CONTINUOUS PROFESSIONAL DEVELOPMENT
(CPD) FOR SCIENCE TEACHERS

OpenSTEM Africa

PLANNING EFFECTIVE LESSONS

Acknowledgements

Ministry of Education

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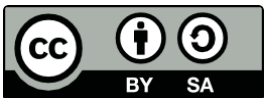
For information on OpenSTEM Africa see: www.open.ac.uk/ido

OPITO for their generous support, which has made OpenSTEM Africa and the development of the Virtual Laboratory and these materials possible.



Contents

OpenSTEM Africa: Ghana

The overarching aim of OpenSTEM Africa, Ghana, is to make a contribution to Government of Ghana/Ministry of Education policy to the effective teaching of practical science.

Effected by:

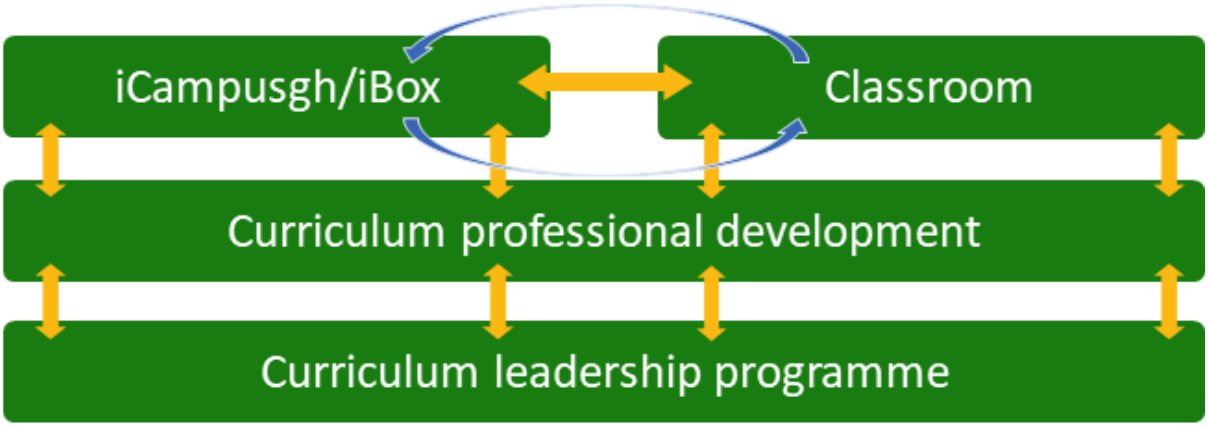
1. **Virtual Lab:** onscreen interactive science instruments using real data and with examples of science lessons, to improve the experiential teaching and learning of science in Senior High Schools, helping develop girls' and boys' practical science study skills, and building on the iCampusgh/iBox model developed by CENDLOS.

Underpinned by:

2. **Continuous Professional Development (CPD) for science teachers:** which develops confidence, skills and strategies to enable improved teaching and learning in the sciences, with a particular focus on ICT-based practical sciences, and which supports them in meeting the aspirations of the SHS elective science curriculum (Physics, Chemistry and Biology).

Embedded in Senior High Schools through:

3. **Curriculum Leadership Programme:** for Heads of Department/Heads of Subject, which enables them to effectively implement short- and long-term strategies to improve teaching and learning in the sciences, with a particular focus on ICT based practical science in their school.



The school-based professional development and leadership programmes will help more teachers use ICT-based science resources more and more effectively, with more learners. The support for school leaders' facilitates the development of a sustainable community of practice in science within the school, led by the Head of Department/Subject Lead and with the support of the Headmaster/Headmistress, in line with National Teaching Council Guidelines.

CPD programme for SHS science teachers

This CPD programme for SHS science teachers is designed by experienced Senior High School science teachers working with Heads of Science and SHS curriculum and Science Resource Centre developers, representing a wide range of Senior High Schools in Ghana. They are working with representatives from the Ministry of Education, CENDLOS, GES, the University of Ghana and from The Open University (UK) on OpenSTEM Africa: Ghana.

Improving teaching and learning in the sciences at SHS level is part of the Government of Ghana's *Education Strategic Plan (2018–30)* to enable increasing numbers of SHS students to specialise in the sciences at tertiary level and then move into STEM careers. Government of Ghana policy points to the importance of in-service training for teachers for acquiring new skills and keeping abreast of new developments. The National Teacher Standards for Ghana (MoE/NTC) set out the importance of teachers continuing to learn as they teach and the importance of the school as the location of that learning. Ghanaian research suggests that continuous professional development (CPD) taking place within the school is more motivating, more coherent, more sustainable and likely to be more effective in the long term This is the "growth approach in which teachers are given the opportunity to try new opinions, gain new perspectives, and extend their professional capabilities in order to understand and find solutions to problems in their individual schools" (Asare et al., 2012).

SHS science teachers, particularly those specialising in the elective sciences are already experts in their field. This programme is to enable them to work directly with their Head of Science, or Heads of Physics/Biology/Chemistry alongside their departmental colleagues to further develop the expertise of the whole department in teaching SHS sciences, with a particular focus on ICT-based teaching and learning and to help build a community of practice among science teachers in the school.

Planning effective lessons

Introduction

Planning is what teachers do all the time, but it is so important that the principles of planning should be re-visited periodically and reinforced in light of new opportunities and new ways of working. Lesson planning is central to organising student learning in order to meet the demands and complete the coverage of the SHS curriculum and support the learners to meet learning outcomes.

National Teachers' Standards for Ghana

The Teacher:

Has comprehensive knowledge of the official school curriculum, including learning outcomes.

Examples of the Standards in action

The Teacher:

references curriculum in planning; knows what learners should have learnt in the previous year and the next, and across the curriculum; discusses issues in implementing and covering the curriculum, particularly for more vulnerable groups and considers how to support learners to attain expected curricular outcomes.

(National Teachers' Standards, 2017)

This unit frames planning in terms of the objectives set out in the SHS science syllabuses, focusing on the elective sciences – Biology, Chemistry and Physics – and highlights a set of principles and questions to consider which will ensure that the vision can be realised.

All the SHS science syllabuses emphasise the importance of active student engagement:

"Try to avoid rote learning and drill-oriented methods and rather emphasise participatory teaching and learning in your lessons."

(Biology Syllabus, pp. 8)

This means that for most teachers, they are expected to teach in a different way to the way in which they were taught themselves. This requires careful planning.

Various planning forms exist and you will probably be used to using a particular form preferred by your school or your Head of Department/Head of Subject. This unit is not linked to a form and is designed to support the thinking that all teachers do before they fill in a formal lesson plan. This unit treats planning as a problem-solving exercise, recognising that there are no 'right' answers, rather a range of possibilities and that the role of the teacher is to plan activities and resources that work for them in their context/with their class. The unit is therefore relevant to any planning pro-forma and will remain relevant even if forms change.

By the end of this unit you will:

- better understand the thinking and the dialogue that underpins the completion of any successful lesson planning form
- better appreciate the link between specific learning objectives, teaching and learning activities and evaluation
- have a greater understanding of how to incorporate active teaching strategies into your lessons
- continued to develop your skills in using ICT in teaching and learning, via the final section of this unit.

Planning and resourcing

It is helpful to think of unit and lesson planning as involving two distinct steps: 'planning' and 'resourcing'.

Planning involves deep thinking. This is where you:

- identify learning objectives
- think about what knowledge, understanding and skills students will be able to demonstrate if they have met those objectives
- think about how you will know that the objectives have been met (evaluation).

It also involves dialogue, particularly if you are teaching this lesson for the first time. This dialogue will be with your Head of Department/Head of Subject and may also involve departmental colleagues who are experienced in your subject. It involves identifying which activities are linked to the objectives from the syllabus and deciding how you are going to organise them.

Resourcing is the next stage and involves:

- identifying relevant sections of the textbook and if enough copies are available to the class
- making teaching and learning materials (TLMs) that you might need such as a card sort or worksheet
- finding videos, demonstrations or equipment that you could use to illustrate a point
- or setting up a practical activity.

If you try and do the 'resourcing' without having a clear plan, it can be bewildering and time consuming. It is much easier to identify and make materials when you have a clear sense of the purpose that you want them to serve.

Reflection point

Is this a helpful distinction for you?

With the guidance of your Head of Department/Head of Subject, work with an experienced colleague to share your approaches to this unit and to lesson planning. Compare the aspects you enjoy and the aspects you find the most challenging.

Effective learning and teaching

The following extracts are taken from the SHS Science syllabuses. They highlight some of the key issues to consider when planning lessons.

As we would expect there is much overlap between the syllabuses. The specific quotes here are taken from one of the three sciences, but the overall philosophy underpinning them all is the same.

Quote and where it is from	Implications for planning
Biology	
"The scope of the content of this syllabus also enables the learner pursue specialised careers relating to biology and fully prepares the students who wish to continue the study of biology at the tertiary level."	Show students how what they are studying relates to everyday life and possible future careers.
"The teaching of biology should be student-centred and activity oriented. The four learning behaviours, 'knowledge', 'understanding', 'application' and 'process' are referred to as dimensions of knowledge. Knowledge is a dimension; application of knowledge is also a dimension… Being able to describe something after the instruction has been completed means that the student has acquired "knowledge". Being able to explain, summarise, give examples, etc. means that the student has understood the lesson taught."	Does the lesson meet the minimum criteria for being student-centred? Do the activities actively engage students? What do you want students to know at the end of the lesson? What do you want the students to understand by the end of the lesson?
Chemistry	
"'Remembering, understanding, applying' etc. are dimensions that should be the prime focus of teaching and learning in schools. Instruction in most cases has tended to stress knowledge acquisition to the detriment of other higher level behaviours such as application, analysis etc. Each action verb indicates the underlying profile dimension of each particular specific objective."	What do you want students to know, understand and be able to do?
"Chemistry enables us to understand, explain, control and prevent phenomena like bush fires, industrial pollution, corrosion of metals and the depletion of the ozone layer. Chemistry is therefore a subject of vital importance for life."	Relate the content of the lesson to students' everyday lives.
Physics	
"The principles and applications of physics cut across the various spectrum of everyday life activities like walking, lifting objects, seeing and taking photographs."	Relate the content of the lesson to students' everyday lives.
"For this reason, and also for the reason that discussion of issues, discussion of	Plan questions to ask which will promote thinking.

reports etc., are some of the major intellectual activities students will be engaged in, in work situations and at higher levels of learning after they have left secondary school, it will be very helpful if you would emphasise discussion questions etc. both in class and in the tests you set."	
All three syllabuses	
"Avoid rote learning and drill-oriented methods and rather emphasise participatory teaching and learning, and also emphasise the cognitive, affective and psychomotor domains of knowledge in your instructional system wherever appropriate… Select a practical problem for each lesson. The selection must be made such that students can use knowledge gained in the previous lesson and other types of information not specifically taught in class. At the beginning of a lesson, state the problem, or write the problem on the board. Let students analyse the problem, suggest solutions etc., criticise solutions offered, justify solutions and evaluate the worth of possible solutions."	Plan activities which actively engage students. Give students opportunity to talk about their ideas and draw on knowledge form other sources.

The above quotes demonstrate an objective for teaching and learning in science that engages students and supports the development of knowledge, understanding and skills. They also emphasise the importance of relating science to everyday lives and of effective questioning to promote thinking.

International research (Black et al., 2002) shows that formative assessment is also a key component of an effective lesson, providing the teacher with evidence about the extent to which the desired learning outcomes have been met. Formative assessment activities need to be part of a plan.

Taken together – the information from the syllabuses and research evidence provide a helpful planning checklist.

Planing for effective learning and teaching

National Teachers' Standards for Ghanan

The Teacher:

- Plans and delivers varied and challenging lessons, showing a clear grasp of the intended outcomes of their learning.

Examples of the Standards in action

The Teacher:

- Has long-term (weekly, termly) objectives of what and how learners should learn.
- Lesson objectives are clear to learners at the beginning of lessons and their progress towards these is monitored.
- Lesson structures and tasks vary, target girls and boys equally and are pitched just beyond what learners already know to stretch and inspire, using whole class, group, pair, individual work and ICT to expand or consolidate learning.

(National Teachers' Standards, 2017)

Drawing on the SHS syllabuses and NTC guidelines, here is a checklist to support planning:

- What do students need to know about the topic?
- What do students need to understand about the topic?
- What will students be able to do as a result of this lesson?
- How could I frame the lesson in terms of a problem?
- What activities will enable them to do these things?
- How will I assess whether or not they have achieved the learning outcomes?
- How will I relate the topic to their everyday lives?
- How will I ensure that the lesson meets the minimum criteria for being student-centred?

Reflection point

When you have answered these questions, consider what materials you will need to support this lesson.

In the rest of this unit, you will work with your Head of Department and colleagues to look at the different aspects of lesson planning in more detail.

Lesson objectives

Drawing on the table above, a helpful way to think about lesson objectives is in terms of knowledge, understanding and skills.

- What do students need to **know** at the end of this lesson?
- What do students need to **understand** at the end of the lesson?
- What do students need to be able **to do** at the end of the lesson?

The advantage of this way of thinking about lesson objectives is that:

- it will enable you to meet the expectation of the SHS syllabuses.
- by promoting understanding alongside knowledge you will be supporting thinking skills, and problem-solving.
- three objectives can be remembered, so you can carry them in your head, without constant reference to your lesson plan, and they will inform all your interactions with students.

Examples

Syllabus topic	**Content**	**Lesson objectives**
Biology, SHS1, Unit 10 Domestic Fowl	• external features of domestic fowl • life processes of domestic fowl • adaptation of domestic fowl to the terrestrial habitat • types and functions of feathers of domestic fowl.	Students will **know** the external features and life processes of domestic fowl. Students will **understand** how they are adapted to their habitats. Students will **be able to** draw the different types of feathers and explain the differences.

Physics, SHS 2, Unit 1 Heat transfer	• Heat transfer
	  • conduction
	  • convection
	  • radiation
		Students will **know** that heat can be transferred through convection, conduction, or radiation.
		Students will **understand** how the different processes work.
		Students will **be able to** set up a practical demonstration of each method.

Chemistry, SHS 3, Unit 4, Environmental pollution	• acid rain • green house • effect of Ozone Depletion • environmental effects of air pollution.	Students will **know** the different sources of air pollution. Students will **understand** how acid rain, the greenhouse effect and ozone deletion affect the environment. Student will **be able to explain** the impacts on vegetation, water and humans.

Activity 1: Lesson objectives

Working with your Head of Department/Head of Subject, preferably alongside a colleague in the same subject, write lesson objectives in the format suggested for two lessons you will be teaching this week.

Planning activities

A lesson is a sequence of linked activities. You may design in detail an activity for each objective, or a single activity might cover more than one objective. Considering the examples above, you should be able to make an explicit link between the activity and the objective.

Subject	Unit/Lesson objectives	Possible activities
Biology – Domestic fowl	Students will **know** the external features and life processes of domestic fowl. Students will **understand** how they are adapted to their habitats. Students will **be able to** draw the different types of feathers and explain the differences.	1. Work in pairs to label a diagram of a domestic fowl and draw out the life cycle. Review the work of another pair. 2. In pairs, annotate the diagram to show how the domestic fowl is adapted to its habitat. 3. Working individually, draw the different types of feathers. Annotate the diagram to explain the different functions and how that relates to the structure of the feather.
Physics – heat transfer	Students will **know** that heat can be transferred through convection, conduction, or radiation. Students will **understand** how the different processes work. Students will **be able to** set up a practical demonstration of each method.	1. Demonstrate the transfer of heat through conduction, convection and radiation. 2. Working individually draw annotated diagrams to explain each process 3. In pairs, discuss problems related to everyday examples that illustrate these processes.
Chemistry – Air pollution	Students will **know** the different sources of air pollution. Students will **understand** how acid rain, the greenhouse effect and ozone deletion affect the environment. Student will **be able to explain** the impacts on vegetation, water and humans.	1. In groups, research acid rain, the greenhouse effect or ozone depletion, explaining how it arises and how it affects the environment. 2. Re-organise the class into groups of three with one expert in each group. Each person has 10 minutes to explain their specialist topic while the others make notes.

Activity 2: Lesson activities

- Working with your Head of Department/Head of Subject, preferably alongside a colleague in the same subject, devise activities that will support you in meeting the lesson objectives you identified in Activity 1.
- For each lesson, devise a starter activity – something to engage students at the beginning of the lesson. It might be a question, a scenario, a photograph, a video or a story that relates to the lesson content.
- Plan some questions that you could ask, associated with the different activities. Use a range of open and closed questions which will probe understanding.

Make a list of the resources you will need to organise the activities.

Formative assessment

National Teachers' Standards for Ghanan

The Teacher:

- Integrates variety of assessment modes into teaching to support learning
- Listens to learners and gives them feedback.

(National Teachers' Standards, 2017)

As a teacher, it is important for you to try and find out the extent that the unit/lesson objectives are being met, so that you can plan the next lesson in the unit. For each activity, therefore, you need to think about how you will know that students have been successful. You can do this by observing and listening to them during the activity, through careful questioning, from the outputs from an activity, or by organising a section at the end of the lesson which tests their understanding of what has just been covered in the lesson.

Subject	Possible activities	Formative assessment
Biology – Domestic fowl	1. Work in pairs to label a diagram of a domestic fowl and draw out the life cycle. Review the work of another pair. 2. In pairs, annotate the diagram to show how the domestic fowl is adapted to its habitat. 3. Working individually, draw the different types of feathers. Annotate the diagram to explain the different functions and how that relates to the structure of the feather.	Listen to conversations while they are doing the task. Look at diagrams produced. Questioning. Diagrams of feathers in their books.

Physics – heat transfer	Demonstrate the transfer of heat through conduction, convection and radiation. Working individually draw annotated diagrams to explain each process In pairs, discuss problems related to everyday examples that illustrate these processes.	Questioning during the demonstration. Monitor individual work/individual questioning. Listen to conversations about everyday issues/questioning.
Chemistry – Air pollution	In groups, research acid rain, the greenhouse effect or ozone depletion, explaining how it arises and how it affects the environment. Re-organise the class into groups of 3 with one expert in each group. Each person has 10 minutes to explain their specialist topic while the others make notes.	Observation and questioning during group work. Notes in notebooks. True/False quiz at the end of the lesson.

Activity 3: Formative assessment

For the lessons that you have planned in Activities 1 and 2, make a table with three columns. Column 1 contains the unit objectives, column 2 the activities. In column 3 write down the opportunities for formative assessment – how will you know the objective has been met! The end result for the unit is of course encapsulated in the evaluation.

Classroom Example 1: Planning a Physics lesson

Miss Dampty decides to teach the second year component of the thermal Physics topic (Physics SHS 2 Section 3). She decides to divide the section into three lessons for a period of three weeks. She plans the outline of each lesson, before beginning to plan the detail of her lesson on the topic, namely the concept of heat and thermal expansion of solids.

What Miss Dampty wants the students to understand is how they can define heat on their own and be able to explain expansion. To help them to do this she decides to set up the ball and ring experiment.

Miss Dampty then plans carefully how the students would benefit from such a demonstration. She decides she would place the setup on a high bench so all the students can see everything from their various seats. She also decides to write questions that the students can answer after the demonstration on the board and she plans how she will do this. She decides to ask the students how the ball can be made to slip through the ring and then plans to write some of their suggestions on the chalkboard.

She allocates 5 minutes for the brainstorming and if they find the right answer she plans to proceed straight to trying it out. She plans that after complete the demonstration she will ask the students what they observed. She decides to allocate 15 minutes to this.

In order for them to have an even better understanding she decides to show them an animation or a simulation to show them what happens within the metal when heated. She plans for this to take 10 minutes.

After the animation she decides she will use leading questions to help the students generate the definition of heat and explain the concept of heat (i.e. expansion of solids). She will then have students write down what they have gleaned. Miss Dampty decides that as they are writing she will spend time going round the class to see how much understanding each individual student has been able to develop (20 minutes).

She then decides to use the remaining 10 minutes to recap on the lesson, correct any misunderstandings, and prepare the students for the next class when they will go through some mathematical relations in expansion.

Classroom example 2: Planning a Biology lesson

Mr Azinah decides to teach the second part of the Cell Biology topic (SHS 3 Biology Section 2). He decides to divide the topic into eight individual lessons for a period of three weeks. He then plans an individual lesson on the first topic in this schedule, 'nucleic acids'. He decides he wants the students to appreciate the roles of DNA and RNA in living organisms which are the types of nucleic acids.

As his introduction he plans to ask his students questions such as *"what is the heaviest or biggest organelle in the cell?", "how is the nucleus important to cells?"*, the function of the nucleus and what makes its function. As students brainstorm to bring out the answers, Mr Azinah plans to write all their responses on the board.

He allocates 5 minutes of intense brainstorming to be followed by him giving the definition of the nucleic acid and the types, and asking the students to link their responses to the definition.

He decides he will then clean the board, write the definitions of nucleic acid, DNA and RNA on the board again, this time leaving out keywords for the students to copy, and he will then then provide the key words, mixing them to find out [a] if the students have understood the definitions and [b] would be able to use them in active note-taking for future reading after the lesson

Mr Azinah decides that his next step in the lesson would be to divide the class into two, and then into smaller groups, each representing one type of nucleic acid either DNA or RNA. As they work in their groups he would move around the class to ensure all students are involved – in particular that all students with a disability such as a visual or hearing impairment are being included and that female voices are being given equal importance to male voices. Each group would work together to make a list of points about the importance of their type of DNA or RNA, after which they would represent it on the board. The student group which made the best case would be rewarded with sweets (he makes a note to bring the sweets along to the class.)

At the end of the lesson Mr Azinah decides he will summarise by revising what nucleic acids are, the types (DNA and RNA) and the differences between the DNA and RNA. He will then ask the students whether they needed to have any part of the lesson repeated or whether they feel ready to continue with the topic of the next planned lesson – which is the structure of DNA.

Did you notice…

- Mr Azinah planned for the entire cell Biology 2 topic.

- He introduced the topic for the students to brainstorm, involving them in the lesson.
- He planned to make the lesson interesting and active through the creation of groups and groupwork.
- His plans included moving around the groups to ensure all students are involved.
- His plans were flexible and included the possibility of spending more time on the topic if needed.

Classroom example 3: Planning a Chemistry lesson

Mrs Ackom wants to teach transition metals (Chemistry SHS2, Section 2, Unit 1. She divides the topic into two major lessons. This is because they are 1-hour lessons.

The first lesson is planned is to look at electron configuration of the first row transition elements and the properties of transition elements. She decides she will ask the students to bring some metals to the lesson and will begin by hanging the periodic table on the wall and displaying the metals she has asked the students to bring.

Based on her previous knowledge – not only of the syllabus but of working with this particular class, she introduces the lesson by asking students to write the electron configuration of some selected elements. She writes one or two transition metals on the board and asks them to write the electron configuration of these elements. From the electron configurations written, she plans that then she will then go on to define the transition metal.

As her next step she plans to ask the students to write a detailed electron configuration for the remaining first row transition elements.

And as a following step her plan is to ask the students to count the number of unpaired electrons. Those unpaired electrons represent the variable oxidation state in the elements.

Mrs Ackon then plans to group the students and give each group two or three pieces of metal to observe, identify and decide on some of their key properties. From the student responses, Mrs Ackon will write the properties of transition metals on the board.

Her conclusion to the lesson will be through giving the students three questions:

1. What is the definition of a transition metal?

2. Why is Zn not considered a typical transition metal?

3. What are the differences between paramagnetism and diamagnetism?

Did you notice…

- Mrs Ackom plans the lesson based on her previous knowledge - both of the syllabus (and what students have already learned),but also her knowledge of this class (in terms of what they find easy and difficult and what kind of pace they learn best at)
- She uses real materials in the lesson
- She involves students in her lesson
- She concludes the lesson with questions.

Active learning and teaching

National Teachers' Standards for Ghana

Examples of the Standards in action

- Learners are active, challenged to think hard, share, talk and feel able to task questions of the teacher and one another. The teacher also ensures that girls and boys participate equally in lesson activities and that they do not reinforce traditional gender roles.

(National Teachers' Standards, 2017)

The extracts from the SHS syllabuses highlight the importance of active engagement, problem-solving and links to everyday life.

The following checklist is intended as a guide to ensure that the lessons that you have planned meet the aspirations of the SHS syllabuses. Some criteria should be met every lesson – for example giving students opportunity to talk about their work, whereas as others will only be relevant over a few lessons.

Criteria for analysing a lesson you have planned:

- Will the lesson actively engage students? What will they be doing?
- Have I taken account of prior knowledge and understanding?
- Does the lesson provide appropriate challenge and have I thought about howto support those who need help?
- Have I planned a mixture of closed and open questions which will promote thinking?
- Will students have the opportunity to talk about their ideas?
- Have a linked the scientific content of the lesson to everyday situations relevant to their lives?
- Is there an opportunity in this lesson to link the context to future jobs or careers?
- Have I given students the opportunity to develop a range of skills?

Activity 4: Criteria for an effective lesson

Working with your Head of Department/Head of Subject, preferably alongside a colleague, use the criteria above to review the lessons you have planned.

Is there anything you would add to or change in the criteria?

As a department, think about how to use these criteria (or the version you have developed) on a regular basis to support effective planning.

If you use a planning form in your department. Review the form in the light of this unit. Is there anything you might want to change on the form?

Using ICT to transform learning

National Teachers' Standards for Ghana

Examples of the Standards in action

- All teachers have good technological pedagogical knowledge, knowing how to incorporate ICT into their practices to support learning.

(National Teachers' Standards, 2017)

Lesson planning using ICT

Activities 5, 6 and 7 will help you to think about the effective use of technology and how to make it transformational. Information and communication technology (ICT) provides a great opportunity to make lessons and learning more interactive, and at the same time help students to engage in 21st century skills that are relevant for their studies and future professional lives. Selecting and integrating a range of ICTs in your lesson requires careful consideration and thought.

Activity 5: Using ICT to transform learning

Think of a science topic that you will be teaching next week.

Imagine that you and your students could have access to any technology that you wished.

- How could you use the technology to support how you would normally teach this topic?
- How could you use the technology to achieve the same learning but in different ways?
- How could you use technology to provide learning opportunities that would otherwise not be available?

As a subject or departmental group and under the guidance and support of your Head of Department, collect all your ideas for points 1–3 on to a flip-chart and keep it as a resource to support future planning or to inform the individual coaching sessions you will be having with your HoD.

OpenSTEM Africa Virtual Lab applications

Practical science

The practical science apps in the OpenSTEM Africa Virtual Lab such as the calorimetry application and the flame test are being introduced are designed to help you to teach your students practical science in the absence of other reliable equipment.

With each instrument there is an example lesson plan, demonstrating how it might be used to support science learning.

The instruments could be used to:

- introduce a topic
- deliver the main content of a lesson
- consolidate key concepts and ideas
- teach practical skills
- help students solve problems you have posed
- encourage critical thinking
- relate science to everyday life.

Working with your Head of Department, take a look at the e.g. the calorimetry application and the lesson plan. Consider:

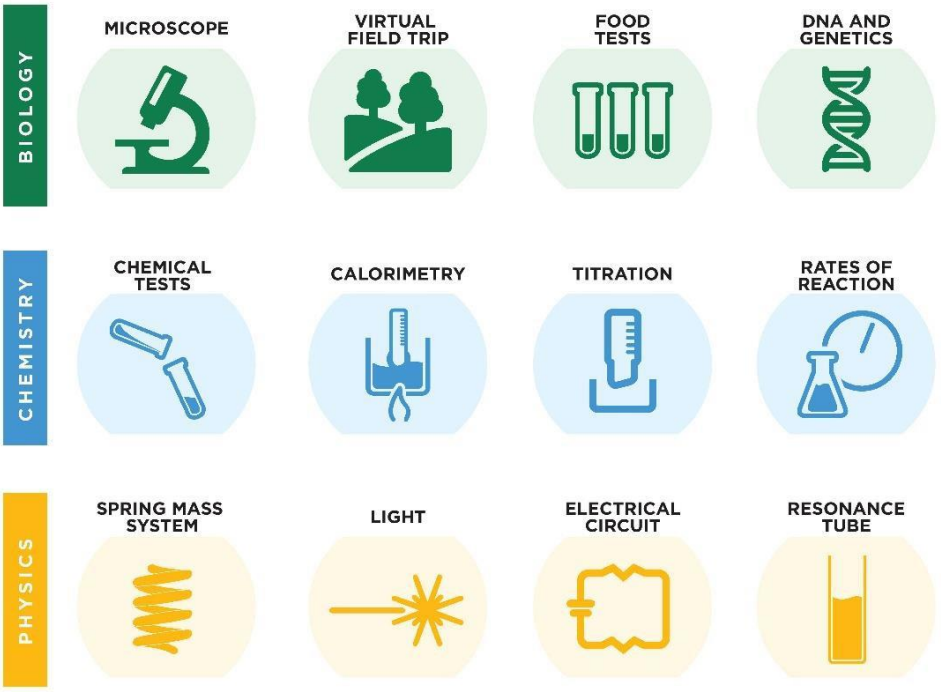
- what practical skills the students will learn
- how the engagement is being used
- alternative ways in which the engagement could be used.

As more apps in the Virtual Lab become available, work with your Head of Department and colleagues to develop more example lesson plans.

Activity 6: Planning to use the Science apps

Work with your HoD to plan activities across the whole department for using the Science apps. For example, you might work with a colleague to choose one of the apps to investigate, work through the exemplar lesson and discuss how it would work best in your school with your students.

OpenSTEM Africa Virtual Lab



The OpenSTEM Science apps in the Virtual Lab have been developed collaboratively by CENDLOS, GES and a group of SHS teachers in Ghana and The Open University (UK). They cover a range of experiments highlighted in the SHS elective ecience syllabuses. Students can interact with the experiment individually at home if the internet is available, or at school if sufficient computers are available. They might benefit more from the experience if they work in twos or threes, so they can discuss the issues and work together to solve problems.

With each Science app there is at least one possible exemplar lesson. These are intended to highlight the possibilities for teaching a lesson rather than anything prescriptive. It is expected that at first you might follow the example as suggested, but you could move towards developing your own plans as you become more familiar with the apps. They have all been designed to be relevant at various points in the syllabus, or over a few weeks of work, so that there is extended opportunity for students to interact with the materials.

Lesson planning using the iCampusgh and iBox

Activities 7 will help you to think about the effective use of technology and how to make it transformational.

Activity 7: Examples of using iCampusgh and the iBox

Teachers in Ghana are using the iBox and iCampusgh, which have been developed by CENDLOS, in a number of ways:

1. **Catch up** – students who have missed lessons are able to access the material at home or in the ICT lab and go through what they have missed.
2. Using the **video** lesson interactively – the teacher plays the video lesson to the class but stops the video periodically to ask questions or to set up a short discussion between the students about one of the issues raised.
3. **Flipping** – students work though the lesson on iCampusgh at home in advance of the classroom lesson. The teacher then organises a series of activities in groups or pairs designed to probe students' understanding. Through careful questioning, peer-support groups can be established and the teacher can focus on those who need the most help.
4. **Note-taking** – the teacher displays the notes and students work in pairs or groups to convert the notes into alternative formats such as poster, a mind-map or a concept map. While they work the teacher walks around asking questions and checking individuals' understanding.
5. **Teacher absence** – the teacher knows that they will be absent on a particular day so arranges for the class to access the lab and work through a designated lesson.

Classify each of the above as:

1. supporting learning as usual
2. extending learning
3. transforming learning.

Reflection point

Think about what you have learnt thought working through this unit. What aspects of your own planning do you do well, and which aspects would you like to develop further?

Reflect on some of the things that you have learnt and some of the things that you would like to get better at. You should raise these with your Head of Department who will be able to help you to think more deeply about your lessons and how they may be further improved step by step.

Summary

Planning is probably the most important aspect of a teacher's work. An effective lesson will tell a story, and all the elements of the lesson will be linked. The activities above have been designed to help you make those links and to ensure that you meet the aspirations set out in the SHS science syllabuses. Once you have worked through this unit as a department, you may want to review the planning pro-forma you use. Hopefully the process of planning collaboratively was helpful to you, and this is something else that you may want to consider on a regular basis.

A full list of the OpenSTEM Africa CPD units can be found at:
https://www.open.edu/openlearncreate/CPD_units

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