



COLLABORATIVE LEARNING



Acknowledgements



Ministry of Education

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



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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:

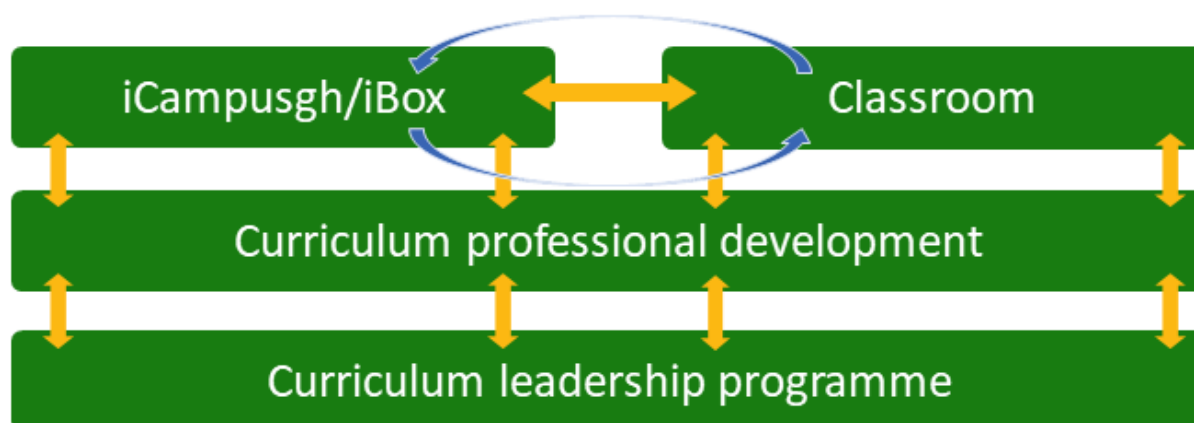
1. **Virtual Lab:** onscreen interactive science instruments using real data and with examples of science lessons, to improve the experiential teaching and learning of science in Senior High Schools, helping develop girls' and boys' practical science study skills, and building on the iCampusgh/iBox model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

Collaborative learning

Introduction

This unit on collaborative working focuses on the ways of organising your SHS science lessons to maximise the learning in your classes and make best use of your lesson time. The collaborative learning detailed in this unit includes group work, pair work and peer learning and support, all of which, as you know, are central to teaching and learning activities and school-based assessment in the SHS elective sciences.

By the end of this unit you will:

- better understand the benefits of collaborative working to support thinking
- better appreciate the benefits of pair work as a way of promoting collaboration
- have been shown a variety of strategies for organising effective group work
- understand more about how to organise peer teaching and support and identified tasks in your subject that might be suitable for this approach
- understand how to create opportunities for students to ask questions to support learning
- continued to develop your skills in using ICT in teaching and learning, via the final section of this unit.

Student participation and collaborative learning

In Ghana as you will already know, the standards for teaching include both student participation and collaborative learning. Encouraging students to talk to each other, and to you, as part of their learning will enhance their progress

National Teachers' Standards for Ghana

The Teacher:

- employs a variety of instructional strategies that encourages student participation and critical thinking
- sets meaningful tasks that encourages learner collaboration and leads to purposeful learning.

Teaching Standard

The Teacher:

- sets meaningful tasks that encourage learner collaboration and lead to purposeful learning.

(National Teachers' Standards, 2017)

Examples of the Standards in Action

- learners work together purposefully on carefully designed tasks that require them to share, talk and debate
- teacher observes groups/pairs
- teacher assigns leadership roles to girls and boys equally
- teacher intervenes skillfully to push or expand learning
- the teacher alters grouping according to what is to be learned: mixed/same ability; genders; interest; language.

In SHS classrooms, if activity is centred on the teacher, then most students will not get enough time to try out or demonstrate their learning or to ask questions. Some students may only give short answers, while some may say nothing at all. In large classes, the situation is even more difficult for student with only time for a small proportion of students to say anything at all. Collaborative learning gives all students the chance to talk about their ideas.

In the elective science syllabuses, 'discuss' is a term widely used, and the rationale is given in the Introduction to the syllabuses:

“Discuss belongs to the evaluation thinking skill and implies the ability to analyze, compare, contrast, make a judgement etc. The word “discuss” asks for a variety of thinking skills and is obviously a higher order thinking behaviour. Students consequently do poorly on examination questions that start with “Discuss”. For this reason, and also for the reason that discussion of issues, discussion of 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 emphasize discussion questions etc. both in class and in the tests you set.”

Teaching Syllabus for Biology (Senior High School) 2010



Activity 1

Think about the word 'Discuss'.

When you see the word 'discuss' in the syllabus what does that mean to you? It occurs in the Teaching and Learning activities in all the science syllabuses.

For example in Physics:

"Brainstorm to bring out the meaning of friction. Discuss the laws of friction (the discussion should include the coefficient of static and dynamic friction). Discuss the methods by which friction can be reduced."

For example in Chemistry:

"Discuss rules, regulations and regulations that should be followed in the chemistry laboratory. Discuss hazard symbols on chemical bottles, glassware, electrical gadgets and other materials found in the laboratory and demonstrate how to handle those materials safely."

Think about how you facilitate a discussion in your class. How easy is it develop whole-class discussion? Are there other ways of developing a discussion?

A discussion could involve careful questioning to the whole class, employing various strategies to involve all students (see the OpenSTEM Africa CPD unit *Effective questioning*: https://www.open.edu/openlearncreate/Teacher_units). 'Why' or 'how' questions may require more thinking than 'what' questions, and lead to follow ups and a wider discussion. For example, 'what is cracking? How important is cracking to the petroleum industry?' (Chemistry SHS3 Section 1 Unit 3).

Alternatively, 'discuss' could involve students working in pairs or groups to share what they already know on a topic. For example, as you will know, SHS Chemistry students are taken through lab safety procedures at the beginning of SHS1, so a short quiz given periodically or in pairs at the beginning of any practical lesson could save time.

Group work is one pedagogical approach, along with pair work and peer teaching which is foregrounded in the standards for teaching in Ghana.

National Teachers' Standards for Ghana

The Teacher:

- employs a variety of instructional strategies that encourage learner participation and critical thinking.

Examples of the Standards in Action

The Teacher:

- uses whole-class dialogue
- uses questioning
- uses group/peer work (collaborative learning)
- uses different learner groupings, peer teaching/support.

(National Teachers' Standards, 2017)

This unit develops ideas and gives examples of all three approaches.

Pair work

Teaching Standards for Ghana

The Teacher:

- manages behaviour and learning with small and large classes.

Examples of the Standards in Action

- uses group and pair work to overcome challenges of large classes
- alters seating plans so that females and males are mixed and that all learners get to the front
- manages resources so all learners (especially girls) get access to resources.

(National Teachers' Standards, 2017)

You may be more familiar with group work, but less familiar with the idea of pair work. Pair work has many of the benefits of group work in terms of providing opportunities to talk, providing a mechanism for peer support, and promoting thinking. It is also easier to organise as students take less time to move into pairs and complete pair work, and it is a helpful precursor for learning how to organise effective group work. It is a very effective way of promoting discussion, even for a few minutes and for ensuring that female students are listened to and have an opportunity to speak.

Pair work gives students the chance to think and try out ideas. It works well in large classes, because pairs can be arranged to help each other. It works best when you plan specific tasks and establish routines to manage pairs, and make sure that all of your students are included, learning and progressing. It gives you the chance to walk around the room, listen to your students and tailor your teaching to their needs.



Classroom example 1

Mr. Elikem Kumordzie was teaching his Year 3 Biology students about meiosis (Biology SHS 3 Section 2 Unit 4). He drew four diagrams to represent the process on the whiteboard but put them in the wrong order. He asked students to work in pairs and for this activity for each pair to be one boy and one girl. In their pair they had to agree the correct order and then compare their conclusion with the pair next to them. If they did not agree, each pair had to persuade the other pair that they had the correct order by explaining their reasoning. Finally, remaining in the same pairs, each student drew the diagrams in their notes, agreed brief explanations of the process and wrote them down, explaining the order of the diagrams.



Activity 2: Thinking about pair work

Think about the classroom example above and list the skills that E liken's students practised in that short activity. Try and imagine taking part in the activity from the perspective of:

- a low achieving student
- a high achieving student.

Are there any questions you would want to ask E liken? If so, discuss them with your Head of Department/Head of Subject.

Tasks for pair work

You can use a variety of pair work tasks depending on the intended outcome of the learning. By talking about their ideas, your students will automatically be thinking about and developing them further.

Pair work tasks could include:

Example classroom activities

- **'Think-pair-share'**: Students think about a problem or issue themselves and then work in pairs to work out possible answers before sharing their answers with other students. This could be used for working through calculations, putting things in categories or in order, giving different viewpoints.



Activity 3: 'Think-pair-share'

Using Physics SHS 3 Section 4 Electric and Magnetic fields, Unit 1 Electromagnetic Induction, divide the class into pairs.

- each student first reflects initially on an idea to design a dynamo to light a bicycle lamp
- all students work in pairs to agree a design and draw diagrams
- each pair then works with another pair to explain how their own design would work.

- **Sharing information:** The class are divided into groups and each group is given information on only one aspect of a topic which they then develop. They then work in share their information in order to analyse the whole problem or come to a decision.



Activity 4: Sharing information

Using SHS 3 Section 3 Biology and Industry, Unit 4 Biology and Agriculture divide the class into groups of four or five.

- Give each group a different question to consider. For example, 'Explain the biological principles by which X can respectively increase the productivity of crops'. X could be fertiliser; pesticide; selective breeding, or irrigation.
- Ask each group to prepare a presentation on their topic.
- Encourage them to use their imagination. They can do a PowerPoint presentation, prepare a TV documentary featuring interviews with experts or prepare a piece of drama to illustrate the points.

When they present to the class, the rest of the class should be asked to make notes on the topics which they did not consider.

- **Solving problems:** Students work together in a pair to solve problems. Alternatively, they work individually then compare solutions. If they don't agree, they have to be able to explain their solution.



Activity 5: Solving problems

Using Chemistry SHS 1 Section 4 Conservation of Mass and Stoichiometry, Unit 3 Stoichiometry and Chemical Equations:

- give your students a set of examples of calculations based on chemical equations
- ask them to work through them in pairs. They both have to agree the answer before they move to the next problem.

Think about how to form the pairs. You might want to use this as an opportunity for higher achieving students to support those who find the work more difficult, or you might decide to pair high achievers together and give them some more challenging examples, while you support those who find it more difficult. Over time, with different sorts of calculations, you could try both approaches.

- **Considering questions:** Ask an open-ended question and then ask students to discuss the answer in pairs before taking response from the class.



Activity 6: Considering questions

Using Biology SHS 2 Section 2 Interactions in Nature, Unit 3 Biological Associations, divide your class into pairs or groups.

What happens if...

Find or draw a food web with 8–12 living organisms. As a class, students should think of scenarios that might impact living organisms e.g. overhunting/poaching/application of a pesticide or fertiliser/decreasing fishing net size/disease/ pollution etc. and number them on the board.

Have a second list to include: increases/decreases/are wiped out.

Person 1 chooses a scenario from both lists that links two groups of living things in the web. e.g. *“What would happen to the number of crabs if the periwinkles were over fished and decreased?”*

Person 2 must explain what will happen back to Person 1.

The roles are then reversed. Try to start with closely related organisms and move to more distantly interrelated examples. You could move on to randomly deciding the scenario. Decide on your best example and explain it to the class.

- **Revision activities:** Each pair works together to prepare a set of revision questions on a topic which another pair then answer.



Activity 7: Revision activities

Divide your class into pairs or groups.

Make revision interactive by having students brainstorm and write mind maps, to share with each other; have them work in pairs on past examination questions and mark each other's answers, set questions for each other, or create drawings summarising a topic.



Activity 8: Trying out a pair work/group work activity

Working with your Head of Department/Head of Subject and preferably also with colleagues in your subject group, take one of these suggested tasks in turn and try it out in a way that works for you in your own classroom.

- think about the topics you are teaching next week and next term, so that you have a spread of ideas that you can bring into your teaching
- when you try one of the activities, note down how it went and report back to your HoD/HoS and your colleagues
- as you gather experience and hear about the experiences of your colleagues in trying out these activities, you will be able to add to the 'top tips' below.

Top tips when managing pair work

Teaching Standard for Ghana

The Teacher:

- sets meaningful tasks that encourage learner collaboration and lead to purposeful learning.

Examples of the Standards in Action

- learners work together purposefully on carefully designed tasks that require them to share, talk and debate
- the Teacher observes groups/pairs and assigns leadership roles to girls and boys equally
- the Teacher intervenes skillfully to push or expand learning
- the Teacher alters grouping according to what is to be learned: mixed/same ability, genders, interest, language.

(National Teachers' Standards, 2017)

Pair work is about involving all. If students are not used to working in this way, they may be reticent about contributing. For example, in a study with younger students in schools in Northern Ghana, it was found that when students shared a desk, they were reluctant for their work to be seen by the person sitting next to them (Nudzor et al., 2015) So It is a good idea to explain the benefits of pair work – e.g., by using examples from family and community contexts where people collaborate.

Following the NTC guidance given above, some practical advice for organising and managing pair work includes:

Planning an activity

- Manage the pairs that the students work in. Sometimes students could work in friendship pairs, sometimes they should not. Sometimes you could pair students of mixed ability together so that they can help each other, at other times you could pair students working at the same level in order to provide extra challenge. You should always consider gender in your pairing: sometimes you should mix genders in your pairs, at other times it may be important for girls to be paired together, and boys to work together. Make sure your students understand that you will decide the pairs to help them maximise their learning.
- Keep records so that you know your students' abilities and can pair them together accordingly.
- Keep initial tasks brief and clear.
- Make sure that students understand the routine of moving quickly around the classroom to work in a particular pair and that your classroom furniture is such that when needed, chairs or benches can be turned or moved easily to face each other.
- Focus often on tasks where each pair in the class is engaged in a different task, or different aspects of the same task. That way, every student in the class can see how much more work can be done in a short space of time and understand the benefit of sharing work in this way.
- Build into your planning, quick ways of each pair giving feedback to the class, e.g., a 1-minute presentation, a poster, or of students sharing their notes when they write up the task for homework.

During pair work

- Tell students how much time they have for each task and give regular time checks.
- Praise pairs who help each other and stay on task.
- Give pairs time to settle and find their own solutions – it can be tempting to get involved too quickly before students have had time to think and show what they can do.
- Monitor the student pairs to make sure that they are working as you want. Observe the students at work and make notes on things that you notice. This is formative assessment and will help you plan future activities. Note any common errors, good ideas or summary points.

At the end of the task

- If the task is one where the class has shared a task, with different pairs doing different aspects of the task, then it is important that the class shares the learning. Build a routine of how this can be done, so that students expect this and are for example, writing a poster/preparing a 1-minute presentation while they are working in their pair.
- If students have worked on the same task, then select one or two pairs to show their work, or you may summarise this for them. You don't need to get every pair to report back – that would take too much time. This might be an opportunity for students who are usually timid about contributing to build their confidence.

- If you have given students a problem to solve, you could give a model answer and then ask them to discuss in pairs how to improve their answer. This will help them to think about their own learning and to learn from their mistakes.

Both during and after the lesson, reflect on how it is going and how it went. This is important because this is how you will learn and how you will improve your teaching. Organising successful pair work is linked to clear instructions and good time management, as well as succinct summarising – this all takes practice.



Activity 9: Teaching and learning

Here is an example of a Teaching and Learning Activity from Biology SHS3 Section 1 Unit 1 that could be used in the classroom.

- If possible, in your locality, send students outside to collect examples of a monocotyledonous and a dicotyledonous plant
- Organise your class into pairs. Ensure that each pair is provided with a monocotyledonous and a dicotyledonous plant.

Ask each pair to examine the structure and function of their plants. If you have access to microscopes, or if you and your students can use the OpenSTEM Africa virtual microscope, have your students examine the sections of the plants.

Draw the structure of the plant and label the parts of the plant. Brainstorm the function of the roots, stems and leaves.

- How is the plant pollinated?
- Do insects visit the plant?
- Does the pollen hang on stamens outside the flower?
- Is it in a windy place?
- What are the main differences between a monocotyledonous and a dicotyledonous plant?

When each pair or group is ready, select two pairs to explain their answers to the class.



Activity 10: Pair work activity

Working with your Head of Department/Head of Subject and if possible, alongside a colleague, discuss the example above by considering the following questions.

- Where could you direct your students to find more/different examples of monocotyledonous and dicotyledonous plants in your local area?
- How would you choose to put your class in pairs for this sort of activity and why?
- Are there any questions or instructions you would change or include?
- What would students learn as a result of taking part in this activity?
- How could the you (the teacher) use formative assessment during this activity to support learning?

Teaching Standard for Ghana

The Teacher

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

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 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)

Using groupwork

Groupwork can be a very effective way of motivating your students to learn by encouraging them to think, communicate, exchange ideas and thoughts, and make decisions. Your students can both teach and learn from others.

As stated earlier, the SHS elective science syllabuses make frequent use of the word 'discuss', implying the frequent use of group work as discussion typically involves talk amongst a group. A number of examination questions at the SHS level begin with the word 'discuss' where the individual student is asked to demonstrate their ability to analyse, compare, contrast, make a judgement, etc. The word 'discuss' in examination asks for a variety of thinking skills and these can be learnt during vocal discussion in groupwork.

Group work requires extra time. Research suggests that learning in groups need not be used all the time to have positive effects on student achievement, so you should not feel obliged to use it in every lesson (Akyeampong et al., 2006). You might want to work, under the guidance of your HoS, with colleagues in your subject to plan one or two effective group work tasks each month and use pair work in between to continue to promote discussion. In this way, you will be meeting the expectations of the SHS elective science syllabuses.

Effective group work

Groupwork is more than students sitting in groups; it involves working on and contributing to a shared learning task with a clear objective. You need to be clear about why you are using groupwork for learning and know why this is of more benefit for this task than other forms of learning in your class. Groupwork has to be well-planned and purposeful.



Activity 11: Organising group work

Working with your Head of Department and alongside a group of colleagues, reflect on your experiences of using group work.

- list the skills and attributes that can be developed through group work
- share examples of successful activities and make a list of the features of effective group work.

Groupwork tasks

The task that you ask your students to complete depends on what you want them to learn. By taking part in groupwork, they will learn skills such as listening to each other, explaining their ideas and working cooperatively. However, the main aim is for them to learn something about the subject that you are teaching. Some examples of tasks could include the following:

Presentations: (e.g. Biology SHS3 Section 2 Unit 7 Evolution) Students work in groups to prepare a presentation for the rest of the class. This works best if each group has a different aspect of the topic, so they are motivated to listen to each other rather than listening to the same topic several times. Be very strict about the time that each group has to present and

decide on a set of criteria for a good presentation (see the section on peer assessment).

Problem solving: (e.g., Physics SHS 1 Section 2 Unit 1 Kinematics) Students work in groups to solve a problem or a series of problems. This could include conducting an experiment, solving numerical problems, or designing a piece of equipment to do a particular job.

Creating an artefact or product: (e.g., Chemistry SHS3 Section 1 Unit 5 Biotechnology) Students work in groups to develop a model to explain a concept, for example a news report on an issue related to the science content, or a poster to summarise information or explain a concept. Giving groups five minutes at the start of a new topic to create a brainstorm or mind map will tell you a great deal about what they already know and will help you pitch the lesson at an appropriate level.

Differentiated tasks: Groupwork is an opportunity to allow students of different achievement levels to work together on an appropriate task. Higher achievers can benefit from the opportunity to explain the work, whereas lower attainers may find it easier to ask questions in a group than in a class, and will learn from their classmates. Alternatively, high achievers can be put together and given a more challenging task.

Discussion: Students consider an issue and come to a conclusion. This may require quite a bit of preparation on your part in order to make sure that the students have enough knowledge to consider different options, but organising a discussion or debate can be very rewarding for both you and them. The potential applications of science provide many opportunities for interesting discussions.



Activity 12: Groupwork tasks

Working with your Head of Department/Head of Subject use the list above and your own experience to identify group work tasks that you could try in your subject.

Work as a department to plan three or four group work activities over the next 2–4 months.

Organising groups

Groups of four to six are ideal but this will depend on the size of your class, the physical environment and furniture, and the attainment and age range of your class. Ideally everyone in a group needs to see each other, be able to talk without shouting and to contribute to the group's outcome.

Guided by the National Teachers' Standards, you should divide groups sometimes by friendship, and sometimes by gender, interest or similar/mixed achievement. Use different kinds of groupings and experiment with different ways.

Plan any roles you will give to group members (for example, note taker, spokesperson, timekeeper or collector of equipment) and how you will make this clear.

Teaching Standard for Ghana

The Teacher:

- demonstrates the effective growing of leadership qualities in the classroom.

Examples of the Standards in action

The Teacher:

- delegates roles to females and males equally
- does not delegate roles based on gender roles and stereotypes.

(National Teachers' Standards, 2017)

Here are two techniques to try when you are feeling confident about groupwork – they are particularly helpful when managing a large class:

'Expert groups': Give each group a different task, such as researching one way of generating electricity or developing a character for a drama. After a suitable time, re-organise the groups so that each new group is made up of one 'expert' from all the original groups. Then give them a task that involves collating knowledge from all the experts.

'Envoys': If the task involves creating something or solving a problem, after a while, ask each group to send an envoy to another group. They could compare ideas or solutions to the problem and then report back to their own group. In this way, groups can learn from each other.



Reflection point

How do you usually organise groups in your classroom? What other ways, following NTC guidance on standards, should you consider organising groups? Reflect on the different options, working with your Head of Department/Head of Subject and colleagues to compare your ideas and share ideas on new ways of creating and reforming groups.

Top tips for Group work

Peer teaching and peer support are practices which are encouraged in the NTC Teacher's Standards for Ghana, so it is helpful to think in detail about what to do before, during and after a group work task.

Planning groupwork

When and how you use groupwork will depend on what learning you want to achieve by the end of the lesson. You can include groupwork at the start, the end or midway through the lesson, but you will need to allow enough time.

A planning checklist for group work could include:

- the goals and expected outcomes of the group activity
- the time allocated to the activity, including any feedback or summary task
- how to split the groups (how many groups, how many students in each group, criteria for groups)
- how to organise the groups and roles within the groups, including student leadership of the groups
- how you will monitor the groups' activities e.g. working with the student leaders.

During group work

While students are working, move around the room and listen to their conversations

- pay attention to individuals and make notes on anything that you notice which will help you with future planning. For example, any misconceptions that you hear about, any students that surprise you, or aspects of the task that are proving to be difficult.
- ask open questions to promote thinking
- try to resist providing solutions – allow students time to solve problems
- remind them how much time is left for the task.

At the end of the task

At the end of the task, summarise what has been learnt and correct any misunderstandings that you have noticed while you have been walking around the room. You may want to hear feedback from each group or ask just one or two groups who you think have some good ideas.

If all the groups have been working on the same task, a good strategy is to ask for one point from each group. They are not allowed to repeat points that have already been made, which ensures that everyone listens. A presentation from each group will take a long time and be repetitive.

If you want students to make presentations, then give each group a different task or topic, so they are effectively teaching each other.



Reflection point

Is there anything you would want to add to these top tips? When you have used group work, what are the main challenges you have encountered?

Challenges

Even if you want to adopt groupwork in your classroom, you may at times find it difficult to organise because some students:

- are resistant to active learning and do not engage
- are dominant
- do not participate due to poor interpersonal skills or lack of confidence.

Explaining the benefits of group work and encouraging them to generate a list of 'rules for effective group work' might help. For example, 'Respect for each other', 'Listen', 'Help each other', 'Try more than one idea', etc. After a group work activity, it is helpful for students to have the opportunity to reflect on how effective they were as a group and whether everyone felt they had the opportunity to contribute.



Classroom example 2

Mrs Essien was teaching Energy to Physics SHS 2 using Section 2 Unit 1 Energy of the syllabus. Students were learning about the different forms of renewable energy and how they work.

She decided that this would be a good opportunity to use groupwork. Students would work in groups to decide which form of renewable energy could be used in the area where they live. Each group considered all the appropriate forms of renewable energy, including solar energy, biomass, wind, hydroelectric power etc. Each group was asked to consider both the advantages and disadvantages of each form of renewable energy. Each group made their own decision. Mrs Essien then tallied the decisions made by all the groups. As both solar energy and wind power received equal numbers of group votes, she then invited one group to speak on why solar energy and one group to speak on why wind power would be the better choice for their area.



Activity 13: Group work for decision-making

Working with your Head of Department/Head of Subject and if possible, alongside a colleague, discuss the classroom example above and consider the following questions.

- How would you divide students into groups to do this activity?
- What information would they need and where would they get it from?
- How long would you give them to do this task?
- How would you ask them to present the information?

Peer Teaching and Support

Think about your own experience of being at school or university. You will have had some subjects – or topics within subjects – which you are really good at. Your friends would probably say the same. Did you ever ask a friend to give you some help with one of the subjects you found difficult? Did you ever do the same for your friends? This *doesn't* mean doing someone else's work, but we know that we all benefit from having something explained again or explained in simpler language – or explained with some examples. The same applies to your students. Each one will benefit from the expertise of other students in their class, especially if you set an open-ended or creative task. This idea of experiential learning – learning by doing – is very important for each individual's learning. It is also important for ideas about community and the ways the student community support each other; again, a reminder that peer teaching and support are important for students in Ghana.



Classroom example 3

Mrs Obeng was teaching Physics and her SHS3 class were approaching the WASSCE examinations. She divided the students into groups, taking care to assign one of the high achieving Physics students to each group and making that person the group leader. She asked the group leaders to draw out from their group the particular difficulties they found with the topic they were assigned. She gave each group a large piece of paper made from four sheets of A4 taped together. She gave each group one topic and asked them to prepare a revision poster. The poster had to cover the specific difficulties in the topic decided on by the group, set out in a clear and logical manner. They also had to provide ten revision questions which would help understanding of the topic.

Before they started, she wrote three criteria on the board, so the students knew how their work would be judged:

- Does the poster cover the topic thoroughly?
- Is the information grouped logically so that it is easy to follow and helps the student?
- Is the poster well-presented with diagrams, different sized writing, clear explanations?

At the end of the lesson, the posters were displayed. Students were able to walk round and look at the posters. They were asked to give each poster a mark out of 5 for each of the criteria. While Mrs Obeng added up the marks they had awarded, they were given 10 minutes to make additions/changes to their own posters in the light of what they had learnt from looking at the others.

In the example, notice how the criteria for the topics were shared in advance so that the students knew how their work would be judged. Once they are used to working in this way, then asking students to identify the criteria can be very effective.

Other forms of peer teaching and support could involve:

- students in female groups and male groups brainstorming and making and sharing mind-maps
- students in groups solving different parts of a set of mathematical calculations based on the laws of gravitation (for example) and then checking the calculations of another group
- students under the guidance of a group leader, constructing a presentation with each member of the group having an individual task (writers, speakers, artists etc.)
- students under the guidance of a group leader answering past examination questions and then presenting their rationale and calculations to the class.



Classroom example 4

Mrs Noi's Chemistry SHS 1 class needed to practise acid-base titration calculations. Usually, she asked them to complete exercises from the textbook and then she took them in for marking or read out the right answers. For a change, she put them in boy-girl pairs, students with someone with a similar achievement level, and asked them to work through the examples together. While they were working, she focused on the pairs who she knew would find the work more difficult. She asked them to set out their answers to show their working, clearly. She then put each lower-achieving pair with a higher achieving pair to exchange and explain their answers. She did not tell them the correct answers during that lesson; they had to follow the working and check each step. She gave the correct answers at the beginning of the following lesson so that each student could check their own working individually.



Activity 14

Working with your Head of Department/Head of Subject and colleagues, discuss the classroom example.

- if you were to do something like Classroom example 4, how would you pair your students? How do you think this exercise enhanced students' learning?
- think about what you will be teaching in the next few weeks and plan an opportunity for peer teaching and support.

Providing feedback

Students will need to be trained in peer teaching/peer support and encouraged to think carefully about the comments they make and how they will be received. They should be encouraged to focus in their discussion and decision-making on what their peers have done well.



Classroom example 5

At the start of their final year of SHS, Mrs Annan wanted to emphasise the fact that physics has many applications that improve the quality of her students' lives. But when they get to a point in the syllabus when they ask for 'applications' of a particular theory or principle she usually dictates a list for students to learn.

She identified four topics from the Physics curriculum where the applications are highlighted and divided her class into groups, each with a student leader who would encourage and motivate the group. Each group took a different topic. They were asked to research the topic and to prepare a ten-minute presentation for the class. The topics were the applications of radioactivity, the applications of fibre optics, the different sources of electricity and the applications of each source, and the applications of lasers.

As each group made their presentation, each of the other groups devised a question to ask about the content of the presentation.



Activity 15

For the Classroom example 5 given above, work with your Head of Department/Head of Subject and one or two subject colleagues to:

- write a brief for students, setting out what their application should include
- write four criteria that you would use to judge the presentations.

Discuss how you would collect feedback at the end.

Providing a detailed brief for this sort of activity will help students focus on what is important. It would be sensible to include in the brief, the extract from the syllabus so students focus on the right content, guidance on the time, and the number of slides (if they are using PowerPoint). Share the marking criteria so they can see in advance how they will be judged. Criteria might include:

- Did the content cover what is in the syllabus?
- Did the presentation stick to the time?
- Where the presentations clear and audible?
- Was the presentation engaging and interesting?

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 practice to support learning.

(National Teachers' Standards, 2017)

Activities 16 and 17 and 18 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 16: 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.

1. How could you use the technology to support how you would normally teach this topic?
2. How could you use technology to achieve the same learning but in different ways?
3. 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 Laboratory Applications

Practical science

The practical science apps such as the calorimetry application being introduced by OpenSTEM Africa 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 one of the science apps and its related exemplar lessons. Consider:

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

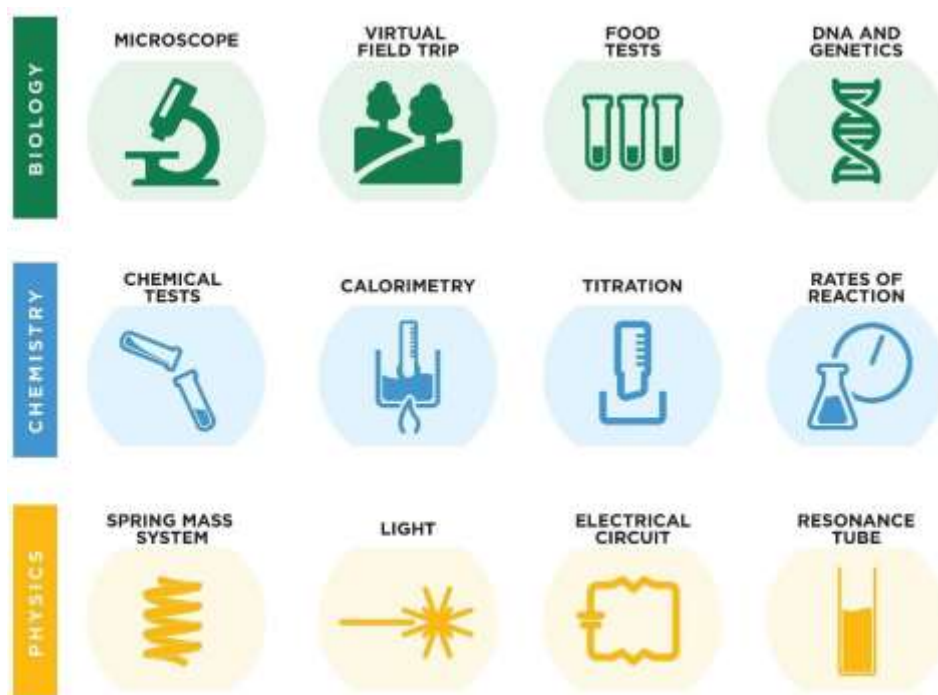
As more apps in the Virtual Lab become available, work with your Head of Department and colleagues to develop more example lesson plans.



Activity 17: Planning to use the OpenSTEM Africa science applications

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 science 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 application 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 iCampusgh/iBox

Activity 18 will help you to think about the effective use of technology and how to make it transformational.



Activity 18: Examples of using the iBox and iCampusgh

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 through 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

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

We all learn through our interactions with others. This unit has provided some practical ways in which you can give students the opportunity to learn collaboratively, and in the process develop important social skills as well as their knowledge and understanding of science. Pair work provides opportunities for short discussions (for example, by giving students two minutes to discuss the response to an open-ended question); group work provides opportunity for longer, in-depth discussions of scientific ideas (for example, by solving a problem, designing an experiment, or preparing a poster or presentation); and peer assessment provides opportunities to develop thinking skills. Using the OpenSTEM Africa Virtual Lab Applications is an excellent opportunity for students to work collaboratively and to support each other as they develop a range of skills as well as their scientific understanding.

A full list of the OpenSTEM Africa CPD units can be found at:

https://www.open.edu/openlearncreate/Teacher_units

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