CEMASTEA

TEACHER PROFESSIONAL DEVELOPMENT TRAINING MODULE-2019

for

SECONDARY SCHOOL MATHEMATICS AND SCIENCE TEACHERS

CEMASTEA –NAIROBI, KENYA 2019
CENTRE FOR MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION IN AFRICA (CEMASTEA)

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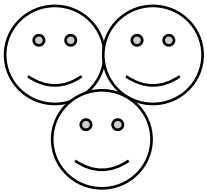
Acronyms and Abbreviations

ASEI-PDSI	Activity Student Experiment Improvisation-Plan, Do, See and Improve
BECF	Basic Education Curriculum Framework
CEMASTEA	Centre for Mathematics, Science, and Technology Education in Africa
CTCDC	County Teacher Capacity Development Committee
ICT	Information Communication Technology
INSET	In-Service Education and Training
KICD	Kenya Institute of Curriculum Development
KISE	Kenya Institute of Special Education
KNEC	Kenya National Examination Council
M&E	Monitoring and Evaluation
MoE	Ministry of Education
NASCOP	National AIDs and STI Control Programme
PBL	Project Based Learning
Q/A	Question and Answer
R&D	Research and Development
SMASE	Strengthening of Mathematics and Science Education
SBLS	School-Based Lesson Study
STEM	Science, Technology, Engineering, and Mathematics
TPD	Teacher Profession Development
TNA	Training Needs Assessment

Symbols

The following symbols will guide trainers and trainees as they go through the training. They have been adapted from UNESCO's training manual on *Quality Gender-Responsive STEM Education- 2018*.

Symbol	Meaning
	Participants to reflect on the issues at hand either individually or in groups. Guidance will be provided by the facilitators
	Participants to work and report on a given activity as a group.
	A question to be answered by participants. They may work on the questions either individually or in groups. Guidance will be provided by the facilitators
	Expected or possible responses to a question posed
	Enclosure for an activity to be done by participants either individually or in groups or for possible responses to a question posed. It is used in combination with other symbols.

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Introduction

This Training Module for Secondary Mathematics and Science Teachers (2019) has been developed by CEMASTEA to empower teachers who have teaching experiences of five years and below. The theme of the module is **'Effective Use of Learner Centered Strategies in Teaching and Learning'** and is intended to contribute to the Teachers Service Commission's (TSC) purpose for Teacher Professional Development (TPD) of continuously equipping and improving teachers' skills, competencies and knowledge for enhanced learning outcomes in Kenya.

The module has been purposefully designed to support the said cadre of teachers in meeting requirements that have been necessitated by the recent education reforms. These include requirements by the Teachers' Service Commission's TPD Policy Framework 2018, and the Competency Based Curriculum (CBC) . Through the TPD Policy Framework, the Commission has defined the Kenya Professional Teaching Standards (KePTS) for TPD for teachers and instructional leaders.

In line with the TSC TPD Policy Framework, the module will provide a range of professional learning opportunities for teachers to enhance learning and performance of learners and to engage in reflection on the practice. Specifically, it is intended that teachers will enhance their knowledge, skills and attitudes in their teaching subjects, pedagogy, ICT integration and 21st Century skills. The module complies with the TSC Policy and guiding principles for TPD focusing on learning; building strong working relationships among teachers; and providing independent and collaborative learning environments. It is also based on new pedagogical theories and practices; being linked to classroom practice as informed by KePTS and competencies prescribed. It also borrows from current education research and practice.

In addition to the policies, the module has also been designed in response to the teaching gaps identified through the CEMASTEA training needs assessment of 2017 and recommendations from the 2016, 2017 and 2018 Reports on Monitoring and Evaluation of County INSETs. The content was also informed by the prescribed TSC- TPD Induction Module for Teachers Level 1 of 2018, global trend in mathematics and science education as well as contemporary and pertinent issues such as the effects of HIV on schooling.

This module is organised into six units. Unit One on *21st Century Skills* focus on how teachers can support learners to develop skills to solve complex problems, adapt and innovate responses to new demanding and changing circumstances. , Unit Two introduces teachers to *Competency Based Curriculum* (CBC) in Kenya and how to integrate the competencies into their subject areas. Unit Three examines *learner-centered strategies* with a view to enhancing teachers' capacities in the design and use of such strategies. Unit Four which is *subject-based* focuses on integrating the contents of these three key units into topic areas identified as challenging to teach and learn. Last but not least, Unit Five focuses on *HIV and AIDs -Eliminating Stigma and Discrimination* and seeks to strengthen teachers' knowledge and skills in HIV and AIDS.

It is expected that after taking this module, the teachers will demonstrate:

1. Understanding of the 21st Century skills and Competency Based Curriculum;
2. The right knowledge, skills, and attitudes in designing innovative learner-centered activities including Project based learning and ICT integration;
3. Ability to reduce HIV and AIDS stigma and discrimination.

Unit One: 21st Century Skills

Introduction

In this unit, you will discuss 21st Century Skills with a view to enhancing your capacity to design and manage learning in a way that facilitates learners to acquire these essential skills. The session will also help you to appreciate the changing role of both the teacher and the learner in the 21st Century learning environment as opposed to the traditional classroom.

Rationale

The rapid advancements being witnessed in the 21st century brings along with it a wide range of societal, economic, and personal challenges. To live and work successfully in the 21st century, learners require unique skills that can enable them to adequately face these challenges and adapt to new ones. To help learners acquire these skills, there is a need for a paradigm shift from the traditional classroom of teacher-centred instruction to learner centred, where the learner takes the centre -stage and the teacher becomes a facilitator of the learning process. This session aims at building your capacity for successful teaching and learning in the context of 21st century education.

Learning outcomes

By the end of this unit, you should be able to demonstrate:

1. Understanding of the 21st Century skills
2. How a 21st Century class can be designed and managed
3. How to inculcate the 21st Century skills in your learners

Traditional Classroom

Reflection

From your experience describe the characteristics of a teacher- centred classroom?

You may have come up with

The teacher is the centre of knowledge and in charge of the learning process, more often learners are viewed as "empty vessels" who passively receive knowledge from their teachers, the teacher does not allow learners to express themselves and direct their own learning. Therefore the classroom remains orderly and students are quiet. During activities, students work alone, and collaboration is often discouraged.

Learner Centred Classroom

Reflection

1. From your experience describe the characteristics of a learner-centred classroom
2. What is the role of the teacher in a learner- centred class-room?

You may have come up with:

Learners plays active role in their own learning through asking questions, completing tasks independently, learner learns from peers through collaborates, group work is encouraged and roles are clearly defined between them, learners often reflect on their own individual learning. Learners are free to talk and therefore the classrooms may appear noisy or chaotic. The role of the teacher is to facilitate students' learning and comprehension of the subject material, by organising the environment to maximise efficiency and monitor learner's progress, guide them to discover and manage their own learning through motivation.

21st Century Skills

As discussed above, in a learner-centred classroom, learners acquire 21st century skills. The 21st Century skills are categorized as:

i. Learning and Innovation
ii. Digital literacy
iii. Life and Career Skills

Think-Pair-Share

In Pairs discuss and list at least five 21st century skills on the sticky notes.

You may have come up with some of the skills in the Wordle below

Table 1: Categories and components of the key 21st Century Skills

Category	Components
Learning and Innovation: These focus on mental processes required to adapt and improve upon a modern work environment	• Core subjects • Critical thinking and problem solving • Communication and collaboration • Creativity and innovation
Digital literacy: Deals with ability to determine trustworthy sources and factual information to separate it from the misinformation that floods the Internet	• Information literacy • Media literacy • Information and communication technology literacy
Life and career skills: Concerned with intangible elements of a student's everyday life focusing on both personal and professional qualities	• Flexibility and adaptability • Initiative and self- directive • Social and cross-cultural interactions • Productivity and accountability • Leadership and responsibility

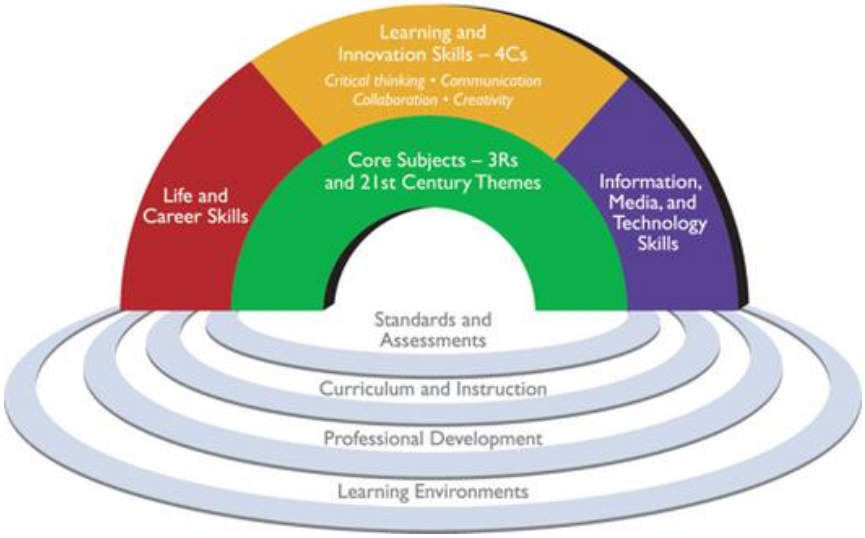


Figure 1: Support Systems in the 21st Century:
Source https://www.researchgate.net/publication/243772941_Decision_Support_Systems_in_the_21st_Century

These components form the 21st Century skills that enable learners to collaborate, communicate, be digitally literate, critical thinkers and problem solvers as well as having self-efficacy among others. It is therefore important for the teacher to know how to inculcate these skills in their learners during the teaching - learning process.

Acquisition of 21st Century Skills

We will now discuss how you can inculcate the 21st Century skills in your learners using the following lesson activity.

In your group, pick at least two pictures from the sample pictures A, B, C and D below. Discuss and write a report on:

i. How the item in the picture contributes to the ecosystem and your existence
ii. Its sustainability in the environment

NOTE: Learners with special needs, especially those who are totally blind require you to Use hands-on manipulatives with areas consisting of tactile boundaries or embossed diagrams

Think-pair-share: What 21st Century skills were evident as you carried out the above activity?

You may have come up with the following:

- Analytical skill, critical thinking and problem solving
- Communication and collaboration
- Leadership social responsibility

Designing 21St Century Classroom

On the paper provided sketch your perception of the 21st Century classroom.

You may have realized that

The 21st century classroom is defined by the available space and not limited to the physical walls. Learner centred environment requires the teacher to organise desks or working areas that encourage collaboration and cooperation among learners. Classroom organisation should allow for easy transitions from one group activity to another.

Effective Classroom Management

Classroom management is an essential component of the classroom learning environment. Since students of all learning abilities and cultural backgrounds learn together in the same classrooms, and teachers are held accountable for each individual student's achievement. It is important for you to understand how to effectively manage your class.

In pairs discuss how you can effectively manage a classroom with a wide range of learning abilities and styles, in a learner-centred way.

You may have realised that

Classroom management should be focused on giving students more control over their own learning and ownership over their behaviour. Allowing learners to take leadership roles and guide each other in the learning process.

Conclusion

You have discussed the 21st Century classroom and how to design and manage your classroom as you inculcate the 21st Century Skills among your learners. It is therefore hoped that you shall be applying these skills as you plan and teach and thereby graduating learners who will meet the demand of the global citizens of the 21st century.

Unit Two: Competency Based Curriculum

Introduction

Welcome to unit two of this module. In this unit, expositions and discussions on Competency Based Curriculum (CBC) will be done to enhance your understanding.

Rationale

Many countries are currently developing or revising their curriculum in the light of the global trend emphasising on 21st century competencies. Most countries are adopting competency-based education. Kenya has not been left behind and is currently shifting to this new model through the efforts of the Ministry of Education (MOE) and Kenya Institute of Curriculum development (KICD). The competency-based curriculum (CBC) is being implemented at the three levels of the basic education. Curriculum designs and learning resources for the Early Years Education (EYE) have been prepared. Teachers for this level have been trained and the piloting of the curriculum done in readiness for the national rollout. The national rollout of CBC started in January 2019. This session gives you an opportunity to enhance your understanding of CBC and strategies to implement it.

Learning outcomes

1) Participants to demonstrate understanding of the competency based curriculum
2) Participants to demonstrate understanding of the competencies, Pertinent and Contemporary Issues (PCIs) and values in the Kenya Basic Education curriculum and how to integrate them in teaching and learning.

Activity 3

From your experience, identify challenges in the implementation of 8-4-4 system of education?

You may have come up with the following:

The guiding philosophy of the 8-4-4 system of education system was 'education for self-reliance'. The guiding philosophy was soon lost due to implementation challenges. These challenges included issues of curriculum content, overloads within and across subjects, unnecessary overlaps and inadequacies in addressing emerging issues. The 8-4-4 system of education did not adequately address fundamental issues that would transform society by enhancing the productivity of every Kenyan citizen and accelerate economic growth.

The implementation of the 8-4-4 system was academic and examination oriented. It can also be described as teacher-centered with a high degree of subject content. The graduates at secondary school level did not acquire adequate entrepreneurial skills for self-reliance. Apart from the high unemployment arising from this phenomenon, there was also the risk of the emergence of social vices such as increased crime, drug abuse and anti-social behaviour. In addition, the current curriculum does not provide flexible education pathways for identifying and nurturing the talents

and interests of learners early enough to prepare them for the world of work, career progression and sustainable development. The current curriculum gives unnecessary focus on examination that has contributed to increased drop out and wastage rates in the education sector.

Curriculum Reforms Vision and Mission

The Basic Education Curriculum Framework (KICD, 2017) spells out the vision and mission of the basic education curriculum reform. The **vision i**s to enable every Kenyan to become an engaged, empowered and ethical citizen. This will be achieved by providing every Kenyan learner with world class standards in the skills and knowledge that they deserve, and which they need in order to thrive in the 21st century. The **mission** of the reforms is 'nurturing every learner's potential'. The curriculum design will ensure that it provides opportunities to identify the potential that every learner brings to school and nurture this potential through the learning pathways that will be provided at Senior Secondary School. This will ensure that no child is labelled a failure at the end of basic education.

Paradigm Shifts in the Curriculum Reforms

Table 1 shows the differences between content-based curriculum and competence-based curriculum.

Table 2: Traditional curriculum compared to CBC

FROM (Content based)	TO Competence Based Curriculum (CBC)
Focus on Content/theory	Focus on Competencies
Rigid and Prescriptive curriculum with limited flexibility	Flexible with opportunities for specialisation
Primarily focused on summative assessment and competition	Balance formative and summative assessment, and excellence
Emphasis on Schooling	Emphasis on Education
Emphasis on Teaching	Emphasis on Learning

Organization of Basic Education

Basic Education will be organized into three levels: Early Years Education, Middle School Education and Senior School.

a) Early Years Education

This shall comprise two years of pre-primary and three years of lower primary school education.

b) Middle School Education

This shall comprise three years of upper primary and three years of lower secondary education.

c) Senior School

Senior School shall comprise three years of education targeting learners in the age bracket of 15 to 17 years. It lays the foundation for further education and training at tertiary level and the world of work. The provision of pathways at senior school is based on the aspiration that all learners can be successful in life. Senior school structures are to facilitate learners to pursue their own interests

and fulfil their potential in line with the curriculum reforms mission of "nurturing every learner's potential". Senior school marks the end of Basic Education as defined in the Education Act (2013). Learners exiting this level are expected to be "empowered, engaged and ethical citizens" ready to participate in the socio-economic development of the nation.

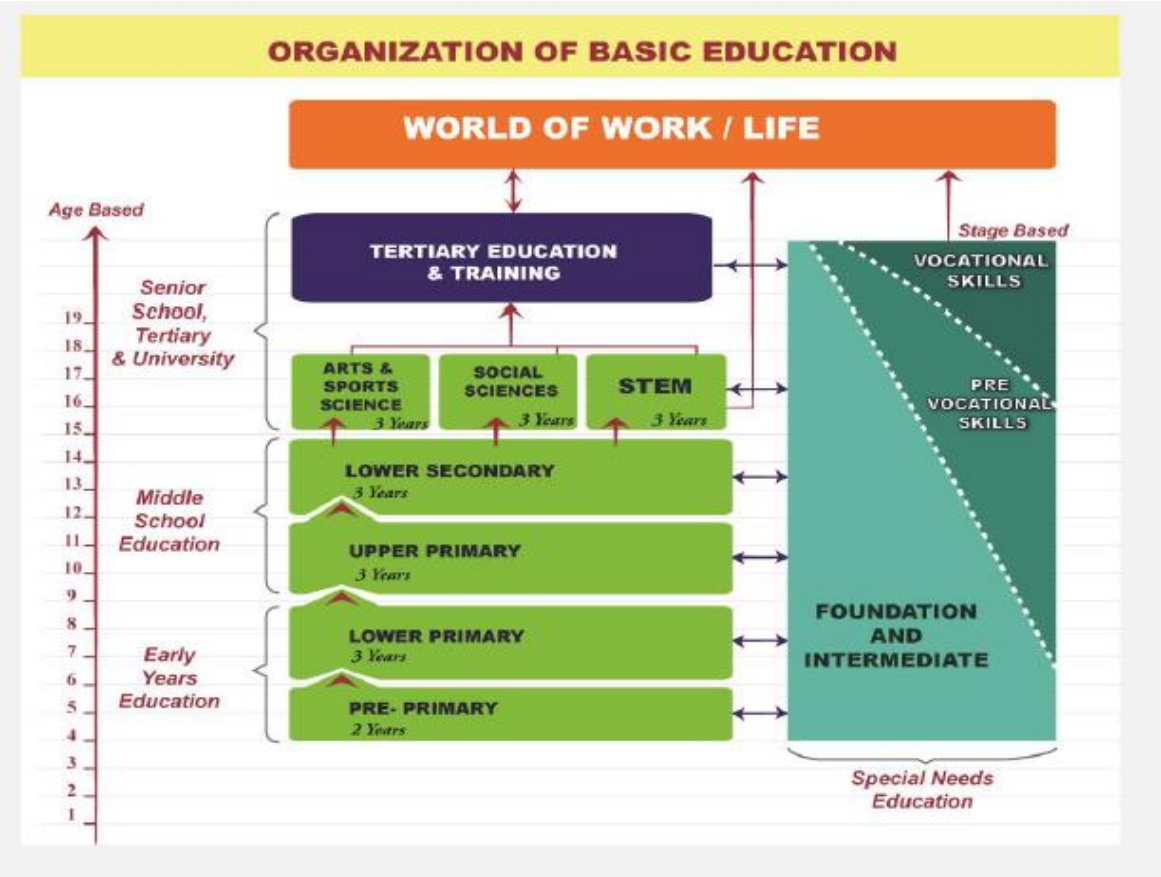


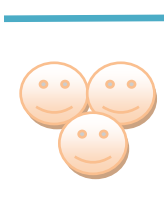
Figure 2: Organisation of Basic Education (source: KICD BECF, 2017)

d) Special Needs Education

Special needs education for learners in this category will start with a functional assessment. The functional assessment determines the placement of the child and the suitable intervention. The child may be placed in a special school, special unit, regular school or home based programme. Figure 1 above shows that there are learners with special needs who may follow the regular curriculum but with adaptations and or enrichment and intervention programmes. Learners under this category include the Gifted and Talented (GT), those with Visual Impairment (VI), Hearing Impairment (HI), Physical Handicaps (PH), Mild Cerebral Palsy (CP), Communication Disorders (CD), Learning Disabilities (LD), and Emotional and Behaviour Disorder (EBD).

Learners with special needs who may not follow the regular curriculum will follow the specialist, specialised syllabuses and intervention programmes including home based programmes. Learners under this category include those with Mental Handicap (MH), Autism (A), Deaf blindness (DB), Cerebral Palsy (CP), Multiple Handicaps (MH) and those with Profound Disabilities (PD).

Competency



Activity 1

a) What is a skill?
b) What is a competency?
c) What is your understanding of competency based curriculum (CBC)?

A skill is the ability to perform a task and solve problems. A competency, on the other hand, is the ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development). A Competency is not limited to knowledge but also encompasses functional aspects involving technical skills as well as interpersonal attributes (e.g., social or organizational skills) and ethical values. Competencies form a necessary condition for reaching an achievement; solving problems, executing a job, obtaining a certain result, making decisions and taking responsibility. KICD conceptualized a competency as the ability to apply learning resources and outcomes (knowledge, skills, values, and attitudes) adequately in a defined context (education, work, personal, or professional development).

21st Century Competencies

A number of countries in the world are exploring how to prepare learners to lead fulfilling lives, be productive contributors in a knowledge economy, and thrive in a information and technology-intensive globalized world. 21st Century competencies are those competencies young people will nee in order to be effective workers and citizens in the knowledge society of the 21st century. These competencies are associated with growth in the cognitive, interpersonal, and intrapersonal domains. Developing a better understanding of the interplay of competencies in the cognitive, interpersonal, and intrapersonal domains support deeper learning practices.

According to Pellegrino and Hilton (2012), deeper learning is the process through which an individual becomes capable of taking what was learned in one situation and applying it to new situations. An emphasis on 'deeper learning' requires a shift in the role of teaching from focusing on covering all required content to focusing on the learning process, developing students' ability to lead their own learning and to do things with their learning. Deeper learning also encourages a more balanced approach to assisting learners in developing the knowledge, skills, attitudes and characteristics that will lead them to become personally successful, economically productive, and actively engaged citizens.

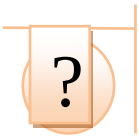
The following categories of 21st century competencies have been shown to have measurable benefits in multiple areas of life:

- critical thinking and problem solving
- innovation, creativity, and entrepreneurship
- communication & collaboration (teamwork)
- a growth mind-set (metacognition / learning to learn, perseverance, and resilience)
- local, global, and digital citizenship

Competency Based Curriculum

Competency based curriculum emphasises what learners are expected to do rather than focusing on what they are expected to know. It is premised on the belief that individuals are lifelong learners who continuously accumulate knowledge and apply the knowing to doing, resulting in performance and mastery of skills. In principle, competency based curriculum is learner-centred, focused on developing skills and capabilities and adaptive to the changing needs of students, teachers, and society. In the context of the Kenyan Competency Based Curriculum (KCBC), a competency is conceptualised as "the ability to apply appropriate knowledge and skills to successfully perform a function". Within this context, the curriculum is designed to emphasise the importance of not only developing skills and knowledge but also applying these to real-life situations. It implies that learners can acquire and apply the knowledge, skills, values, and attitudes to solve situations they encounter in everyday life.

Characteristics of Competency Based Curriculum



Activity 1

What are the characteristics of competency based curriculum (CBC)?

The following are the characteristics of Competency Based Curriculum (CBC):

i. Specific measurable competency
ii. Content based on learners outcomes
iii. Continuous learner involvement
iv. Use of a variety of instructional strategies
v. Focuses on what learners need to know
vi. Pacing instructions to learner needs

Core competencies in the Kenya Basic Education Curriculum

Activity 3

Which 21st century competencies do students need to acquire as they learn in order to be productive global citizens?

(Participants to present the discussion reports)

Core competencies for Basic Education in Kenya

The CBC aims at integrating 21st century competencies into the curriculum. The core competencies to be achieved in basic education are to be mainstreamed in every strand and lesson. The following are the core competencies identified by the Basic Education Curriculum Framework (BECF):

1) Communication and Collaboration
2) Critical Thinking and Problem Solving

3) Creativity and Imagination
4) Citizenship
5) Digital Literacy
6) Learning to Learn
7) Self-efficacy

Activity 3

Discuss each of the seven core competencies and identify strategies for developing them in learners during a lesson.

Table 3: Summary of Core competencies

Collaboration a) Participates in teams; establishes positive relationships b) Learns from, and contributes to, the learning of others c) Co-constructs knowledge, meaning, and content d) Assumes various roles on the team e) Manages conflict f) Networks with a variety of communities/groups g) Respects a diversity of perspectives	**Communication** a) Communicates effectively in different contexts in oral and written form b) Asks effective questions to acquire knowledge c) Communicates using a variety of media d) Selects appropriate digital tools according to purpose e) Listens to understand all points of view f) Gains knowledge about a variety of languages g) Voices opinions and advocates for ideas
Critical Thinking and Problem Solving a) Solves meaningful, real-life, complex problems b) Takes concrete steps to address issues c) Designs and manages projects d) Acquires, processes, interprets, and analyses information to make informed decisions (critical and digital literacy) e) Engages in an inquiry process to solve problems **f)** Makes connections and transfers learning from one situation	**Creativity and Imagination** a) Contributes solutions to complex problems b) Enhances a concept, idea, or product c) Takes risks in thinking and creating d) Makes discoveries through inquiry research e) Pursues new ideas to meet a need of a community f) Leads and motivates with an ethical entrepreneurial spirit
Learning to Learn / Self-Aware & Self-Directed Learning a) Learns the process of learning (metacognition) b) Believes in the ability to learn and grow (growth mindset) c) Perseveres and overcomes challenges to reach a goal d) Self-regulates in order to become a lifelong learner e) Reflects on experience to enhance learning f) Cultivates emotional intelligence to understand self and others g) Adapts to change and shows resilience to adversity h) Manages various aspects of life – physical, emotional (relationships, self-awareness), spiritual, and mental well-being	**Citizenship** a) Contributes to society and the culture of the local, global, and digital community in a responsible, accountable, and ethical manner b) Engages in local and global initiatives to make a difference c) Learns from and with diverse people d) Interacts safely and responsibly within a variety of communities e) Creates a positive digital footprint f) Relates to the environment and is mindful of the importance of all living things
Digital literacy a) Uses a wide range of digital content and devices. b) Uses computer communication networks	**Self-efficacy** a) Believes in his or her capabilities to perform tasks or assignments that can change and

c) Engages in online communication and social networks, d) Aware of and adheres to ethical behavior protocols, e) Aware of societal issues raised through digital media, f) Able to search, evaluate and use information channeled through digital platforms.	transform his or her life b) Determines four major processes namely cognitive, motivational, and affective and selection processes. c) Fosters intrinsic interest and deep engrossment in activities. d) Nurtures intra-personal skills and values such as self-awareness, self-esteem, confidence and personal integrity. e) Demonstrates interpersonal relationship skills such as assertiveness, empathy, effective communication, negotiation skills, non-violent conflict resolution skills and peer pressure resistance skills

Pertinent and Contemporary Issues (PCIs)

Children like adults are faced with a myriad of challenges owing to the legal, technological, social, cultural and economic developments in society. It is important that these challenges are addressed as the overall wellbeing of a child is critical for the survival of any society. These areas in the CBC are referred to as Pertinent and Contemporary Issues (PCIs) formerly known as emerging or cross-cutting issues. Issues that have been identified as pertinent and contemporary have been put into six broad categories as follows: Citizenship, Health Education, Life Skills and Values Education, Education for Sustainable Development (ESD), Learner Support programmes, Community Service learning and Parental Empowerment and Engagement.

Table 4: Pertinent and Contemporary Issues

Broad Area	Pertinent and Contemporary Issue
Citizenship	Peace education, integrity, ethnic and racial relations, social cohesion, patriotism and good governance, human rights and responsibilities, child's rights, child care and protection, gender issues in education.
Health Education	HIV and AIDS Education, Alcohol and drug abuse prevention, lifestyle diseases, personal hygiene, Common Communicable and chronic diseases
Life Skills and Values Education	Life skills, values, moral education and human sexuality, etiquette.
Education for Sustainable Development (ESD)	Environmental Education, Disaster Risk Reduction, Safety and security Education (small arms, human trafficking, Financial Literacy, Poverty eradication, Countering terrorism, extreme violence and radicalization, and Animal Welfare Education
Learner Support programmes	Guidance services, Career guidance, counselling services, Peer education, mentorship, Learning to Live together, clubs and societies, Sports and games
Service learning and parental engagement	Service learning and community involvement and parental empowerment and engagement

Acquisition of knowledge, values and skills in various PCIs will enable the learner to translate what they have learnt in school into real life situation both in and outside school.

Values Based Education (VBE)

Values are standards that guide an individual on how to respond or behave in given circumstances. Thus, values influence how we feel, act and make choices in life. Today, there is noticeable values and behavioural crisis among the general population and young people. Many youngsters are growing up without the desired values, positive attitudes and psychosocial competencies needed to function as responsible citizens. The primary responsibility for nurturing values rests with parents and the community, but education too has a key role to play in this regard. The teaching of values will facilitate the achievement of the curriculum reforms' vision, particularly with respect to moulding ethical citizens. The Core Values in the BECF are: love, responsibility, respect, unity, peace, patriotism, social justice and integrity. CBC aims at moulding and reinforcing values upon which the learner's character is formed

Community Service Learning (CSL)

Community Service Learning (CSL) is an experiential learning strategy that integrates classroom learning to learning from the community to enable learners to reflect, experience, and learn from the community. CSL engages students in community service that is integrated with the learning objectives of core academic curricula premised on providing students with contextualized learning experiences that are based on authentic, real-time situations in their communities. It is a process where learners link personal and social development with academic and cognitive development.

CSL will create opportunities for learners to apply the knowledge and skills acquired through the formal dimension in their community while at the same time learning from the community. This will help learners to develop not only employability skills but also promote personal growth through strong and productive relationships with the community. Learners will utilise the acquired knowledge, skills, values and attitudes to improve the welfare of the community. CSL covers aspects of Citizenship, Entrepreneurship, Financial Literacy, Life Skills, Communication Skills and Research.

Non-formal Learning

Non-formal learning can be used to teach cognitive, interpersonal, and intrapersonal competencies in ways that promote deeper learning and the transfer of learning. Non-formal activities are structured learning activities that are geared towards development of affective and psychomotor dimensions of learning. Some of the non-formal activities may include: singing, dancing, swimming, reciting poems, club activities, games and debates.

Assessment in Competence Based Curriculum

CBC focuses on the extent to which a competency (the ability to carry out a certain task) has been acquired as opposed to laying emphasis on the acquisition of knowledge of the concepts. The assessment needs to use a variety of ways to collect information about a learner's learning and progress in all subjects. The collection of a learner's information should be a continuous process and should be recorded constantly. The teacher should give importance to each learner's way of responding and learning and the span of time he or she takes to do so. The teacher should provide feedback that will lead to positive action and help the learner. When a teacher is providing reports on a continuous basis he or she should be sensitive to every learner's response. The following are the types of assessments in the competence based curriculum:

a) Formative Assessment or Assessment for Learning (AFL)

Assessment for learning is an investigative tool to monitor the progress of an individual learner in meeting the learning outcomes in a subject or learning area. It involves gathering data during the learning process and provides feedback to both the learner and the teacher to help improve learning. This approach helps build an accurate and detailed profile of your understanding of the curriculum and inform teaching so that you can provide appropriate assistance to the learner.

b) Assessment as Learning

Assessment as Learning occurs when a learner is assisted to develop a capacity to be independent, self-directed to set individual goals, monitor own progress/ self-assess, and reflect on his/her learning. A learner can self-assess when you provide the learner with a clear picture of steps required to reach proficiency, a set criterion that have a variety of examples or models of decent work for comparison.

c) Assessment of Learning

This summative assessment and is carried at the end of a unit or task. It is designed to provide information on the achievement of a learner to parents, educators and learners themselves.

d) Summative Assessment

They include tests, examinations, performances, presentation, portfolios, and a variety of written, oral and visual methods. They provide feedback to educators, parents and learners, about a learner's achievement to make decisions for appropriate placements or further studies.

Assessment Tools:

Some of the assessment tools that may be used with the above assessment methods include:

- **Checklists**: assist the teacher to determine areas of focus to enable the learner to develop relevant knowledge and skills
- **Rating Scales**: Use of descriptive words, such as always, usually, sometimes and never
- **Questionnaires**: A list of questions on various aspects of a person's situation
- **Project Method**: a set of activities implemented within a set timeframe. Learners identify a need in their community where they can provide services based on what they have learned.

- **Journaling**: the learner keeps a record of their personal feelings, thoughts and experiences daily.
- **Portfolio**: a purposeful collection of work samples, self-assessments and goal statements that reflect a learner's progress.

Activity 6: Group discussion

a) Using the provided extracts **(Annex 1)** of the curriculum designs for Early Years Education (EYE), identify the components of a curriculum design.

b) Using a strand / sub-strand from your subject area discuss how you would integrate a given core competency, a PCI and a value.

Conclusion

A well designed CBC can assure the connection between the work market, the challenges of postmodern society and the school programs. The curriculum should be responsive and relevant to learners and enable flexibility for teachers – who are designers of learning opportunities – to enable them to meet the diverse needs of the students. More focus should also be directed to competencies and less on content. Competency based instruction measures what learners have learned as opposed to what teachers think they have taught. There should also be a fundamental shift from teacher-centred to learner-centred orientation. Learning is measured according to how well the learner performs in relation to competencies (learning outcomes). The goal should be the appropriate application of knowledge, and not necessarily just its acquisition. This kind of curriculum enables the creation of meaningful connections within and among subject areas by focusing on competencies.

Unit Three: Learner-Centred/Active Learning Strategies

Introduction

Welcome to Unit 3 of this module which will discuss learner-centred teaching and learning strategies (pedagogy). According to The Great Schools Partnerships (2014), learner-centred teaching and learning refers to education programmes, learning experiences, instructional approaches and learner support strategies that are intended to support specific learning needs/learning styles. It places responsibility for the learning path in the hands of the learner and shifts the focus of instruction from the teacher. This is in line with the Activity Student, Experiment, Improvisation (ASEI) and; Plan, Do, See Improve (PDSI) pedagogical paradigm advocated by the Strengthening of Mathematics Science Education (SMASE) intervention as a framework to promote learner centred teaching and learning. Among the many learner centred instructional strategies include Inquiry-Based Learning, Project Based Learning, Problem Based Learning and ICT Integration.

In this unit we will focus on the learning styles, ASEI-PDSI pedagogical paradigm and further explores learner centered instructional strategies specifically Project Based Learning and ICT Integration. Such strategies give learners opportunity to explore what interests them, design their own learning activities/projects; takes leadership in the learning activities, do much of the communication during learning through discussions and responding to a teacher and peer questions.

Rationale

This unit is informed by the Teachers Service Commission (TSC) Teacher Professional Development Induction Module, Unit two on ***Instructional Design /Pedagogical Content Knowledge.*** **The Unit** seeks to provide teachers with an opportunity to practice the use of various teaching strategies. Additionally, the ongoing curriculum reforms in Kenya with a shift to Competence Based Curriculum (CBC) call for the use of learner-centered instructional strategies. It is therefore important for teachers to use learner focused instructional strategies so as to develop requisite competencies among learners to enable them to fit in the 21st-century society.

Specific Learning Outcomes: By the end of this you should be able to

1. Demonstrate knowledge and skills in designing learner-centred activities.
2. Use Project Based Learning (PBL) to demonstrate knowledge and skills in designing learner-centred activities in science and mathematics lessons
3. Demonstrate knowledge and skills in the use and integration of technology in teaching and learning of science and mathematics lessons
4. Appreciate differentiated learning and adapt learning activities to suit the needs of the learners, including those with special needs.

Ways of learning

Learners are different and therefore learn differently. Gardner (1983) identified 8 intelligences that describe ways of learning as follows: logical-mathematical, visual bodily-kinesthetic, naturalistic, verbal-linguistic, intra-personal, interpersonal, and musical/rhythm. He referred to these as **multiple intelligences**. Below is a brief description of each of the intelligences.

1. **Visual** also known as spatial individuals who prefer using pictures, images, and spatial understanding.
2. **Musical/ rhythm** also known as auditory individuals who prefer using sound and music.
3. **Verbal or linguistic** individuals who prefer using words, both in speech and writing.
4. **Bodily or Physical or kinesthetic** individuals who prefer using your body, hands and sense of touch.
5. **Logical also known as mathematical** are individuals who prefer using logic, reasoning and systems.
6. **Interpersonal or social** are individuals who prefer to learn in groups or with other people.
7. **Intrapersonal or solitary** are individuals who prefer to work alone and use self-study.
8. **Naturalistic** are individuals who are sensitive to nature and the world e.g. zookeepers, biologists, gardeners, and veterinarians.

Figure 3 Summarises the multiple intelligences

Figure 3: Summary of multiple intelligences

Source: https://www.tes.com/lessons/BPDxaGGvG8PFtg/multiple-intelligences-in-my-class, 2019

A teacher is required to prepare learning activities which appeal to diverse intelligences among the learners. Students will undoubtedly learn more effectively if teachers match their methodologies to suit one or more of the intelligences. This calls for learner-centred approaches where teachers deliberately plan for varied activities to suit different learners.

Choose one of the intelligences and list how you ever promoted it in your classroom?

You may have come up with the following

i. Visual— use of drawings, maps, outlining processes, watching videos, reading silently, graphs, tables.
ii. Auditory— listening to speeches or videos, reading out loud, participating in group discussions.
iii. Bodily/kinesthetic— taking field trips, visiting museums, playing learning games, doing hands-on activities, writing notes.
iv. Intellectual processes- discussions and report writing

Note: It is important to consider learners with special needs as you plan learning activities.

In the next section, you will explore the concept of learner-centered pedagogy

Learner-Centered Pedagogy

As seen earlier learner-centred pedagogy gives learners the opportunity to explore what interests them, enable them to take leadership in learning activities, do much of the communication during learning and design their own learning activities/projects. This is informed by their different learning styles.

To what extent do you think classroom practices in your schools are learner-centred? Share with your colleagues and give examples of good practice in your school?

In the following section ASEI-PDSI pedagogical framework is described as a model of learner-centred pedagogy.

ASEI-PDSI Pedagogical Paradigm

The Strengthening of Mathematics and Science Education (SMASE) intervention advocates for ASEI-PDSI as a framework that enhances learner-centered pedagogy. The term ASEI-PDSI is an acronym that stands for **A**ctivity, **S**tudent, **E**xperiment and **I**mprovisation. PDSI, on the other hand, stands for **P**lan, **D**o, **S**ee and **I**mprove. A survey by CEMASTEA (2015) revealed the poor mastery of content by some teachers, failure to do lesson preparation, lack of basic practical skills and innovativeness, and teacher-centred approach to teaching. The ASEI-PDSI approach is aimed at continuously rally and focus teachers on certain elements that are useful in making classroom practices more learner-centred.

(a) Let us focus on A*ctivity* in an ASEI lesson

Activity in ASEI implies active, meaningful and constructive participation of the learner in learning by way of activities. Such can be hands-on (manipulative), minds-on (intellectual),

mouths-on (discussions), hearts-on (activities that stir up the learner's interest/feelings), Q/A, practice and drill as in mathematics, calculations, experiments, project work and role-play.. Choice of activities and how they are linked to bringing out desired concepts assist learners to develop anticipated knowledge, skills and attitude.

(b) Let us focus on Student in an ASEI lesson

The 'S' in ASEI is a focus on the student (learner). It calls for teachers to plan teaching and learning activities with learners in mind. Further, you should take into considerations the interests, motivations and needs of the learner.

(c) Let us focus on *Experiments* in ASEI.

E refers to experiments or practical work in a lesson. You need to select lesson activities based on the knowledge, skills and attitude you want your learners to acquire. Activities are important as they offer the opportunity to inculcate mathematical and science process skills. Such would include manipulation and observation, measurements and recording, questioning and discussion, critical thinking and problem solving, among others. These skills are important for their everyday life.

(d) Let us consider the 'I' in ASEI which denotes *improvisation*.

Improvisation involves the use of locally available materials, scaling down of teaching or learning resources or innovative ways of teaching and learning the content. Use of objects, modelling or where possible the use of living specimens makes a mathematical and scientific phenomenon real enough to be understood. Improvised materials that are locally available are convenient, economical for utilization and also raise learners' interest and curiosity.

Figure 4: Improvised Stethoscope

The ASEI-PDSI cycle described in the next section helps to realize a lesson that is learner centred.

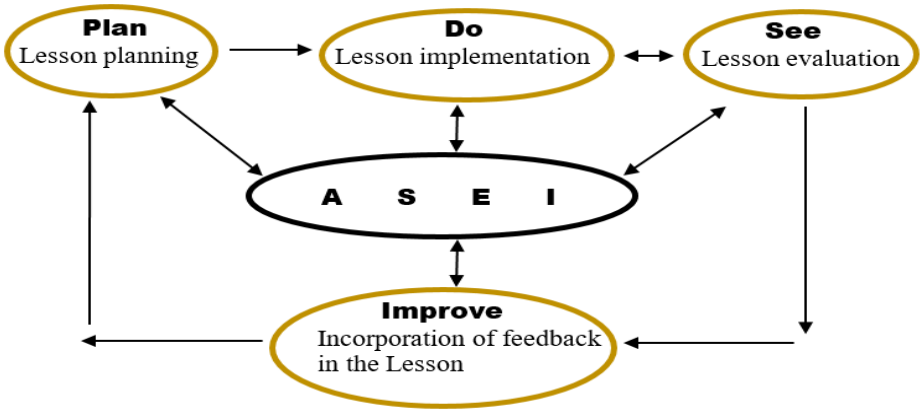


Figure 5: The ASEI-PDSI Cycle

a) Let us consider the 'P' in PDSI which denotes Plan

The 'P' for **Plan** refers to the practice of planning where a teacher's detailed the course of instruction or "learning trajectory" for a lesson. A lesson plan is developed by a teacher(s) to guide how a lesson will be implemented, including, teaching strategies and lesson activities such as group work, experiments, and questions to be posted among others. Details usually vary depending on policies, teacher preferences, the subject being covered, and more importantly in this case, the needs of the students.

What is the practice of lesson planning in your school?

b) Let us consider the 'D' for Do in PDSI:

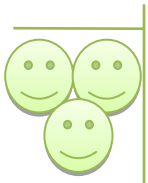
This is the process of implementing the planned ASEI lesson. After planning for the lesson, your role in the class is to facilitate and guide learners as they carry out tasks, answer questions, and seek clarification. As a facilitator, you may pose questions to ensure that the process taking place in the classroom focuses on the expected learning outcomes. Consider the type of questions to ask land invite learners to share their learning. Ensure that all learners have equal access to resources, and equal opportunities to participate.

c) Let us consider the 'S' for See in PDSI

As you implement lessons, you need to engage in a **reflective** and formative evaluation of how learners are reacting to the experience. When you ask questions, what kind of answers do you get? When you listen to the discussions, what do you hear When you observe their activities and outputs, what do you conclude? Use appropriate strategies and suitable modes of communication to gather information on the effectiveness of your teaching and learning strategies and how to improve subsequent lessons. **(Use sign language or services of a sign language interpreter in case of learners with hearing impairment)**

d) Let us consider the 'I' for Improve in PDSI

Improve denotes the use of information gathered during the reflective evaluation of the learning process to make improvements in the ongoing and subsequent lessons. This ensures continuous improvement of the teaching process.



Activity1

Use the provided materials to balance all the provided on the nail on the wooden block. . What concept in your subject area can you teach with this activity? How can you justify the level of learner engagement in this activity?

Materials: Wooden block with one 5 inch nail one nailed on top, 21 pieces of 5-inch nails

Strategies for Active Learner Engagement

As mentioned earlier, several strategies for active learner engagement exist. We will now explore ICT Integration and Project Based Learning (PBL) teaching and learning strategies.

ICT Integration in Teaching and Learning

One way of appealing to the diverse multiple intelligences is to integrate Information Communication Technology (ICT) in teaching and learning.

Reflection

Activity 2

What do you understand by the term ICT Integration in teaching and learning?

ICT integration in teaching and learning refers to the seamless incorporation of information, communication and technology to support and enhance the appropriate competencies including skills, knowledge and attitudes (Basic Education Act, 2013). ICT is an important tool for further creating and an enabling environment for multiple learning styles. In learner-centred teaching, sustaining interest is very crucial.

One model of integrating ICTs in the classroom is The Technological Pedagogical Content knowledge (TPACK). When well understood TPACK is very and, interesting to use. Other ICT integration models Substitution Augmentation Modification Redefinition (SAMR) and Replacement, Amplification, Transformation (RAT). We now get into some details of TPACK. **Note that there is ICT software suitable for learners with learning difficulties such as visual impairment.**

Technological Pedagogical Content Knowledge (TPACK) Model

The major elements of the TPACK model:

(a) Content Knowledge (CK): This knowledge emanates from the curriculum documents, including facts, concepts, theories, and principles that are taught and learned in specific academic courses. It could also encompass the deep learning of concepts, as well as higher order thinking, high-level communication and other processes in the curriculum.

(b) Pedagogical knowledge (PK): This knowledge is related to the strategies, and techniques used in classrooms and other learning environments to ensure curriculum goals are met.

(c) Technology knowledge (TK): This knowledge is concerned with the digital and non-digital technologies and tools that we use in our classrooms.

These elements must actively interact at all times for the full benefits of ICT integration to be realized. This interaction is illustrated in figure 3

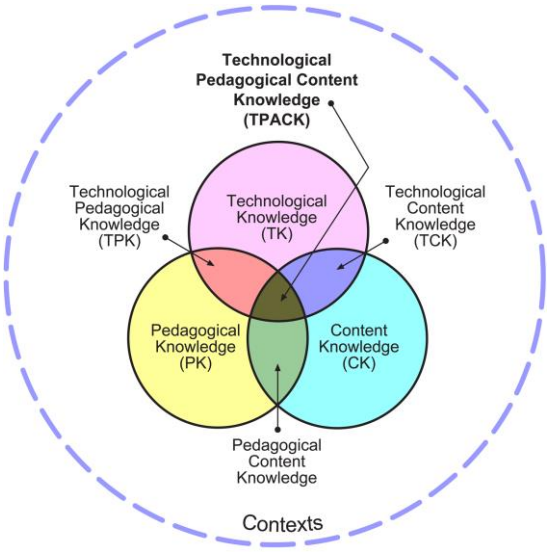


Figure 6: TPACK Model

In order to structure an ICT integrated learning activity, we need to consider some questions viz..

(i) What concept (content) do I want to teach?
(ii) What is the expected outcome?
(iii) What technology can I use to teach this concept?
(iv) Why will I need to use the technology to teach this content?
(v) What activities will the learners do?

Activity 3
Apply the questions mentioned above to develop ICT integrated lesson activity in your subject area.

Suppose a physics teacher wants to teach photoelectric effect and the concept of factors affecting photoelectric emission (photocurrent). The following questions illustrate how you can achieve an ICT integrated lesson

1. *What concept (content) do I want to teach?* The first step would be for the teacher to identify the concept to teach. This is obviously the content as per the syllabus. An example in physics could be factors affecting photoelectric emission.
2. *What technology can I use to teach this concept?* The second step would involve the coming up with the teaching and learning resources appropriate to use in teaching this concept. A simulation of photoelectric emission would be appropriate here. Hence the teacher chooses an appropriate *photoelectric simulation.*
3. *Why do I need technology for this content?* The third step involves an analysis of what value would this technology add to teaching and learning. What difference would it make if I delivered the lesson with or without this technology? In this case, the technology makes it possible for learners to visualize some aspects that would be otherwise difficult, for instance, the rate of flow of electrons, varying intensity of light, varying frequency of light, etc.

4. *What activities will the learners do?* This is a very important consideration to make for meaningful learner engagement. Learning is not for the teacher, but for the learner so the learner should be at the center of learning and therefore coming up with learner tasks is very crucial. These tasks should be in line with the learning objectives and also help learners develop 21st-century skills and requisite competencies such as critical thinking, creativity, collaboration and communication. In this example the teacher would create learner tasks as below;

Form groups of 5 and do the tasks below

a. Using the simulation photoelectric jar, set the source of light to 450nm (near the UV). Select sodium as the target metal.
b. Vary the intensity from 0% to 100% and make an observation
c. With intensity at 80% vary the wavelength of the source of light. Record your observations
d. Change the target metal and follow the same procedure and record your observations
e. Find out what else you can observe with the simulation.
f. Make a group report on the following citing evidence from the simulation
    - What are the factors that affect photoelectric emission?
    - Explain how the said factors affect photoelectric emission
g. Explain how you would design a solar panel that is appropriate to power domestic lighting, a TV and radio for a single house.

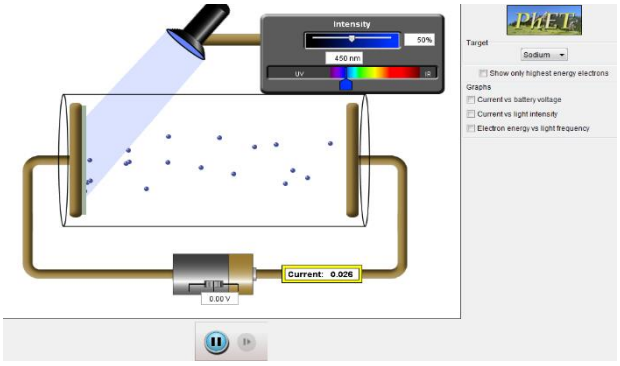


Figure 7: Simulation of photoelectric effect

Let us now explore the **Project Based Learning** as another strategy to promote learner-centered teaching and learning

Project Based Learning (PBL)

Reflection

What do you understand by the term project-based learning?

You may have come up with the following responses

- A research

- A carefully planned and executed undertaking aimed at achieving certain objectives
- Working on projects
- Looking for solutions to problems
- Coming up with tools or materials for solving real-life problems

Project Based Learning (PBL) is a teaching strategy in which a student gains knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge. PBL places the learner at the centre of the learning process. It not only encourages students to learn, but also apply knowledge and skills learnt through engaging experiences. In this regard, it is one of the teaching methods in which multidisciplinary approach to learning can be enhanced as students are encouraged to apply knowledge and skills learned in different subjects to their projects. The use of PBL in teaching and learning can, therefore, lead to a deeper understanding of concepts because learners are given opportunities to take control of their own learning.

Elements of Project Based Learning

There are seven key elements of project-based learning as follows: challenging problem or question; sustained inquiry; authenticity; student voice and choice; reflection; critique and revision; and public product (BIE, 2015). In the following section, we examine each of these key elements in detail.

i. Challenging Problem or Question

As mentioned, PBL allows students to work for an extended period of time to respond to an authentic, engaging, and complex question. The starting point in PBL is, therefore, a challenging problem or question. The question needs to be that which seeks to address a real-life situation. That way, students will be motivated to work towards resolving the situation as they learn with something in mind to look forward to. The examples of questions that can be applied in PBL are as follows.

a) How can we improve our school's solid and wastewater management?
b) How can we solve the water problem we experience in this school?

ii. Sustained Inquiry

Inquiry is about "seeking information" or "to investigate". After a problem has been identified and a question posed, an investigation is designed and data collected. The data are then analysed and the results interpreted and presented. A reflection about the inquiry activity follows with a view to engaging in further investigations. The process is repeated until a satisfactory solution is found. Thus, inquiry is iterative and therefore if students learn through PBL, sustained inquiry is part of the process they will be involved.

iii. Authenticity

Authenticity is synonymous with original or genuine. In terms of teaching and learning, authenticity in PBL has to do with carrying out research about a real-world problem. In PBL students will endeavour to find their original and genuine solutions to problems. As they work, the students may use real-world processes and tools to carry out tasks. Authenticity in PBL, therefore, increases student motivation and interest as well as improving learning. This is because they relate what they are learning through their projects to real life experiences and view themselves as creators of knowledge and as well as being part of the solution to problems in society.

iv. Student Voice and Choice

When students work on projects under the umbrella of PBL, they think and make decisions and choices on the next steps regarding their work. They also give inputs at various stages of their work that may include, questions they generate, resources needed for their project, putting the resources to use, revising designs, and communicating information about their work. In working on projects, you should give opportunities to each and every learner involved in the project to make their inputs. You need to ensure all your students benefit from each other's research by requiring that each group teaches their topic to the rest of the class. You can also use online tools to make sure that each student's research benefits everybody. This creates a sense of ownership and as a result may increase student motivation.

v. Reflection

Reflection on learning is an important virtue that should be encouraged. Reflection means becoming aware of your own thinking processes, and being able to make them open and transparent to others. Reflection in PBL helps both learners and teachers to think about their actions and how those actions are impacting on their projects. They may also think about what further actions are needed to make an improvement to their project. You are therefore required to guide students to document their reflection as it can help them in tracking their learning. In addition, you will make a conclusion to consolidate the reflections.

vi. Critique and Revision

You will guide learners to make a presentation of their documents findings, allow for critique and revision as a means to give and receive feedback. According to Kirschner & Neelen (2018), feedback is one of the most important tools for supporting learning. You as well as other invited people can also give feedback. The final quality of the project outcome will depend on thoughtful critique followed by a revision of the work already undertaken.

vii. Public Product

The last key element of PBL is a public product. This product is the result of the revision of the project. This implies that there is more value added if students share their project work (i.e., product) with other people (public) who are not part of the project process. When students share their project product with the public it enhances school-community relationships. In addition, it is

one way to let the public see how students apply their learning in school in solving real-world problems. Figure 5 represents a summary of the key elements of PBL

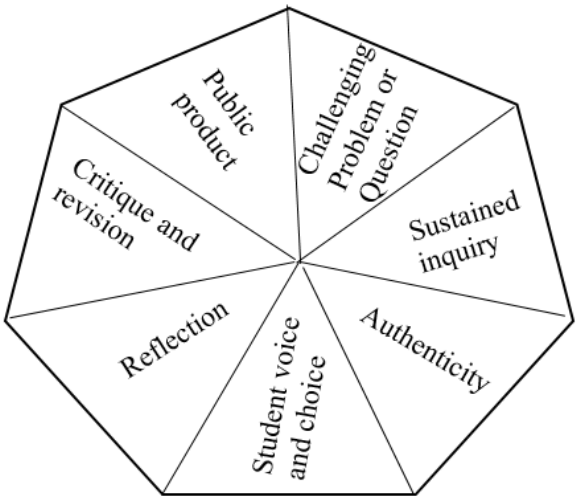


Figure 8: Summary of Key Elements
Source: BIE (2015)

Benefits of Teaching through PBL

Reflection

What could be the benefits of PBL?

√ It places the learners at the center of the learning process, thus making them active participants in their own learning

a) It helps learners acquire a variety of valuable skills such as: questioning, planning, researching, creating, reflecting, presenting, problem solving and collaboration.
b) It can enhance independent learning and thinking among learners
c) It can lead to the solution of real-life problems

Examples of PBL Activities

1. Students have probably learned that the use of fossil fuels is harmful to the environment. For example, gases emitted as a result of burning fossil fuels (e.g., carbon (IV) oxide, carbon (II) oxide, Sulphur (IV) oxide and nitrogen (IV) oxide) pollute the air. In addition, global warming has been linked to the use of fossil fuel. ***What project(s) can students do as one way of resolving problems associated with fossil fuels?***

2. In the school neighbourhood lives an old widow whose old hut is no longer habitable. As a way of giving back to the community, the School Board of Management (BoM) would like to build a decent house for her using building materials that remained from the school building project. Your form three class is asked to design a decent house that can be built using the bricks and iron sheets that are available in the school store and spearhead its

construction to completion. *You may challenge students to think of what to consider* ***in their design to ensure minimum cost of construction.***

Activity 4
Discuss some examples of problems in real life that students can pursue solutions through PBL in your subject area?

The PBL strategy will help develop learners' problem solving, critical thinking and information processing skills. In designing PBL activity, students are subjected to a real-life problem to investigate and come up with possible solutions. It is possible for students to pose questions, design investigations that will lead them to answers to the problems. These solutions can then be discussed to pick of the best. The solutions given are not necessarily right or wrong as each solution has its own merits or demerits and learners have to analyze by themselves.

Conclusions

Learner-centred instructional strategies gradually develop independent thinkers, endowed with the tools necessary for lifelong learning. It develops students' ability to identify their academic strengths, motivations, as well as their weaknesses or what it is that they may struggle with in school. Consequently teachers should endeavour to facilitate learners to identify:

- *what they want to learn*
- *how they are going to learn it iii*
- *how to track their progress, and*
- *what determines success.*

Learner -centred instructional strategies will enable you to design appropriate learning activities and appreciate the need to adapt the activities to suit individual learners including those with special needs.

Unit Four: Learner-Centred Strategies as applied in Subject Areas of Mathematics and Science

Subject: Biology

Topic one: Genetics

Introduction

Welcome to this session in which you will explore the topic of **Genetics** and look at how Project Based Learning (PBL) strategy can be used in the teaching and learning of the content in the topic Genetics. The session is divided into two sub-sessions. Sub-session one consists of preliminaries which include rationale, learning outcomes, and background information. While, Sub-session two consists of **learning activities in the topic using** PBL strategy.

Rationale

This topic is taught at form four level and has been identified to be challenging to teach and learn (CEMASTEA TNA report, 2017; M&E report 2016). The topic is perceived to have few practical activities hence it is mostly taught theoretically. There is also a tendency to rush through it being one of the last topics in secondary biology syllabus. This session gives you an opportunity to integrate PBL strategies to enhance learning and core competencies in Curriculum Based Curriculum (CBC).

Learning Outcomes

By the end of this session, you will be able to integrate Project Based Learning (PBL) strategies to enhance teaching and learning.

Objectives of the topic Genetics

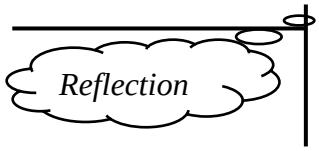
The teaching objectives for genetics as stated in the Secondary Education Syllabus (KIE, 2002) are outlined below:

By the end of the topic, the learner should be able to:

1. Distinguish between continuous and discontinuous variations
2. Describe the structure and properties of chromosomes
3. State the first law of inheritance and describe Mendel's work
4. Construct and use Punnet square/checker board
5. Distinguish between F1 and F2 generations, genotype and phenotype, haploidy and diploidy, homozygosity and heterozygosity, dominance and recessiveness, linkage and sex-linkage, mutations and mutagens
6. Predict and explain the inheritance of the ABO blood groups and Rhesus (Rh) factor
7. State examples of genetically inherited disorders
8. Explain causes of chromosomal mutations
9. Explain the practical application of genetics

Teaching and Learning Activities in Genetics

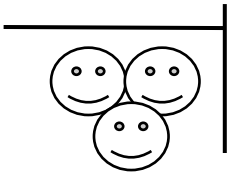
This section provides you with opportunities to carry out some suggested activities that can help in understanding concepts in genetics. You will also be expected to develop your own teaching and learning activities in the topic that involve the use of PBL as a teaching strategy.
The activities should help you to engage learners and trigger them to express their own ideas and understanding of this topic.



What are some of the learning challenges your learners experience in the topic genetics?

You may have come up with the following:

- Genetic terms (e.g. complete and incomplete dominance, allele and genes, etc)
- Cause of gene and chromosomal mutations
- Genetic crossing
- The significance of the phases of mitosis



Activity 1: Analyse the topic genetics as outlined in the syllabus. Select the concepts that can be taught best through PBL.

You could have come up with the following:

Variations (e.g. in height, fingerprints)

- Mutations
- Complete and incomplete dominance
- Genetic counselling
- Genetic engineering
- Genetic disorders
- Plant and animal breeding

Activity 2: Pick any of the challenging concepts from your reflection above and plan how to teach it using PBL learning strategy.

You may have come up with the following with a concept like variation and designed your PBL strategy as follows:

- Problem presentation
  - How similar or different are we from each other?
- Inquiry into the problem:
  - What do we know about variations that can help us solve the problem above?
    - Phenotypes such as height, colour of skin, tongue rollers, Phenylthiocarbamide (PTC) tasting arise due to variation
  - What else do we need to know to solve the problem? For example, we need to know :
    - Why some people are tall and others are short within the same family.
    - Why some people are able to roll their tongues while others cannot
  - Where and how can we get relevant information to explain the differences above?
    - Seek for the information required from the internet, journals and books
- Analysis of the information the group has come up with to solve the problem for instance;
  - Understanding the role of genes, dominant genes, recessive genes, mutations, environment, among others in variation.
- Prepare a report
- Present the report
- Evaluate and then review with the help of a teacher or teachers to clarify misconceptions

Application of Genetics to Real Life

Knowledge of genetics can be used in a number of ways in our lives.

Why do we teach genetics in secondary school?

You may have come up with the following:

- To prepare learners for future careers
- To be able to pass examinations
- To understand the causes of differences between living organisms

Activity 3: Suggest some areas where genetics is used in everyday life

You may have come up with the following:

Health, Agriculture, Forensic science, Genetic counselling and law

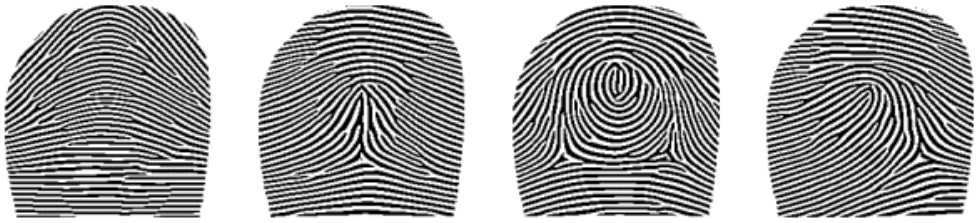
Activity 4: Read the scenario below on how PBL can be applied in teaching the concept variation in genetics. Follow the procedure given to enable you understand how the learners were to apply PBL in identifying a thief.

Scenario

A student sneaks into the principal's office and steals a mobile phone. In the event, he/she also drank a glass of juice that was placed on the principal's desk. The principal's secretary reveals it was a Form Four North student but could not recall the name. The Form Four North teacher of biology sets to 'investigate' the case.

Resources

Picture of the four Basic Fingers prints, a hand lens, an Ink pad, black ink, photo copying paper and methylated spirit or ethanol.



Arch (A) Tented Arch (T) Whorl (W) Loop (U or R)

Source:https://www.google.com/search?q=FINGER+PRINTS+PICTURES&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiLt8qX7q_dAhWMKMAKHVaTChMQ_AUICigB&biw=1366&bih=672#imgrc=ZEFyGFzm0BKbrM

Procedure

a. Using an ink pad, let all students take their right hand thumbprint.
b. Let them make thumbprints on a **photo paper** and let the teacher give each print a 'secret code name' which individual students should remember
c. The teacher should make his or her thumbprint and name as 'thief'

Ink Pad

Fingerprint

Hand lens

d. Let the teacher mix **all** the thumbprint from students and one copy of his or her coded finger and distribute all of them to the students in groups.
e. Ensure each group gets a copy of the 'thief's' thumb print for comparison

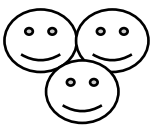
f. Using the hand lens and pictogram of the four fingerprint whorls, students compare the prints in their groups and by elimination 'identifies' the thumbprint thumb print that resembles the 'thiefs' provided sample as in 'e' above.

g. The students could come up with mixed results. Some claiming they have identified the 'thief'; isolated suspects that could possibly be the thief; some could claim the 'thief' is not in their group etc.

Note: For learners with visual impairment, charts with embossed fingerprints should be provided as shown below.

Discussion questions

1. Why did the teacher use his or her own fingerprints as the 'thief's'?
2. What kind of discussions can ensue from this activity?
3. What are the other known uses of fingerprint technology?



Activity 5: Use the steps in activity 2 above to organise the fingerprint scenario into a PBL activity.

You may have come up with the following:

- Problem presentation
- Inquiry into the problem
- Prepare a report
- Make presentations
- Evaluate and then review (with help of the teacher - to clarify misconceptions)

Discussion question

Identify competencies that can be promoted, core values that can be learned and pertinent and contemporary issues that can be enhanced through activity 4.

You may have come up with the following

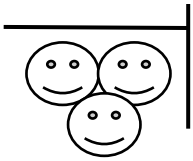
Activity 4	Competence	Values	Pertinent and contemporary issues
Identification using fingerprints	Communication and collaboration	Respect ,Unity ,Patriotism,love	Citizenship Life skills and values education
	Critical thinking and problem solving	Social justice. Peace	Learner support service Community service learning

Source: KICD. 2017

Activity 6: How would you use the scenario above to further the application knowledge of genetics in your own school set up?

You may have come up with:

- Biometric identification of people
- Deaths in schools
- Sexual abuse in schools
- Good conduct
- Cybercrime
- Tasting of tasters
- Resistance to medicine and drugs



Activity 7: Prepare an ASEI lesson to teach a concept in genetics using PBL strategy.

Conclusion

In this unit, we have looked at PBL as a strategy in ASEI-PDSI approach in teaching and learning using the topic genetics. You must have realised that PBL strategy is a learner-centred approach that provides an opportunity for in-depth individual and collaborative study, application of knowledge, skills and attitudes required in the 21st Century classroom. You were able to infuse aspects of Competency Based Curriculum (CBC) in the course **o**f applying PBL stages i.e. Core Competencies, Core Values, Community Service Learning, Pertinent and Contemporary Issues (PCIs), It is therefore recommended that you apply what you have learnt in other topical areas in biology in the course of your teaching.

Topic Two: Cell physiology

Welcome to this session. In this session, we will use the topic 'Cell Physiology to illustrate how to use ICT integration in teaching and learning. The session is divided into the following parts; an introduction, rationale, learning outcomes, teaching and learning activities that include hands-on activities, ICT integration, lesson planning, and conclusion.

Rationale

Analysis of KNEC report (2017), CEMASTEA Monitoring and Evaluation and Training Needs Assessment reports (2016: 2017) shows that the topic **Cell Physiology** is challenging for most learners. Performance in questions on this topic reveals low-learner comprehension of various concepts in the topic. The KNEC report noted that terms used in this topic such as hypertonic, hypotonic, flaccid, plasmolysis and turgid are poorly understood by learners. The abstract nature of some of the concepts makes it difficult for learners to understand although they have ideas about the cell from primary science education as well as through interactions with the environment. In order to simplify these concepts, the use of Information and Communication Technology (ICT) has been mainstreamed. This session gives you an opportunity to practically conduct activities in this topic as well as integrate ICT in teaching the topic to simplify concepts.

Learning Outcomes

By the end of this session, you will be able to:

1. Demonstrate integration of ICT to teach the topic 'cell physiology' effectively.
2. Develop a lesson plan for a concept in the topic 'cell physiology' that incorporates ICT Integration
3. Demonstrate an activity in the topic using ICT integration

The objectives of the topic cell physiology

The teaching objectives for the topic cell physiology stated in the current curriculum (KIE, 2002) are outlined below:

By the end of the topic, the learner should be able to;

1. Define cell physiology
2. Correlate the membrane structure with the cell physiology in relation to permeability
3. Differentiate between diffusion, osmosis and active transport
4. State and describe factors affecting diffusion, osmosis and active transport
5. Carry out experiments on diffusion and osmosis
6. Explain the role of diffusion, osmosis and active transport in living organisms
7. Explain turgor and plasmolysis in terms of osmotic pressure.

Teaching and Learning Activities in Cell Physiology

This section provides you with opportunities to carry out some suggested activities that can help in understanding of concepts in this topic. You will also be expected to develop your own teaching learning activities in the topic that includes ICT integration.

The activities are aimed at giving you additional strategies that will help you to engage learners and trigger them to explore and explain their own ideas and understanding of this topic.

What do you understand by the term cell physiology?

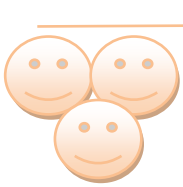
You may have come up with the following:

- Cell physiology is about activities that take place within a cell to keep it alive
- Cell physiology is concerned with how cells function
- Cell physiology is the study of the mechanical, physical, and biochemical functions of living cells
- It is concerned with the function of cells, and how they interact with each other and with the larger organism in which they are found

NB: In the Kenya Secondary school syllabus the topic of *cell physiology* is used to assist learners to understand processes through which cells take in and release substances.

Why Teach Cell Physiology?

Let us now discuss why we introduce the concept of cell physiology at Form one level.



Activity 1:

i. Why do you think it is important to teach Cell Physiology at Form one?
ii. What pre-requisite knowledge and skills do learners need to facilitate the understanding of this topic and why?

You may have come up with the following:

Teaching cell physiology at form one level is important because it forms the foundation in the learning of other topics in biology such as nutrition, absorption of food, translocation of food in plants, coordination and others. .

The pre-requisite knowledge, skills, and attitudes needed include knowledge of the cell structure, microscopy, drawing skills, particulate nature of matter, and a disposition to learn.

Activity 2:
What ideas do learners have about Cell Physiology?

You may have come up with the following:

- Something about Cells in our bodies
- Study of cells
- How cells work
- Physical appearance of a cell
- Cell physiology is a about activities that take place within a cell to keep it alive
- Cell physiology is about how cells function

Use of ICT integration strategies to explain concepts in cell physiology

Activity 3:
In this activity, we will consider some content areas in cell-physiology and discuss how ICT integration strategies can be used to teach them by completing table 4.

Table 5: ICT strategies for teaching and learning cell physiology

Content Area	Expected learning outcome(s)	Identify ICT resources that could be used to achieve the expected learning outcome	Describe pedagogical strategies to apply using the identified ICT resources to achieve the expected learning outcome.
Structure and properties of cell membrane (Theories of membrane structure not required)			
Physiological processes- diffusion, osmosis and active transport			
Water relations in plant and animal cells; turgor, plasmolysis, wilting and haemolysis			

Reflection

Why is osmosis referred to as special diffusion?

You may have come up with the following:

- Only Osmosis occurs across a semi-permeable membrane
- It is the movement of solvent molecules across a semi -permeable membrane into a region of higher solute concentration
- In osmosis only water molecules move from a region where the water molecules are in high concentration to where the water molecules are in low concentration across a semi permeable membrane.

Activity 4a:

In this activity, you are going to investigate water relation in plants- Turgidity, plasmolysis and wilting. You have been provided with 2 potatoes, 1 Cork borer, 4 beakers labelled A, B, C and D, 4 Petri dishes labelled A, B, C and D, 1 measuring cylinder, water, salt, balance, forceps and means of timing .

Procedure:

a) Using cork borers make 12 equal potato cylinders each measuring 4 cm long.
b) Make salt solutions of 0 g/100 ml, 1.5 g/100 ml, 3 g/100 ml and 4.5 g/100 ml. Place each of them in the beakers labelled A, B , C and D respectively.
c) Place 3 potato cylinders of equal length made in (a) above in each beaker containing the different salt solutions prepared in (b) above as shown in figure 9.

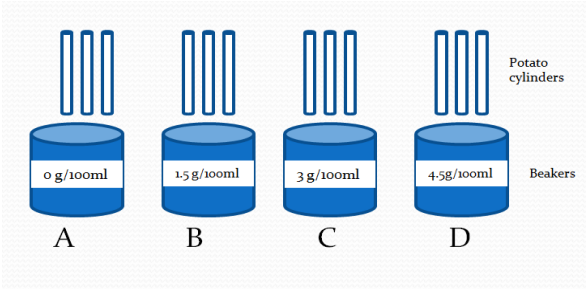


Figure 9: Experiment set up

Leave the potato cylinders in the solutions for 20 minutes.

d) Remove potato cylinders using forceps and place them in the four corresponding Petri dishes labelled A, B, C and D as shown in figure 10.

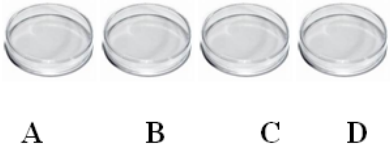


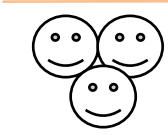
Figure 10: Petri dishes

e) Feel the different potato cylinders and try to bend them. Record your observations.
f) Re-measure the cylinders as accurately as possible and record the lengths to the nearest mm in the table 5.

Table 6: Experimental results

Salt concentration g/100ml	Initial potato cylinder Length (cm)	Final potato cylinder Length (cm) after 20 minutes	Change in length (%)	Average change in length (%)
0				
1.5				
3				
4.5				

Using excel plot a graph of the average change in length against salt concentration (g/100 ml).
At which solution was the concentration of salts isotonic to those of potato cells?
What does the negative average change in length of cylinders imply?



Wrap up activity 4 b:
Describe the application of principles in this activity in real life.
What other materials can be used to perform this experiment?

Use the video: https://www.youtube.com/watch?v=jTDATlaBV-o

What is diffusion and how does it take place?

Learning Outcomes

By the end of these activities you should be able to:

- describe how diffusion takes place in liquids
- model the process of diffusion
- demonstrate factors affecting diffusion

The purpose of these activities is to explore why learners find the concept of diffusion challenging to understand and what misconceptions they have about it. This helps in coming up with teaching approaches and activities including ICT integration to address the misconceptions. It is hoped that by doing this the concept of diffusion will be made simple and interesting to teach and learn.

What does the word diffusion mean to your learners?

You may have come up with the following:

- Movement of particles from one place to another
- Dissolving of substances
- Dispersal of gases
- Movement of particles from region a of their high concentration to region of their low concentration
- Mixing of things
- Spreading of dyes in solutions

Diffusion is a physical process where molecules of a substance move from an area of high concentration (place with many molecules) to an area of low concentration (place with few molecules).

Activity 5:
What are some of the misconceptions that learners have about diffusion?

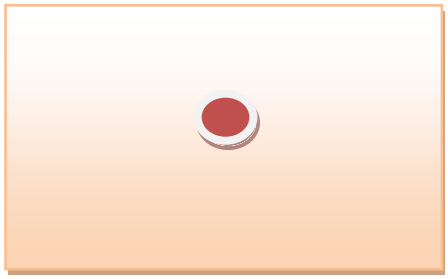
You may have come up with the following:
Learners think that;

- Particles or molecules do not move independently but only do so when the container is moved
- Particles move in only one direction to create equilibrium
- Particles do not move in a random manner but move in a specific direction due to some external force

- Pericles only move when the vessel containing them moves
- Learners expect to see with their own eyes particles moving

Activity 6: How do scent molecules move?
Introduce a scented substance in a Petri dish at the middle of the class. Ask participants to put up their hands once they smell the scent. Represent the distribution of the scent particles in the room diagrammatically in the diagram below

Distribution of scent molecules in the room



Activity 7: Observing diffusion in action

Materials

- Transparent disposable plastic cups
- Tea bags(2 per group)
- Hot water above 80 degrees celcius
- Cold water at room temperature
- Pice of rod(ball point pen or pencil)

Procedure

a. Predict and record what would happen if tea bags are simultaneously put in a cup of hot water (above 80 degrees) and cold water for 5 minutes as shown in figure 12

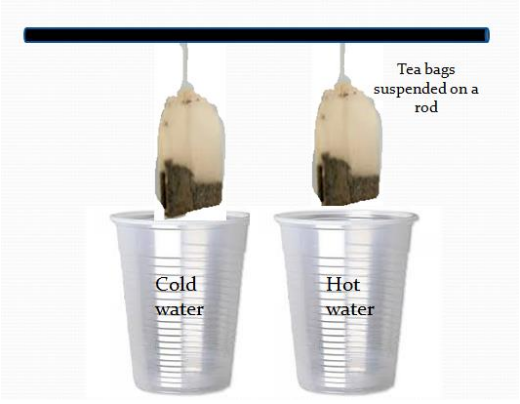


Figure 11: Experimental set up for prediction

You may have come up with the following:

- The hot water turns brown faster than the cold water
- The colour tea leaves diffuse into hot water faster than in cold water
- Tea dissolves faster in hot water than in cold water

b. Verify your predictions above by simultaneously suspending a tea bag in a cup of hot water and another in a cup of cold water for 5 minutes. Record your observations (take videos and photos of your experiments and results for sharing).

c. Explain your observations

d. What factors were being investigated in this experiment?

You may have come up with the following

- (1) Size of the diffusing particles(2) Temperature (3) Medium of diffusion(4) Concentration gradient (5) Distance

Activity wrap up

Follow the link below showing the animated process of diffusion. Observe it carefully and use it to describe the events in activity 6 and 7.Use your explanation to revise your diagram above.
https://www.youtube.com/watch?v=qBig2wevHhw(accessed 24th November 2018)

You may have come up with the following:

There is a high concentration of molecules at one place

- The molecules are in constant random motion, bumping into each other
- The random collision makes them move to areas with less molecules
- The movement continues leading to even distribution of molecules
- Even when uniformly distributed, the random movement continues

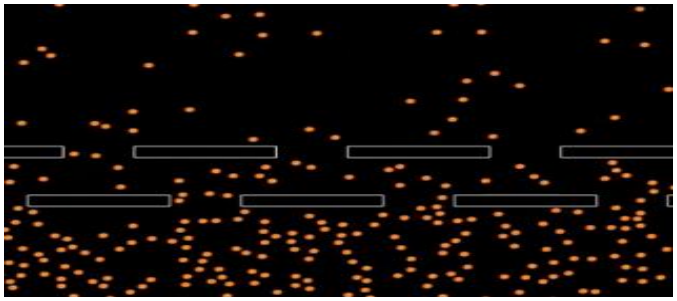


Figure 12: Diagrammatic representation of diffusion

Application of diffusion in real life

1. The Kenya Tobacco Control Act 2007 restricted public smoking to designated zones. Explain.

2. Prepare a poster that can be used to create public awareness on the effect of air pollution

You may have come up with the following

- The particles in tobacco can diffuse to reach and be inhaled by non-smokers
- To protect the public from the harmful effects of tobacco
- To reduce environmental pollution
- To discourage smoking

Activity 8:
Prepare an ICT integrated lesson to teach a concept in cell physiology.

Wrap up

Write down two ideas from this session that you consider powerful enough to transform how you will teach biology from now onwards.

Conclusion

In this unit, the focus was learner- centred strategies in teaching and learning of mathematics and science. We have conducted hands- on activities and ICT integration as some of the teaching and learning strategies that promote learner- centred classroom environments. The topic Cell Physiology was chosen for reasons outlined during the introduction. While going through this topic, we made deliberate effort to put ourselves in the shoes of our learners in order to try and understand the learning challenges they encounter. We further went ahead to carry out activities that were designed with the learner as the focus. This was through logically planned questions and activities that were done, individually, in pairs as well as in groups. Opportunities were given for participants to give feedback in form of findings from investigations, brainstorming or discussions and sketches. This was to demonstrate that immediate feedback is essential to asses learning and for improvement. Although only cell physiology was used to demonstrate the power of ICT integration and hands- on activities in teaching and learning, it is envisaged that you have gained good experience to transfer and apply skills and competencies learned to the teaching of other topics in biology.

Subject: Chemistry

Welcome to this section, in which you will discuss how to enhance learners understanding of concepts in chemistry through learner-centred approaches. You will focus on the topics Metals and Radioactivity. In Metals the emphasis will be on the use of Project Based Learning (PBL), while on the topic Radioactivity emphasis will be on use of ICT integration.

Topic one: Metals

Introduction

In this session, you will enhance your knowledge and skills on the use of PBL in the topic metals. You will explain how PBL can be used to reinforce the teaching and learning of the concepts in the topic by investigating a sample of soil to determine metal ions present. Design a project on construction of a mini-blast furnace used for extraction of Iron metal. Finally, you will design and share an activity that can be used to reinforce PBL in teaching the topic on Metals.

Rationale

The Kenya secondary chemistry syllabus emphasises the use of projects to enable learners to link the subject with the physical environment around them. The learners are expected to use these opportunities to interact with the physical and chemical processes, which take place within the local environment. The projects also make the learners aware of the scientific processes in everyday life and thus enable them to appreciate their responsibility to the society.

The inclusion of the topic metals in this INSET is based on findings of CEMASTEA Training Needs Assessment (CEMASTEA, 2015), which showed that teaching and learning in this topic was still teacher-centred. Project Based Learning (PBL) generates excitement in students and triggers curiosity; enhance creativity, critical thinking and the ability to make logical decisions. Thus, make teaching and learning more student-centred as learners become more inquisitive and are able to learn using their own experiences.

Learning Outcomes

a. Enhanced knowledge and skills on the topic of metals
b. Demonstrate ability to design activities that promote teaching and learning using PBL
c. Appreciate usefulness of PBL to enhancing learners' creativity, critical thinking and making logical decisions.

Activity I: Reflection on the current situation of teaching and learning

Reflect on your teaching and learning of the topic metals

I. Share your experiences on how you teach this topic
II. Which activities do you involve your students in when teaching extraction of metals?
III. Based on the general session you were taken through, discuss and share your experiences in using PBL in teaching and learning the topic metal

You may have come up with the following:

(i) Use of flow charts & group discussions (ii) Drawing diagrams, taking notes

PBL in Chemistry

The use of PBL approach in teaching and learning helps learners to undertake projects during the learning process which enable them to have a deeper understanding of concepts in Chemistry and gives them opportunities to take control of their own learning. In section 2.2.6 and 2.2.7, you will carry out activities 2 & 3 respectively to help you practice the application PBL approach in the teaching and learning of metals.

Activity 2: Analysis of soil sample A

You are provided with a soil sample A. You are required to design an investigation to determine the cations in soil sample A using steps of PBL approach.

Step 1: Challenging Problem or Question

Discuss and suggest a driving question or a challenging problem that you could use to guide learners to analyse cations present in a soil sample.

Note: The problem you come with should be real and related to the subject content. It should also be motivating, interesting, and generate good discussion. Ensure that there is no one answer or solution to the identified problem.

Step 2: Sustained inquiry

In this step, you are required to guide learners to create a schedule detailing timelines of their projects. Also, encourage students to think and make decisions and choices in all steps regarding their projects by allowing them to carry out the activity given below;

Design an investigation to address the problem identified by;

a) Listing down materials and resources you will require
b) Outlining the procedures you will follow to determine metal ions present in the soil sample.
c) Identifying the data that will be collected and planning how to analyse it
d) Carrying out the investigation to determine metal ions present in the soil sample

Step 3: Authenticity

In this step, you will encourage your learners to find original and genuine solutions to solve the problem identified by; seeking information that will guide them to design activities, develop procedures and carryout the investigation.

Step 4: Student's voice and choices.

In this step, you ensure that all learners benefit from each other's investigation by giving each group an opportunity to share their findings with the rest of the class.

Share your group findings with rest of the participants

Step 5: Reflection

At each step of the project, learners should be given opportunities to think about their actions and how those actions are helping in the attainment of their projects. They should also think about what further actions are needed to make improvements to their project.

In your group reflect on the actions you took and document how they contributed towards the attainment of your project. Suggest any further actions or improvements that could make your project more successful.

Step 6: Critique and Revision

In a classroom situation, as learners make presentation of their findings to the rest of the class, you should guide them on how to give and receive constructive peer feedback that will improve the project.

1. Critique and give feedback to group presentations
2. Based on the feedback given to your group project, make necessary revision to improve it

Step 7: Public Product

In a school situation, students should be given an opportunity to share their project report with the public for example during science fairs. This is one way to let the public see how students apply their learning in school to solve real-world problems.

Revise your project report including inputs from the other groups and upload your work in the CEMASTEA website

Activity 3: Designing a mini-blast furnace Project

Some of the projects proposed in the secondary school chemistry syllabus for the topic on metals include; analysis of ores, construction of a mini-blast furnace and carrying out iron-smithing.

i. Use the steps of PBL and design a project that will lead to construction of a mini-blast furnace that can be used to teach extraction of Iron metal. Indicate all that you will require learners to do.
ii. Share your designs and explain how you intend to implement them in your schools.

Activity 4: Designing PBL activities in the topic Metals

Design and share an activity on PBL that can be used in the teaching and learning of the topic Metals

Conclusion

This session has given you an opportunity to explore the use of PBL in teaching the topic Metals. It is expected that the activities you carried out have enhanced your skills on how to apply PBL in teaching and learning. The skills you have gained will enable you to guide learners on how to design and carry out a project. This will enable learners to continuously interact with the environment around them in order to solve problems in the community.

Topic Two: Radioactivity

Introduction

In this topic, you will discuss how to enhance learners understanding of concepts in the topic *Radioactivity* using ICT Integration. You will develop and demonstrate teaching and learning activities in this topic as well as critique the lesson plan and suggest how to improve it.

Rationale

The inclusion of the topic Radioactivity in this module is based on findings of Training Needs Assessment (TNA) for Secondary programme for 2018 and beyond (CEMASTEA, 2017) and needs from Monitoring and /Evaluation (M&E) report of 2016 County INSET. The topic was cited as challenging to teach and learn. One of the challenges is the unavailability of the teaching and learning resources due to a policy prohibiting the use and storage of radioactive materials in the school laboratory. ICT is one tool that can be used to demonstrate radioactive decay and properties of the radiations and emissions. This may enhance learners' understanding of concepts in the topic.

This session will give you an opportunity to explore suitable activities that may be used in teaching and learning of the topic.

Learning Outcomes

1. Enhanced knowledge and skills in teaching Radioactivity
2. Enhanced ability to integrate ICT in teaching and learning of concepts in Radioactivity.
3. Appreciate how ICT Integration can enhance understanding of concepts in Radioactivity.

Background information

Radioactivity is the last topic in the Secondary Chemistry Syllabus with eight specific objectives to be achieved in ten lessons. In this session you will explore activities that will help in the attainment of two of the objectives as follows:

i. Name the particles emitted during radioactive decay and state their properties and
ii. Carry out simple calculations involving half-life ($t_{1/2}$)

Activity 1: Reflection on teaching the topic Radioactivity

Reflect and share your experiences in the teaching and learning of radioactivity?

Activity 2: Properties of Radioactive Radiations or Emissions

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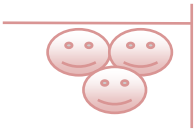


In this activity you will carry out a virtual experiment to investigate a property of radioactive radiation or emission

Worksheet

Procedure:

1. Open the following link to access virtual apparatus for the experiment https://www.uccs.edu/vgclintro/nuclear-chemistry/experiment-1-radiation-and-matter
2. Click on the apparatus to start the virtual laboratory. The experimental setup includes three radioactive sources, different types of shielding (materials), and the apparatus to measure the radioactivity. On the right is a Geiger counter that will measure radiation in counts per second. On the left is a holder for the radioactive source and in the middle is a holder for the shielding material
3. Click on the drop-down list of radioactive sources and choose one source. Drag the source into the sample holder
4. Click on the Geiger counter switch to turn it on. Record the reading from the gauge in the worksheet then turn it off
5. Click on the drop-down list of shielding materials and choose one. Drag the shielding into its holder in the apparatus
6. Turn on the counter and record the reading Table 6 in the worksheet
7. Repeat steps 6 and 7 using the other types of shielding materials and record the readings.
8. Repeat steps 3 - 8 for the other radioactive sources and record the readings

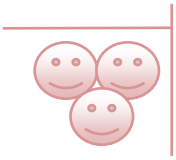
Table 7: Results

		Activity (Counts/sec)				
	Source	**No shielding**	**Paper**	**1 mm cardboard**	**1 mm Aluminium**	**1mm Lead**
1.						
2.						
3.						

Analysis of results

1. Which property of radiations or emissions is being investigated?
2. Identify the type of radiation or emission from each of the source. Give reason?
3. From your results in table 1, what other conclusions can make about the radiations or emissions being investigated?
4. Assuming you are working in an environment where the radiations or emissions in 2 above are emitted, which materials would you use to protect yourself against each of the emissions or radiation?
5. Discuss the effectiveness of this activity in teaching the concept of penetrating power of radiation/emission. Suggest improvements or alternatives, if any.

Activity 3: Determination of half-life of a radioactive substance



In this activity, you will carry out virtual experiment to determine the half-life of protactinium.-234.

Procedure:

1. Click on the video provided

Half life of protactinium.mp4

http://www.schoolphysics.co.uk/age1619/Nuclear%20physics/Radioactivity/experiments/half_life_of_water.doc

2. Allow the counter to run until it pauses. (note that the counter pauses for 2.5 seconds to allow you to take the reading)
3. Record the reading in a table (Note there this background count of 6)
4. Repeat step 2 and 3 until the end of the video.

Questions

1. Determine the half-life of protactinium-234
2. What do you understand by a background count?
3. Discuss the appropriateness of this virtual experiment for teaching the concept of half-life . Suggest improvements or alternatives, if any.

Activity 4: Designing or sourcing ICT activity

Design or source an ICT activity that can be used to teach a concept in the topic Radioactivity and share

Activity 5: Critique of the sample ASEI Lesson

Form: 4
Subject: Chemistry
Number of Students: 40
Topic: Radioactivity
Time: 40 Minutes
Date:
Sub Topic: Types of radiations

RATIONALE:

Radioactivity is simply elements losing different particles in their nucleus, releasing energy as they change. Every element has a characteristic amount of protons and neutrons, tiny particles inside an atom that make up their core, or nucleus. During radioactivity, the atom loses some neutrons and/or protons, physically changing it into another element and emitting large amounts of energy. This process happens randomly in nature, but it can also be created by humans, such as inside a nuclear reactor. Humans use radioactivity all the time, from medicine to food production.

OBJECTIVES

By the end of the lesson the learner should be able to state the properties particles emitted during radioactive decay.

Prerequisite Knowledge: Knowledge on sub atomic particles particularly the nuclides.
Teaching /Learning Resources: Video clip
References: Secondary Chemistry Students Book 4, KLB Pp

STAGES/TIME	LEARNING ACTVITIES	LEARNING POINTS
Introduction 5minutes	Learners name the different types of radiation and emission given out during radioactive decay.	Radioactivity is the spontaneous emission of particles and energy from an atomic nucleus as it disintegrates into more stable nucleus releasing enormous energy. ▪ Alpha radiations ▪ Beta radiations ▪ Gamma emission Atoms that have over 80 protons are unstable and show reactivity Becquerel, Marie Curie and her husband Pierre in 1896 discovered radium-226 that decays to radon-222(inert gas)
Lesson Development 30 minutes	***Learners watch video***  Radiation Rays.mp4 https://www.youtube.com/watch?v=KYDil96NR5Q learners are divided into groups where they discuss what they observed in the video: Learners give properties of different radioactive radiation or emissions	Properties in terms of mass, charge and penetrating power
Conclusion 3minutes	Teacher consolidate learners ideas on types of radiations	Students summarise what they have learnt
Evaluation 2 minutes	Teacher deliberately seek ideas on progress of lesson of the learners and notes areas which need improvement	Evaluation for future lesson improvement

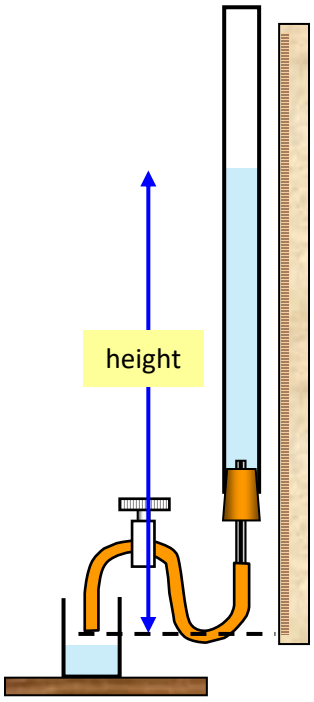
Connection to 21st Century Skills

This lesson promotes the 21st Century skills as learners are given the opportunity to work in groups hence encourages collaboration. At the same time, ICT literacy is incorporated through watching video clips explaining different types of radiation.

Other Activities

The Half -Life of Water: A Radioactive Decay Analogue

The aim of the experiment is to plot a graph of the water height against time and from this find the time taken for the water height to halve. You will need Glass tube, rubber bung, fine glass tube metre ruler, tube clamp, beaker, water, retort stand, boss and clamp



Procedure

1. Carefully fill the tube A with water (with the clip closed!)
2. Undo the clip aid to allow water to flow freely from the capillary tube.
3. When the water level reaches a convenient point near the top of the tube start the stop clock and record the height at equal time intervals (every 5 or 10 seconds will probably be suitable depending on the tube diameter and the tap).
4. Record these results
5. Repeat the readings twice more always starting the clock when the water level is at the same mark on the scale.
6. Find the average of the readings for each time

Analysis and conclusions

1) Plot the graph of:
    a. h against time (t)
    b. ln h against t
2) Determine the half-life of water from both graphs and compare the two values.

Simple Model of Exponential Decay

In this activity, we will model radioactive decay using coins. The results from the model provide an insight into what might be happening within radioactive atoms.

Apparatus and materials

1. Coins – 5 pieces per person
2. Writing material

Note: Five-shilling coins are recommended because of their small size.

Procedure

1) Hold the coins in your cupped hands.
2) Together with other participants shake the coins for at least 5 seconds. ***Ensure that the coins are moving around inside the cupped hands***.
3) Open the hands with one hand flat and facing upwards so that the coins can be seen.
4) Take out all the coins with heads down and place them on the table.
5) Count the number of coins on the table and record the total number from each member in the following table.

No. of shaking	No. of coins you have removed	Total No. of coins removed for all the participants
1st shaking		
2nd shaking		
3rd shaking		
4th shaking		
5th shaking		

6) Repeat procedure 1) to 5) with the coins remaining in your hand five times
7) Assume that the No. of shaking represents time in minutes, plot a graph of time against the total number of coins removed per minute.
8) Explain the shape of the graph?

Notes:

- The activity raises interesting question about how long a radioactive source will last and what happens to the last 'atom'.
- This activity is a good analogy of radioactive decay as it is based on probability. The decaying trend will be noticeable and so too will the random nature.
- Only coins that are left can 'decay'. As there are fewer of them each time, fewer will decay.

Source: Institute of Physics (IOP). Available at http://practicalphysics.org/simple-model-exponential-decay.html

Teaching notes

1. You might want to appoint a counter and a scribe to count the coins and record the results.
2. Take care with how you ask students to signal the numbers. They may be tempted to add their own (rude) gestures.
3. Draw out the similarities with the protactinium experiment. The trend is the same and there is also some randomness. The close match between the results from this model and the results from Measuring the half-life of protactinium show that radioactive atoms have a chance of decaying at any fixed time.
4. Use the activity to explain the downward trend of the decay curve. Only coins that are left can 'decay'. As there are fewer of them each time, fewer will decay.
5. The activity raises the interesting question about how long a radioactive source will last and what happens to the last 'atom'.
6. An alternative to shaking the coins in students' palms is to flick them. But this takes longer.
7. You could repeat the experiment with small dice to give a longer half-life. Combining results (as outlined here) makes for a smoother curve.

This experiment was safety-tested in May 2007

Subject: Mathematics

Topic one: Statistics

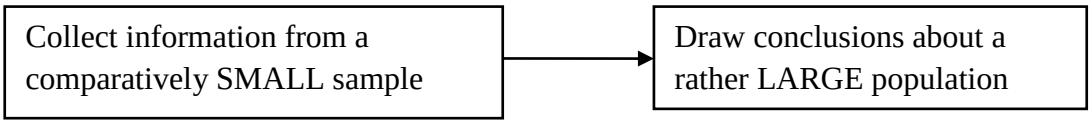
Introduction

In this section we will use the topic *Statistics 1* to enhance learners' Project-Based Learning (PBL) skills. Statistics involves use of scientific methods for collecting, organizing, summarizing, presenting, analyzing and interpreting data, as well as drawing valid conclusions and making reasonable decisions on the basis of this analysis. Areas of focus in the topic include understanding how to collect, organize, represent, interpret data and make predictions from its results. Basic description of each of these topic areas with relevant examples and activities will be used to enhance learners' PBL skills.

Rationale

Training Needs Assessment (TNA) conducted by CEMASTEA cited statistics as a topic of concern which poses challenges to learners (CEMASTEA, 2018). This paper will seek to address these challenges using Project-based Learning (PBL). There are many projects in statistics that learners can carry out within and outside the classroom. Kenya education system is transiting from content-based curriculum to Competence-Based Curriculum (CBC). PBL in statistics will enhance learner's competences such as; communication and collaboration as the carry out projects in groups, critical thinking and problem solving as they carry out projects to solve certain real-life problems, learning to learn as they construct their own knowledge, and self-efficacy as they present their findings.

Statistics is an important tool for analysing data. It is one of the most reliable basis for making decisions, for example, on effectiveness of medical procedures and in the business industry such as industrial quality control. Statistics is also used in opinion polls, where a sample population provides information from which conclusions are drawn that refer to the entire population.



The main function of statistics is to provide information that will help in making decisions. Statistics provides a description of the present, a profile of the past and an estimate of the future.

Learning outcomes

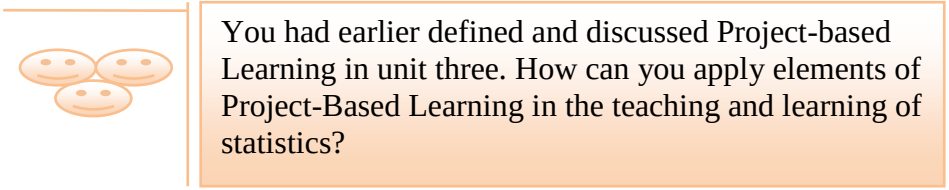
By the end of the session, you are expected to:

a) Demonstrate deeper understanding in teaching and learning of statistics using PBL
b) Develop PBL activities in statistics
c) Prepare a 40-minutes ASEI lesson plan, incorporating PBL
d) Appreciate use of PBL in the teaching and learning process

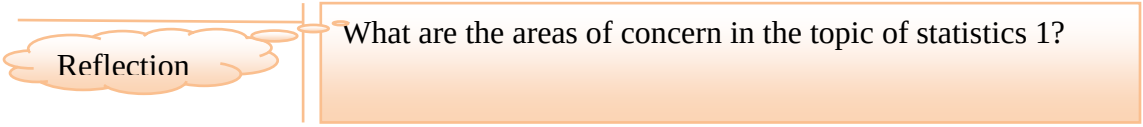
The following are the objectives of statistics 1, as outlined in the KICD syllabus:

a) Define statistics
b) Collect and organize data
c) Draw a frequency distribution table
d) Group data into reasonable classes
e) Calculate measures of central tendency
    i. Mean
    ii. Mode
    iii. Median, for un grouped and grouped data
f) Represent data in form of line graph, bar graphs, pie-charts, pictogram and frequency polygons
g) Interpret data from real life situations

Activity 1 (Think- Pair-Share)

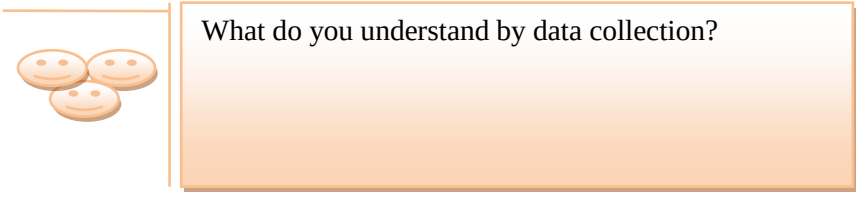


Elements of Project-based learning can be applied in statistics by learners coming up with a challenging problem or question; collecting, organizing, and analysing data about the problem or the question (sustained inquiry); representing and interpreting the data (student choice and reflection), and sharing their findings with other students (student voice); and other students giving feedback on the findings (critique and revision).



Collection of data

Activity 2 (Think- Pair-Share)



Data collection is the process of gathering and measuring information on targeted variables, which is then used to answer relevant questions and evaluate outcomes (Clarke and Cooke, 1992).

Activity 3 (Think- Pair-Share)

What kind of activities do you involve your learners in data collection?

You may have come up with the following:

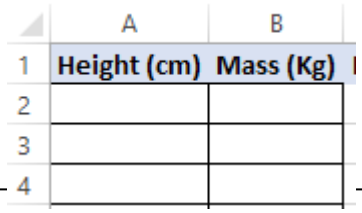
i. Asking learners to record their favourite meals
ii. Asking learners to record the sizes of their shoes.
iii. Asking learners to measure and record their heights.
iv. Asking the learners to measure the circumference of trees within their school

Note: Provide braille measuring instruments for learners with visual impairment

Activity 4 (Group Activity)

Measure and record your heights and masses in your group.

1. Explain your data?
2. What meaning can you attach to this data?



	A	B
1	Height (cm)	Mass (Kg)
2		
3		
4		

Use the Excel Workbook to enter the data and respond to the questions

Some possible responses based on the data collected:

- The data is raw, thus it is difficult to attach any meaning.
- Most people weigh between *n* kg and *m* kg, where *n* and *m* are real numbers
- Most people have a height of between *x* cm and *y* cm, where *x* and *y* are real numbers
- The tallest and the shortest height

You may find it difficult to deduce important information when the data is raw, hence the need to organize the data for easier interpretation.

Organization of data

Activity 5 (Think-Pair-Share)

What do you understand by data organisation

Data organization is re-ordering or analysing the arrangement of data items in a physical record to make it more efficient to work with (Clarke and Cooke, 1992).

Activity 6 (Group Activity)

1. Organise the data you have collected?
2. What meaning can you attach to this data?

You can organize the data by distributing it into classes or categories and determine the number of individual items belonging to each class.

Measures of Central Tendency

Activity 7 (Think- Pair-Share)

What are measures of central tendency? How do you introduce the concept of measures of central tendency to your learners?

Measures of central tendency indicate where most values in a distribution fall and are also referred to as the central location of a distribution. It is the tendency of data to cluster around a middle value. There are three measures of central tendency: mean, median, and mode (Clarke and Cooke, 1992).

Activity 8 (Group Activity)

Determine measures of central tendency using the data you collected.

Activity 9 (Think- Pair-Share)

What other activities would you involve your learners in, to determine measures of central tendency?

Possible activities

Scenario 1

You can ask learners to record their shoe sizes and pose the following question:
Suppose you are to advice a shoe dealer on the best shoe size to stock in his business based on the data you have collected. Which shoe size would you recommend to the shoe dealer?

Scenario 2

A lift in a 9-storey building is not in working condition. The workers want to hold a meeting at a common floor. Which is the most convenient floor to hold the meeting?

Scenario 3

Three schools, A, B and C, competed in a Mathematics contest. The schools had 40, 35 and 50 learners respectively. How would the organizers determine the winning school?

Representation and interpretation of data

Activity 10 (Think- Pair-Share)

What do you understand by representation and interpretation of data?

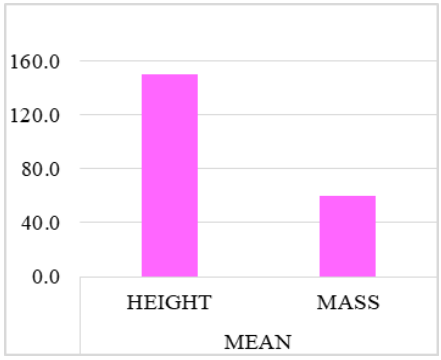
Presentation of data refers to the organization of data into tables, graphs or charts, so that logical and statistical conclusions can be derived from the data. Data interpretation is the process of assigning meaning to the collected information and determining the conclusions, significance and implications of the findings (Clarke and Cooke, 1992).

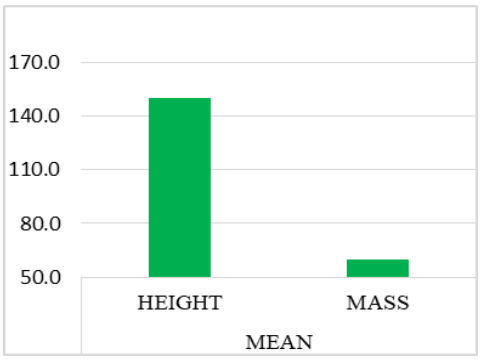
Activity 11 (Group Activity): Representing data for decision making

You are the Games Master in your school. An assistant in the sanatorium has been collecting data on students who seek medical attention and prepared the following charts. The charts are derived from the following table:

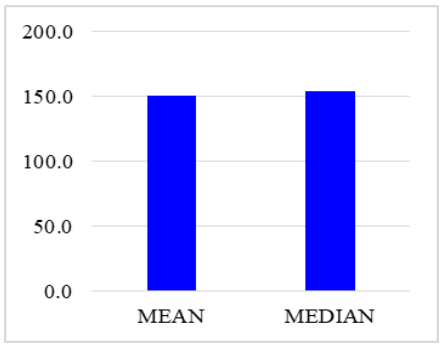
	Height (cm)	Mass (Kg)
Mean	150.6	59.75
Median	154.0	62.0

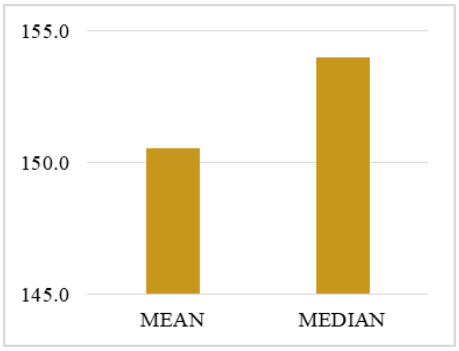
Category	No.
Very Overweight	4
Overweight	7
Normal Weight	6
Underweight	3



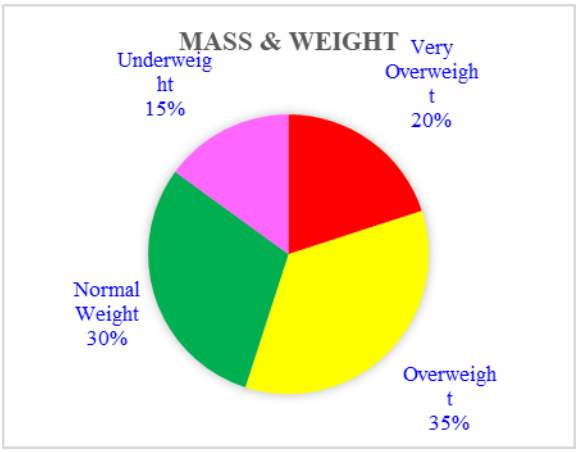


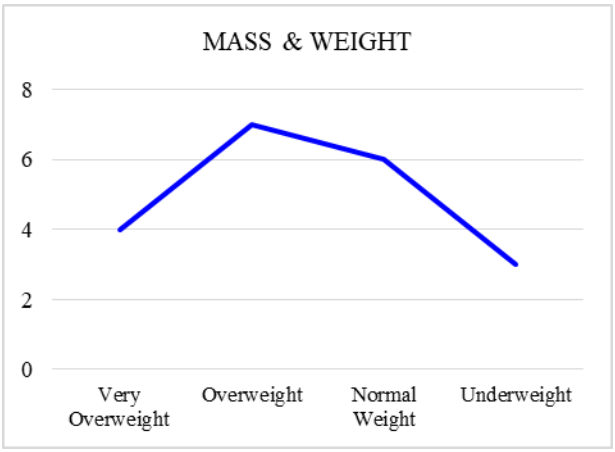
Average height and mass of sampled students





Mean and Median height of sampled students





Categorization of sampled students based on Body Mass Index (BMI)

Activity 12 (Group Activity)

Discuss

(a) The advantages and disadvantages of using either chart in each of the three sets of data representation.

(b) Recommend when and where either chart in each set may be used

Activity 13 (Group Activity)

Represent the data you collected using any method of data representation.

Activity 14 **(Think- Pair-Share)**

Suggest a project you can use to enhance learner's understanding of data representation and interpretation?

Possible projects

Scenario 1

You can ask the learners to record their shoe sizes and pose the following questions:

a) How can you arrange yourselves according to your shoe sizes?

b) What can you say about the shoe sizes in the class?

Some possible ways:

a) Making lines according to their shoe sizes (bar graphs)
b) Making a circle according to their shoe sizes (pie chart)

Scenario 2

Give students sticks of different sizes and ask them to demonstrate how the sticks can be used to represent their ages, heights, or mass.

Discussion task

In your groups, generate an activity in a given sub-topic in statistics that promotes project-based learning. Prepare a 40-minutes ASEI lesson plan incorporating the activity.

A sample ASEI lesson plan

Topic: Statistics
Subtopic: Mode
Class: Form 2
Duration: 40 minutes
Rationale:

Knowledge of statistics is useful in planning, making informed decisions on matters of everyday life, such as predicting enrolment in primary schools in subsequent years, population census, and marketing.

Objectives:

By the end of the lesson, the learner should be able to:

1) Collect, record, and organize data on a given activity
2) Determine the mode of the data obtained

Prerequisite skills and knowledge:

Integers, Measurements

Teaching/Learning Resources:

Students' shoes

Stage/Time	Teaching/Learning activities	Learning Points	Remarks
Introduction (5 minutes)	-Learners are presented with the following scenario: Suppose you are to advice farmers in your area on the most appropriate month for planting. Which month would you recommend to the farmers? Why?	Linking real life situation to the classroom	
Lesson Development I (20 minutes)	- In groups of 10, learners record their shoe sizes and asked to deduce important information from their data.	Data collection and organization	
Lesson Development II	Learners are presented with the following scenario: Suppose you are to advice a shoe dealer on the best		

Stage/Time	Teaching/Learning activities	Learning Points	Remarks
(10 minutes)	shoe size to stock in his business based on the data you have collected. Which shoe size would you recommend to the shoe dealer? Why?	Mode	
Summary/Conclusion (5 minutes)	Learners are guided in describing the mode	Mode	

Body Mass Index Chart

	Height in centimeters																					
Weight Kg	142		147.3	149.9	152.4	154.9	157.5	160	162.6	165.1	167.6	170.2	172.7	175.3	177.8	180.3	182.9	185.4	188	190.5	193	195.6
117.9	**58.3**	**56.3**	**54.3**	**52.5**	**50.8**	**49.1**	**47.5**	**46.1**	**44.6**	**43.3**	**42.0**	**40.7**	**39.5**	**38.4**	**37.3**	**36.3**	**35.3**	**34.3**	**33.4**	**32.5**	**31.6**	**30.8**
115.7	57.2	55.2	53.3	51.5	49.8	48.2	46.6	45.2	43.8	42.4	41.2	39.9	38.8	37.7	36.6	35.6	34.6	33.6	32.7	31.9	31.0	30.2
113.4	**56.0**	**54.1**	**52.2**	**50.5**	**48.8**	**47.2**	**45.7**	**44.3**	**42.9**	**41.6**	**40.3**	**39.2**	**38.0**	**36.9**	**35.9**	**34.9**	**33.9**	**33.0**	**32.1**	**31.2**	**30.4**	**29.6**
111.1	54.9	53.0	51.2	49.5	47.8	46.3	44.8	43.4	42.0	40.8	39.5	38.4	37.2	36.2	35.2	34.2	33.2	32.3	31.5	30.6	29.8	29.0
108.9	**53.8**	**51.9**	**50.2**	**48.5**	**46.9**	**45.3**	**43.9**	**42.5**	**41.2**	**39.9**	**38.7**	**37.6**	**36.5**	**35.4**	**34.4**	**33.5**	**32.5**	**31.7**	**30.8**	**30.0**	**29.2**	**28.5**
106.6	52.7	50.8	49.1	47.5	45.9	44.4	43.0	41.6	40.3	39.1	37.9	36.8	35.7	34.7	33.7	32.8	31.9	31.0	30.2	29.4	28.6	27.9
104.3	**51.6**	**49.8**	**48.1**	**46.4**	**44.9**	**43.5**	**42.1**	**40.7**	**39.5**	**38.3**	**37.1**	**36.0**	**35.0**	**34.0**	**33.0**	**32.1**	**31.2**	**30.3**	**29.5**	**28.7**	**28.0**	**27.3**
102.1	50.4	48.7	47.0	45.4	43.9	42.5	41.1	39.9	38.6	37.4	36.3	35.2	34.2	33.2	32.3	31.4	30.5	29.7	28.9	28.1	27.4	26.7
99.8	**49.3**	**47.6**	**46.0**	**44.4**	**43.0**	**41.6**	**40.2**	**39.0**	**37.8**	**36.6**	**35.5**	**34.5**	**33.4**	**32.5**	**31.6**	**30.7**	**29.8**	**29.0**	**28.2**	**27.5**	**26.8**	**26.1**
97.5	48.2	46.5	44.9	43.4	42.0	40.6	39.3	38.1	36.9	35.8	34.7	33.7	32.7	31.7	30.8	30.0	29.2	28.4	27.6	26.9	26.2	25.5
95.3	**47.1**	**45.4**	**43.9**	**42.4**	**41.0**	**39.7**	**38.4**	**37.2**	**36.0**	**34.9**	**33.9**	**32.9**	**31.9**	**31.0**	**30.1**	**29.3**	**28.5**	**27.7**	**27.0**	**26.2**	**25.6**	**24.9**
93.0	46.0	44.4	42.8	41.4	40.0	38.7	37.5	36.3	35.2	34.1	33.1	32.1	31.2	30.3	29.4	28.6	27.8	27.0	26.3	25.6	25.0	24.3
90.7	**44.8**	**43.3**	**41.8**	**40.4**	**39.1**	**37.8**	**36.6**	**35.4**	**34.3**	**33.3**	**32.3**	**31.3**	**30.4**	**29.5**	**28.7**	**27.9**	**27.1**	**26.4**	**25.7**	**25.0**	**24.3**	**23.7**
88.5	43.7	42.2	40.8	39.4	38.1	36.8	35.7	34.5	33.5	32.4	31.5	30.5	29.6	28.8	28.0	27.2	26.4	25.7	25.0	24.4	23.7	23.1
86.2	**42.6**	**41.1**	**39.7**	**38.4**	**37.1**	**35.9**	**34.7**	**33.7**	**32.6**	**31.6**	**30.7**	**29.8**	**28.9**	**28.1**	**27.3**	**26.5**	**25.8**	**25.1**	**24.4**	**23.7**	**23.1**	**22.5**
83.9	41.5	40.0	38.7	37.4	36.1	35.0	33.8	32.8	31.8	30.8	29.9	29.0	28.1	27.3	26.5	25.8	25.1	24.4	23.8	23.1	22.5	21.9
81.6	**40.4**	**38.9**	**37.6**	**36.4**	**35.2**	**34.0**	**32.9**	**31.9**	**30.9**	**30.0**	**29.0**	**28.2**	**27.4**	**26.6**	**25.8**	**25.1**	**24.4**	**23.7**	**23.1**	**22.5**	**21.9**	**21.3**
79.4	39.2	37.9	36.6	35.3	34.2	33.1	32.0	31.0	30.0	29.1	28.2	27.4	26.6	25.8	25.1	24.4	23.7	23.1	22.5	21.9	21.3	20.7
77.1	**38.1**	**36.8**	**35.5**	**34.3**	**33.2**	**32.1**	**31.1**	**30.1**	**29.2**	**28.3**	**27.4**	**26.6**	**25.8**	**25.1**	**24.4**	**23.7**	**23.1**	**22.4**	**21.8**	**21.2**	**20.7**	**20.2**
74.8	37.0	35.7	34.5	33.3	32.2	31.2	30.2	29.2	28.3	27.5	26.6	25.8	25.1	24.4	23.7	23.0	22.4	21.8	21.2	20.6	20.1	19.6
72.6	**35.9**	**34.6**	**33.4**	**32.3**	**31.2**	**30.2**	**29.3**	**28.3**	**27.5**	**26.6**	**25.8**	**25.1**	**24.3**	**23.6**	**23.0**	**22.3**	**21.7**	**21.1**	**20.5**	**20.0**	**19.5**	**19.0**
70.3	34.7	33.5	32.4	31.3	30.3	29.3	28.3	27.5	26.6	25.8	25.0	24.3	23.6	22.9	22.2	21.6	21.0	20.4	19.9	19.4	18.9	18.4
68.0	**33.6**	**32.5**	**31.3**	**30.3**	**29.3**	**28.3**	**27.4**	**26.6**	**25.7**	**25.0**	**24.2**	**23.5**	**22.8**	**22.1**	**21.5**	**20.9**	**20.3**	**19.8**	**19.3**	**18.7**	**18.3**	**17.8**
65.8	32.5	31.4	30.3	29.3	28.3	27.4	26.5	25.7	24.9	24.1	23.4	22.7	22.0	21.4	20.8	20.2	19.7	19.1	18.6	18.1	17.6	17.2
63.5	**31.4**	**30.3**	**29.3**	**28.3**	**27.3**	**26.4**	**25.6**	**24.8**	**24.0**	**23.3**	**22.6**	**21.9**	**21.3**	**20.7**	**20.1**	**19.5**	**19.0**	**18.5**	**18.0**	**17.5**	**17.0**	**16.6**
61.2	30	29	28.	27.	26.	25.	24.	23	23.	22.	21.	21.	20.	19.	19.	18.	18.	17.	17	16.	16	16.

	Height in centimeters																					
	.3	.2	2	3	4	5	7	.9	2	5	8	1	5	9	4	8	3	8	.3	9	.4	0
59.0	**29.1**	**28.1**	**27.2**	**26.3**	**25.4**	**24.6**	**23.8**	**23.0**	**22.3**	**21.6**	**21.0**	**20.4**	**19.8**	**19.2**	**18.7**	**18.1**	**17.6**	**17.1**	**16.7**	**16.2**	**15.8**	**15.4**
56.7	28.0	27.0	26.1	25.2	24.4	23.6	22.9	22.1	21.5	20.8	20.2	19.6	19.0	18.5	17.9	17.4	17.0	16.5	16.0	15.6	15.2	14.8
54.4	**26.9**	**26.0**	**25.1**	**24.2**	**23.4**	**22.7**	**21.9**	**21.3**	**20.6**	**20.0**	**19.4**	**18.8**	**18.2**	**17.7**	**17.2**	**16.7**	**16.3**	**15.8**	**15.4**	**15.0**	**14.6**	**14.2**
52.2	25.8	24.9	24.0	23.2	22.5	21.7	21.0	20.4	19.7	19.1	18.6	18.0	17.5	17.0	16.5	16.0	15.6	15.2	14.8	14.4	14.0	13.6
49.9	**24.7**	**23.8**	**23.0**	**22.2**	**21.5**	**20.8**	**20.1**	**19.5**	**18.9**	**18.3**	**17.8**	**17.2**	**16.7**	**16.2**	**15.8**	**15.3**	**14.9**	**14.5**	**14.1**	**13.7**	**13.4**	**13.0**
47.6	23.5	22.7	21.9	21.2	20.5	19.8	19.2	18.6	18.0	17.5	16.9	16.4	16.0	15.5	15.1	14.6	14.2	13.9	13.5	13.1	12.8	12.4
45.4	**22.4**	**21.6**	**20.9**	**20.2**	**19.5**	**18.9**	**18.3**	**17.7**	**17.2**	**16.6**	**16.1**	**15.7**	**15.2**	**14.8**	**14.3**	**13.9**	**13.6**	**13.2**	**12.8**	**12.5**	**12.2**	**11.9**
43.1	21.3	20.6	19.9	19.2	18.6	17.9	17.4	16.8	16.3	15.8	15.3	14.9	14.4	14.0	13.6	13.2	12.9	12.5	12.2	11.9	11.6	11.3
40.8	**20.2**	**19.5**	**18.8**	**18.2**	**17.6**	**17.0**	**16.5**	**15.9**	**15.4**	**15.0**	**14.5**	**14.1**	**13.7**	**13.3**	**12.9**	**12.6**	**12.2**	**11.9**	**11.6**	**11.2**	**11.0**	**10.7**
38.6	19.1	18.4	17.8	17.2	16.6	16.1	15.5	15.1	14.6	14.1	13.7	13.3	12.9	12.6	12.2	11.9	11.5	11.2	10.9	10.6	10.3	10.1
36.3	**17.9**	**17.3**	**16.7**	**16.2**	**15.6**	**15.1**	**14.6**	**14.2**	**13.7**	**13.3**	**12.9**	**12.5**	**12.2**	**11.8**	**11.5**	**11.2**	**10.8**	**10.6**	**10.3**	**10.0**	**9.7**	**9.5**

Topic two: Trigonometry 1

Introduction

Welcome to section four (4) of unit two (2), topic two (2). In this topic, we will explore learner-centred activities using ICT integration in the teaching and learning of *Trigonometry*. The section covers an introduction, rationale, objectives, learning outcomes and activities. The topic is covered at Form Two, Form Three and Form Four in the Kenyan secondary school Syllabus, although related concepts on the study of a triangle are introduced in primary school level.

Rationale

According to CEMASTEA needs assessment survey (2018) Trigonometry, was ranked among the topics that teachers find challenging during teaching and learning and therefore would want it considered for INSET. This is the reason it is included in the 2019 INSET. Further, Trigonometry has many applications in real life. For example, engineers rely on trigonometric relationships to determine the sizes and angles of mechanical parts used in machinery, tools and equipment. Architects use trigonometry to calculate structural load, roof slopes, ground surfaces and many other aspects. They also use the fundamentals of trigonometry to design bridges, build structures and solve scientific problems. The sine and cosine functions are also fundamental to the theory of periodic functions, which describe the sound and light waves.

Learning Outcomes

By the end of the session, you should be able to:

1. Identify areas of concern in teaching and learning of Trigonometry
2. Develop ICT Integrated activities for teaching and learning of Trigonometry
3. Develop ASEI lesson in Trigonometry, that incorporate ICT integration

Background on Trigonometry

Trigonometry is a branch of mathematics that studies relationships between the sides and angles of triangles. The word trigonometry is derived from the Greek words for triangle (*trigōnon*) and measure (*metron*). It was first developed during the third century B.C., as a branch of Geometry focusing on triangles and was used extensively for astronomical measurements. The major trigonometric functions, including sine, cosine, and tangent, were first defined as ratios of sides in a right- angled triangle. In the eighteenth century, the definitions of trigonometric functions were broadened to a unit circle and development of graphs of functions related to the angles they represent which were periodic. Today, using the periodic nature of trigonometric functions, mathematicians and scientists have developed mathematical models to predict many natural periodic phenomena**.**

Specific objectives from the Secondary Education Syllabus Volume II Form Two

By the end of the topic, the learner should be able to:

a) Define Tangent, sine and cosine ratios from a right angled triangle
b) Read and use tables of trigonometric ratios
c) Use sine, cosine and tangent in calculating lengths and angles

d) Establish and use the relationship of sine and cosine of complimentary angles
e) Relate the three trigonometric ratios
f) Determine the trigonometric ratios of special angles 30°,45°,60° and 90° without using tables
g) Read and use tables of logarithms of sine, cosine and tangent
h) Apply knowledge of trigonometry to real life situations

Form 3 (covered in this section)
By the end of the topic, the learner should be able to:

a) Define and draw the unit circle
b) Use the unit circle to find trigonometric ratios in terms of co-ordinates of points for $0 \leq \theta \leq 360°$
c) Find trigonometric ratios of negative angles
d) Find trigonometric ratios of angles greater than 360° using unit circle
e) Use mathematical tables and calculators to find trigonometric ratios of angles in the range of $0 \leq \theta \leq 360°$

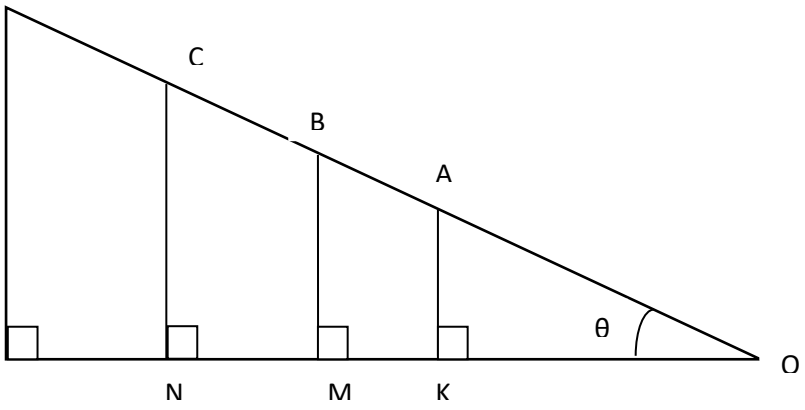
Areas of concern in the teaching and learning of Trigonometry

Activity 1
1) What areas, are of concern in the teaching and learning of Trigonometry?
2) How can these challenges be overcome?

Introduction to trigonometric ratios

Activity 2
How do you introduce the trigonometric ratios to your learners?

You may introduce using a strategy as below:
Sine of an angle
Use right- angled triangles as shown below

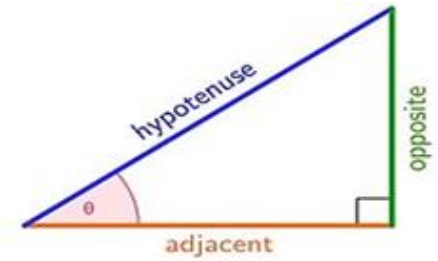


Measure AK and OA and determine the ratio $\frac{AK}{OA}$. Similarly, determine the ratios $\frac{BM}{OB}$ and $\frac{CN}{OC}$

The three ratios are approximately the same. This constant ratio for a given angle θ is called the sine of θ denoted as sin θ.

Thus sin θ = $\frac{Opposite}{Hypotenuse}$. Repeat the process for cos θ and tan θ.

In summary, for any right angled triangle, the following trigonometric ratios hold:



$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \qquad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

Complementary angles

Two angles are complementary if their sum is 90°. We say that θ and (90- θ) are complements of each other

?

Activity 3

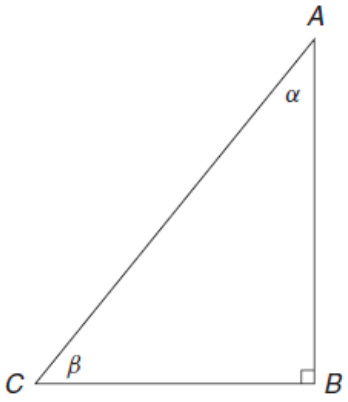
1) Use the mathematical tables or a calculator to complete the table below.
2) What relationship exists between the sine and cosine of an angle and its complement?
3) Is this true for all angles θ where $0° < \theta < 90°$?

Fill the table below

Angle (θ°)	**Sin θ°**	**Cos θ°**	$(90-\theta)°$	**Sin** $(90-\theta)°$	**cos** $(90-\theta)°$
15°			75°		
19°					
37°					
60°					

You may have come up with the following relationship between the sine and cosine of an angle and its complement

Using triangle ABC, we can conclude that if α and β are complementary angles,



a) $\sin\alpha = \cos\beta = \cos(90° - \alpha)$

b) $\cos\alpha = \sin\beta = \sin(90° - \alpha)$

Relationship between sine, cosine and tangent of an angle

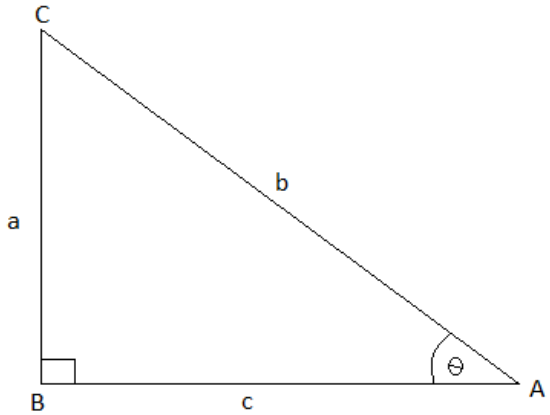
Consider a right-angled ABC with sides a, b, and c as shown in the figure below.

By definition ,

$\text{Sin}\,\theta = \frac{a}{b}$; $\text{Cos}\,\theta = \frac{c}{b}$; and $\tan\theta = \frac{a}{c}$

Now , $\frac{\sin\theta}{\cos\theta} = \frac{a/b}{c/b} = \frac{a}{c} = \tan\theta$

Therefore, $\frac{\sin\theta}{\cos\theta} = \tan\theta$



Fill the table below

$0° \le \theta < 90°$	**Sin** θ	**Cos** θ	**tan** θ	$\frac{Sin\theta}{\cos\theta}$
$10°$				

$0^o \leq \theta < 90^o$	Sin θ	Cos θ	tan θ	$\frac{Sin\theta}{\cos\theta}$
25^o				
55^o				
85^o				

What do you observe? What can you conclude?

Trigonometric ratios of special angles (30^0, 45^0, $60^0$and 90°)

Reflection

Why are the angles 30^0, 45^0,60^0 and 90° referred to as special angles?

Activity 4: Pair and Share

1) How do you teach special angles to your learners?

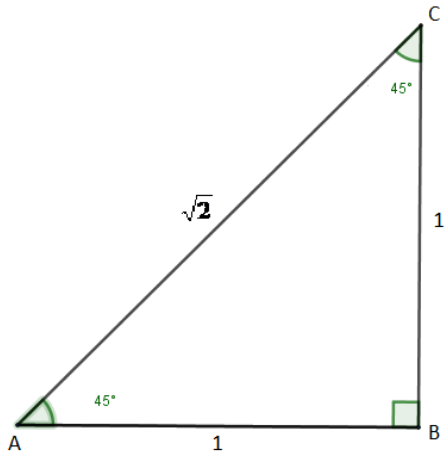
You may have come up with the following:

a) Trigonometric Ratios of 45^0

Given an isosceles right- angled triangle ABC such that AB=BC=1 unit. Angle ABC=90^0 and Angle BCA = Angle BAC= 45^0

1. Find the length of AC leaving your answer in the surd form.
2. Find the trigonometric ratios of 45^0 leaving your answer in surd form:-
   a) $\sin 45^0$ b) $\cos 45^0$ c) $\tan 45^0$
3. What can you say about the sine and cosine ratios of 45^0

Solution



Let AC= x

Using Pythagoras theorem

$x^2=1^2+1^2$

$x = \sqrt{2}$

$\text{Sin}45^0 = \frac{Opposite}{Hypotenuse} = \frac{1}{\sqrt{2}}$

$\text{Cos } 45^0 = \frac{Adjacent}{Hypotenuse} \frac{1}{\sqrt{2}}$

$\text{Tan } 45^0 = \frac{Opposite}{Adjacent} = \frac{1}{1} = 1$

What can you say about the sine and cosine of 45°

Note: The $\sin 45^0 = \cos 45^0 = \frac{1}{\sqrt{2}}$

b) Trigonometric ratios of 30^0 and 60^0

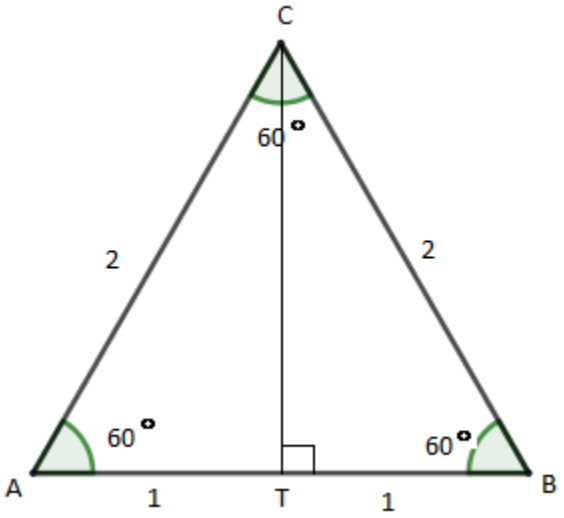
Consider an equilateral triangle ABC of side 2cm. Drop a perpendicular from C to meet AB at T. Triangle ATC and BTC are right angled triangles. Using one of these triangles,

a) Find the length of CT leaving your answer in surd form
b) Find: a) sin 30° b) cos30° c) tan30°
c) Find: a) sin 60° b) cos 60° c) tan60°

Solution

Taking triangle BTC, Angle BTC =90°, Angle CBT=60° and Angle TCB= 30° (CT bisects angle ACB), AT=1 unit and TB= 1 unit

Using Pythagoras theorem we can get the length of CT leaving the answer in surd form.



$T^2 = 2^2 - 1^2$

$= 4-1$

$CT = \sqrt{3}$

Therefore,

$\sin 30^\circ = \frac{Opposite}{Hypotenuse} = \frac{1}{2}$

$\cos 30^\circ = \frac{Adjacent}{Hypotenuse} = \frac{\sqrt{3}}{2}$

$\tan 30^\circ = \frac{Opposite}{Adjacent} = \frac{1}{\sqrt{3}}$

$\sin 60^\circ = \frac{Opposite}{Hypotenuse} = \frac{\sqrt{3}}{2}$

$\cos 60^\circ = \frac{Adjacent}{Hypotenuse} = \frac{1}{2}$

$\tan 60^\circ = \frac{Opposite}{Adjacent} = \sqrt{3}$

Trigonometric ratios of 90^0

$\sin 90^0 = 1$, $\cos 90^0$ = zero and $\tan 90^0$ is undefined. As you increase the angle of from 0^0 to 90^0, the sin ratio increases while that of the cosine decreases.

The tan ratio is given by $\frac{\sin}{\cos}$ therefore $\tan 90^0$ will be given by $\frac{\sin 90}{\cos 90} = \frac{1}{0}$ which is undefined.

In conclusion, it can be observed that

a) $\sin 30^\circ = \cos 60^\circ = \frac{1}{2}$; $\sin 60^\circ = \cos 30^\circ = \frac{\sqrt{3}}{2}$ (Note: 30° and 60° are complementary angles)

b) $\sin 45^\circ = \cos 45^\circ = \frac{1}{\sqrt{2}}$

c) $\tan 45° = 1$

d) $\sin 90^0 = 1$, $\cos 90^0$ = zero and $\tan 90^0$ is undefined.

Classroom strategies to cater for students with Special Needs

Activity 5: Pair and Share

What strategies can you apply in your teaching to enhance learning of trigonometry, if you have learners who are visually impaired and others with learning difficulties?

You may have identified some of the following:-

1. Use picture/diagrams presentations and handouts, and describe what is pictured. Read out the presentations/handouts and allow them enough time to interact with the materials
2. Provide verbal explanations
3. Encourage the students to come to the front of the classroom or presentation area in order to be certain that he/she hears all instruction/explanation correctly
4. Extra time may be required when carrying out tasks
5. Expect them to complete the same assignments as the rest of the students
6. Address all students by name
7. Treat them equally with other students. This includes discipline and special privileges as well as involvement in extracurricular and leadership opportunities.
8. Give them many opportunities to help and to be helped by others

9. As much as possible, treat the student the same as any other student and your example will encourage the classmates to do the same
10. Use teaching and learning resources that will aid visibility and understanding such as the one below

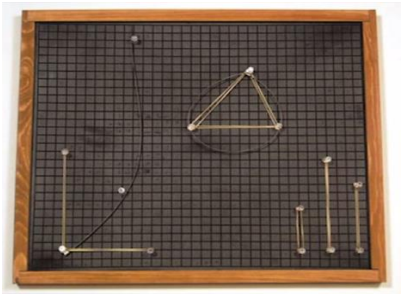


Figure 13: Graphic Aid for use by visually impaired

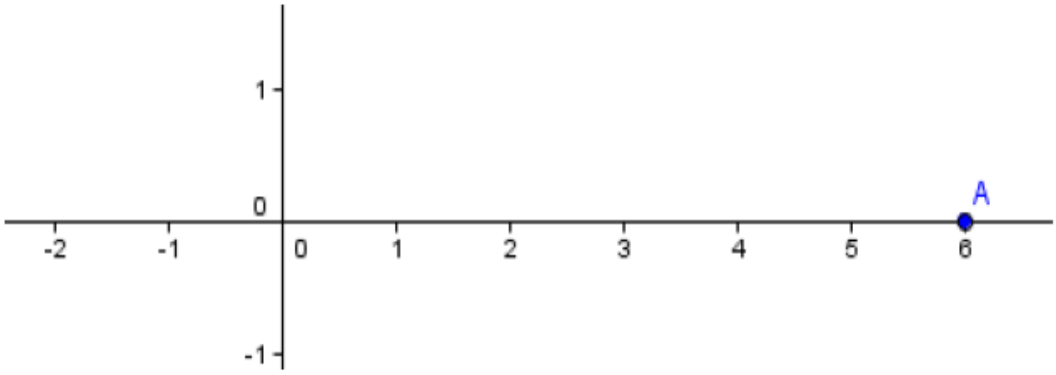
ICT integration in Trigonometry

Activity 6 ***Pair and Share***

a) Explore sine, cosine and tangent of angles $(0 \leq \theta \leq 90°)$

Steps

1) Open GeoGebra. Make sure the axes appear in the graphics view.
2) Select the Point on Object tool  and click somewhere on the *x* axis. This creates a new point called A on the axis.



3) Select the Point on Object tool  and click on the axis three units to the left of A to create a point called B.
4) Right click the point A and choose Object Properties. Click on the box beside Fix Object to fix A.

5) Using the Perpendicular line tool  , draw a line through A perpendicular to the *x* axis.

6) Create an angle slider using a Slider tool  by clicking the circle beside Angle option in the dialogue box. Set Min to 0° and Max to 90° and Increment to 1° . Click Apply. This creates a slider called α.

7) Select the Angle with Given Size tool  . Click on the point A followed by the point B. A new dialogue box appears. Delete 45° in the dialogue box. Click on the symbol on the right of this dialogue box and choose α. Click OK. This creates an angle called β, the size of which depends on the slider α and a point A^1 .

8) Select the Line through Two Points Tool  . Click on B and A^1.

9) Intersect the x Axis and the line forming the angle at B using the Intersect Two objects tool  and the point of intersection C (The computer will name it C automatically)

10) Using the Segment Between Two Points tool  , draw line segments AC and BC.

11) Hide line AC, line BC and point A^1.

12) Rename the sides of the resulting triangles so that each side corresponds to the angle opposite to it.

13) Show the Name and Value of each side using Object Properties

14) Hide the axes and the grid

15) In the input bar type v1=b/a ; v2 =c/a; and v3=b/c

Inserting dynamic Text

Activity 7 Pair and Share

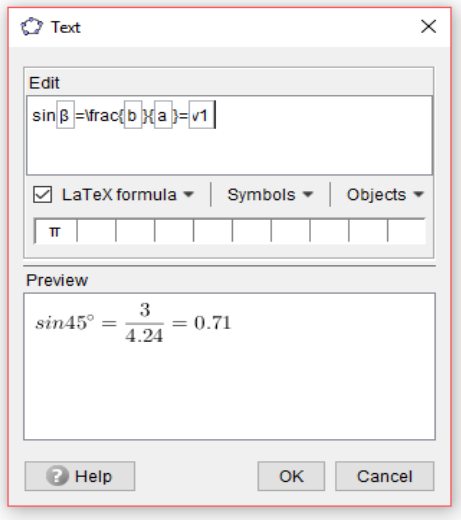
Inserting dynamic Text

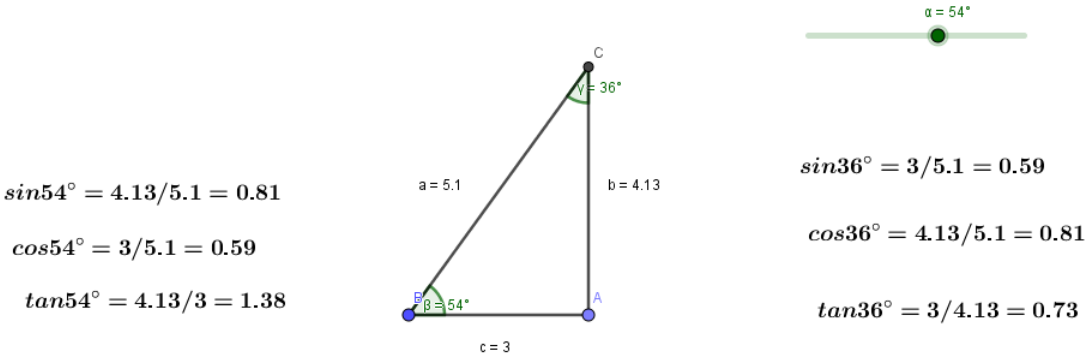
1. Carry out activities in steps 1 to 5
2. Answer questions in steps 6,7,8,9 and 10.

Steps

1) Select the Insert Text tool  and click on the Graphics View where you require the text to appear. A new dialogue box appears.

2) Type *Sin*, follow the down arrow beside Objects and choose β followed by =
3) Click the checkbox beside LaTeX formula. Choose fraction a/b from the options under Roots and Fractions. Choose *b* from the down arrow beside Objects for the numerator and a for the denominator, then = followed by *v1* as shown in the dialogue below
4) Repeat the process for *cos* β and *tan* β to have a Graphics view as shown below:





5) Move the slider and note the changes in the sides of the triangle and the trigonometric ratios
6) Move the point B.
7) What do you observe? What can you conclude?
8) What can you say of the trigonometric ratios as the angle changes?

Angle (θ°)	**sin θ°**	**cos θ°**	**tan θ°**
0°			
15°			
30°			
50°			
75°			
89°			

9) What can you say of the trigonometric ratios of the complementary angles of the triangle?

Angle (θ°)	**sin θ°**	**cos θ°**	**(90-θ)°**	**sin(90-θ)°**	**cos (90-θ)°**
20					

38					
30					
45					
60					

10) In the input bar, type v8= $\frac{\sin\beta}{\cos\beta}$ and enter. Write v8= $\frac{\sin\beta}{\cos\beta}$ as dynamic text. Move the slider and compare the values of v8 and tan β. What do you conclude?

Angle β	**tan** β	$\frac{\sin\beta}{\cos\beta}$
15		
43		
78		
80		

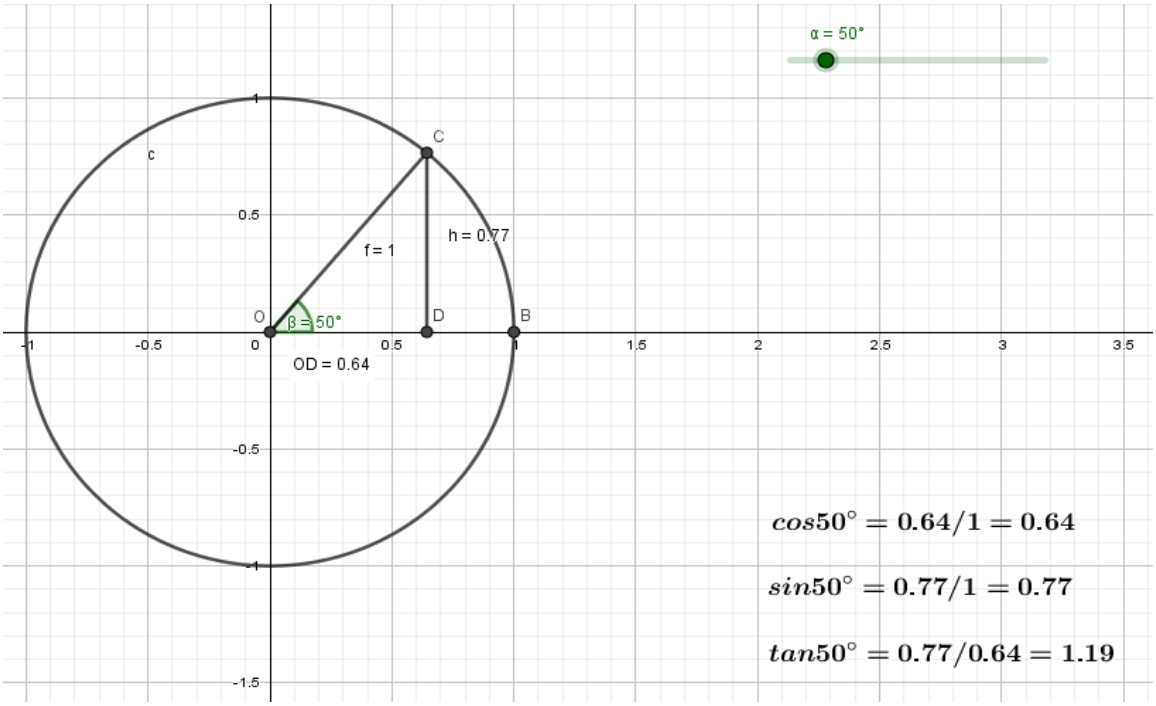
a) The Trigonometric ratios on the unit circle

Activity 8 Pair and Share

The trigonometric ratios on the unit circle

3. Carry out activities in steps 1 to 10
4. Answer the question in step 11

1) Open GeoGebra. In the graphics view, intersect the axes to create the point A. Rename the point A to O
2) Draw a circle centre O and radius 1. You can enlarge the circle maintaining the ratio of *x* to *y* at 1:1
3) Intersect the circle with the *x* Axis to get a point B
4) Create a slider of angle α with a minimum 0°, maximum 360° and increment 1°.
5) Using the Angle with Given Size tool, click on point B followed by O. Type α in the dialogue box. Click OK. A new point B^1 is created. Rename it point C.
6) Draw line segment OC.
7) Draw a perpendicular line to the *x* Axis from point C. Intersect the perpendicular line and the *x* Axis to get point D
8) Show the Name and Value of the lengths OD, OC and CD.
9) In the Input Bar, type and enter $\sin\alpha$, $\cos\alpha$ and $\tan\alpha$
10) Insert dynamic text for $\sin\alpha$ =OC/CD, $\cos\alpha$ =OD/CD, and $\tan\alpha$ =OC/OD, to have a Graphics View as shown below:



11) Move the slider and note the changes in the sizes and signs of trigonometric ratios as the angle α changes. Read the Cartesian coordinates of points in each quadrant. Note the signs of the coordinates in each quadrant. Fill your observations in the table below. What do you conclude?

β	**Quadrant**	**x-coordinate**	**y-coordinate**	**sin β**	**cos β**	**tan β**	**Comment**
22							
45							
90							
96							
150							
180							
196							
210							
250							
270							
280							
300							
330							
360							

Simple trigonometric graphs

Trigonometric graphs are commonly used in all areas of science and engineering for modelling many different natural and mechanical phenomena such as waves, engines, acoustics, electronics,

populations, UV intensity, growth of plants and animals Periodic trigonometric graphs mean that the shape repeats itself exactly after a certain amount of time. Anything that has a regular cycle, like the tides, temperatures, rotation of the Earth, can be modelled using a sine or cosine curve.

Graphs of trigonometric functions

By drawing up tables of values from 0° to 360° graphs of $y = \sin A$, $y = \cos A$ and $y = \tan A$ may be plotted. Values obtained with a calculator or mathematical tables (correct to 3 decimal places – which is more than sufficient for plotting graphs), using 30° intervals, are shown below, with the respective graphs shown below.

Activity 9: Pair and Share

Fill the tables given below and plot the sine graph and the cosine graph on a graph paper. Describe the graphs.

y=sin A

A	**0°**	**30°**	**60°**	**90°**	**120°**	**150°**	**180°**	**210°**	**240°**	**270°**	**330°**	**360°**
Sin A												

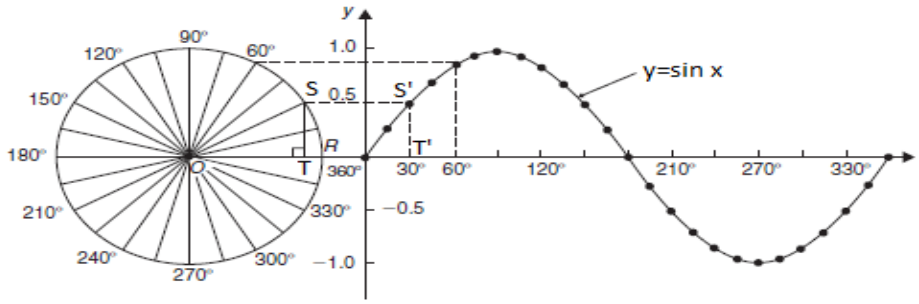
y=cos A

A	**0°**	**30°**	**60°**	**90°**	**120°**	**150°**	**180°**	**210°**	**240°**	**270°**	**330°**	**360°**
Cos A												

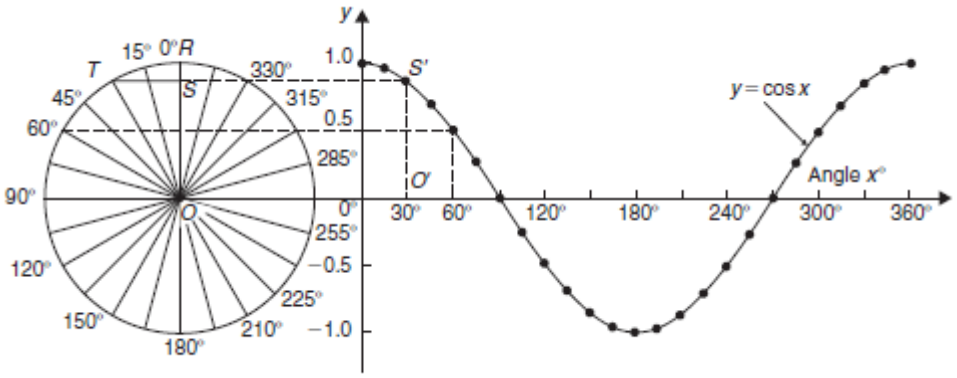
y=tan A

A	**0°**	**30°**	**60°**	**90°**	**120°**	**150°**	**180°**	**210°**	**240°**	**270°**	**330°**	**360°**
tan A												

Trigonometric Waves



The vertical component *TS* may be projected across to T^1S^1 which is the corresponding value of 30° on the graph of *y* against angle *x*°.



Activity 10 Group activity

a) Develop ICT Integration activities for teaching the topic trigonometry using GeoGebra software or any other application
b) Prepare a lesson plan showing how you would integrate activities in a) in teaching and learning.
c) Present the lesson/ narrate with emphasis on the ICT integration.
d) Identify some outdoor activities that can be used to enhance the teaching and learning of trigonometry

Sample Lesson Plan

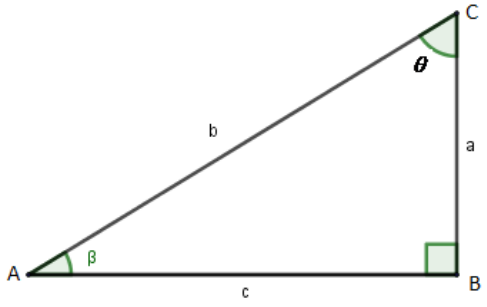
Activity 11 Group activity

f) Study the lesson plan below. Try out the lesson in your group.
g) How can the lesson be improved to enhance learning.

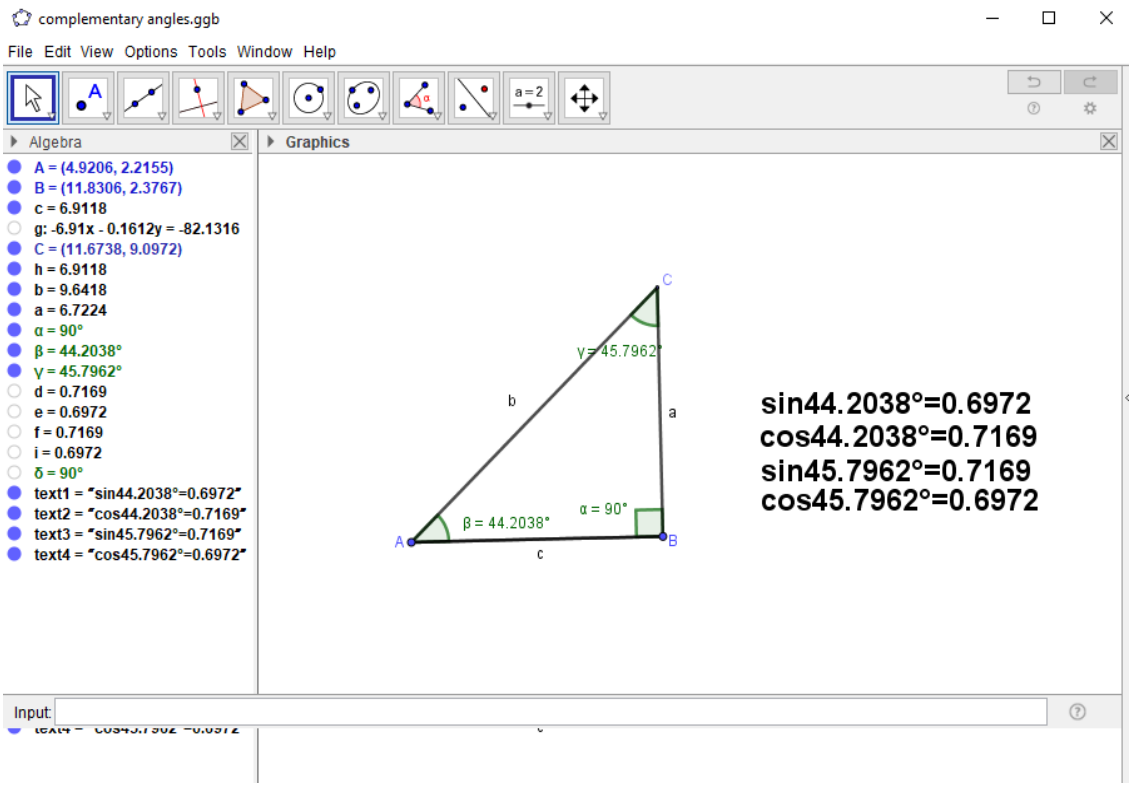
Class: Form 2
Subject: Mathematics
Topic: Trigonometry
Sub-topic: Establish and use the relationship of sine and cosine of complementary angles
Objectives: By the end of the lesson, the learner should be able to:

a) Derive the relationship of sine and cosine of complementary angles
b) Use the relationship of sine and cosine of complementary angles in solving mathematical problems

Prerequisite Knowledge: triangles, types of angles, complementary angles, Trigonometric ratios of angles, and Geo-Gebra software

Stage/Time	Teaching/Learning activities	Learning Points	Remarks
Step 1 – Introduction Engagement (5minutes)	Learners in pairs to draw 3 right angled triangles in their exercise books.	Geometrical sets	
Exploration (5 minutes)	Learners in pairs to: a) Measure the acute angles in the triangles. b) Work out the sum of the two acute angles in each of the triangles. What can you say of the sum of the acute angles in right-angled triangles?	Acute angles in right-angled triangles add up to 90° Complementary angles	
Step 2 – Development Explanation (7 minutes)	Learners in pairs to work out the sine and cosine of the acute angles in the right-angled triangles using calculators or mathematical tables and record  $\sin\beta$; $\cos\beta$ a) $\sin\theta$; $\cos\theta$ Compare the sine and cosine of the acute angles in right-angled triangles. Teacher poses the following questions: a) What do you observe? b) What conclusion can you draw?	$\sin\beta = \cos\theta$ $\cos\beta = \sin\theta$ Sine and cosine of complementary angles are equal	
Elaboration (10 minutes)	Learners in pairs to work out the sine and cosine of acute angles in right-angled triangles given one acute angle. How did you work out the sine and cosine of the missing acute angles? What do you conclude?	*a)* $\sin\alpha = \cos\beta = \cos(90° - \alpha)$ *b)* $\cos\alpha = \sin\beta = \sin(90° - \alpha)$	
Step5 Evaluation (5 minutes)	In a right- angled triangle, one of the acute angles is 75°. If sin75°=0.9659,work out cos15° without using mathematical tables or calculators		

Stage/Time	Teaching/Learning activities	Learning Points	Remarks
Conclusion (8minutes)	Teacher leads learners in going over key points of the lesson using GeoGebra. Move the point C in the GeoGebra and observe $\delta = \beta + \gamma$ and sine and cosine of the acute angles in the right-angled triangles. What do you conclude?	$\delta = \beta + \gamma = 90°$ $\sin \beta = \cos \gamma$ (sine and cosine of complementary angles are equal)	



Conclusion

In this section, we have discussed how we can use ICT integration in the teaching and learning of the topic Trigonometry, to enhance learner's understanding and interest. It's our hope that you had an opportunity to use ICT integrated activities in the topic and you are now empowered on the use of the same in the teaching and learning of Trigonometry and other topics in Mathematics. You have also developed ICT integrated activities and outdoor activities, incorporated them in lesson plans shared them among yourselves. As we go back to our schools let us make use of these activities in our teaching and let us also share with other colleagues back in our schools. We wish you well as you take up this noble task

Subject: Physics

Topic one: Electronics

Introduction

Welcome to the topic of electronics. This topic will be used to demonstrate how to use Project Based Learning (PBL) in teaching and learning. You will be taken through the rationale, learning outcomes, content which includes some hands-on activities and designing projects that could be used to enhance the understanding of concepts in the topic.

Rationale

According to training needs assessment by CEMASTEA (2017), the topic of Electronics was found to be challenging by both teachers and learners. It is for this reason therefore that the Project Based Learning strategy will be used to address this challenge. The purpose of this session is to make it easier and interesting for you to teach and enhance learning outcomes.

Learning outcome

Participants should be able to use PBL in teaching and learning of concepts in the topic of Electronics.

Background Information

The introduction of vacuum tubes at the beginning of the 20th Century was the starting point of the rapid growth of electronics. With vacuum tubes, the manipulation of signals became possible, which could not be done with the early telegraph and telephone circuit or with the early transmitters that used high-voltage sparks to create radio waves. For example, with vacuum tubes, weak radio and audio signals could be amplified. Further audio signals such as music or voice, could be superimposed on radio waves. The development of a large variety of tubes designed for specialized functions made possible the swift progress of radio communication technology before World War II and the development of early computers during and shortly after the war.

The transistor, invented in 1948, has now almost completely replaced the vacuum tube in most of its applications. Incorporating an arrangement of semiconductor materials and electrical contacts, the transistor provides the same functions as the vacuum tube at reduced cost, size, weight, and power consumption and with higher reliability. Subsequent advances in semiconductor technology, in part attributed to the intensity of research associated with the space-exploration effort, led to the development of the integrated circuit. Integrated circuits may contain hundreds of thousands of transistors on a small piece of material and allow the construction of complex electronic circuits, such as those in microcomputers, audio and video equipment, and communications satellites.

Definition

Electronics basically deal with the flow of very low electric currents, also referred to as flow of electrons in vacuum and matter. In modern times more and more semi-conductors are used in place of vacuum valves and this has made telecommunication gadgets small and small. The study

of semi-conductor devices related to technology is known as solid state physics, while the design and construction of electronic circuits to solve a problem is known as electronics engineering.

Syllabus statement

Table 7, presents the Secondary school syllabus statement for the topic electronics (KIE, 2002). It shows topic objectives and the content to be learnt.

Table 8: Syllabus for the topic electronics

Topic objectives	Content
By the end of the topic the learner should be able to: ♦ State the differences between conductors and insulators ♦ Define intrinsic and extrinsic semi-conductors ♦ Explain doping in semi-conductors ♦ Explain the working of a p-n junction diode ♦ Sketch the current-voltage characteristics for a diode ♦ Explain the application of diodes in rectification.	♦ Conductors, semiconductors, insulators ♦ Intrinsic and extrinsic semi-conductors ♦ Doping ♦ p-n junction diode ♦ Applications of diodes: half-wave and full-wave rectification

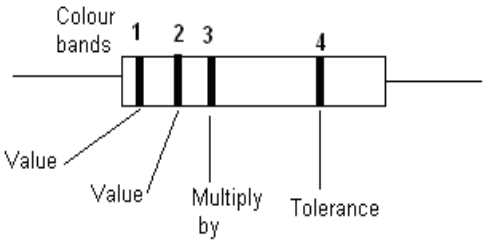
Resistor colour codes

Reflection — What is a resistor?

√ You may have come up with the following

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit.There are various types of resistors such as fixed resistors made from resistance wires, carbon resistors, variable resistors which include light depended resistors among others. The most common type of resistors in electronic circuits is the carbon resistors. The value of resistance in a carbon resistor can be determined using colour bands as explained below.

a) Four bands



b) Five bands

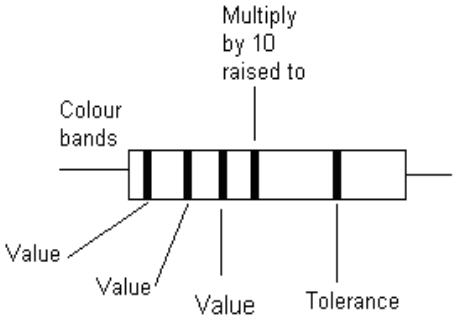
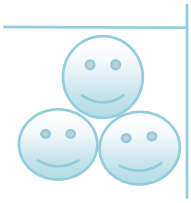


Table 9: Resistor colour codes

Colour	Value	Value	Multiply by	Tolerance
Black	0	0	1	Red = ± 2% Gold = ± 5% Silver = ± 10% No band = ± 20% Brown = ± 1% this gives the maximum error in the value of the resistor.
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1000	
Yellow	4	4	10000	
Green	5	5	100000	
Blue	6	6	1000,000	
Violet	7	7	Not used	
Grey	8	8	,,	
White	9	9	,,	

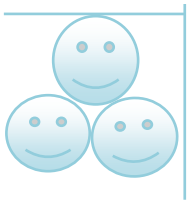
Hands-on Activities and project work



Activity 1

You are provided with junk electronic circuit board. Identify any four resistors and label them A, B, C and D. Determine their resistance. Confirm your figures using a multimetre

The function of resistors in an electronic circuit



Activity 2

Carry out this activity using the procedure that follows.

Discuss how this activity can be carried out for learners with visual impairment?

Procedure

1. You are provided with the following materials: Project Board, Connecting wires, LED, Fixed resistor (470Ω), 4 dry cells, Multimeter.
2. Study the circuits A and B as shown in figure 14. The two circuit diagrams illustrate the use of resistors, light emitting diode (LED) and the effect of resistors in series and in parallel connections. NB the resistors R_1, R_2, and R_3all have equal resistance; i.e. $R_1=R_2=R_3=R_4$

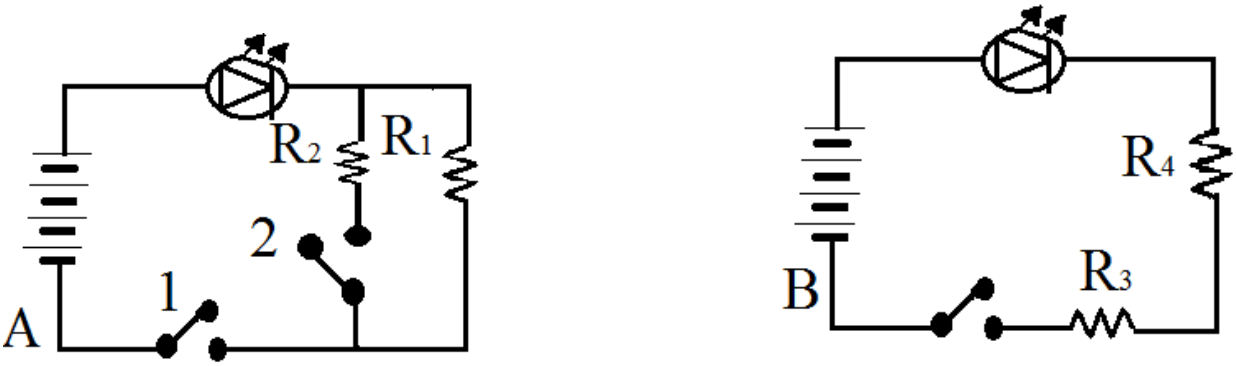


Figure 14: Arrangement of resistors in a circuit

3. From circuit A, predict a possible observation on the brightness of the LED:

a) When only switch 1 is on

……..……

b) When both switch 1 & 2 are on When switch 1 is off and switch 2 is on

……..……

4. Connect the circuit and check your predictions.

5. Measure the current through the LED in A, B. Record values in the data table.

Table 10: Data table

Circuit	Current through
A (only switch 1 is on)	
A (both switch 1 & 2 are on)	
B(when switch is on)	

Questions to analyse your observation in Table 9

a) What do you notice about the LED at every switch configuration?

……..……

……..……...

……..……

b) Explain your observation

……..……..

……..……...

……..……

c) What do the results tell you about the effect of resistors in series and in parallel to the circuit?

……..……..

……..……...

……

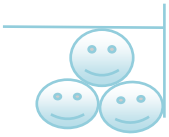
d) Do the measured values support your prediction?

……

e) What is the function of the resistors in electronic circuits?

……

The function of a diode in a circuit



Activity 3

Carry out the activity following the procedure provided

Procedure

1. You are provided with the following materials: Project board, Connecting wires, Fixed resistor(470Ω), 4 Dry cells, rectifier diode (IN4001), Light emitting diode

   Suggestion: Light can be replaced with sound to enable learners with visual impairment to participate in the activity.

2. Assemble the circuit as shown.

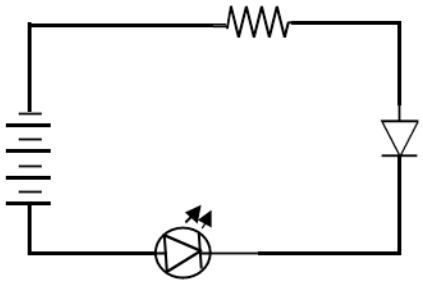


Figure 15: Function of a diode in a circuit

3. Reverse the orientation of the diode and describe what you observe.
   Questions to analyse your observations

   a) How should a diode be inserted in a circuit so that the LED glows? What does the glowing LED indicate?

   ……..

   ……...

   b) What happened when you reversed the orientation of the diode?

   ……

   ……

   c) What can you infer from this observation?

   ……

   ……

Function of a capacitor in an electronic circuit

Activity 4

Carry out the activity following the procedure provided

Procedure

1. You are provided with the following materials: Project Board, Connecting wires, Resistors (470 Ω),4 dry cells, 2 capacitors (100 μF each), LED, Switch, Stopwatch

2. On the project board, assemble the circuit shown in Fig 16.

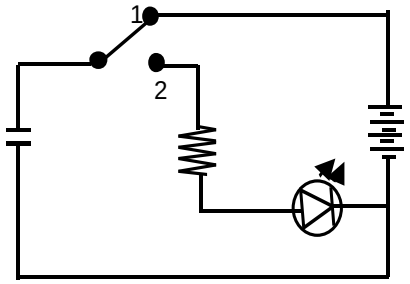


Figure 16: Function of a capacitor in a circuit

3. Wait for 1 minute and transfer the switch from point 1 to 2. Observe what happens.

4. Add one more capacitor to the circuit as shown in Fig. 17. Wait again for 1 minute then transfer the switch from point 1 to 2. Observe what happens.

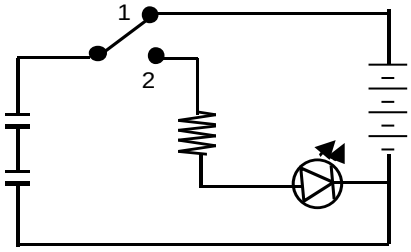


Figure 17: Capacitors in series

5. On the same project board, assemble the circuit shown in Fig. 18. Wait for 1 minute and transfer the switch from point 1 to 2. Observe what happens.

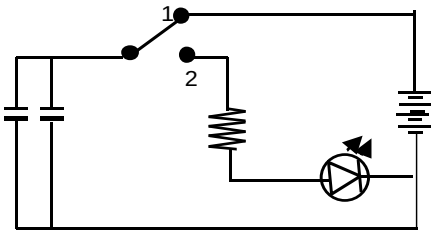


Figure 18: Capacitors in parallel

6. Repeat the activity, this time noting the time the LED was on. Record the time in the data table below.

Table 11: Data Table

Circuit	Time LED is on			
	Trial 1	Trial 2	Trial 3	Average
1				
2				
3				

Questions to analyse your observation

a) What happens to the LED when the switch was transferred from 1 to 2 as indicated in the circuits? What do you think is happening?

b) What was happening to the capacitors when the switch was connected to point 1 as indicated in the circuit? (you may need to trace the circuit diagram)

c) In which circuit did the LED light up for the longest time? Explain these observations?

A project on full wave rectifier

Activity 5

In this activity, which is a project, you are required to come up with a full wave rectifier.

Procedure

1. You are provided with the following materials: Rectifier diodes (IN4001), A.C signal (range 0-20V), Connecting wires, Cathode Ray Oscilloscope, Circuit board, Switch
2. Draw a circuit diagram for your project
3. Set up the circuit and use the cathode ray oscilloscope to test if your rectifier is working
4. How would you smoothen the output signal?

Activity 6

Select one of the concepts under the topic *electronics* in the secondary Education syllabus and prepare a project that can be used to teach the concepts. Explain how the project can be used:

- to enhance the core competencies as outlined in CBC
- in community service learning as a teaching and learning strategy

Conclusion

We have used the topic *Electronics* as an example to apply the strategy of Project Based Learning in the lessons we developed. We have discussed and carried out activities that promote PBL, developed and demonstrated a project on the same. We hope that applying PBL strategies will enhance student's ability to understand and apply the concepts not only in the topic of *electronics* but also in other physics topics as well.

Topic Two: Quantity of Heat

Introduction

Welcome to this session in which you will further explore the use of ICT integration in the teaching and learning of concepts in Physics using the topic of Quantity of Heat.

In this session, you will be taken through the rationale, learning outcomes, critical content and the conclusion. Learners are expected to use ICT to develop communication and collaboration, critical thinking and problem solving, creativity and imagination, citizenship, digital literacy, learning to learn and self-efficacy, which are the competencies stipulated in CBC. You will have an opportunity to discuss and share best practices in the use of ICT integration and practical activities in the teaching and learning of concepts in quantity of heat to enhance learner achievement.

Rationale

According to the monitoring and evaluation report by CEMASTEA (2016), the topic of Quantity of heat was rated position 4 out of 32 challenging topics. The topic was also found challenging as observed by CEMASTEA (2017) during a Training Needs Assessment (TNA) for its Secondary programme. One of the reasons given for the difficulty in the topic was inadequate exposure of learners to practical work. It is therefore advised that teachers expose learners to more practical activities for them to understand concepts in this topic. In the case of areas where practicals are not easy to perform, ICTs can be used to simulate the actual process. During this session, you are expected to come up with various activities that incorporate ICT integration and practical work.

Specific learning outcomes

Participants should be able to:

1. Demonstrate the use of ICT integration and practical activities in teaching and learning of concepts in the topic of quantity of heat.
2. Design ICT integrated activities and also carry out some practical activities that can be used in teaching and learning of concepts in the topic of quantity of heat.

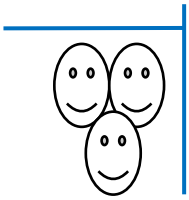
Background information

When heat energy is applied to a substance, the molecules and atoms vibrate faster. The faster the motion of the molecules inside it, the hotter an object is. Thus, the heat of an object is the total energy of all the molecular motion inside that object. Temperature is a measure of how hot or cold something is; specifically, a measure of the average kinetic energy of the particles in an object, which is a type of energy associated with motion. Therefore applying more heat would increase the vibrations of its particles hence raising its temperature. At some point the heat applied may not necessarily increase the motion of particles but rather break the bonds or forces that hold the particles together. Under such a case we say the substance has undergone a change of state. This means that during the change of state, the temperature remains constant while heat is being applied on the substance.

The amount of heat required to raise the temperature of a substance by one unit is called *heat capacity*. If the quantity of the substance in one unit and a certain amount of heat raises its temperature by one unit, we refer to this amount of heat as *specific heat capacity* of that substance. The SI unit for specific heat capacity is the joule per kilogram Kelvin (J/kgK or $Jkg^{-1}K^{-1}$). If we represent the amount of heat transferred to a substance as ΔQ, the mass of a substance as m, and the temperature change as ΔT, then specific heat, c, can be expressed as follows.

$$c = \Delta Q/m\Delta T$$

Water has one of the highest specific heat capacities among the common substances. This is why it is used for central heating systems in houses, where heat is carried around the building by means of hot water flowing through pipes, heat being released as the water cools down. The high specific heat capacity of water means that it can carry more energy than any other common liquid for a given temperature and mass. This phenomenon has many effects in daily life, such as the land and sea breezes.



Activity 1

Pair and share

Using the graphics in figures 19 and 20 to explain land and sea breeze as a result of high specific heat capacity of water?

Figure 19: Land Breeze and sea Breeze

Source:https://www.google.com/search?q=land+breeze

When a substance changes from one state to another heat is applied without resulting in any change in temperature. *The amount of heat energy required to change the state of a substance is called Latent Heat*. The amount of heat energy required to cause a change of state is often very large compared with that required to change the temperature. For example, it requires 340,000 J to melt 1 kg of ice, and 2,300,000 J to vaporize 1 kg of water. However, it only requires 42,000 J to raise the temperature of 1 kg of water by 1° C. *Latent* heat is responsible for breaking the bonds between particles of a substance.

Energy is conserved in all physical processes. The implication to this is that heat energy has to be absorbed or released when a change of state occurs. For instance, when 1 kg of steam condenses to water, 2,300,000 J of heat energy is released. This is the same amount of heat energy that would be required to change 1 kg of water into steam. The term latent comes from a Latin word which means hidden. The amount of heat energy required to change 1 kg of a substance from solid to liquid is called specific latent heat of fusion of the substance. Specific latent heat of vaporization of a substance, on the other hand, is the amount of heat required to change one kg of the substance from liquid to gas. The specific latent heat of vaporization of a substance can be determined using the equation:

$$Q = mL$$

where Q is the heat energy supplied in joules, m is the mass, in kg, of liquid vaporized, and L is the specific latent heat of vaporization in J/kg.

Many everyday effects are caused by the fact that changing the state of substances requires a lot of heat energy. For example, the existence of icebergs at relatively low latitudes can only occur because it takes so long for them to absorb enough heat energy to melt as they drift southward with the polar currents.

Reflection

Activity 2

Why do you think burns caused by escaping steam are more severe than those caused by hot water?

Figure 20: Burns caused by escaping steam

Syllabus statement

Table 11below shows the syllabus statement on the topic Quantity of Heat (KIE, 2002).

Table 12 Syllabus statement for Quantity of Heat

Objectives:	**Content:**
Define heat capacity and specific heat capacity	Heat capacity, specific heat capacity, units (Experimental treatment required)
Define specific latent heat of fusion and specific latent heat of vaporization	Latent heat of fusion, latent heat of vaporization, units (Experimental treatment necessary)
State the factors affecting melting point and boiling point	Boiling and melting
Explain the functioning of a pressure cooker and a refrigerator	Pressure cooker and refrigerator
Solve problems involving quantity of heat.	Problems on quantity of heat ($Q=MC\Delta\theta$, $Q=ML$)

Project Work: Construct a charcoal refrigerator (cooler)

Concepts in the topic of quantity of heat

In one of the lessons in this topic, a learner wondered aloud whether electricity was cold or hot! Asked by the teacher why she said that she had observed electricity making foodstuff cold in a refrigerator and at other instances making pressing iron hot! How can ICT be used to explain the working of a refrigerator?

Activity 3

Use a digital device to capture either photos or clips which you can use to teach the concept of quantity of heat. Briefly explain how the resource you have captured can be used in teaching and learning

To structure an ICT integrated activity we need to answer the following questions:

1. *What concept (content) do I want to teach?* In this case, it is the working of a refrigerator and specifically how it cools substances kept inside
2. *What technology can I use to teach this concept?* A video that illustrates the cooling mechanism of a refrigerator can be used.
3. *Why do I need technology for this content?* To illustrate how latent heat of vaporization brings a cooling effect in the refrigerator. Technology adds value to teaching and learning because it is very difficult to relate latent heat of vaporization and cooling, but with a video, it can be illustrated.
4. *What activities will the learners do?* Learners will keenly observe the movement and behaviour of the refrigerant and explain their observations. They will discuss tasks given, make group report and present.

Activity 4

Observe the video labelled **Refrigerator** (Learn Engineering, 2017). Using the video revisit the four steps to see how the video can be used and come up with possible questions for learner discussion.

Please note that the video clip is audio to enable learners with visual impairments to follow what is being done

You may have come up with the following responses:

- Learner tasks
    - What have you learned from the video?
    - What parts of a refrigerator have you identified from the video?
    - Describe some uses of the parts you identified.

- A student at home put bottled water in the refrigerator for 5 minutes. While another student put bottled water in the refrigerator for an hour. Explain why the drinking water left in the refrigerator for an hour was colder?

ICT Integrated activity

Activity 5
Explaining the working of a pressure cooker can also be a challenge. Design an ICT integrated activity to help in teaching this concept. Describe the learner's tasks in the activities you designed.

Hands on activities

Activities 6 to 9

Carry out the activities as indicated. In each of the activities, explore how persons with Visual impairments can carry out the activities.

Activity 6
Explaining the working of a pressure cooker can also be a challenge. Design an ICT integrated activity to help in teaching this concept. Describe the learner's tasks in the activities you designed.

Activity 7: Boiling water under low pressure
Boil some water in a round- bottomed flask in a set up as shown in figure 22. When it is boiling vigorously, seal the tube and turn off the flame immediately. Then invert the flask and pour cold water over the flask. Observe and record the boiling temperature of the water. Comment on your observations.

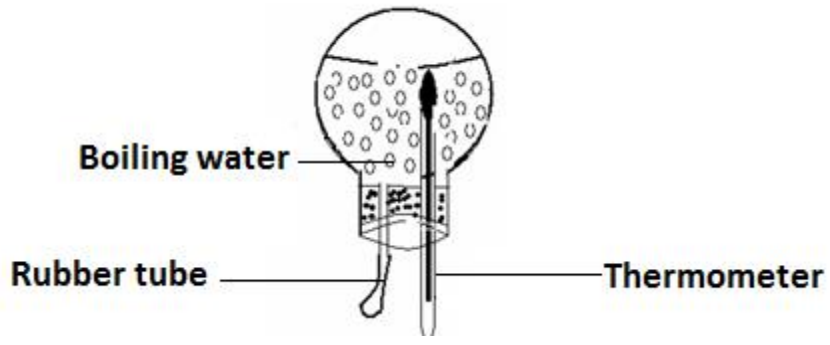


Figure 21: Experiment set up to demonstrate the effect of low pressure on the boiling point of water

Activity 8: Boiling water under high pressure

Heat some water in a strong round bottomed flask. When the water is boiling squeeze the rubber tubing on the steam outlet with a clip and continue heating until the thermometer reading is slightly above 100^0C. Quickly release the pressure and stop heating. Explain your observation.

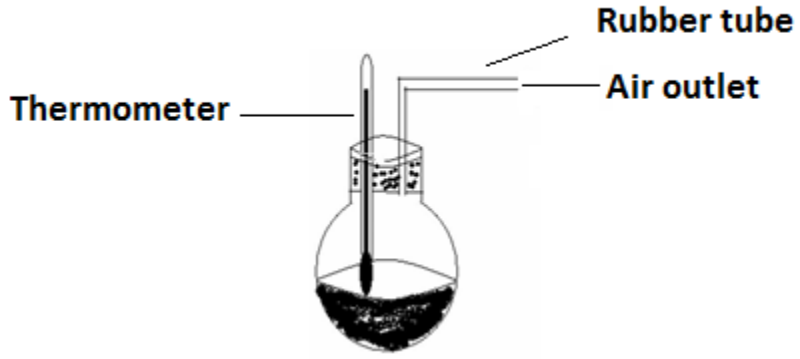


Figure 22: Experiment set up to demonstrate the effect of high pressure on the boiling point of water

Activity 9: Regelation and the ice block

Use the ice block provided and rest it between two stools on a couple of paper towels. Hang two 500g masses over it on a copper wire. Explain your observation.

Repeat the experiment with the different masses hang on a string. Explain your observation.

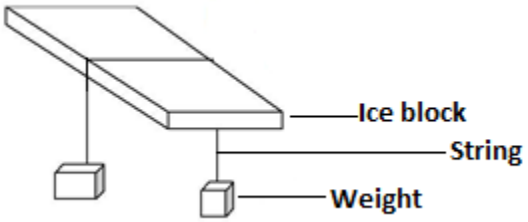


Figure 23: Relegation of ice

Activity10

Develop and present an ICT integrated lesson on any of the concepts in the topic of quantity of heat

Conclusion

You have been taken through the introduction, rationale, specific learning outcomes, ICT integrated activities and some hands-on activities in the topic of quantity of heat. It is envisioned that you will apply the knowledge and skills gained in the teaching and learning process in order for the learners to enhance their competencies and 21st Century skills.

Unit Five: HIV and AIDS – Eliminating Stigma and Discrimination

Introduction

Welcome to Unit Five on eliminating HIV-related stigma and discrimination affecting learners. In Unit Two, you were taken through Competence Based Curriculum (CBC), where you discussed Pertinent and Contemporary Issues (PCIs) that are cross cutting in all subjects. As you may be aware, HIV and AIDS is one of the PCIs under Health Education in CBC for basic education which affects teaching and learning both directly and indirectly.

Rationale

The impact of HIV and AIDS among adolescents paints a grim picture of a problem that needs appropriate response and action as revealed by statistics (WHO, 2015). Out of the 1.6 million people living with HIV in Kenya, 16% of are adolescents. Adolescents are the only group where new HIV infections and AIDS-related deaths are increasing. Some of the factors contributing to the increase in the infections are stigma and discrimination from their teachers and peers. The global response through a campaign led by UNAIDS and UNICEF on "***ALL IN"***, is aimed at reducing the negative impact among adolescents. Kenya was listed among the countries to host the launch of the campaign. Noting that the vast majority of the adolescents (age 10 to 19 years) are learning in secondary schools, the Ministry of Education is tasked with ***effecting positive attitudinal change*** in schools aimed at addressing the negative impact the youth. In this unit we shall engage in activities that enhance your knowledge, skills and attitudes on HIV-related stigma and discrimination of adolescents affected by HIV and AIDS in schools.

Learning outcomes

By the end of the unit, you should be able to:

a) Demonstrate desirable knowledge and skills on HIV-related stigma and discrimination.
b) Show supportive attitudes towards eliminating stigma and discrimination.

Content

Stigma

Let us reflect on how learners behave in schools.

Reflection

Activity One

Look at the pictures shown in Figure 22 and describe what is happening.

Figure 24: Students in school

Source: NASCOP (2016). Guide for educational institutions to support learners living with HIV in Kenya.

You may have observed the following:

- One learner discriminated by others during a football game
- A learner denied admission by the school head teacher

Reflection

Activity Two
Watch the video provided. What messages have you received on HIV-related stigma and discrimination?

The video can also be accessed at https://www.youtube.com/watch?v=VdMZDBO9PKI.

Let us illustrate discrimination and stigma from our experiences.

Activity Three
Demonstrate your perception of HIV-related stigma, e.g by drawing, role play or otherwise

Generally, *stigma* is a process of devaluation that significantly discredits an individual in the eyes of others. HIV-related stigma, refers to the negative beliefs, feelings and attitudes towards people living with or families of people living with HIV.

The following are some of the main types of stigma.

- ***Self-stigma*** occurs when a person believes that he or she will be devalued or judged negatively if other people know his or her HIV status (Fatoki, 2016). Some of the manifestations in the learners entail; Refusal to take drugs or go to clinics, hiding drugs from other people, low self-esteem, and self-pity.

- ***External stigma*** emanates externally from members of the society (Figure 5.2). Some of the manifestations of external stigma include; isolation and ridicule by students and teachers, for example being referred to as *'mtu wa matembe'* (the person of drugs).
- ***Institutional stigma*** emanates from the practices in the systems within institutions. They entail; extra sympathy from teachers, such as exemption from games and responsibilities; giving special meals, such as milk; denying admission for HIV-positive learners or asking parents to transfer them to other schools. In extreme cases, some teachers refuse to teach them.

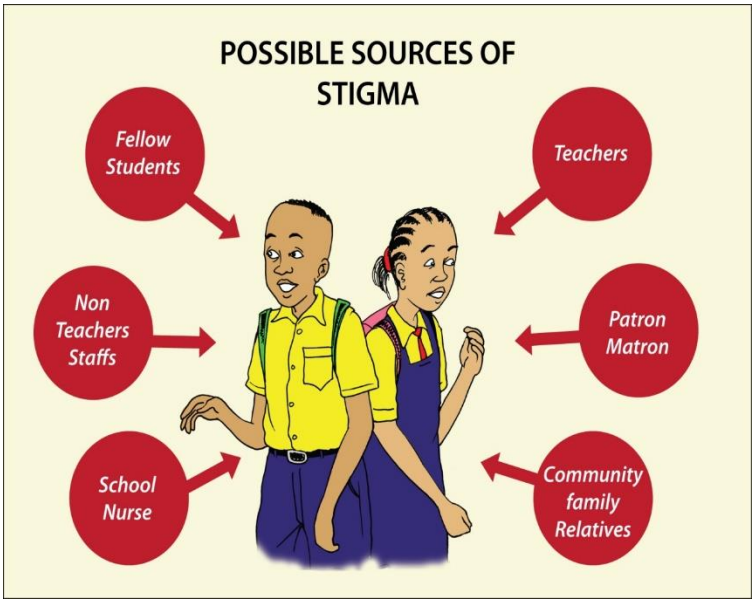


Figure 25: Possible sources of stigma

Source: NASCOP (2016). Guide for educational institutions to support learners living with HIV in Kenya.

Discrimination

Having discussed the meaning of stigma, let us now consider HIV-related discrimination

Activity Four
Discuss and share your perception of HIV-related discrimination

You may have discussed some of the following;

HIV-related *discrimination* refers to the unfair and unjust treatment (act or omission) of an individual based on his or her real or perceived HIV status (UNAIDS, 2014). Every learner has a right to be treated equally regardless of their personal identity. Legal action can be taken against discrimination. A learner may be discriminated as a result of stigma. You need to view HIV as any other health condition where the affected require to be treated like any other learner.

Stigma, discrimination and HIV prevention

Reflection

Activity Five
In your opinion, how does stigma and discrimination contribute to the spread of HIV infections?

√ **You may have come up with the following.**
When people who are HIV positive are not stigmatized and not negatively discriminated, they become careful not to infect others. This contributes significantly to the prevention of HIV infections. It is therefore important for everyone not to stigmatize or discriminate anybody on the basis of real or perceived HIV status.

Teachers as role models in elimination of stigma and discrimination
To eliminate stigma and discrimination in school leaders and teachers should play a leading role. They should demonstrate positive attitudes towards HIV-positive learners and colleagues. Teachers can do this by eliminating the stigma among themselves and in the community.

Effects and elimination of stigma and discrimination
Let us discuss the effects of stigma and discrimination on adolescents in school.

Activity Six
1. Share a real life scenario/experience on how HIV-positive students are treated in school/classroom?
2. Discuss effects of stigma and discrimination to the learner
3. Suggest ways of eliminating HIV-related stigma and discrimination in your classroom / school

√ **You may have discussed some of the following:**
Effects of stigma and discrimination impact negatively on learner's school life and should be eliminated. Effects may include; learners dropping out from school, poor health due to refusal to take medication, poor academic performance, and depression.

The following are some of the ways of eliminating stigma and discrimination.

- Teachers **not** to be propagators of stigma and discrimination directed at learners through utterances, body language and actions.
- The school should develop and enforce anti-stigma regulations and guidelines.
- During lessons, deliberately integrate knowledge and skills aimed at eliminating HIV-related stigma and discrimination.
- Use of existing forums like assemblies, parents' days, debates, health clubs, bulletins, drama, poems, songs to pass messages on how to eliminate stigma and discrimination.

- Create awareness among the parents on how to support learners living with HIV.
- Create learner-friendly environment for disclosures and psycho-social support.

Conclusion

This Unit was meant to enhance your knowledge and skills on the meaning, effects and elimination of HIV-related stigma and discrimination. You are expected to use the knowledge and skills in teaching and learning with a view to eliminating stigma and discrimination. It is hoped that you will be a role model in practices that do not propagate stigma and discrimination both in the school and the community at large.

Unit Six: Action Planning and Way Forward

Introduction

Welcome to the last unit of this module. You will be taken through Action Planning and be guided on how to effectively implement county INSET activities. As county trainers, after undergoing training on Learner centered strategies in classroom instruction and Conflict resolution you are expected to cascade the same to mathematics and science teachers at county level. In this session, you will share your action plans. In addition, you will be guided on how to minimize distortion of training content during county INSET using facilitators guide.

Rationale

CEMASTEA depends on county trainers to cascade the content to mathematics and science teachers at the County INSET as delivered during the National INSET. The expectation from CEMASTEA is that the county trainers prepare very well for the INSET so that the content is cascaded without dilution and therefore the need to deliberately create time during the National INSET to enable you prepare for County INSET. This session gives you an opportunity to share your action plans for county INSET activities, discuss logistics of implementing county INSET 2019 as well as how to effectively use facilitators guide during the training.

Objectives

Participants are expected to:

1. Share an action plan for implementation of County INSET activities
2. Share logistics on implementing county INSET for 2019
3. Appreciate the need to use facilitator's guide during training

Action Plan

An action plan is a document that lists what steps must be taken in order to achieve a specific goal. The purpose of an action plan is to clarify what resources are required to reach the goal, formulate a timeline for when specific tasks need to be completed and determine what resources are required (Rouse, 2013). Action plans are useful in planning the way forward especially after training. Providing trainees with an opportunity to make action plans during county INSET can provide them with a roadmap to implement what they learn during the INSET. Tables 12 and 13 show templates of action plans at the National INSET and County INSET respectively

Table 13: Example of an action plan at national level

Date	Activity	Objective(s)	Personnel involved	Assumptions	Remarks
9-04-2018	Planning Meeting for INSET	• Audit INSET Centre status • Allocate duties • Check preparations for INSET	36 trainers (3 INSET centres)	All County Trainers involved in INSET will attend	
16- 4-2018	County INSET	• To conduct county INSET	36 trainers (3 INSET centers)	All C T involved in INSET will participate	
23-4-2018	Post INSET meeting	• Reflect on the implementation of the INSET • Compile INSET report	36 trainers (3 INSET centers)	All CTs involved in INSET will attend	
25-5-2018	Lesson Study	• To conduct Lesson Study	8 trainers	100% turn up	

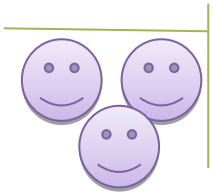
Table 14: Action plan Template for County INSET

Date	Activity	Objective(s)	Personnel involved	Assumptions	Remarks
1-5-2018	Meeting with the principal	Share the action plan with the principal	Teachers who attended County INSET	Principal will be available	
4- 5-2018	Meeting with HOD (if one is not a HOD)	Brief the HOD about INSET training content	• HOD • Teachers who attended County INSET	HOD will be available	
7-5- 2018	Meeting with the M & S teachers	Sensitizing the staff on lessons learnt during the INSET	• HOD • Teachers who attended County INSET • All M & S teachers	The targeted staff will be available	
Continuous	Prepare lesson activities that incorporate IBL	• Incorporate IBL in teaching and learning • Incorporate 5E instructional model in teaching and learning	Science and Mathematics teachers	Teachers will embrace the idea on IBL and 5E instructional model	

Facilitator's guide

A facilitator's guide is a companion document to the standards for professional learning. It is intended to guide facilitators in introducing and helping others implement the standards (Kennedy, 2016). Facilitator's guide is a standard that helps in minimizing deviation in the way

different trainers conduct training. It minimizes the gap between the intended training content and the implemented training content. You are encouraged to familiarize yourself with the facilitator's guide and use it during county INSET to achieve the intended learning outcomes.



Activity

You have prepared an action plan for Implementation of County INSET activities; share it with your colleagues.

Logistics of implementing county INSET

County INSET will be implemented during school vacations either in April or in August. Proper planning should be done before the actual implementation. Each INSET center will be expected to have twelve trainers including the county trainers' representative. Only the trainers who attend the national INSET and were certified will be expected to implement the INSET activities. It is expected that both the general and subject sessions are distributed fairly among the trainers. The trainers' representative is expected to facilitate the session on objectives and guidelines and action planning and way forward in addition to any other session. In cases where the INSET is being held in more than one INSET center, the trainer in charge will facilitate the two sessions in addition to any other.

Conclusion

In this section, you have been able to share your action plan for implementation of County INSET activities and hence appreciated its importance. Through these activities, we realize that action plans are very important because they enable one to be more focused and well prepared for INSET activities at the county. Implementing the action plans ensures quality of INSET activities conducted at the counties. It is worth noting that teacher's benefit a lot when they make action plans during county INSET because they serve as a roadmap to implementation of what they learn during the County INSET. We have also realized that facilitator's guide is a very important document that guides the way training is conducted. By use of facilitator's guide, deviations that would be observed during training are minimized. We have also strategized on how to implement county INSET and look forward to successful implementation of teacher professional development activities at the county level.

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NATIONAL GOALS OF EDUCATION

1. Foster nationalism, patriotism, and promote national unity

Kenya's people belong to different communities, races and religions and should be able to live and interact as one people. Education should enable the learner acquire a sense of nationhood and patriotism. It should also promote peace and mutual respect for harmonious co-existence.

2. Promote social, economic, technological and industrial needs for national development

Education should prepare the learner to play an effective and productive role in the nation.

a) Social Needs

Education should instill social and adaptive skills in the learner for effective participation in community and national development.

b) Economic Needs

Education should prepare a learner with requisite competences that support a modern and independent growing economy. This should translate into high standards of living for every individual.

c) Technological and Industrial Needs

Education should provide the learner with necessary competences for technological and industrial development in tandem with changing global trends.

3. Promote individual development and self-fulfillment

Education should provide opportunities for the learner to develop to the fullest potential. This includes development of one's interests, talents and character for positive contribution to the society.

4 Promote sound moral and religious values

Education should promote acquisition of national values as enshrined in the Constitution. It should be geared towards developing a self-disciplined and ethical citizen with sound moral and religious values.

GENERAL LEARNING OUTCOMES FOR EARLY YEARS EDUCATION

By the end of early years' education, the learner should be able to:

1. Demonstrate basic literacy and numeracy skills for learning.
2. Communicate appropriately using verbal and/or non-verbal modes in a variety of contexts.
3. Demonstrate appropriate etiquette in social relationships.
4. Apply creativity and critical thinking skills in problem solving.
5. Explore the immediate environment for learning and enjoyment.
6. Practice hygiene, nutrition, sanitation, safety skills to promote health and wellbeing.
7. Demonstrate the acquisition of emotional, physical, spiritual, aesthetic and moral development for balanced living.

8. Demonstrate appreciation of the country's rich and diverse cultural heritage for harmonious co-existence.
9. Apply digital literacy skills for learning and enjoyment.

Mathematics Activities

ESSENCE STATEMENT

Numeracy is a foundational skill that prepares the learner for number work, Mathematics in higher levels of schooling and mathematical approaches in all aspects of life. Numeracy activities involve identification and value placement of mathematical numerals, basic mathematical operations as well as measuring and describing shapes.

GENERAL LEARNING OUTCOMES

By the end of Early Years Education, the learner should be able to:
1) Demonstrate mastery of number concepts by working out problems in day to day life,
2) apply measurement skills to find solutions to problems in a variety of contexts,
3) Describe properties of geometrical shapes and spatial relationships in real life experiences

GRADE ONE Strand	Sub-Strand	Specific Learning Outcomes	Suggested Learning Experiences	Key Inquiry Question(s)
1.0 Numbers	1.1 Number Concept (20 lessons)	By the end of the sub-strand, the learner should be able to: a) sort and group objects according to different attributes within the classroom, b) pair and match objects in the environment, c) order and sequence objects in ascending and descending order, d) make patterns using real objects, e) recite number names in order up to 50, f) represent numbers 1-30 using concrete objects, g) demonstrate through counting that a group in all situations has only one count, h) Appreciate the use of sorting and	□ Learners in pairs/groups to collect different types of safe objects. □ Learners in pairs/groups to sort objects with same attribute and group them together. □ Learners to play digital games involving sorting and grouping according to different attributes. □ Learners in pairs/groups to pair and match objects to establish “equal to”, “more than” and “less than.” □ Learners to order objects according to size from smallest to biggest and vice versa. □ Learners to make patterns using real objects. □ Learners to recite number names up to 50. □ Learners to represent numbers 1-30 using concrete objects as well as their body parts.	1) How can we find out which group has more objects than another? 2) How can we group items?

		grouping items in day to day activities.	□ Learners to demonstrate that any given group has only one count. □ Learner in pairs/groups to collect and sort litter in the environment and put it in various groups according to an attribute of their choice and give reasons for the grouping. □ Learners in pairs/groups could assist in arranging, edible items like fruits, cabbages according to size and colour in the school store. □ Learners could visit a market for them to observe the sorting and grouping of fruits and vegetables.	
Core Competences to be developed: learning to learn, communication and collaboration, imagination and creativity, digital literacy, critical thinking and problem solving.				

LINK to PCI's: Life skills: self-awareness and self-esteem- when using body parts in counting. ESD: DRR; safety- when collecting items and litter in the environment, environmental awareness-don't litter the environment.	Link to Values: □ responsibility □ unity
Link to other learning areas: □ Environmental activities □ Religious activities □ Language activities	Suggested Community Service Learning Activities: learners to assist in collecting and sorting litter in their locality and observe how it is disposed.
Suggested non-formal activity to support learning: Learners to count trees in the school compound.	Suggested assessment: oral questions, written exercise, observation.

Assessment Rubrics Exceeds expectations	Meets expectations	Approaches expectations	Below expectations
Correctly: sorts and groups, pairs and matches, orders and sequences, recites numbers 1-50, represents numbers 1-30 using concrete objects and beyond.	Correctly: sorts and groups, pairs and matches, orders and sequences, recites numbers 1-50, represents numbers 1-30 using concrete objects.	Inconsistently: sorts and groups, pairs and matches, orders and sequences, recites numbers 1-50, represents numbers 1-30 using concrete objects.	Major inaccuracies in: sorting and grouping, pairing and matching, ordering and sequencing, reciting numbers 1-50, representing numbers 1-30 using concrete objects.

Environmental Activities

Essence Statement

This is an integrated learning area comprising of Science, Social and Agricultural activities. The learner will acquire knowledge, skills, values and attitudes leading to competency that will enable exploration of the environment for enjoyment, learning and problem solving. The competences will form basis for concepts to be acquired at higher levels of learning for sustainable development.

General Learning Outcomes: By the end of Early Years Education, the learner should be able to:

a) Practice proper sanitation and safety precautions to limit risks to self, others and the environment
b) Demonstrate appropriate values, attitudes and practices for sustainable interactions
c) Explore the immediate environment for learning and enjoyment
d) Apply acquired competences in solving environmental challenges for sustainable development
e) Appreciate the country's rich, diverse environmental resources and cultural heritage for harmonious living
f) Develop appropriate organizational, practical and technological skills for problem solving in conserving the environment
g) Communicate environmental friendly messages through technological, verbal and non-verbal modes for conservation, improvement and protection of the environment
h) Participate in community service learning to promote the environmental and social wellbeing.

Strand	Sub-Strand	Specific Learning Outcomes	Suggested Learning Experiences	Key Inquiry Question(s)
1.0 Environment and its resources	**1.1 Weather and Sky** (10 lessons) 1.1.1 Observing the Sky	By the end of the sub-strand, the learner should be able to: a) describe the appearance of the sky during the day and at night b) observe differences in appearance of the sky during the day and at night c) develop curiosity in observing appearance of the sky for enjoyment.	• Learners to observe the sky(the sun, moon, stars and clouds)during the day and share their observations with others • With the help of parents or guardians learners to observe appearance of the sky at night and report back • Use stimulus materials to show appearance of the sky during the day and at night • Learners to play educative computer games on the Sun, moon, clouds and stars • Learners to draw and colour the Sun, moon, clouds and stars.	1) What do we see when look at the sky during the day and during the night? 2) What differences do we observe in the day and night sky?
	1.1.2 Exploring weather conditions	By the end of the sub-strand, the learner should be able to: a) identify weather conditions of the day b) make reasonable weather forecast of the day c) appreciate weather conditions at different times of the day.	• Learners to explore weather conditions as an outdoor activity (windy, cloudy, rainy and sunny) • In groups, learners to observe weather conditions of the day in the immediate environment • Learners to share experiences about daily weather conditions • Learners to identify various weather conditions of a day using age appropriate stimulus materials • Learners to mime various weather conditions for enjoyment	How is the weather today?

			• Learners to find out more about the sky during the day and at night from parents or guardians. • Learners to draw and colour a picture on weather.	
Core Competences to be developed: Communication and collaboration, imagination and creativity, critical thinking and problem solving.				
Link to PCIs and Values :ESD: Environmental Education			**Link to values:** Unity and respect when working together	
Links to other learning activity areas: Religious Education :Appreciating God's creation Movement and Creative Arts: drawing and coloring			**Suggested Community Service Learning activities:** learners are guided by parents or guardians to observe the sky at night.	
Suggested non formal activity to support learning: Learners to develop and colour a poster on weather.			**Suggested assessment:** observation as they draw and colour the poster, oral questions on weather.	

Suggested Assessment Rubric

Exceeds expectations	Meets expectation	Approaches expectations	Below expectations
• Consistently and accurately identifies the sun, moon ,stars and clouds • Appreciates different weather conditions.	• Accurately identifies the sun, moon, stars and clouds • Appreciates different weather conditions.	• Occasionally identifies the sun, moon ,stars and clouds • Sometimes appreciates different weather conditions.	Rarely identifies and appreciates weather conditions.

Let our thoughts, actions and footprints promote

Love, Peace & Unity

Our Diversity, Our Strength