as per the example in Figure 7.24.
17. Ask the student teachers to use their balloon models to role-play a cell membrane. Provide them with a hint that reminds the groups that polar ends must mix with water and the hydrophobic ends must mix with nonpolar molecules.
18. Ask the student teachers to suggest why laundry detergents, shampoo, and toothpaste contain amphipathic molecules.

19. Explain to the groups that Figure 7.28 presents the human sex hormones: oestrogen ($C_{18}H_{24}O_2$) and testosterone ($C_{19}H_{28}O_2$). Ask the groups to identify the polar sections of these molecules. Then ask the groups to suggest why these molecules have two polar ends.

Assessment

Ask the student teachers to reflect on the use of role-play in the understanding of the nanoscale perspective of amphipathic molecules. Provide an opportunity for open discussion of the usefulness of role-play.

Possible student teachers' responses

The possible responses will be indeterminate as this reflection is personal. However, the following points might be useful to include in student teacher reflections:

- Immediate application content in a relevant, real-world context
- Decision-making that allows divergent knowledge and skills to develop
- Thinking and acting beyond the confines of the classroom setting
- Relevance of the content for handling real-world situations
- Receiving immediate feedback about student understanding of concepts
- Engaging in higher-order thinking and learning content in a deeper way.

Learning activity 2. Interpretation: Chemical hazards

Time	20 minutes
Class organisation	Groups of 3 (same groups as Learning activity 1)

Purpose

The purpose of this learning activity is for student teachers to evaluate chemical hazard information.

1. Refer the student teachers to Figure 7.29, the popular drain-cleaning product.
2. Engage the groups in a discussion about drain cleaner. Ask: "*What is it used for? What are the labels like on the on the bottle? How does it work in the*

drain?" It is likely that most student teachers know about drain cleaner and that it cleans drains, but the chemistry and the toxic properties of the drain cleaner may be unknown.

3. Inform the student teachers that drain cleaner contains at least 20% volume/volume for a liquid and 20% mass/mass for a solid of sodium hydroxide (caustic soda). It also contains aluminium oxide.
4. Explain the chemical reactions using the board and the examples given. Highlight the production of hydrogen gas and the difference between endothermic and exothermic reactions.
5. The main chemical reaction (Figure 7.30) is called saponification or making soap. The hydroxide ion reacts with the fats and oils that clog the drain and creates an amphipathic molecule: the crude soap.
6. Ask the student teachers what the advantage is of having polar molecule products in the saponification reaction in drain cleaner.
7. Ask: "*What effect will the amphipathic soap molecules have on the unreacted oil and fats?*"
8. Explain to the class that the hydroxide ions also attack proteins. Use the general equations presented in the textbook to demonstrate the production of polar molecules. Ask the student teachers: "*What is the purpose of changing nonpolar molecules into polar molecules?*"
9. Answer: The purpose is to enable the molecules to dissolve in water.
10. Tell the class that drain cleaner is probably among the most toxic and hazardous chemicals they have in their homes. Ask the groups to discuss this and decide whether they agree or disagree.
11. Present the safety warning found on the website for a particular drain cleaner and point out that there is no warning on the label of the product.
12. Ask the student teachers if the safety warning adequately informs the user of the hazards of using the product shown in Figure 7.29.
13. Ask the student teachers why the safety information advises against use with aluminium products.
14. Highlight that hydrogen is a product of the chemical reactions of the drain cleaner. Ask the class why hydrogen is so dangerous.
15. Point out to the class that product labelling is important to provide information for users, particularly about potential hazards. Symbols are often used to represent hazards.
16. Refer the class to the hazard symbol for the use of concentrated sulphuric acid in Figure 7.31.
17. Ask the students to comment on what the symbol is suggesting about the hazard of using sulphuric acid.

18. Direct the groups to make a list of the five most hazardous aspects of using drain cleaner. Direct them to create five hazard symbol labels that they believe should be displayed on the drain cleaner product.

Assessment

Ask the groups to display their labels and ask other groups to explain what the labels mean to them. Encourage groups to use positive feedback and allow the symbols to be modified based on the feedback.

Possible student teachers' responses

An example is provided in the following figure.

Figure. Example of hazard symbol labels

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Discuss the statement: 'the Chemistry of amphipathic molecules provides a nanoscale perspective understanding of everyday life'.

Expected student teachers' responses for the review questions in TB

Question 1: What is the difference between a solution, a colloid, and a mixture?

Answer: *See the following table.*

Table. Difference between a solution, a colloid, and a mixture

Type of mixture	Type of particle	Effect of light	Settling	Separation
Solution: molecular dispersion	Small molecules, atoms, and ions (<1.0nm)	Transparent	Particles do not settle on the bottom of the container	Particles cannot be separated by filters or semi permeable membranes
Colloid: colloidal dispersion	Large molecules or clumps of smaller molecules (1.0nm to 0.5µm)	Disperses light	Particles do not settle on the bottom of the container	Particles can be separated by a semi-permeable membrane or centrifugation
Suspension: coarse dispersion	Very large particles, visible (> 0.5µm)	Opaque	Particles settle on the bottom of the container	Particles can be separated by filtration

Question 2: Explain the importance of Chemistry to environmental monitoring.

Answer: *Chemistry provides the nanoscale understanding of chemical reactions and chemical contaminants. Chemical analysis techniques provide a quantitative measure of contaminants.*

Question 3: Why are all the large molecules in your body amphipathic molecules?

Answer: *The body is a water environment that depends on all molecules dissolving as ion or colloid dispersions to allow chemical reactions on which life depends.*

Unit Summary

Key messages

- Chemistry has macroscale observations that are explained by the nanoscale, using its own symbolic language.
- The understanding of the everyday world depends on the nanoscale aspects of Chemistry.
- Chemistry has macroscale observations that are explained by the nanoscale, using its own symbolic language.
- The understanding of the everyday world depends on the nanoscale aspects of Chemistry.

Unit reflection

Create a mind map using the key terms and the key messages of this unit.

Further reading

Environmental Chemistry in Society

Australian Academy of Science. *Primary connections: Linking science with literacy.* https://www.primaryconnections.org.au

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Sewell-Smith, A., & Smith, W. (2014). W*orking scientifically with natural and processed materials.* Educational Directions Publications.

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Unit 8

Physics II

In this unit, student teachers will explore types of forces, including gravitational force, and the effect of forces on the motion of objects. Student teachers will learn how to measure the densities of substances and use this knowledge to predict whether objects will sink or float. They will also consider pressure, in particular buoyant forces and Archimedes' principle, when determining whether objects sink or float.

Student teachers will explore light, including the effect of materials on the behaviour of light, and the effect of lenses, and consider light in the context of the human eye. They will learn how to measure thermal expansion in linear, area, and volume dimensions and apply this knowledge to real-life examples.

Student teachers will deepen their knowledge of electric charges and electric force, and learn about electric fields. They will construct an electromagnet and explore the real-life applications of electromagnets.

The unit will conclude by exploring the solar system, including the major planets and other features of the solar system, and examining the benefits of satellite technologies.

Expected learning outcomes

By the end of this unit, student teachers will be able to:

- Classify the forms of forces and conduct an experiment designed for a Grade 1/2 class that shows types of forces;
- Examine the relationship between force, mass, and acceleration based on Newton's law of motion;
- Explain the difference between mass and weight with the effect of gravity on objects;
- Define density;
- Compare the densities of various substances;

- Use Archimedes' principle to explain why objects sink or float, giving examples from daily life;
- Explain how the properties of materials affect the behaviour of light, including shadow formation;
- Describe the difference between the laws of refraction and reflection with real-life examples;
- Explain absorption of light using examples from everyday life;
- Design a learning activity for a Grade 1/2 class that identifies and classifies sources of light;
- Use diagrams to show the path of light as it contacts concave and convex lenses;
- Describe the application of refraction of light in the context of the human eye;
- Identify that thermal energy is an internal energy of matter;
- Examine linear, area, and volume expansion using the coefficient of thermal expansion;
- Develop a simple explanation suitable for a Grade 1/2 class that explains some of the everyday applications and consequences of thermal expansion;
- Explain electric charges and their properties;
- Describe the difference between electric force and electric fields and distinguish their units;
- Apply Coulomb's law to quantify the force between charged particles;
- Perform a demonstration suitable for a Grade 1/2 class that demonstrates the magnetic effect of electric current;
- Explain how alterations to the solenoid would change its magnetic field
- Discuss the uses of electromagnets;
- Collaboratively construct a model of the features of the solar system suitable as a teaching resource for a Grade 1/2 class, including planets, dwarf planets, moons, asteroids, comets, and meteors;
- Explore the differences in the major planets of the solar system including orbital and rotational periods; and
- Explain the methods used to explore the solar system and how we benefit from satellite technology.

Competency gained

A5.1 Demonstrate understanding of the subject matter to teach the assigned subject/s for the specified grade level/s

8.1. Force and Movement

In this sub-unit, student teachers will classify the different types of forces and examine the relationship between force, mass, and acceleration. They will explore gravitational force to understand the difference between mass and weight. They will explore the densities of substances and conduct practical activities to measure density in different ways.

Student teachers will learn about Archimedes' principle and use this to explain why objects sink or float. They will use a range of scientific inquiry skills to explore these concepts and consider how they can be explained in a Grade 1/2 classroom.

8.1.1. Forms of forces

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Classify the forms of forces and conduct an experiment designed for a Grade 1/2 class that shows types of forces;
- Examine the relationship between force, mass, and acceleration based on Newton's law of motion; and
- Explain the difference between mass and weight with the effect of gravity on objects.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Practical: Classifying forces in a Grade 1/2 activity

Learning activity 2. Pairs: Calculating weight

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Source materials.

Cut cardboard or plastic tubing if necessary.

Resources needed

Learning activity 1. Cardboard tubes (like the inside of paper towel) cut longitudinally into half-pipes or plastic half-pipes pipes, small balls (marbles or similar), blocks, fabric (cotton or washing cloths), plastic wrap, sheets of paper

Learning activity 2. Two oranges (or similar citrus fruit) – one peeled, tub of water or large glass or plastic cylinder

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Practical: Classifying forces in a Grade 1/2 activity

Time	25 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to classify the types of forces by conducting an experiment suitable for a Grade 1/2 classroom.

1. Explain to the student teachers that in this learning activity they will be exploring forces through a learning activity suitable for a Grade 1/2 classroom.
2. Ask the student teachers what types of forces they can recall. Write the types of forces that student teachers can recall on the board.
3. Explain that the student teachers will be conducting some simple activities to demonstrate some of the types of forces to Grade 1/2 students.
4. Ask the student teachers to read through the activities in the Student Teacher Textbook. Explain that for each set-up, student teachers need to record their observations in Table 8.1 and draw a simple diagram, labelling the forces acting on the object.
5. Direct the student teachers to form groups and conduct the activities.
6. Observe the student teachers as they work.
7. When the student teachers have completed the activity, facilitate a discussion about their observations and the types of forces they recorded. Ask guiding questions such as:
   - What type of forces were acting on the ball at rest?
   - What observations did you make as the surface material in the tube changed, and why did these changes occur?
   - What did you observe when you dropped the papers at the same time?
   - What force caused the differences you observed between the two papers?
8. At the end of the learning activity, remind the student teachers that these activities are useful ways to demonstrate forces to Grade 1/2 students. In the early years of learning, forces are a difficult concept to understand because forces themselves cannot usually be seen, but the effects of forces can be observed. Activities such as these are age appropriate and can help students in the early years of learning gain conceptual understanding.

Assessment

Check student teachers' tables to ensure they are recording observations and labelling force diagrams correctly. Listen to student teachers' conversations and correct any misconceptions or misunderstandings.

Possible student teachers' responses

Table 8.1. Forces acting on objects – Completed

Activity	Observations	Forces
1	The ball stays still.	Gravitational force; normal force. Forces are balanced (object is stationary).
2	The ball moves quickly along the pipe.	Applied (push) force; gravitational force; normal force; frictional force. Forces are unbalanced (object is in motion).
3	The ball rolls down the tube.	Gravitational force; normal force; frictional force. Forces are unbalanced (object is in motion). The force of gravity acts in a downward direction but the normal force acts perpendicular to the surface, so the forces are not balanced as in Activity 1.
4	The ball rolls more slowly down the tube than it does in Activity 3.	Increased frictional force compared with Activity 3.
5	The ball rolls more quickly (or about the same speed) as it does in Activity 3.	Reduced frictional force.
6	The scrunched paper reaches the ground before the flat paper.	Less force of air resistance on the scrunched paper compared to the flat paper, due to the smaller surface area.

Learning activity 2. Pairs: Calculating weight

Time	20 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to explore the difference between mass and weight with the effect of gravity on objects.

1. Ask the student teachers what they understand the mass of an object to be.
2. Ask what they understand the weight of an object to be.
3. Explain that it is a common misconception among students that mass and weight are the same thing.[3]
4. Explain to the student teachers that they have some background information in the Student Teacher Textbook about the difference between mass and weight.
5. Direct the student teachers to read the information in the Student Teacher Textbook.
6. Once the student teachers have read the information, ask if there are any questions about the information. Respond to any questions and clarify the concepts as necessary.
7. Explain that the student teachers will work in pairs to complete the calculations in Table 8.3.
8. Direct student teachers to turn to another student teacher and complete the calculations in Table 8.3.

Assessment

Check student teachers' answers in Table 8.3. Listen to student teachers' conversations as they complete the calculations and correct any misconceptions or misunderstandings.

Correct student teachers' responses

Table 8.3. Weight of a person of 70kg mass on different celestial objects – Completed

Object	g (m/s^2)	Weight of a 70kg person
Mercury	3.72	260.4N
Venus	8.89	622.3N
Earth	9.80	686N
Earth's moon	1.63	114.1N
Mars	3.69	258.3N

3 Bar, V., Brosh, Y., & Sneider, C. (2016).

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers what a person would feel or experience on the different celestial bodies;
- Ask student teachers how they could demonstrate the difference between mass and weight to students in a Grade 1/2 class; and
- Listen to student teachers' suggestions, and also suggest that showing a video of objects (people) on the moon can help to demonstrate the concept.

8.1.2. Pressure: Sinking and floating

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Define density;
- Compare the densities of various substances; and
- Use Archimedes' principle to explain why objects sink or float, giving examples from daily life.

Competency gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Practical: Comparing the densities of substances

Learning activity 2. Think-pair-share: Archimedes' principle

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 8.1.2.

Resources needed

Learning activity 1. Rulers, graduated measuring cylinders, water, objects cut into regular (square or rectangular) shapes (e.g., bits of fruit or vegetables, Styrofoam, wood, plastic, erasers, clay, dough), scales, toothpicks

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Practical: Comparing the densities of substances

Time	25 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to define density and calculate the densities of various substances.

1. Explain to the student teachers that in this period they will be exploring concepts relating to densities of substances and why objects sink or float.
2. Read out the learning objectives for the lesson.
3. Facilitate a short brainstorming activity to collaboratively develop a definition and understanding of density.
4. To develop the definition, ask the student teachers to consider two objects that are the same size, one of which floats in water and one of which sinks. Ask the student teachers: "*Why? What is different about these objects?*"
5. Explain to the student teachers that they have space in their Student Teacher Textbook to record the definition of density and the formula to calculate the density of a substance.
6. Draw the student teachers' ideas together to collectively define density as: *a measure of mass per volume.*
   The density, ρ, of a material is the mass, m, per unit volume, V, that a material contains:
   $$\rho = \frac{m}{V}$$
7. Ask the student teachers how density is related to whether an object will sink or float.
8. Explain that when objects are placed in a liquid, they sink or float depending on whether they are more dense or less dense than the fluid in which they are placed. Objects that are denser will sink, while objects that are less dense than the liquid will float.
9. Explain to the student teachers that in this practical learning activity they will be investigating the density of various substances in different ways.
10. Tell the student teachers that they will receive various substances that have been cut into regular sizes. The student teachers need to measure the dimensions of each substance, calculate the volume of the substance, and then determine its density. Remind student teachers that they need to use the rulers to measure the dimensions in centimetres. They can then determine the volume by: length x width x height of the object.

11. The student teachers should record the information in Table 8.4.
12. Explain that the student teachers will then need to make a prediction about whether the substance will sink or float in water. They need to record the prediction in the table and then place the substance in water and record their observations. The student teachers should try to explain any predictions that did not match their observations.
13. The student teachers will then use the water displacement method to determine the densities of irregularly shaped objects. The method and explanation are given in the Student Teacher Textbook. For this part of the activity, the student teachers can find objects in the classroom or that they have with them (e.g., pens, coins, and so on) and determine the density of those objects.
14. Divide the student teachers into groups and provide each group with the materials needed for the activity.
15. Direct the student teachers to work through the activity and observe the student teachers as they work.
16. Assist where required. When measuring the water displacement of objects that do not sink, provide the student teachers with toothpicks to hold the object just under the surface of the water.

Assessment

Check student teachers' calculations as they work. Listen to student teachers' conversations as they test their predictions, and guide student teachers to provide scientific explanations if there is a discrepancy between their prediction and observation.

Possible student teachers' responses

Responses will vary depending on the substances provided for student teachers to measure. If predictions about floating or sinking do not match observations, this may be due to objects not being a precise shape for volume to be accurately determined.

Learning activity 2. Think-pair-share: Archimedes' principle

Time	20 minutes
Class organisation	Individual, pairs, and whole class

Purpose

The purpose of this learning activity is for student teachers to use Archimedes' principle to solve problems related to sinking and floating objects.

1. Demonstrate the orange experiment to the student teachers by placing a peeled orange and an unpeeled orange into water. Ask the student teachers to explain why one orange sinks and one orange floats. Encourage the student teachers to use their knowledge and understanding of density from the previous learning activity.
2. Explain to the student teachers that there is information in the Student Teacher Textbook about buoyant force and Archimedes' principle, which further explains the physics fundamental to floating and sinking objects.
3. Direct the student teachers to read through the background information.
4. When the student teachers have read the information, ask if there are any questions and respond to any queries.
5. Tell the student teachers that there are two problems relating to Archimedes' principle in the Student Teacher Textbook, which they should work through in pairs to check their understanding.
6. Direct the student teachers to work in pairs to solve the problems.
7. Ensure there is time remaining at the end of the learning activity for the student teachers to share their calculations. Ask the student teachers to contribute their understanding as you check their calculations. Tell the student teachers to add any information to their working to support their understanding.

Assessment

Check student teachers' calculations as they work. Listen to student teachers' conversations and provide feedback to pairs as you inspect their work. The peer discussion will provide student teachers with feedback.

Correct student teachers' responses

Question 1: Since the wood is floating, $F_w = F_B$.

So, $F_w = mg = \rho Vg = 500 \times 5 \times 5 \times 0.3 \times 9.8 = 36{,}750$N. So, the buoyant force has a magnitude of 36,750N and is pointing upward.

How much of the wood is displaced? The buoyant force is the weight of the water displaced.

$36{,}750 = mg = \rho V g$

$V = 36{,}750 / (\rho g)$

$= 36{,}750 / (1000 \times 9.8)$

$= 3.75 m^3$

Since the volume of wood that is submerged equals the volume of water displaced, the volume of wood submerged is $3.75 m^3$.

Question 2: The magnitude of the buoyant force equals the weight of the boat before the cargo is added.

So, $F_B = mg = 5000 \times 9.8 = 49{,}000N$.

When the cargo is added, the weight of the boat will become $F_w = 6000 \times 9.8 = 58{,}800N$.

The maximum buoyant force is equal to the weight of the sea water displaced when the whole boat is *just* submerged.

We know that a buoyant force of 49,000N is equal to one third of the boat being submerged (no cargo). So, the whole boat being submerged has a buoyant force of $3 \times 49{,}000N = 147{,}000N$, which is greater than the weight of the boat with the cargo.

Therefore, the magnitude of the buoyant force will be able to match the weight of the boat with cargo. The boat will remain floating.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Remind the student teachers of the learning objectives of the lesson;
- Ask the student teachers if they feel they have achieved the learning outcomes for the lesson; and
- Address any questions that the student teachers may have about the lesson.

Expected student teachers' responses for the review questions in TB

Question 1: How is mass measured using a scale?

Answer: *The scale reads the normal force, and the reading on the scale is the normal force divided by g.*

Question 2: How would you explain gravitational force to Grade 1/2 students?

Answer: *Explain that all objects with mass attract each other. Teaching these concepts to Grade 1/2 students can be enhanced with visual support. Draw a diagram to show the forces acting between two objects. Explain that the Earth attracts objects on its surface, with a force directed towards the centre of the Earth.*

Question 3: How would you explain to a Grade 1/2 student the forces acting on a floating object?

Answer: *Draw a diagram of a floating object, such as a toy boat on water, or demonstrate a floating boat in a tub of water in the classroom. Draw both the weight force and the buoyant force, ensuring that both arrows are the same length to indicate that the forces have the same magnitude. Use language that is familiar and age-appropriate to the students at Grade 1/2 level.*

8.2. Waves: Light

In this sub-unit, student teachers will explore the interactions of light with objects and investigate the different ways light behaves depending on the materials it contacts. They will explain reflection, refraction, and absorption of light using real-life examples. Student teachers will draw ray diagrams to demonstrate the path of light as it encounters different materials and discuss refraction of light in the context of the human eye.

Student teachers will continue to develop ways of working scientifically and design learning activities about the behaviour of light suitable for Grade 1/2 students.

8.2.1. Nature of light

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Explain how the properties of materials affect the behaviour of light, including shadow formation;
- Describe the difference between the laws of refraction and reflection with real-life examples;
- Explain absorption of light using examples from everyday life;
- Design a learning activity for a Grade 1/2 class that identifies and classifies sources of light;
- Use diagrams to show the path of light as it contacts concave and convex lenses; and
- Describe the application of refraction of light in the context of the human eye.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: Two periods of 50 minutes

Learning strategies

Learning activity 1. Group work: Design a learning activity about sources of light

Learning activity 2. Scavenger hunt: Behaviour of light

Learning activity 3. Pairs: Ray diagrams

Learning activity 4. Think-pair-share: The human eye

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 8.2.1.

Resources needed

Learning activity 1. Nil (other than Student Teacher Textbook and pen)

Learning activity 2. Pencils, rulers

Learning activity 3. Pencils, rulers

Learning activity 4. Nil (other than Student Teacher Textbook and pen)

Period 1

Nature of light

This period is structured as follows:

Learning activity 1	20 minutes
Learning activity 2	25 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Group work: Design a learning activity about sources of light

Time	20 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to design a learning activity for a Grade 1/2 class that identifies and classifies sources of light.

1. Ask the student teachers to brainstorm sources of light. As suggestions are made, write them in a vertical list on the board.
2. When the student teachers have contributed at least 10 ideas about sources of light, draw a table around the list of light sources with two additional columns. Label these columns 'artificial' and 'natural'.
3. Ask the student teachers to classify each source of light as artificial or natural.
4. Direct the student teachers to the learning activity in the Student Teacher Textbook.
5. Explain that some sources of light are given in Table 8.5. The student teachers can add to the list with ideas of light sources from the brainstorming activity.
6. Explain that in this learning activity the student teachers will work in small groups to design a learning activity for a Grade 1/2 class that identifies and classifies sources of light.
7. Tell the student teachers that there are some guiding questions in the Student Teacher Textbook, which they should consider as they design a learning activity.

8. Divide the student teachers into small groups and direct them to design a learning activity.
9. Explain that there is space in the Student Teacher Textbook to record notes and/or a script about the learning activity.

Assessment

Listen to student teachers' conversations and provide feedback about the learning activities as you observe their work. Ensure the learning activities are suitable for Grade 1/2 learners. If necessary, remind student teachers that at Grade 1/2 the topic of 'light' is not explicitly taught in the curriculum, and encourage student teachers to identify a suitable opportunity to embed their activity in the curriculum.

Possible student teachers' responses

Student teachers' learning activities will vary. Check the learning activities are engaging, have clear learning objectives, can be differentiated depending on student needs, have appropriate levels of language, and can be implemented in a Primary classroom.

Learning activity 2. Scavenger hunt: Behaviour of light

Time	25 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to observe the behaviour of light in contact with various materials.

1. Ask the student teachers what happens to light when it strikes an object.
2. Ask the student teachers whether light behaves differently depending on the type of material it strikes.
3. Display Figure 8.5 or direct student teachers to Figure 8.5 in the Student Teacher Textbook.

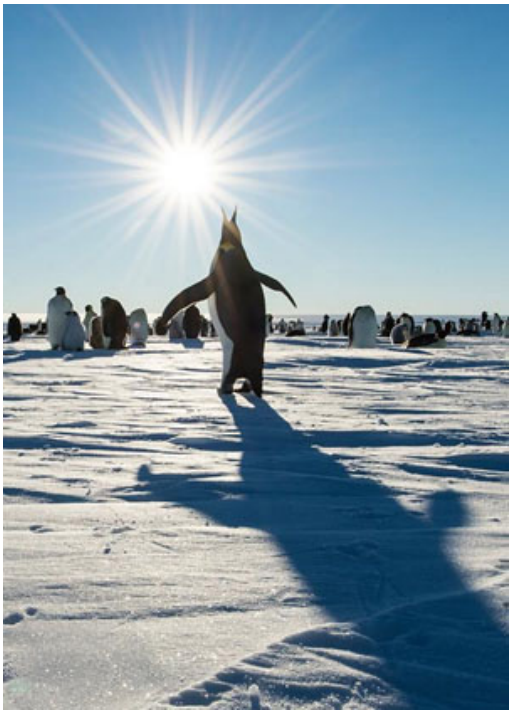


Figure 8.5. A penguin's shadow

4. Facilitate a quick think-pair-share activity using the image in Figure 8.5, by asking student teachers the following questions:
   - What is the source of light in this image? (The sun)
   - How would you describe the object the light strikes? (Opaque)
   - Where does the shadow form? (On the snow)
5. For each question, direct the student teachers to think of their answer, share it with another student teacher, and then share their response with the class.
6. Explain that ray diagrams are used to show the path of light as it encounters materials. The type of material determines how the light behaves.
7. Explain to the student teachers that they have some background information in their Student Teacher Textbooks.
8. Instruct the student teachers to read through the background information.
9. When the student teachers have read the information, ask if there are any questions and respond to these if required.
10. Explain that the student teachers will now conduct a scavenger hunt activity in pairs.

11. Explain that, during the scavenger hunt, student teacher pairs will move around the classroom to find objects and describe how each object affects the path of light. Student teachers will record the information in Table 8.6 and draw ray diagrams to explain the behaviour of the light.
12. Explain to the student teachers that they should include at least one coloured object, find at least one example of refraction (have an object such as a pencil or some flowers in a jar of water in the classroom), and find transparent, translucent, and opaque materials and a shadow.
13. Direct the student teachers to form pairs and complete the scavenger hunt activity.

Assessment

Observe student teachers as they conduct the scavenger hunt activity and listen to their conversations to ensure they have understood the concepts. If necessary, support student teachers to find the objects described for the scavenger hunt. For example, ask student teachers where they might observe refraction occurring (reminding them that there must be two different mediums), and encourage student teachers to look for objects that are in water (or oil or other substance).

Possible student teachers' responses

Student teachers' responses will vary depending on the objects they find and the light sources in the classroom.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Check for student teachers' understanding by asking each pair of students to draw an example of a ray diagram on the board to share with the class, labelling the diagrams appropriately.

Period 2

Concave and convex lens

This period is structured as follows:

Introduction/Explicit teaching	15 minutes
Learning activity 3	10 minutes
Learning activity 4	20 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	15 minutes
Class organisation	Individual and pairs

Purpose

The purpose of this learning activity is for student teachers to understand the images produced by convex and concave lenses.

1. Begin by reading through the lesson outcomes for this period:
   - Use diagrams to show the path of light as it contacts concave and convex lenses.
   - Describe the application of refraction of light in the context of the human eye.
2. Elicit prior knowledge by asking student teachers:
   - What is a lens? (A transparent material with curved sides that focuses or disperses a light by means of refraction.)
   - What is the purpose of lenses? (To focus or magnify an image.)
   - Can you give an example of where a lens might be used? (Telescopes, glasses, magnifying glass, eye, traffic and car mirrors, cameras, microscopes, and so on.)
   - How is a lens different to a mirror? (A mirror reflects light; a lens refracts light.)

- What is a concave lens?
- What is a convex lens?

3. Explain to the student teachers that you will work through the background information about concave and convex lenses in the Student Teacher Textbook. Encourage the student teachers to make additional notes in the textbook as you introduce concave and convex lenses.
4. Work through Figures 8.12 and 8.13 with the student teachers. These show concave and convex lenses. Ensure that the student teachers know:
   - Lenses are curved pieces of transparent material that refract light.
   - A convex lens curves outwards and causes parallel light rays to converge after they refract through the lens; the light rays converge at a point known as the 'focal point'.
   - A concave lens curves inwards and causes parallel light rays to refract away from each other; light rays appear to come from a focal point in front of the lens.
5. Explain that ray diagrams are used to predict the size and orientation of images after they have passed through a lens.
6. Work through the rules for drawing ray diagrams for concave and convex lenses. Draw the ray diagrams on the board as you work through the rules.
   Rules for drawing ray diagrams for convex lenses:
   - Light rays that are parallel to the principal axis will pass through the focal point after refraction.
   - Light rays that pass through the optical centre will continue in a straight line without refraction.
   - Light rays that pass through the focal point before the lens will become parallel to the principal axis after refraction.

   Rules for drawing ray diagrams for concave lenses:
   - Light rays that are parallel to the principal axis will appear to come from the opposite focal point after refracting through the lens.
   - Light rays that pass through the optical centre will continue in a straight line without refraction.
   - Light rays that are directed at the opposite focal point will become parallel to the principal axis after refraction.

Learning activity 3. Pairs: Ray diagrams

Time	10 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to practise drawing ray diagrams to understand the images produced by convex and concave lenses.

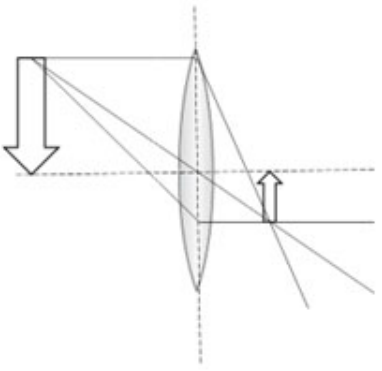
1. Explain that the student teachers will work in pairs to practise drawing ray diagrams, to understand the images produced by convex and concave lenses.
2. Instruct the student teachers to form pairs and work through the ray diagrams in Table 8.7 in the Student Teacher Textbook.
3. Provide support where required.

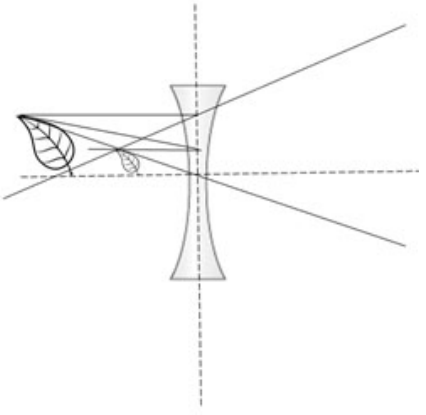
Assessment

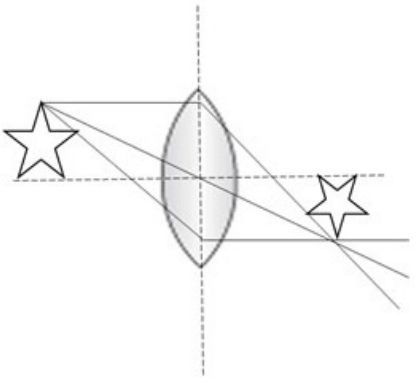
Observe student teachers' work and listen to their conversations. This is a good opportunity to assess student teachers' understanding of ray diagrams and the behaviour of light.

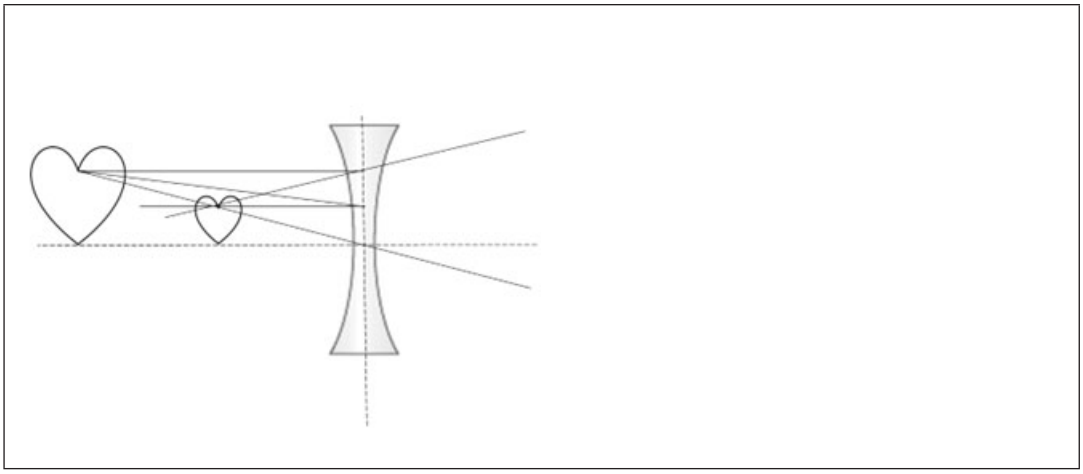
Correct student teachers' responses

Table 8.7. Ray diagrams – Completed









Learning activity 4. Think-pair-share: The human eye

Time	20 minutes
Class organisation	Individual, pairs, and whole class

Purpose

The purpose of this learning activity is for student teachers to describe refraction of light in the context of the human eye.

1. Explain that the student teachers have a list of the structures of the human eye in Box 8.3. The functions of these structures are listed in Table 8.8.
2. Explain that the student teachers should work independently to try to match the functions to the structures of the human eye. When they have completed this, the student teachers need to identify the locations of the structures and label the diagram of the eye in Figure 8.16.
3. Explain that the student teachers will initially work independently and then form pairs to discuss their responses.
4. Explain that you will then facilitate a discussion about the structures of the human eye.
5. Direct the student teachers to begin the learning activity. As they complete the work independently, instruct the student teachers to share their responses with the student teacher beside them.

6. Once the student teachers have had the opportunity to discuss their responses in pairs, facilitate a class discussion about the structures and functions of the human eye. Correct responses are given below.
7. Ask the student teachers whether the lens of the human eye is concave or convex, and direct them to consider the shape of the lens in their responses (convex).
8. Ask the student teachers to draw a simple image (such as a tree) in front of the diagram of the human eye in Figure 8.16. Ask the student teachers to draw a ray diagram to show the path of light of the image. The student teachers should draw a ray diagram similar to those in the previous learning activity.
9. Ask the student teachers to describe the image that would form on the retina. The student teachers should notice that the resulting image is smaller and inverted on the retina.
10. Explain that the brain inverts the image again so that we detect our surroundings in the correct orientation.

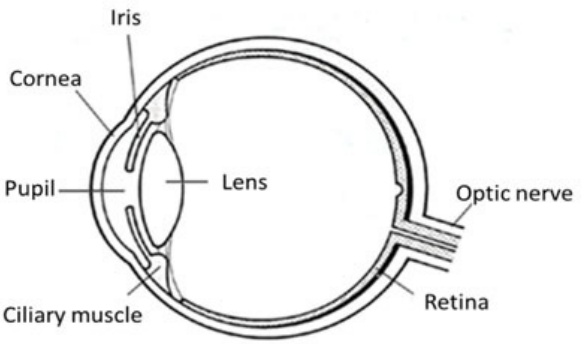
Assessment

Observe the student teachers' work and listen to their conversations. This is a good opportunity to assess student teachers' understanding. The discussion will provide student teachers with feedback and consolidate their understanding.

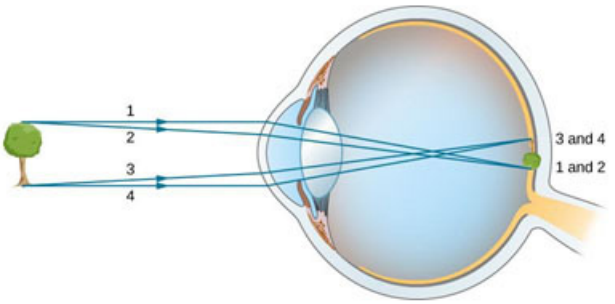
Correct student teachers' responses

Table 8.8. Functions of the structures of the human eye – Completed

Structure	Function
Retina	Contains the cells that detect light.
Optic nerve	Transmits information to the brain.
Ciliary muscle	Controls the shape of the lens.
Iris	Controls the size of the pupil.
Pupil	Opening to the inner eye where the light enters the eye.
Cornea	Outermost, transparent layer of the eye that begins the focusing process; refracts light.
Lens	Focuses image of the object.



(a) Structures of the human eye



(b) Example of ray diagram[4]

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson, check for student teachers' understanding by reflecting on the learning objectives from the lesson:

- Explain how the properties of materials affect the behaviour of light, including shadow formation;

4 https://cnx.org/contents/rydUIGBQ@20.1:h-o37jYA@7/2-5-The-Eye?minimal=true Image licensed under CC BY-SA 4.0. View license: https://creativecommons.or g/licenses/by-sa/4.0/

- Describe the difference between the laws of refraction and reflection with real-life examples;
- Explain absorption of light using examples from everyday life;
- Design a learning activity for a Grade 1/2 class that identifies and classifies sources of light;
- Use diagrams to show the path of light as it contacts concave and convex lenses; and
- Describe the application of refraction of light in the context of the human eye.

Read through the learning objectives and ask student teachers to indicate how well they feel they have achieved each learning objective by using a 'thumbs up' (well), 'thumbs to the side' (okay), or 'thumbs down' (not very well) indicator.

Expected student teachers' responses for the review questions in TB

Question 1: Explain why the colour of a light source does not affect the colour of a shadow.

Answer: *Shadows occur when the path of light is blocked by an object. Shadows form from the absence of light. It does not matter what the colour of the light source is because the absence of light is darkness. Shadows will always appear black.*

Question 2: Consider the diagram in Figure 8.17. The image forms behind the retina in a condition known as farsightedness (hyperopia). What type of lens could be used for the image to form on the retina? Explain how this lens would correct the condition.

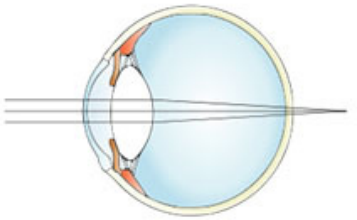


Figure 8.17. Ray diagram showing farsightedness (hyperopia)[5] – Completed

Answer: *A convex lens will converge the light rays, causing the image to form closer to the lens and upon the retina. The curve of the lens can be controlled to ensure the image forms on the correct structure of the eye.*

Question 3: Draw a ray diagram to show how this lens would correct this condition.

Answer:

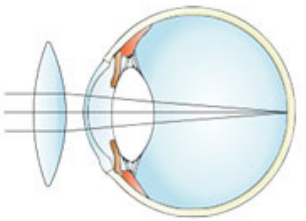


Figure 8.17. Figure diagram correcting farsightedness (hyperopia)[6]

5 Adapted from https://commons.wikimedia.org/wiki/File:Hypermetropia_color.svg#filelinks Image by Гуменюк И.С. licensed under CC BY-SA 4.0. View license: https://creativecommons.org/licenses/by-sa/4.0/

6 Adapted from https://commons.wikimedia.org/wiki/File:Hypermetropia_color.svg#filelinks Image by Гуменюк И.С. licensed under CC BY-SA 4.0. View license: https://creativecommons.org/licenses/by-sa/4.0/

8.3. Heat Energy

In this sub-unit, student teachers will explore the thermal expansion of substances in one, two, and three dimensions. Student teachers will explore real-life examples of thermal expansion and consider how these concepts can be incorporated into a Grade 1/2 classroom.

8.3.1. Thermal expansion of substances

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Identify that thermal energy is an internal energy of matter;
- Examine linear, area, and volume expansion using the coefficient of thermal expansion; and
- Develop a simple explanation suitable for a Grade 1/2 class that explains some of the everyday applications and consequences of thermal expansion.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Think-pair-share: Thermal expansion in solids, liquids, and gases

Learning activity 2. Group work: Design an explanation of thermal expansion

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Read the lesson activities.

Ensure you are familiar with the formulae and calculations.

Resources needed

Learning activity 1. Calculators

Learning activity 2. Chart paper, marker pens

This period is structured as follows:

Introduction/Explicit teaching	10 minutes
Learning activity 1	20 minutes
Learning activity 2	15 minutes
Check student teachers' understanding	5 minutes

Introduction/Explicit teaching

Time	10 minutes
Class organisation	Whole class

1. Read out the learning objectives for the lesson:
   - Identify that thermal energy is an internal energy of a matter;
   - Examine linear, area, and volume expansion using the coefficient of thermal expansion; and
   - Develop a simple explanation suitable for a Grade 1/2 class that explains some of the everyday applications and consequences of thermal expansion.
2. Explain that thermal energy was discussed in Semester 1.
3. Ask the student teachers for their understanding of thermal energy.
4. Prompt the brainstorm with questions such as:
   - What is heat?
   - What are the units in which heat energy is measured?
   - How is something determined to be 'hot' or 'cold'?
   - What happens when two objects of different temperatures come into contact with each other, such as ice being put into a glass of water at room temperature?
   - What is thermal expansion?
   - Can you recall an example of thermal expansion?
5. Explain that liquid-in-glass thermometers are based on the principle of thermal expansion. Explain that the student teachers will investigate thermal expansion in more detail in this period.

Learning activity 1. Think-pair-share: Thermal expansion in solids, liquids, and gases

Time	20 minutes
Class organisation	Individual, pairs, and whole class

Purpose

The purpose of this learning activity is for student teachers to apply the coefficient of thermal expansion in real-life contexts.

1. Explain to the student teachers that an object will change in size with a change in temperature.
2. Remind the student teachers that a liquid-in-glass thermometer is an example of this. As temperature increases, the particles of the liquid begin to move faster, expanding the liquid's volume. When the temperature decreases, the particles of the liquid begin to slow down and cover less area with their motion. This results in a contraction of the liquid's volume.
3. Explain to the student teachers that they have more information about thermal expansion in their Student Teacher Textbooks.
4. Direct the student teachers to read through the information about linear thermal expansion and then work in pairs to solve Question 1.
5. Once the student teachers have completed Question 1, invite pairs of student teachers to share their answers and how they solved the problem. Ensure that all student teachers have the correct response before moving on.
6. Ask the student teachers to give other examples of when linear expansion could occur.
7. Direct the student teachers to read the information about thermal expansion in two and three dimensions and work in pairs to answer the questions.
8. Once the student teachers have completed the questions, invite pairs of student teachers to share their answers and how they solved the problem.

Assessment

Listen to student teachers' conversations as they work through the questions. This is a good opportunity to assess student teachers' understanding. Answer any questions the student teachers raise. The discussion will provide student teachers with feedback and consolidate their understanding.

Correct student teachers' responses

Question 1: The bridge changes in length by 1.06m from the coldest temperature to the warmest temperature.

$\Delta L = \alpha L \Delta T$

$= 12 \times 10^{-6} \times 3.4\text{km} \times (40°\text{C} - 14°\text{C})$

$= 0.00106\text{km}$

$= 1.06\text{m}$

Question 2: 34m^3

Question 3: 0.2cm (0.002m)

Question 4: 39,050L

Learning activity 2. Group work: Design an explanation of thermal expansion

Time	15 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to develop a simple explanation suitable for a Grade 1/2 class that explains some of the everyday applications and consequences of thermal expansion.

1. Explain to the student teachers that the concept of thermal expansion is not explicitly part of the Grade 1/2 curriculum.

2. Explain that at this level the strand of 'Energy' is integrated in other stands of the Science curriculum.
3. Explain to the student teachers that they will work in small groups to develop a simple explanation that would provide the opportunity to introduce the concept of thermal expansion to students in a Grade 1/2 classroom.
4. Explain that the student teachers will work in small groups to develop an explanation and then briefly share their ideas with the class.
5. Explain that there are some guiding questions that the student teachers can consider as they develop their explanations.
6. Direct the student teachers to form groups of 3-4 and provide each group with chart paper and marker pens.
7. Instruct the student teachers to develop their explanations.
8. Allow five minutes at the end of the activity for groups to share their explanations with the class.

Assessment

Listen to student teachers' conversations as they develop an explanation for a Grade 1/2 class. Ensure the language is appropriate for the age group and literacy level of Grade 1/2 students. Ensure student teachers can use a relevant example to help students understand. Provide verbal feedback as student teachers share their explanations with the class.

Possible student teachers' responses

Student teachers' explanations will vary. Check for scientific accuracy and suitable literacy level for Grade 1/2 students.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Check for student teachers' understanding by asking for real-life applications of the coefficient of thermal expansion; and

- Ask student teachers when or where it is important to consider this and where it might be observed.

Answers might include building/construction or houses, bridges, railways, objects that are heated such as glass dishes, petrol tanks made of metal that must allow for expansion of petrol, and so on.

Expected student teachers' responses for the review questions in TB

Question 1: How would you explain the thermal expansion of liquid in a liquid-in-glass thermometer to Grade 1/2 students?

Answer: *Demonstrate thermal expansion of a liquid using a thermometer or constructing a similar device. Show and draw illustrations to explain that as the temperature increases, the liquid expands and takes up more space in the glass tube. As it cools, the liquid takes up less space in the tub*e.

Question 2: How does a change in temperature affect the dimensions of a system?

Answer: *Most materials expand when their temperatures increase. A change in the length of an object is proportional to the change in temperature and to the length of the object. Similarly, a change in an object's area or volume is proportional to the change in temperature and the dimensions of the object.*

Question 3: You need to fill the 60L petrol tank of a car in Naypyidaw. The petrol costs 1000 Kyat per litre. You know that at 2pm the temperature will be 40°C but at 2am it will be 20°C. How much money will you save by filling up at 2am rather than 2pm?

Answer: *Change in volume = 60L × 950 × 10^{-6} × (40°C – 20°C) = 1.14L*

At a cost of 1000 Kyat per litre, the saving is 1140 Kyat.[7]

7 Please note that this is a hypothetical scenario and does not consider other aspects of thermal expansion (such as the material from which the tank is composed) or the storage temperature of the petrol.

8.4. Electricity and Magnetism

In this sub-unit, student teachers will explore electric charge, electric force, and electric field, including the use of Coulomb's law to quantify the forces between charged particles. They will construct an electromagnet and investigate the variables that affect the magnetic field. Student teachers will explore the real-life applications of electromagnets and consider how these concepts can be integrated into the Grade 1/2 curriculum.

8.4.1. Electric force and electric field

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Explain electric charges and their properties;
- Describe the difference between electric force and electric fields and distinguish their units; and
- Apply Coulomb's law to quantify the force between charged particles.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

A5.1.3 Describe approaches used to promote learning in key areas of literacy, numeracy, science, and social studies for the grade levels taught and linked to real life

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Practical: Measuring static electricity

Learning activity 2. Pairs: Coulomb's law

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Read the Student Teacher Textbook Lesson 8.4.1.

Purchase the materials.

Resources needed

Learning activity 1. Paper confetti, paper plates, balloons, ruler, wood blocks, cotton fabric, balls of wool, plastic

Learning activity 2. Nil (other than Student Teacher Textbook and pen)

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Practical: Measuring static electricity

Time	25 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to explain electric charges and their properties through a practical investigation about static electricity.

1. Remind the student teachers that in Sub-unit 4.4 (Semester 1), they began to discuss electrification via friction, that is, the transfer of electrons from one surface to another.
2. Explain to the student teachers that in this practical learning activity they will investigate the electrification of different materials to explain the properties of electric charges.
3. Tell the student teachers that they have the method for the practical activity in the textbook. Direct the student teachers to read through the method.
4. When they have read through the method, divide the student teachers into small groups and provide each group with the materials for the practical.
5. Instruct the student teachers to conduct the practical and answer the questions that follow.
6. At the end of the learning activity, facilitate a discussion about the properties of electric charges to ensure student teachers' understanding. Correct or possible student teachers' responses are given below.
7. After the discussion, explain that the practical does not show the exact amount of static electricity an object has, but it does allow the relative amounts of static electricity the materials contain to be observed.

Assessment

Listen to student teachers' conversations as they work through the questions. This is a good opportunity to assess student teachers' understanding. The discussion will provide student teachers with feedback and consolidate their understanding.

Correct student teachers' responses

Question 1: What effect does the material used to make static electricity have on the amount of charge transferred?

Answer: Different materials accept and transfer electrons differently. Some materials transferred more electrical charge than others. Hair should transfer the most charge. Wood and plastic should not transfer much charge.

Question 2: What does it indicate when more pieces of paper stick to the balloon? Explain your answer in terms of electron transfer.

Answer: When more pieces of paper stick to the balloon, it indicates that the material has a higher static charge. The fewer pieces of paper, the less the static charge. The balloon gains electrons from the human hair. The human hair loses electrons. The balloon gains fewer electrons from the wood than from hair.

Question 3: What are the properties of the electrical charge that you observed in this practical?

Answer: Charge can be quantified. (Ensure that student teachers know that in this practical, the charge was not quantified; rather the relative amounts of charge were observed.) The overall amount of charge between the two objects stayed the same. Even though the protons and electrons moved, the overall amount of charge did not change. Opposite charges attract, like charges repel.

Learning activity 2. Pairs: Coulomb's law

Time	20 minutes
Class organisation	Pairs

Purpose

The purpose of this learning activity is for student teachers to apply Coulomb's law to quantify the force between charged particles and model the electric field between point charges.

1. Explain to the student teachers that there is background information about electric force, Coulomb's law, and electric field in the Student Teacher Textbook.
2. Instruct the student teachers to read through the background information.
3. After the student teachers have read the background information, direct them to work in pairs to answer the questions in the textbook.

Assessment

Check the responses to the questions.

Correct student teachers' responses

Question 1:

$$F = k\frac{|q_1||q_2|}{r^2} = 8.99 \text{ x } 10^9 \frac{2\text{x}3}{1000^2} = 53{,}940\text{N}$$

Figure. Illustration of direction of the forces acting on both charges (Question 1)

Question 2:

$$F = k\frac{|q_1||q_2|}{r^2} = 8.99 \text{ x } 10^9 \frac{1 \text{ x } 4}{200^2} = 899{,}000\text{N}$$

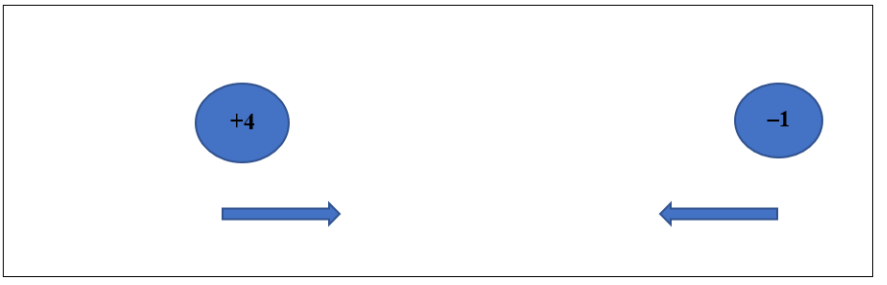


Figure. Illustration of direction of the forces acting on both charges (Question 2)

Question 3: Electric field lines flow out of positive charges and into negative charges. The four charges are also equal in magnitude because they have the same number of lines.

Question 4: B has the greatest charge, shown by the greatest number of lines moving away from the electric charge. C has the smallest electric charge, shown by the fewest number of lines moving away from the charge.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Reflect on the learning objectives and teacher competencies for the lesson;
- Ask the student teachers if they feel they have accomplished the objectives for the lesson; and
- Address any questions that student teachers have about the lesson content.

8.4.2. Electromagnetism

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Perform a demonstration suitable for a Grade 1/2 class that demonstrates the magnetic effect of electric current;
- Explain how alterations to the solenoid would change its magnetic field; and
- Discuss the uses of electromagnets.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Practical: Constructing an electromagnet

Learning activity 2. Gallery walk: Uses of electromagnets

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Source materials for the practical activity and research task.

Check that the material you have sourced for the practical works to construct an electromagnet and that students will get results.

Resources needed

Learning activity 1. Insulated copper wire, large iron nail, sandpaper, batteries, paperclips, tape

Learning activity 2. Internet access, magazines, information sheets, textbooks, chart paper, marker pens

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Practical: Constructing an electromagnet

Time	25 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to investigate the magnetic effect of electric current.

1. Read out the learning objectives for this learning activity:
   - Perform a demonstration suitable for a Grade 1/2 class that demonstrates the magnetic effect of electric current; and
   - Explain how alterations to the solenoid would change its magnetic field.
2. Direct the student teachers to read through the background information about electromagnets in the Student Teacher Textbook.
3. Once the student teachers have read through the background information, explain that they will be working in small groups to construct an electromagnet and investigate ways to change the strength of the magnetic field.
4. Ensure the student teachers are aware of the safety risks with this investigation: that the electromagnet can get very warm, especially at the terminals, so the battery should be disconnected frequently. The student teachers should use an implement, such as a pencil to push the magnet off the battery and let the coil cool before adjusting the set-up.
5. Direct the student teachers to read the method in the Student Teacher Textbook.
6. Explain that they will construct an electromagnet and test it by observing how many paperclips it can hold. The student teachers will then need to make changes to the electromagnet to investigate how the strength of the magnetic field changes with alterations to the electromagnet and complete Table 8.12.

7. Divide the student teachers into groups of about 4 and provide each group with the resources.
8. Once the student teachers have completed the practical activity, facilitate a discussion using the explanatory information and the results from their investigations.

Assessment

Ensure the student teachers are working safely during the practical activity. Check that student teachers are conducting a fair test to obtain valid information by only changing one variable at a time. Listen to their conversations and correct any misunderstandings. The discussion at the end of the learning activity will provide student teachers with feedback.

Possible student teachers' responses

The student teachers should observe that the electromagnet attracts more paperclips with more coils and when using batteries with higher current.

Learning activity 2. Gallery walk: Uses of electromagnets

Time	20 minutes
Class organisation	Small groups

Purpose

The purpose of this learning activity is for student teachers to explore the real-life uses of electromagnets.

1. Explain to the student teachers that electromagnets are widely used in electric and electro-mechanical equipment.
2. In this learning activity, the student teachers will work in small groups to investigate a real-life use of electromagnets and create a poster about the use.
3. Explain that the student teachers will have 15 minutes to create a poster that will then be displayed in the classroom. The student teachers will conduct a gallery walk to observe the posters that other groups have created showing real-life uses of electromagnets.

4. Provide the student teachers with chart paper, markers, and resources for research, such as Internet access, books, magazines, or information sheets.
5. Allow the student teachers to choose the example of electromagnet they research, but ensure groups select different applications. Interesting examples include doorbells, hard drives, speakers, maglev (magnetic levitation) trains, anti-shoplifting systems, microphones, home security systems, and motors.

Assessment

Listen to student teachers' conversations as they research the uses of electromagnets. Provide support where required.

Possible student teachers' responses

This is an open-ended activity. Student teachers' posters will vary depending on the application of electromagnet they choose.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson:

- Ask student teachers to share one interesting fact about electromagnets that they learnt during the lesson.

Expected student teachers' responses for the review questions in TB

Question 1: How would you explain the relationship between distance and electric force between two charges?

Answer: *The force between the two charges is inversely proportional to the distance between the charges squared.*

Question 2: How would you explain the direction of a magnetic field produced by an electromagnet?

Answer: *Using the right-hand rule: the direction of the magnetic field and the north and south pole of the electromagnet can be found by curling your right hand in the direction of the current. Your thumb will point towards the north pole.*

8.5. Earth and Space

In this sub-unit, student teachers will explore the features of the solar system and construct models to represent the celestial bodies. Student teachers will compare the features of the major planets and explore the modern technologies being used to investigate the solar system. Student teachers will explain the real-life benefits of space exploration and satellite technologies.

8.5.1. Solar system

Expected learning outcomes

By the end of this lesson, student teachers will be able to:

- Collaboratively construct a model of the features of the solar system suitable as a teaching resource for a Grade 1/2 class, including planets, dwarf planets, moons, asteroids, comets, and meteors;
- Explore the differences in the major planets of the solar system including orbital and rotational periods; and
- Explain the methods used to explore the solar system and how we benefit from satellite technology.

Competencies gained

A5.1.1 Describe key concepts, skills, techniques and applications for the subjects covered in the grade levels taught

A5.1.2 Include in lessons accurate and relevant information, examples and exercises to support student learning of subject content and skills

Time: One period of 50 minutes

Learning strategies

Learning activity 1. Modelling: Solar system

Learning activity 2. Research: Exploring the solar system

Assessment approaches: Questioning, observation, peer and whole class discussion, reviewing student work

Preparation needed

Write relevant learning outcomes on board.

Have resources available for research task and modelling activity.

Resources needed

Learning activity 1. Corkboards, toothpicks or pins, plasticine or playdough, paper, straws, rulers, sticky tack, marker pens

Learning activity 2. Internet access or other resources for research such as textbooks, newspaper or magazine articles, textbooks

This period is structured as follows:

Learning activity 1	25 minutes
Learning activity 2	20 minutes
Check student teachers' understanding	5 minutes

Learning activity 1. Modelling: Solar system

Time	25 minutes
Class organisation	Individual, pairs, groups, and whole class

Purpose

The purpose of this learning activity is for student teachers to work collaboratively to construct a model of the solar system suitable as a teaching resource for a Grade 1/2 class.

1. Explain to the student teachers that they will work in small groups to construct a model of the solar system.
2. Direct the student teachers to the textbook and explain that they have information about the relative sizes of the planets of the solar system.
3. The student teachers also have information about the moons, orbital and rotational periods, and other aspects of the solar system.
4. Explain that the groups will be provided with a corkboard and that the model can be constructed by using toothpicks or pins to attach the features of the solar system to the board.
5. Tell the student teachers to begin by constructing a model of the major planets of the solar system and then think of creative ways to incorporate other aspects such as comets and moons.
6. Divide the student teachers into groups of about 6 and provide each group with resources to construct their solar system model.

Assessment

Check student teachers' models for accuracy of information, including the locations of the planets relative to the sun and relative size. Check that other features of the solar system have been incorporated where possible.

Possible student teachers' responses

Models will vary depending on how student teachers choose to construct the models.

Learning activity 2. Research: Exploring the solar system

Time	20 minutes
Class organisation	Groups of about 4

Purpose

The purpose of this learning activity is for student teachers to research a type of space exploration and explain the benefits of these technologies.

1. Ask the student teachers if they know what a satellite is. Explain that the moon is a natural satellite. Explain that a satellite is an object that orbits a planet or a star.
2. Ask the student teachers if they can think of other examples of natural satellites. (Earth is a natural satellite as it orbits the sun; other planets and so on.)
3. Tell the student teachers that satellites can also be artificial, or human-made.
4. Ask if the student teachers know of any artificial satellites. Student teachers might mention the International Space Station or Global Positioning System.
5. Explain that satellites have many purposes such as:
   - Observing space for dangerous rays coming from the sun
   - Exploring asteroids and comets
   - Obtaining information about the history of stars and the origin of planets
   - Flying near or orbiting other planets to look for evidence of water or to capture close-up pictures for analysis.
6. Explain that satellites are only one way that information about the solar system is gathered. Tell the student teachers that other ways that the solar system is being explored include:
   - Flyby spacecraft
   - Orbiter spacecraft
   - Atmospheric spacecraft

- Lander spacecraft
- Penetrator spacecraft
- Rover spacecraft
- Observatory spacecraft
- Communications and navigation spacecraft.

7. Explain that the student teachers will choose one of these methods to explore in more detail in a group with other student teachers.
8. Direct the student teachers to the textbook and explain that they need to find information to answer the questions in the textbook.
9. Divide the student teachers into groups of about 4 and provide resources to conduct the research.

Facilitator's notes

Tell the student teachers (if Internet is available) that a good starting point is the National Aeronautics and Space Administration (NASA) website.

Assessment

Check student teachers' responses to the questions in the Student Teacher Textbook. Use the NASA website to support student learning where possible.

Possible student teachers' responses

This is an open-ended activity so student teacher responses will vary.

Check student teachers' understanding

Time	5 minutes
Class organisation	Whole class

At the end of the lesson, ask teachers to share the benefits for humans from space exploration, and ask student teachers questions such as:

- What was the purpose of the type of exploration you researched?

- What type of information or knowledge is expected to come from this exploration?
- Are there ways we have already benefited from space exploration?
- How will we continue to benefit from space exploration?

Expected student teachers' responses for the review questions in TB

Question 1: What causes the planets to orbit the sun and the moons to orbit a planet?

Answer: *Gravity. The gravity of the sun keeps the planets in their orbits. The moons orbit a planet because of the gravity of the planet.*

Question 2: Which planet is most similar to Earth?

Answer: *Mars has the closest duration for a rotation on its on axis (24 hours, 37 minutes) when compared to Earth (23 hours, 56 minutes). Venus is the most similar in size to Earth (12,100km diameter compared to 12,750km).*

Question 3: Geostationary satellites are satellites that stay at the same position above Earth. How long is the orbital period of a geostationary satellite?

Answer: *24 hours (its orbital period is equal to Earth's rotational period).*

Question 4: For what purposes might geostationary satellites be useful?

Answer: *Weather satellites that monitor real-time weather in a particular location; some communication satellites so that the antennae on Earth can be pointed permanently at a position in the sky where the satellite is located; navigation satellites.*

Unit Summary

Key messages

- The acceleration of an object of mass (m) depends on the sum of the forces acting on that object.
- Acceleration due to gravity on earth is generally given as 9.8m/s^2 but varies depending on the height from the earth's surface.
- Density is a measure of mass per volume.
- Archimedes' principle describes the forces exerted on a body immersed in a fluid.
- The behaviour of light is affected by the materials with which the light comes in contact, and light can be reflected, refracted, absorbed, and transmitted.
- Lenses are transparent materials that refract light.
- Matter changes in size with changes in temperature and can be predicted using the coefficient of thermal expansion.
- Coulomb's law quantifies the amount of force between two stationaries, electrically charged particles.
- Electric field is the physical field that surrounds an electric charge and exerts force on other charges in the field; it can be visualised using electric field diagrams.
- Electromagnets are coils of wire carrying a current.
- The solar system includes celestial bodies such as planets, moons, dwarf planets, asteroids, comets, and meteors.

Unit reflection

Student teachers should consider ways in which complex Physics concepts can be introduced to students in an engaging way in a Primary school classroom. Student teachers should consider where in the curriculum there is the opportunity to incorporate these concepts.

Student teachers should think of how to ensure that Physics concepts are taught in ways that are relevant to Primary school students and relate to real-life examples.

Student teachers should draw a mind map connecting opportunities in the Grade 1/2 curriculum, Physics concepts, relevant examples, and pedagogical strategies for teaching these concepts.

Further reading

Force and Movement

University Physics Volume 1. Chapter 14. *Fluid mechanics.* (2016, August 3). Simple Book Publishing. https://courses.lumenlearning.com/suny-osuniversityphysics

Waves: Light

Physics tutorial: Vibrations and waves. (n.d.). The Physics Classroom. https://www.physicsclassroom.com/class/waves

Heat Energy

Thermal expansion of solids and liquids. (n.d.). Lumen Physics. https://courses.lumenlearning.com/physics/chapter/13-2-thermal-expansion-of-solids-and-liquids

Electricity and Magnetism

Static electricity – Lesson 4 – Electric fields. (n.d.). The Physics Classroom. https://www.physicsclassroom.com/class/estatics/Lesson-4/Action-at-a-Distance

Earth and Space

Doody, D. (n.d.). *Basics of space flight.* NASA. https://science.nasa.gov/learn/basics-of-space-flight/

Glossary

Terms	Elaborations
5Es	A framework for science learning and teaching where students are supported to think and work scientifically by gathering and analysing evidence and communicating their ideas.
Air	The invisible gas containing oxygen that surrounds the Earth.
Air resistance	The forces that are opposite to the relative motion of an object as it moves through the air.
Amphipathic molecules	Chemical compounds containing both polar and nonpolar portions in their structure.
Anus	The opening at the end of the gastrointestinal tract through which solid waste material leaves the body.
Archimedes' principle	The scientific law that explains the forces acting on objects in fluids.
Asteroid	A small, rocky object that orbits the sun.
Autotroph	A plant that produces its own food (energy) using light, water, carbon dioxide, or other chemicals.
Balanced forces	Equal forces acting in opposite directions.
Buoyant force	A force exerted by a fluid to oppose the motion of an object.
Carbon dioxide	A colourless, odourless gas that is absorbed by plants as part of the process of photosynthesis.
Carnivore	An animal that obtains its energy requirements only through consuming other animals.
Centrifugation	A technique used for the separation of particles from a solution according to their size, shape, density, viscosity of the medium and rotor speed. The particles are suspended in a liquid medium and placed in a centrifuge tube. The tube is then placed in a rotor and spun at a defined speed.
Collaborative	Activity involving two or more people working together to produce a particular outcome.
Colloid	A mixture in which one substance of microscopically dispersed insoluble particles is suspended throughout another substance.
Comet	A small object made of ice and dust that orbits the sun.
Concave	A surface that curves inwards.
Consumer	An organism that cannot make its own food and feeds on other organisms to obtain energy.
Contact force	A force arising from a direct, physical contact.
Convex	A surface that curves outwards.
Coulomb's law	The scientific law that quantifies the amount of force between two stationaries, electrically charged particles.
Density	A material's mass divided by its volume.
Digestion	The breakdown of food into smaller molecules and absorption into the bloodstream.
Digestive system	The system of organs involved in digestion.

Terms	Elaborations
Dwarf planet	Has the first two properties of a planet but does not have the third property – it is not big enough to have cleared away similar-sized objects in its orbit.
Elaborate	Applies and extends students' developing ideas to new contexts.
Electric charge	The property that determines how a particle is affected by electric and magnetic fields.
Electric field	The physical field around electrically charged particles.
Electric force	The force that exists between two charged objects.
Electromagnet	A magnet made by passing an electric current through a coil of wire.
Energy	A property of objects that can be transferred and transformed.
Engage	Focuses student attention on the context and concepts of science learning.
Enzymes	Substances that speed up chemical reactions.
Epiphyte	A plant that grows on another plant.
Evaluate	Encourages students to assess their learning progress.
Explain	Introduces formal language, terms, symbols, and models relevant to science concept learning.
Explore	Provides opportunities for students to examine their ideas through first-hand experiences.
Feedback	Feedback in the classroom can be defined as information allowing a learner to identify their strengths and weaknesses and target areas that need work.
Force	A push or a pull.
Formative assessment	The goal of formative assessment is to monitor student learning to provide ongoing feedback that can be used by instructors to improve their teaching and by students to improve their learning.
Frictional force	The contact force acting against an object in motion.
Gallbladder	The organ that stores bile.
Gram %	A measure of concentration expressed as the number of grams of a solute per 100 grams of a solution.
Gravitational force	An attractive force between two objects, which depends on the mass of the two objects and the distance between them.
Herbivore	An animal that feeds on plants.
Heterogeneous mixture	A mixture in which the composition is not uniform throughout the mixture.
Heterotroph	An organism that cannot make its own food and obtains nutrition by consuming plant and animal matter.
Homogeneous mixture	A mixture in which the composition is uniform throughout the mixture.
Hydrophilic	Attracted to water. A hydrophilic molecule or substance is attracted to water. Water is a polar molecule that acts as a solvent, dissolving other polar and hydrophilic substances.
Hydrophobic	Hydrophobic literally means 'fear or water'. Hydrophobic molecules and surfaces repel water.
Insectivore	An organism that feeds on insects, worms, and other invertebrates.
Large intestine	Part of the lower gastrointestinal tract where water is absorbed.
Light	A form of energy that can be detected by the eyes.

Terms	Elaborations
Liver	An essential organ that is an accessory organ in the digestive system.
Mass	A measure of how much matter is in an object.
Mass/volume %	The ratio of the mass of solute that is present in a solution, relative to the volume of the solution. Because this type of concentration is expressed as a percentage, the ratio must be multiplied by 100.
Meteor	A meteoroid that enters a planet's atmosphere.
Micelles	Lipid molecules that arrange themselves in a spherical form in aqueous solutions. The formation of a micelle is a response to the amphipathic nature of fatty acids, meaning that they contain both hydrophilic regions (polar head groups) and hydrophobic regions (the long hydrophobic chain).
Moon	A natural satellite in orbit around the Earth.
Mouth	The opening of the digestive system and the cavity where the process of digestion begins.
Non-contact force	A force that acts on an object without any physical contact.
Normal force	The force acting against the surface of an object that is in contact with a stable object.
Nutrients	Essential substances for growth and development.
Oesophagus	The tube that connects the mouth to the stomach.
Omnivore	An organism that consumes both plant and animal matter to obtain energy.
Opaque	An object that does not allow the transmission of light.
Pancreas	A gland that secretes enzymes that aid in digestion.
Parasite	An organism that obtains nutrients from another organism, causing it harm.
Parts per million (ppm)	A measure of concentration. 1 ppm is one part by weight or volume of solute in 1 million parts by weight or volume of solution.
Pharynx	The cavity behind the nose and mouth that connects them to the oesophagus.
Photosynthesis	The conversion of carbon dioxide from the air into glucose by plants to provide the plant with energy for growth and reproduction.
Planet	A celestial body that orbits a star.
Precipitate	A precipitate in Chemistry is a solid formed by a change in a solution, often due to a chemical reaction or change in temperature that decreases solubility of a solid.
Predator	An organism that preys on other organisms.
Producer	An organism that makes its own food and is consumed by other organisms.
Ray diagram	A way of representing the paths of light.
Rectum	The straight portion at the end of the large intestine connected to the anus.
Reflection	Light incident on a plane smooth surface, which rebounds from the surface at the same angle as the angle of incidence.
Refraction	The bending of a light ray as it moves from one transparent material to another transparent material.
Salivary glands	Glands that secrete saliva into the mouth.
Saponification	A hydration reaction where free hydroxide breaks the ester bonds between the fatty acids and glycerol of a triglyceride, resulting in free fatty acids and glycerol, which are each soluble in aqueous solutions.

Terms	Elaborations
Saprophyte	An organism that lives on dead organic matter.
Satellite	A natural or artificial body that orbits the Earth, other planet, or moon.
Saturated	A saturated solution is a solution that contains the maximum amount of solute that is capable of being dissolved at a specific temperature.
Shadow	An area of darkness that results from an object blocking the path of light.
Small intestine	The part of the digestive system between the stomach and large intestine where most of the absorption of nutrients occurs.
Solar system	Sun, planets, and their natural satellites.
Solenoid	A type of electromagnet that generates a magnetic field around a coiled wire.
Solubility	The ability of a solid, liquid, or gaseous chemical substance (referred to as the solute) to dissolve in solvent (usually a liquid) and form a solution.
Solubility constant	The solubility product constant, Ksp, is the equilibrium constant for a solid substance dissolving in an aqueous solution. It represents the level at which a solute dissolves in solution.
Solute	The substance that is being dissolved.
Solvent	The dissolving medium.
Space	An empty area that is available to be used.
Stomach	The organ of the digestive system that receives food.
Summative assessment	The methods that teachers use to conduct after-lesson evaluations of student understanding and progress.
Supernatant	The clear liquid that lies above the solid residue after centrifugation, precipitation, crystallisation or settling.
Suspension	A heterogeneous mixture of a fluid that contains solid particles sufficiently large for sedimentation. The particles may be visible to the naked eye, usually must be larger than one micrometer, and could eventually settle.
Symbiont	An organism that lives in close association with an organism of a different species in which neither organism is harmed by the relationship.
Thermal expansion	The expansion (shape, area, volume, and/or density) of matter due to a change in temperature.
Tongue	The fleshy, muscular organ in the mouth that aids in the breakdown of food into smaller particles in the process of digestion.
Translucent	An object that allows some transmission of light.
Transparent	An object that allows the transmission of light.
Unsaturated	An unsaturated solution is a solution in which the amount of dissolved solute is less than the saturation point of the solvent at a specific temperature.
Volume/volume %	Volume/volume percentage (v/v percent) is a measure of the concentration of a substance in a solution. It is expressed as the ratio of the volume of the solute to the total volume of the solution multiplied by 100.
Water	A colourless, transparent liquid that is a compound of hydrogen and oxygen.
Weight	The force of gravity acting on an object, measured in newtons (N).

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