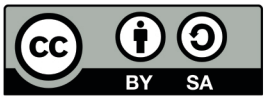
YEAR 1

SEMESTER 2

Four-Year B.Ed. Course Manual

LEARNING, TEACHING, AND APPLYING NUMBER AND ALGEBRA

The Government of Ghana



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FOREWORD

These Initial Teacher Education course manuals were developed by a team consisting of members from Colleges of Education and four universities namely the University of Ghana, Kwame Nkrumah University of Science and Technology, University of Education, Winneba, and University for Development Studies. This team was originally constituted by the National Council for Tertiary Education (now the Ghana Tertiary Education Commission) in 2019 to support the delivery of the new B.Ed. curriculum with assistance from T-TEL and UK Aid. The revision, finalization and printing of these manuals took place in 2021 with support from T-TEL and Mastercard Foundation.

The course manuals have been produced for use as general guides for the delivery of the new four-year B.Ed. curriculum in Colleges of Education in collaboration with their affiliated universities. They are designed to support student teachers, tutors, and lecturers in delivering a complete B.Ed. course for training student teachers which meets the requirements of the National Teachers' Standards, enabling them to teach effectively in basic schools.

The first section of the manuals is focused on the course information and vision for the B.Ed. curriculum. The second section presents the course details, goal for the subject or learning area, course description, key contextual factors as well as core and transferable skills and cross-cutting issues, including equity and inclusion. The third section is a list of course learning outcomes and their related learning indicators. The fourth section presents the course content which is broken down into units for each week, the topic and sub-strands and their related teaching and learning activities to achieve the learning outcomes and the teaching and learning strategies. This is followed by course assessment components in section five. Each manual contains a list of required reading and references as well as teaching and learning resources. The final section presents course related professional development for tutors and lecturers to be able to use each section of the manual.

Field instructions to guide Supported Teaching in School are integrated into the course manuals to provide the student teacher with guidance in developing teaching throughout the entire period of study to be able to meet the requirements of the National Teachers' Standards (NTS) and the National Teacher Education Curriculum Framework (NTECF). To ensure maximum benefit the course manuals should be used in addition to other resources such as the NTS, NTCEF, National Teacher Education & Assessment Policy and the National Teacher Education Gender Equality and Social Inclusion (GESI) Strategy and Action Plan.. This will help to ensure that student teachers' learning is integrated within the wider teacher education policy framework.

Professor Mohammed Salifu
Director General,
Ghana Tertiary Education Commission

ACKNOWLEDGEMENTS

The course manuals were developed through the collaborative efforts of a team of individuals from Colleges of Education, University of Ghana, Kwame Nkrumah University of Science and Technology, University of Education, Winneba, and University for Development Studies. They were produced in association with the Ghana Tertiary Education Commission of the Ministry of Education, Ghana.

A participatory team approach was used to produce this set of resources for tutors/lecturers, mentors, and student teachers. We are grateful to the specialists who contributed their knowledge and expertise.

Special thanks to Professor Jophus Anamuah-Mensah - T-TEL Key Advisor, Dr. Eric Daniel Ananga - T-TEL Key Advisor for Curriculum reform and Beatrice Noble-Rogers who provided key editorial, review and content input and facilitated the process of drafting and finalising the course manual.

Patricia Appiah-Boateng and Gameli Samuel Hahomene, served as typesetting and formatting coordinators and designed and produced the illustrations, tables, and other graphics which appear in the pages. They spent time and effort designing and redesigning the graphic layout and producing the camera-ready copy resulting in a set of materials that are easy to use, read, and reference.

Thanks also goes to all T-Tel staff members who worked to support production of these course manuals, particularly Beryl Opong-Agyei and Gideon Okai. Their frankness and co-operative attitude complimented the team approach used to produce this manual.

We are indebted to the Ministry of Education and the Ghana Tertiary Education Commission (GTEC) for the general support and specific helpful advice provided during production of the course manuals. Recognition and thanks must go to Chief Technical Advisor for T-TEL and Policy Advisor to the National Education Reform Secretariat, Akwasi Addae-Boahene, Prof. Mohammed Salifu, the Director General of GTEC and Mr. Jerry Sarfo the coordinator for the colleges of education, who in diverse ways supported during the course manual writing workshops.

In addition to all the staff who participated visibly in the development of these materials we would like to acknowledge all those people from the many colleges of education and universities in which we have worked who have, directly or indirectly, shared their views on the curriculum with us.

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INTRODUCTION TO COURSE MANUALS

Welcome to this B.Ed. Course manual.

Following the accreditation of the B.Ed. by the National Accreditation Board with its recognition as a world class teacher education curriculum, the decision was taken to support effective implementation through the development of course manuals. The course manuals provide tutors and lecturers with the materials necessary to support teaching each of the B.Ed. Courses. The manuals adhere directly to, and emphasise, the principles and standards set out in the NTS, NTECF and in the B.Ed. and will help ensure operationalising the Government's Teacher Education Reform Policy.

The manuals serve the following purposes:

- They are the key educational agreements between the training institution and the student teachers. In this way student teachers know what the expectations are for them and for the training they will receive.
- They lay out the course outcomes, content, strategies and assessment, thereby providing direction to and consistency in training and B.Ed. implementation among tutors across the country.
- They are explicit documents that provide other institutions with information on which to base transfer/ articulation decisions.

Specifically, they also:

- Support coherent lesson planning and teaching which will enable student teachers to achieve the NTS and become good teachers who ensure all pupils' learning whilst offering tutors the flexibility for adaptation for local needs and contexts.
- Provide a lesson by lesson overview of the course, building on and developing the material in the course specifications.
- Inform tutors, student teachers and others working with student teachers about:

    1. What is to be taught and why.
    2. How it can be taught.
    3. How it should be assessed.

- Provide opportunities for student teachers to develop and apply knowledge during supported teaching in school, creating a strong bond between learning in school and in the training institution.
- Reflect the stage of student teacher development, set out in the model for progress across the four years of the B.Ed.
- Can be used as self-study tools by student teachers.
- Ensure that all information necessary to inform teacher training is in one place (serves as reference document).
- The manuals are the basis of the CoEs and university professional development sessions to ensure Principals, Tutors, lecturers and Heads of Department are fully familiar with the details of: courses, outcomes, content, approaches, assessments and lessons.

Who are course manuals for:

- College of Education Tutors
- Teacher Education University Lecturers
- Student Teachers
- Mentors and Lead Mentors
- All those with an interested in teacher education.

USING THIS MANUAL

Writers of the manuals engaged widely with colleagues in each subject area at each stage of development. Besides, writers envisaged themselves in varied contexts as they wrote, to suggest methodologies and strategies for teaching the topics which would ensure student teachers are enabled to achieve the learning outcomes. In view of our commitment to creativity, problem solving, collaboration and to lifelong learning, we expect that individual tutors will "own" their manuals and become user-developers. Lessons in the manuals will be topics for weekly PD meetings where tutors/lecturers will situate the lessons in the contexts of their colleges and their student teachers, in order to maximize the benefits.

It is also expected that tutors will model the best pedagogic practices for student teachers. Key among such practices is the communication of the importance of having a personal teaching philosophy. We expect that tutors and lecturers will explicitly communicate their personal teaching philosophies to their student teachers during the first meeting of every course. In preparation for this, we suggest you set out your personal teaching philosophy and how it will be demonstrated in your teaching using, or adapting, the sample sentence introductions below.

My teaching philosophy is ……..

In view of this philosophy, I will facilitate this course by/through …….....

LEARNING, TEACHING, AND APPLYING NUMBER AND ALGEBRA

COURSE DETAILS					
Course name	Learning, Teaching, and Applying Number and Algebra				
Pre-requisite	Senior High School Mathematics				
Course Level	100	**Course** Code		Credit Value	3

THE VISION FOR THE NEW FOUR-YEAR B.Ed. CURRICULUM

To transform initial teacher education and train highly qualified, motivated new teachers who are effective, engaging and fully prepared to teach the basic school curriculum and so improve the learning outcomes and life chances of all learners they teach as set out in the National Teachers' Standards. In doing this to instil in new teachers the Nation's core values of honesty, integrity, creativity and responsible citizenship and to achieve inclusive, equitable, high quality education for all learners.

GOAL FOR THE SUBJECT OR LEARNING AREA

This aspect of the mathematics programme will prepare tutors and student teachers to be competent and knowledgeable enough to facilitate teaching and learning of mathematics and demonstrate commitment to equity and inclusivity in their work, in order to maintain acceptable values and attitudes, knowledge and skills for application in real life.

COURSE DESCRIPTION

There is the need to do auditing of subject knowledge to establish and address student teachers' learning needs, perceptions and misconceptions in Number and Algebra. This can be done through verbal interactions on the students' previous knowledge and experiences within the scope of Number and Algebra. Knowledge, skills and generalization of fundamental concepts of Number and Algebra can lead to a student teacher's ability to apply these areas of mathematics. Algebra is about generalized mathematical thinking arising from observing and applying patterns in creating relationships. Such patterning, generalisation and algebraic reasoning serve as a means to develop deductive reasoning in student teachers.

Topics in Number and Algebra include recognizing and developing patterns, using numbers and number operations, properties of numbers, concept of sets, number bases and modulo arithmetic, and algebraic expressions. In addition, student teachers will explore operations on algebraic expressions, apply mathematical properties to algebraic equations and functions.

KEY CONTEXTUAL FACTORS

- Teachers often tend to present mathematical concepts, work several examples on the board, and then assign exercises in which learners practise whatever has just been presented, that is an approach that has been widely criticised.
- The current educational system pays much more attention to preparing students for examinations, at the expense of helping them to develop core skills such as critical thinking, creativity, digital literacy, reflection and evaluation they will need to participate fully in society.
- Previous experiences of learners indicate lack of connection between Number and Algebra.
- Teachers' inadequate pedagogical knowledge in teaching Number and Algebra.
- The mode of assessment and assessment items in examination do not promote the use of sound methodology of teaching and learning Number and Algebra.
- Lack of and / or effective use of relevant and appropriate teaching and learning resources in the teaching and learning of Number and Algebra.

CORE AND TRANSFERABLE SKILLS AND CROSS CUTTING ISSUES, INCLUDING EQUITY AND INCLUSION

Core and transferable skills include: critical thinking, problem solving, social skills, creative thinking and communication skills, use of ICT.

Problem solving, critical and creative thinking: Mathematical critical thinking is based on objective analysis of facts which will lead creative thinking and problem-solving. Problem-solving is the central focus of mathematics instructions as well as an integral component of assessment.
Problem-solving techniques should therefore be consciously employed in the teaching and learning of mathematics. (CLO 1, 2).

Social and communication skills: Communication is an important skill in the teaching and learning of mathematics. Presentation of classroom instructions should support student teachers to develop mathematical language, including symbols and vocabulary. There is the need to promote interaction in the mathematics classroom to enhance critical thinking and interpersonal relationship for effective learning. (CLO 1).

Use of ICT: the 21st century has come with a revolution regarding the use technology tools. This has influence what and how mathematics is to be taught. There is therefore, the need to Integrate ICT in developing number and algebraic concepts in the mathematics classroom. (CLO 2).

Cross cutting issues include: assessment literacy and assessing students' progress and professional values and attitudes, reflection and classroom enquiry.

Cultural issues: The multicultural nature of the Ghanaian child calls for classroom instructional and assessment practices (including examples) should address socio-cultural issues emerging from the teaching and learning of mathematics. (CLO 4).

Gender issues in Mathematics: Discuss to demystify the notion that Mathematics is male dominated subject (gender issues). (CLO 3).

Background of student teachers: Since student teachers come from different backgrounds with possible different entry behaviours, abilities, conscious efforts should be made to include them in the teaching and learning situation. Engage in reflective thinking about how mathematics was taught in student-teacher's basic and high school days. (CLO 4)

Needs of the student teachers: Student teachers may have different needs (such as hunger, stress, sickness, financial, etc.) that are likely to affect their participation and learning in the mathematics classroom. Conscious efforts should be made to identify and address these needs and to inspire student teachers for effective transfer of knowledge.

Inclusivity: Since student teachers may have different levels of physical challenges, classroom instructional and assessment practices should consciously be designed to include all. Provide support for all learners in the mathematics classroom, irrespective of their challenges. (CLO 3).

Course Learning Outcomes	Learning Indicators
On successful completion of the course, student teachers will be able to:	
1. Demonstrate deep understanding of key mathematical concepts in Geometry and Handling Data content domains in the basic school mathematics curriculum (professional values, knowledge & practice) (NTS, 2b)	• Select and use the most appropriate mathematical method(s) or heuristics in carrying out tasks/exercises/ problems in Geometry and Handling data within the basic education mathematics foundation list. • Make connections between mathematical concepts in Geometry and Handling Data content domains and applying them to solve real-life problems. • Identify and resolve mathematics related learning difficulties within Geometry and Handling Data content domains such as inability to visualise geometrical shapes.
2. Use manipulatives and other TLMs including ICT in a variety of ways in learning mathematics concepts in Geometry and Handling data (practical skills, digital literacy, problem solving) (NTS, 3j)	• Use manipulatives and other TLMs in developing Geometry and Handling data concepts. • Use ICT as a tool in developing Geometry and Handling data concepts. E.g. Geometer Sketchpad, Geogebra. • Use drawing tools to conduct geometrical investigations emphasising visualization, pattern recognitions and conjecturing. • Solve mathematics problems using manipulatives and/ or technology related strategies in a variety of ways.
3. Demonstrate value as well as respect equity and inclusivity as well as core skills in the mathematics classroom (knowledge) (NTS, 2f)	• Both tutors and student-teachers do individual reflection on their knowledge of Geometry and Handling Data. • Identify and reflect on core skills applied in the mathematics classroom. • Appreciate the contributions of and supports colleagues in the mathematics classroom. • Cooperate with colleagues in carrying out mathematics tasks in Geometry and Handling Data. • 3.5 Engage in reflective thinking about how mathematics was taught in student-basic and high school days.
4. Demonstrate awareness of socio-cultural issues in teaching and learning mathematics in the content domains of Geometry and Handling data (knowledge) (NTS, 2f)	• Reflect and show how student-teachers' mathematics history influences their views of mathematics and its learning. • Identify appropriate TLMs for teaching topics in Geometry and Handling data. • Identify and use manipulates in Geometry and Handling data lessons.

1. Course Content			
Unit	**Topics**	**Sub-topic (if any)**	**Teaching and learning activity to achieve the learning outcomes**
1	**Plane Geometry (Patterns in shape): Learning, teaching and applying** **2 weeks**	• Angles at a point, angles and parallel lines, angles and triangles. Properties of triangles, quadrilaterals and polygons. • Learning about 3-Dimensional shapes: comparing polyhedral, forming 3-Dimensional shapes. • Learning about 2-Dimensional shapes: polygons ($n \geq 3$), tessellations and applying these to the teaching of the JHS Mathematics curriculum/ • Congruence and similarities (teaching symmetry, congruence and similar shapes).	• Use tutor-led and student-led presentations on the teaching and learning of patterns in shape. • Use investigations to explore perceptions, properties and application of angles and polygons. • Group discussion of the application of 2D and 3D shapes in real situations. • Use shapes to explore properties of symmetry and congruency in the basic school mathematics curriculum. • Explore through problem-solving application of congruence and symmetry.
2	**Geometrical Constructions: Learning, teaching and applying** **2 weeks**	• Teaching measurement of a line, bisection of a line and angles and construction of basic angles (60°, 90°, 30°, 15°, 45°). • Teaching construction of other angles (e.g. $75^\circ = 45^\circ + 30^\circ$, $105^\circ = 90^\circ + 15^\circ$). • Teaching construction of triangles, quadrilaterals and loci and their applications in the basic school mathematics curriculum.	• Use sets of construction tools to construct given shapes and angles. • Use verbal exposition to identify common misconceptions from students' work in construction. • Use group work to explore the relationships between the various angles that can be constructed.
3	**Basic trigonometry: Learning, teaching and applying** **2 weeks**	• Teaching and application of right-angled triangle, Pythagorean triples, trigonometry ratio (sine, cosine and tangent), trigonometry applications to real life.	• Tutor-led and student-led presentations on the application of trigonometric ratios. • Using explorations to establish basic trigonometry ratios and their applications in the teaching of geometry.
4	**Vectors and Bearing: Learning, teaching and applying** **1 week**	• Algebra of vectors, vector representation notation components of vector, vector operations, magnitude and direction of a vector. • Teaching types of bearings and their applications. • Mathematical vocabulary related to vectors and bearing.	• Using worksheets on bearing to explore the relationship between angles in bearing and back bearing. • Discussing translation of word problems into mathematical statements in vectors and bearing.

Unit	Topics	Sub-topic (if any)	Teaching and learning activity to achieve the learning outcomes
5	**Mensuration: Learning, teaching and applying** **1 week**	• Teaching parts of a circle. • Teaching measurement of length (arc length, radius, diameter, chord). • Teaching area of a sector, area of segment, volume of cone, cylinder. • Application of mensuration in real life problems.	• Project work – individual/group presentations on the application of circle concepts in real life situation.
6	**Global Mathematics: Learning, teaching and applying** **1 week**	• The earth as a sphere, lengths on latitudes and longitudes.	• Tutor led presentations on lengths on a sphere. • Using worksheets for practical investigation to distinguish between latitudes and longitudes.
7	**Introductory Statistics (Patterns in data): Learning, teaching and applying** **2 weeks**	• Teaching collection of data, measures of central tendencies, measures of dispersion, graphical representation (cumulative frequency).	• Project work – individual/group presentations on data collection. • Discussion on establishing the relationship between the measures of central tendencies and measures of dispersion.
8	**Basic probability: Learning, teaching and applying** **1 week**	• Teaching basic concepts of probability: sample space, events, mutually exclusive and independent events. • Applications to real life situation.	• Interactive collaborative group work on probability. • Exploring the concept of probability through experiments. • Different ways of presenting probability through games in mathematics lessons.

2. Suggested Teaching and Learning Strategies

- Discussions of concepts and misconceptions.
- Investigations to arrive at generalizations.
- Problem-solving strategies.
- Collaborative activities (think-pair-share).
- Multiple representations (principle of multiple embodiment).
- Establishing connections between and among related concepts.
- Using mathematical explorations, transitioning from number patterns to algebraic ideas.

3. Course Assessment Components

Component 1: Formative assessment

Summary Assessment Method: written assignment, (Not more than 1500 words)
Student teachers to write a reflective paper on their past experiences and knowledge of key concepts based on Geometry and Handling Data, establish the relationship among the three basic trigonometry rations (sine, cosine and tangent) and to explain their applications to real life, solve real life problems based on length of arcs and chords, area of sector and of segment through small groups projects.
Weighting: 30%
Related CLOs: 1, 2.
NTS:
2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes.
2f) Takes accounts of and respects learners' cultural, linguistic, socio-economic and educational backgrounds in planning and teaching.
3i) Explains concepts clearly using examples familiar to students.

3. Course Assessment Components

Component 2: Formative assessment

Summary of assessment Method: (Group and individual presentation)
Student teachers to develop and present models of cones and cylinders using odds and bits, write instruction notes on methods used to develop the models, and on the relationship between the cone and cylinder of the same base and height, and share their results with colleagues.
Weighing: 30%
Related CLOs: 2, 3
NTS:
3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning
2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge)
3h) Sets meaningful tasks that encourages learner collaboration and leads to purposeful learning.

Component 3: Summative assessment

Summary of assessment Method: (End of Semester Examination and/or Project)
Solve examination questions based on Geometry and Handling Data, This includes questions demanding "how", "discuss", "explain", "illustrate", etc. (NTS 2b, 2f; NTECF, 38)
Weighing: 40%
Related CLOs:1, 2, 3
NTS:
2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes.
2b) Has comprehensive knowledge of the official school curriculum, including learning outcomes.
2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge)

Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.

4. Required reading and reference list

Backhouse, J. K., Houldsworth, S. P. T. & Horril, P. J. F. (2005). Pure mathematics 1. (7th ed.). London: Longman.
Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education.

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Hesse, C. A. (2012). Core mathematics for senior high schools. Accra: Akrong Publications Ltd.
Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
Martin, J. et. al. (1993). Mathematics for teacher training in Ghana: Tutor notes, Accra: Unimax Publishers.
Martin, J. et. al. (1993). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers.

5. Teaching and Learning Resources

1. Maths posters.
2. Manipulatives and visual aids.
3. Computers and other technological tools.
4. Set of Mathematical instruments.
5. Geoboard (Geodot).

6. Course related professional development for tutors/ lecturers

See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 1

Year of B.Ed.	1	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	Plane Geometry (Patterns in shape): Learning, teaching and applying	Lesson Duration	3 hours
Lesson description	This seeks to audit content knowledge and experiences of student teachers to establish and address their learning needs, perceptions and misconceptions in Geometry. The areas to be covered include angles at a point, angles and parallel lines, angles and triangles. Properties of triangles, quadrilaterals and polygons. Learning about 3-Dimensional shapes: comparing polyhedral, forming 3-Dimensional shapes. The lesson begins with starters or a mind reading word game that is used to review student teachers' knowledge and understanding of key vocabulary items. In addition, this warm up activity has the potential of unearthing student teachers' misconceptions of some basic concepts. The main lesson focuses on reviewing the student teachers' knowledge and understanding, of basic concepts and to refine these misconceptions of geometric properties and relationships quickly and accurately.		
Previous student teacher knowledge, prior learning (assumed)	Student-teachers have learnt plane geometry at the Junior High School (JHS) and Senior High School (SHS) levels and can define certain fundamental concepts with some degree of proficiency. Their knowledge in Number and Algebra will help them to explore connections between Algebra and Geometry.		
Possible barriers to learning in the lesson	Different entry behaviours, socio-cultural issues, different learning needs, misconceptions about transformation and related concepts. Student teachers' previous knowledge of transformation and related concepts is mainly by rote learning. Learning styles of student teachers may not match how teaching is to be done in this lesson.		

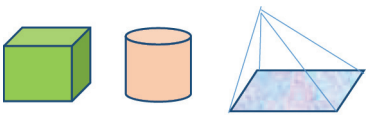
Lesson Delivery - chosen to support student teachers in achieving the outcomes	Face-to-face	Practical Activity	Work-Based Learning	Seminars	Independent Study	e-learning opportunities	Practicum
	√	√			√	√	

Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face, e-learning opportunities, practical activity, and independent study** • **The face-to-face** mode will include lecturer / tutor initiated class discussions, small group in class exploration, group presentations, think-pair-share moments and lecture. • **The e-learning opportunities** will include exploring games and activities to develop plane geometry concepts and their relationships with numbers. • **The practical activity** will include student teachers engaged in hands-on activities involving plane geometry. • **The independent study** mode will include writing self-assessment and presenting reflective journals.

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• Introduce student teachers to the various aspects of the year 1 semester 2 course manual.
• Audit content knowledge and experiences of student teachers to establish and address their learning needs, perceptions and misconceptions in plane geometry concepts.
• Introduce student teachers to reasoning in geometrical setting and to develop in them the ability to communicate their thinking in an atmosphere that promotes mathematical discourse.
• Engage student teachers in a geometric recreational environment (e.g. using tangrams and other puzzles) to spur on cooperative investigations to promote critical and creative thinking skills.</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes</td><td>Learning Indicators</td><td>Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?</td></tr>
<tr><td>• Demonstrate knowledge and understanding of fundamental concepts in plane geometry as found in the basic school mathematics curriculum.
• Use manipulatives and other TLMs and models in a variety of ways in developing and learning geometrical concepts.
• Develop an appreciation for geometry as a means of describing the physical world
• Demonstrate awareness of the world outside the classroom as a rich source of geometrical ideas.</td><td>• Interpret and analyse definitions of given plane geometry concepts that appear in the Basic School mathematics curriculum.
• Identify, select (or design) and use manipulatives and other TLMs and models to develop geometrical concepts, as well as, suggest such materials for teaching given concepts in the Basic School curriculum.
• Outline the usefulness of geometry and justify why it should be taught in school.
• Produce and present a few minutes video clips in groups, using designs in the environment including architectural, artistic designs in fabrics, tiles etc., and to discuss their findings.</td><td>• Background of student teachers: Instructional practices and policies will be designed to take care of student teachers' background and promote effective participation by all.
• Problem solving, critical and creative thinking: This can be achieved through mathematical investigations and explorations, with emphasis on supporting student teachers to develop pedagogical content knowledge needed for teaching plane geometry.
• ICT knowledge will enable student teachers to explore the properties of various geometrical shapes to promote the understanding of basic concepts in plane geometry.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning activities to achieve learning outcomes depending on the delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 1 **Plane Geometry (Patterns in shape): Learning, teaching and applying**	Angles and their properties (angles at a point, angles and parallel lines, angles and triangles).	1 Hour	Introduce student teachers to the Course Manual and discuss the various components with them.	Participate in the discussion of various components of the course manual, take opportunity to ask questions about the Course Manual. Outline their expectations and views about the mathematics course.
		2 Hour	Initiate review of vocabulary and fundamental concepts related to points, lines and angles and their properties. E.g. using read my mind vocabulary game (See CPD Needs) (PD Theme 1 & 3).	Engage in review of vocabulary and fundamental concepts related to points, lines and angles and their properties. Solve riddles about points, lines, line segments, rays, and angles.
			Put student teachers into groups for collaborative activities to provide justifications for why plane geometry should be studied in school (PD Themes 3 &4).	Use various collaborative activities to discuss the place of plane geometry in our lives and to justify the need for studying it in school.
			Model investigations and problem-solving activities for refining and reformulating definitions and interpretations of geometric concepts such as equilateral, isosceles, scalene, acute, etc. (PD Theme 3).	Engage in investigations and mathematical problem-solving strategies involving definitions, review, and reformulation of given concepts. Classify triangles e.g. equilateral, isosceles, scalene, acute, etc.) according to their relative measures through exploration and mathematical discourse.
			Lead an investigation and discussion on the development of triangle; types and relationships (PD Theme 3).	Engage in collaborative activities including think-pair-share, and collaborative group work to determine types of triangles and their relationships using construction and ICT tools, such as geogebra.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
	Triangles and properties of triangles.		Model the teaching of types of triangle and their properties using the construction approach (PD Theme 1). Monitor group presentations and refine student teachers' misconceptions based on types and properties of triangles. (PD Theme 1).	Use the construction approach and appropriate geometric models to explore the types and properties of triangles.  Explore and review different ways of classifying triangles and discuss the properties of triangles through paper folding and inquiry-based activities using designs in fabrics and other cultural artefacts. 
	Quadrilaterals and other polygons.		Assign student teachers to explore types of quadrilaterals (including; rectangles, rhombus, parallelograms, kite, etc.) and their properties (PD Theme 1).	Explore types of quadrilaterals in collaborative group discussions using geometric recreational and investigative activities and to discuss properties of special quadrilaterals such as trapezoids (trapezium), parallelogram (and its members namely rectangles and rhombuses).
	Learning about 3-Dimensional shapes: comparing polyhedral, forming 3-Dimensional shapes.		Provide models of 3-D shapes and their nets for group investigations. (PD Themes 1, 3 &4).	Engage in an investigation (available models and nets of shapes) to explore types and properties of 3-D shapes. Hold discussions to compare the various polyhedral and critically analyse the 2-D polygonal faces of the various polyhedral. 

<table>
<tr><td>Lesson assessments – evaluation of learning: of, for and as learning within the lesson</td><td>
Think-pair-share
• Assign student teachers in groups to outline, interpret and analyse definitions of given plane geometry concepts that appear in the Basic School mathematics curriculum, to be presented later in class. (Assessment for learning)
Related CLOs: 1, 2.
NTS:
1a) Critically and collectively reflects to improve teaching and learning.
2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes.

(Group and individual presentation)
• Student teachers to write few lines about their past experiences and knowledge of key concepts based on plane geometry to unearth their misconceptions of such concepts. (Assessment as learning)
Weighing: 20%

Related CLOs: 2, 3
NTS:
3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning
2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge)

(class exercise)
Student teachers make presentations of self-prepared notes on the importance of geometry in our lives and to justify the need for including geometry in the basic school curriculum.
Weighting: 20%
(NTS:
2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes.
3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning
2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge)
Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
</td></tr>
<tr><td>Instructional Resources</td><td>Manipulatives such as geometric models, sets of mathematical instruments, cut-out shapes, 3-D models made of POP, card boards, designs in fabrics.</td></tr>
<tr><td>Required Text (core)</td><td>Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.</td></tr>
<tr><td>Additional Reading List</td><td>Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education.
Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers.
Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers.</td></tr>
<tr><td>CPD Needs</td><td>
Design and use of innovative materials and ideas for teaching and learning plane geometry concepts, for example, the mind reading word game, designs in fabrics, etc.
<table>
<tr><th>KEY WORDS</th><th colspan="3">MIND READING WORD GAME</th></tr>
<tr><td rowspan="7">1. Point
2. Line
3. Angle
4. Ray
5. Line segment
6. Parallel
7. Circle</td><td>Column A</td><td>Column B</td><td>Column C</td></tr>
<tr><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Line segment</td><td>Line</td><td>Line segment</td></tr>
<tr><td>Angle</td><td>Angle</td><td>Ray</td></tr>
<tr><td>Point</td><td>Parallel</td><td>Parallel</td></tr>
<tr><td>Circle</td><td>Circle</td><td>Circle</td></tr>
</table>
GAME STRUCTURE

Instructions:
• Pick a word from the list of seven words above
• Answer questions with yes or no

Answers: If your responses are
Yes + Yes + Yes = Circle
Yes + Yes + No = Angle
No + Yes + Yes = Parallel
Yes + No + Yes = Line segment
No + No + Yes = Ray
Yes + No + No = Point
No + Yes + No = Line

Questions:
1. Is your word in column A? Yes/No
2. Is your word in column B? Yes/No
3. Is your word in column C? Yes/No
</td></tr>
</table>

LESSON 2

Year of B.Ed.	1	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	Plane Geometry (Patterns in shape): Learning, teaching and applying 2					Lesson Duration	3 hours
Lesson description	This lesson seeks to extend content knowledge and experiences of student teachers to establish and address their learning needs, perceptions and misconceptions in geometry of motions. The focus of the lesson is on learning about 2-Dimensional shapes: polygons (where **n** is the number of sides of a polygon, tessellations and applying these to the teaching of the Basic School Mathematics curriculum. Other areas include congruence, symmetry and similarity (teaching symmetry, congruence and similar shapes). The lesson begins with starters or mind reading word game that is used to review student teachers' knowledge and understanding of key vocabulary items. In addition, this warm up activity has the potential of unearthing student teachers' misconceptions of some basic concepts. The main lesson focuses on exploring and reviewing student teachers' knowledge and understanding of basic concepts of 2-D shapes and the effects of certain transformations on the sizes and shapes of such polygons.						
Previous student teacher knowledge, prior learning (assumed)	Student-teachers have learnt concepts in Plane Geometry (Patterns in shape): Learning, teaching and applying 1.						
Possible barriers to learning in the lesson	Different entry behaviours, socio-cultural issues, different learning needs, misconceptions about number and numeration system.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity** √	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face, e-learning opportunities, practical activities, and independent study.** • **The face-to-face** mode will include lecturer/ tutor initiated class discussions, small group in class exploration, group presentations, think-pair-share moments, lecture, etc., • **The e-learning opportunities** will include exploring number games and activities to develop properties of numbers and relationships between and among sets of numbers. • **The practical activity** will include student teachers engaged in hands-on activities involving plane geometry; • **The independent study** mode will include writing self-assessment and presenting reflective journals.						

<table>
<tr><td>Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.</td><td colspan="3">The purpose of the lesson is to;
audit content knowledge and experiences of student teachers to establish and address their learning needs, perceptions and misconceptions in plane geometry concepts.
introduce student teachers to reasoning in geometrical settings and to develop in them the ability to communicate their thinking in a manner that promotes mathematical discourse.
Engage student teachers in a geometric recreational environment (e.g., using tangrams and other puzzles) to spur on cooperative investigations to promote critical and creative thinking skills.</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes</td><td>Learning Indicators</td><td>Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?</td></tr>
<tr><td>• Demonstrate knowledge and understanding of fundamental concepts in plane geometry as found in the basic school mathematics curriculum.
• Use manipulatives and other TLMs and models in a variety of ways in developing and learning geometrical concepts.
• Develop an appreciation for geometry as a means of describing the physical world.
• Demonstrate awareness of the world outside the classroom as a rich source of geometrical ideas.
• Demonstrate understanding the concepts congruence, similarity, and symmetry of objects and shapes.</td><td>• Interpret and analyse definitions of given plane geometry concepts that appear in the basic school mathematics curriculum.
• Identify, select (or design) and use manipulatives and other TLMs and models to develop geometrical concepts, as well as, suggest which materials can be used to teach given concepts in the basic school curriculum.
• Outline the usefulness of geometry and justify why it should be taught both orally and in writing.
• Outline the influence of translation, rotation, and reflection on polygons in a plane.
• Recognise and analyse the importance of symmetry, congruence and similarity in real life situations
• Determine relationships between and among polygons including similarity and congruence</td><td>• Inclusivity: Conscious effort in the composition of groups based on equity and inclusivity and mixed abilities, as well as, the interactive nature of the activities will go a long way to ensure effective participation of all student teachers.
• Background of student teachers: Instructional practices and policies will be designed to take care of student teachers' background.
• Problem solving, critical and creative thinking: This can be achieved through investigations and explorations based on geometry.
• Social and communication skills: Presentation of group activities and participation in mathematical discourse promote the development of geometric vocabulary.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 2 **Plane Geometry (Patterns in shape): Learning, teaching and applying**	Learning about 2-Dimensional shapes i.e.: polygons ($n \geq 3$) , within the scope of tessellations and applying these to the teaching of the JHS Mathematics curriculum, Congruence, symmetry and similarity (teaching symmetry, congruent and similar shapes). Triangles and properties of triangles.	3 Hours	Initiate review (through read my mind vocabulary game) of vocabulary and fundamental concepts related to properties of selected polygons (PD Theme 1).	Engage in a review of vocabulary and fundamental concepts related to properties of selected polygons. Solve riddles about polygons that tessellate and those that cannot tessellate a plane.
			Model investigations and problem-solving activities for refining and reformulating definitions and interpretations of symmetry, congruence, and similarity (PD Themes 1 & 3).	Use various collaborative activities to discuss the place of geometry in our lives and to justify the need for studying plane geometry in school. Scout around the world outside the classroom to produce a 15 minutes video clip from designs in our cultural and contemporary cultural practices and artefacts in groups for class presentation.
			Puts student teachers into groups for collaborative investigative activities to provide justifications for why the concepts symmetry, congruence, and similarity should be studied in school mathematics curriculum (PD Theme 1, 3 & 4). Observes student teachers as they explore properties of congruent shapes, show a video of architectural and artistic designs as well as designs in our fabrics to spark a discussion of the types of symmetry (PD Theme 1).	Engage in investigations and mathematical problem-solving strategies involving definitions, review, and reformulation of symmetry, congruence, and similarity. Explore and discuss the concept of congruence through construction and transformations of shapes by means of rotation, reflection and translation. Use paper folding to explore the characteristics and properties of congruent shapes. Explore symmetry of plane figures, i.e., line symmetry, rotational symmetry, translational symmetry, using common plane shapes.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
			Provide an album of designs in tiles and linoleum and other appropriate models to spark a discussion about tessellation. (PD Theme 1).	Engage in collaborative activities including think-pair- share, and collaborative group work to determine types of triangles and other polygons that can tessellate a plane.
			Demonstrate paper folding and the use of construction approach to explore types of triangles and their properties. (PD Theme 1).	Use paper folding, construction and appropriate geometric models to explore the types and properties of triangles.
			Monitor group presentations and refine student teachers' misconceptions based on types of symmetry. (PD Theme 4).	Explore and review different ways of classifying triangles and other polygons to identify and confirm lack of proper understanding of the concept of symmetry among student teachers.
	Symmetry of plane figures		Assign student teachers in groups to explore types of symmetry of plane figures. (PD Theme 4).	Explore types of symmetry using paper folding and our cultural artefacts. Investigate and discuss the number of lines of symmetry of given polygons.
	Similarity and dilations		Lead an investigation and discussion to highlight the application of similarity in real life. (PD Theme 1).	Engage in an investigation using construction and enlargement of shapes to explore the concept of similarity and to outline the place of similarity in real life.

Lesson assessments - evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** • Assign student teachers in groups to outline, interpret and analyse definitions of given plane Geometrical Constructions that appear in the Basic School mathematics curriculum, to be presented later in class. (Assessment for learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. • Student teachers to write few lines about their past experiences and knowledge of key concepts based on Geometrical Constructions to unearth their misconceptions of such concepts. (Assessment as learning) Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) : (class exercise) Student teachers to complete worksheets on Geometrical Constructions Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) • Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as geometric models, sets of mathematical instruments, cut-out shapes, 3-D models (made from different materials), card boards, fabrics.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra The design, production, and use of manipulative materials and cultural artefacts in teaching.

LESSON 3

Year of B.Ed.	LEVEL 100	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	Geometrical Constructions: Learning, teaching and applying					Lesson Duration	3 hours
Lesson description	This is the third lesson that seeks to extend knowledge and understanding student teachers have developed in the previous lessons on plane geometry. It is also meant to expose them to extend their content knowledge and experiences. The focus of the lesson is on teaching measurement of a line, bisection of a line and angles and construction of basic angles (60°, 90°, 30°, 15°, 45°). Other areas include teaching construction of other angles (e.g. 75° = 45° + 30°, 105° = 90° + 15°) as is found in the Basic School Mathematics curriculum. The lesson begins with starters or mind reading word game that is used to review student teachers' knowledge and understanding of key vocabulary items in the previous lessons on plane geometry. In addition, this warm up activity has the potential of unearthing student teachers' misconceptions of some basic concepts. This will be followed by series of interactive activities to discover and to analyse some key geometric constructions, loci and other related concepts. Some of the key (big) ideas in the lesson is that angles that can be constructed are multiples or fractions of 60° and combinations of these fractions and multiples of 60°.						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have had experiences with construction of various shapes in the JHS and SHS. They have also learnt concepts in Plane Geometry (Patterns in shape): Learning, teaching and applying 1 & 2.						
Possible barriers to learning in the lesson	Different entry behaviours, socio-cultural issues, different learning needs, the nature of the board in the lecture hall may pose a problem for lessons based on geometric construction and related concepts.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity** √	**Work-Based Learning** √	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face, e-learning opportunities, practical activities, and independent study.** • **The face-to-face** mode will include lecturer/ tutor initiated class discussions, small group in class exploration, group presentations, think-pair-share moments, and lecture. • **The e-learning opportunities** will include exploring number games and activities to develop properties of numbers and relationships between and among sets of numbers. • **The practical activity** will include student teachers engaged in hands-on activities involving plane geometry. • **The independent study** mode will include writing self-assessment and presenting reflective journals.						

• **Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description.**	**The purpose of the lesson is to:** • Audit content knowledge and experiences of student teachers to establish and address their learning needs and misconceptions in plane geometry concepts. • • Lead student teachers to construct given angles and to develop the ability to communicate their thinking in an environment that promotes mathematical discourse.		
• **Learning Outcome for the lesson, picked and developed from the course specification.** • **Learning indicators for each learning outcome.**	**Learning Outcomes By the end of the lesson, the student teacher will be able to:**	**Learning Indicators**	**Identify which cross cutting issues – core and transferable skills, equity and addressing diversity. How will these be addressed.**
	• Recognise professionals and artisans who use the knowledge and skills derived from geometric construction in their work. • Demonstrate knowledge and understanding of fundamental concepts based on constructions of angles as found in the Basic School mathematics curriculum. • Demonstrate awareness of the world outside the classroom as a rich source of geometrical ideas.	• Examine the usefulness of geometric construction and be able to justify the need for studying this in Basic Schools. • Identify and provide sound argument about angles that are possible to construct and those that cannot be constructed. • Identify, select (or design) and use appropriate tools and equipment that can be used in solving problems based on geometric construction and loci in the basic school mathematics curriculum.	• Background of student teachers: Instructional practices and policies will be designed to take care of student teachers' deficiencies or challenges in the subject matter. • Problem solving, critical and creative thinking can be achieved through mathematical investigations and explorations with appropriate tools for geometric constructions. • Social and communication skills can be enhanced through mathematical discourse to promote the development of mathematical language, including symbols and vocabulary.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 3 **Geometrical Constructions: Learning, teaching and applying**	Teaching measurement of a line, bisection of a line and angles and construction of basic angles such as (60°, 90°, 30°, 15°, 45°). Teaching construction of other angles (e.g. 75° = 45° + 30°, 105o = 90° + 15°).	3 Hours	Initiate review (through read my mind vocabulary game) of vocabulary and fundamental concepts related to points, lines and angles and their properties. (PD Theme 1).	Engage in review of vocabulary and fundamental concepts related to points, lines and angles and their properties. Solve riddles about points, lines, line segments, rays, and angles.
			Put student teachers into groups for collaborative activities on the construction of given angles. (PD Theme 4).	Use various construction and ICT tools to construct angles such as (60°, 90°, 30°, 15°, 45°) and (75° = 45° + 30°, 105° = 90° + 15°) and to justify their strategies using think-pair-share.
			Model investigations and problem-solving activities for refining and reformulating definitions and interpretations of geometric concepts (PD Theme 1 &3).	Engage in investigations and mathematical problem-solving strategies involving definitions, review, and reformulation of given concepts. Classify angles according to their relative measures through exploration and mathematical discourse.
			Lead an investigation and discussion on the development of angle types and relationships (PD Theme 3).	Engage in collaborative activities including think–pair-share, and collaborative group work to determine types of angles and their relationships using construction and ICT tools.
			Model the teaching of types of triangles and their properties using the construction approach (PD Theme 1). Monitor group presentations and refine student teachers' misconceptions based on types and properties of triangles. (PD Theme 1 & 3).	Use the construction approach and appropriate geometric models to explore the types and properties of triangles. Explore and review different ways of classifying triangles and discuss the properties of triangles.
	Quadrilaterals and other polygons		Assign student teachers to explore types of quadrilaterals and their properties (PD Theme 1).	Explore types of quadrilaterals in collaborative group discussions using geometric recreation. Investigate and discuss properties of special quadrilaterals such as trapezoids (trapezium), parallelogram (and its members namely rectangles and rhombuses).

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
	Learning about 3-Dimensional shapes: comparing polyhedral, forming 3-Dimensional shapes.		Provide models of 3-D shapes and their nets for group investigations (PD Theme 1 & 4).	Engage in an investigation (available models and nets of shapes) to explore types and properties of 3-D shapes. Hold discussions to compare the various polyhedral and critically analyse the 2-D polygonal faces of the various polyhedral.

Lesson assessments – evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** Student teachers, in their small groups, are to examine the usefulness of geometric construction and be able to justify the need for studying this in basic school mathematics curriculum. (Assessment for learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. **(Group and individual presentation)** Student teachers to carry out individual assignments on how to identify, select (or design) and use appropriate tools and equipment that can be used in solving problems based on geometric construction and loci in the basic school mathematics curriculum. (Assessment as learning) Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) **(class exercise)** Student teachers to identify angles that are possible to construct and those that cannot be constructed. (Assessment of learning). Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as geometric models, sets of mathematical instruments, cut-out shapes, 3-D models made of POP, card boards, designs in fabrics.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 4

DUPLICATE THE PLANNER FOR EACH LESSON

Plans for each lesson in the semester.
The following format should be completed for each lesson in the semester.

Year of B.Ed.	LEVEL 100	**Semester**	2	Place of lesson in semester	1 2 3 **4** 5 6 7 8 9 10 11 12

Title of Lesson	**Plane Geometry (Patterns in shape): Learning, teaching and applying 2**					**Lesson Duration**	**3 hours**
Lesson description	This is the fourth lesson and seeks to extend the knowledge and understanding student teachers have developed in the previous lessons on plane geometry. The focus of the lesson is on teaching construction of triangles, quadrilaterals and loci and their applications in the basic school mathematics curriculum. The lesson begins with starters or mind reading word game that is used to review student teachers' knowledge and understanding of key vocabulary items in the previous lessons on plane geometry. In addition, this warm up activity has the potential of unearthing student teachers' misconceptions of some basic concepts. This will be followed by series of interactive activities to discover and to analyse some key ideas on construction of polygons, loci, and related concepts.						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have had experiences with construction of various shapes in the JHS and SHS. They have also learnt concepts in Plane Geometry (Patterns in shape): Learning, teaching and applying 1 & 2.						
Possible barriers to learning in the lesson	Different entry behaviours, socio-cultural issues, different learning needs, misconceptions about geometric construction of polygons and related concepts.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study**	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face and e-learning opportunities** • **The face-to-face** mode will include lecturer/ tutor initiated class discussions, small group in class exploration, group presentations, think-pair-share moments, lecture, etc., • **The e-learning opportunities** will include exploring number games and activities to develop properties of numbers and relationships between and among sets of numbers.						

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• Audit content knowledge and experiences of student teachers to establish and address their learning needs and misconceptions in plane geometry concept.
• Lead student teachers to construct given polygons and loci to develop the ability to communicate their thinking in an environment that promotes mathematical discourse.</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes</td><td>Learning Indicators</td><td>Identify which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?</td></tr>
<tr><td>• Demonstrate knowledge and understanding of geometric construction and loci as found in the basic school mathematics curriculum.
• Use geometric construction instruments and other relevant TLMs to draw and construct given polygons and to apply the strategies for specified loci.
• Demonstrate awareness of how geometric construction and related concepts are used by architects and other tradesmen in their work.</td><td>• Interpret and analyse definitions and properties of given polygons and apply these in constructing such shapes.
• Identify, select (or design) and use construction instruments and relevant TLMs to solve problems based on geometric construction and loci and be able to justify their strategies.
• Produce and present a reflective paper on the usefulness of geometric construction of polygons and related concepts in professions like architecture and others.</td><td>• Background of student teachers: relative knowledge of background of the student teachers will enable them to grasp concepts of geometric constructions.
• Conscious effort in composition of groups should be gender sensitive with mixed abilities.
• Problem solving, critical and creative thinking should be enhanced to achieve mathematical investigations and explorations.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 3 **Geometrical Constructions: Learning, teaching and applying**	Teaching construction of triangles, quadrilaterals and loci and their applications in the basic school mathematics curriculum. Construction of triangles and solving problems on loci	3 Hours	Initiate review of vocabulary and fundamental concepts related to triangles and their properties through read my mind vocabulary game. (PD Theme 1)	Engage in review of vocabulary and fundamental concepts related to triangles and their properties. Solve riddles about points, lines, line segments, rays, and angles.
			Put student teachers into groups for collaborative activities to provide justifications for why geometric construction should be studied in school. (PD Theme 1 & 4)	Use various collaborative activities to discuss the place of geometric construction and related concepts in our lives and to justify the need for studying it in school. Present a previously assigned project on designs in our cultural and contemporary cultural practices and artefacts in groups.
			Model investigations and problem-solving activities for building shapes using paper folding. (PD Theme 1)	Engage in investigations and mathematical problem-solving strategies involving paper folding to build shapes and to justify the appropriateness of the strategy. Classify polygons according to their properties through collaborative exploratory activities and mathematical discourse.
			Lead an investigation and discussion on the development of strategies for constructing given polygons using construction and ICT tools. (PD Theme 1 & 3)	Engage in collaborative activities including think-pair-share, and collaborative group work to determine types of angles and their relationships using construction and ICT tools.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
			Model the teaching of types of triangle and their properties using the construction approach (as a review). (PD Theme 1) Monitor group presentations and refine student teachers' misconceptions based on types and properties of triangles. (PD Theme 1 & 4)	Use the construction approach to review types of triangles and their properties in small group discussion sessions. Explore and review different ways of constructing triangles with given conditions and discuss strategies with colleagues in peer review sessions. Highlight potential misconceptions that peers have and seek for support of tutor/lecturer when necessary.
	Quadrilaterals and other polygons		Assign student teachers to explore types of quadrilaterals and their properties (PD Theme 1). Guide student teachers to use paper folding to explore different quadrilaterals and to construct given quadrilaterals using construction tools. (PD Theme 1)	• Explore types of quadrilaterals in collaborative group discussions using geometric recreation. • Investigate and discuss properties of special quadrilaterals such as trapezoids (trapezium), parallelogram (and its members namely rectangles and rhombuses). • Participate in the paper folding and construction activities and be ready to communicate their strategies to other colleagues.

Lesson assessments - evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** Student teachers to outline definitions and properties of given polygons in class (Assessment for learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. (Group and individual presentation) Produce and present a reflective paper on the usefulness of geometric construction of polygons and related concepts in professions like architecture and others. (Assessment as learning). **Weighing: 20%** Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class exercise) Student teachers to use construction instruments and relevant TLMs to solve problems based on geometric construction and loci and to justify their strategies used. (Assessment of learning) Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as geometric models, sets of mathematical instruments, cut-out shapes, 3-D models made of POP, card boards, designs in fabrics.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 5

Year of B.Ed.	LEVEL 100	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	Basic trigonometry 1: Learning, teaching and applying					Lesson Duration	3 hours
Lesson description	This is the fifth lesson which is designed to introduce student teachers to the concept of basic trigonometry 1. The areas to be covered include introduction and application of right-angled triangles, Pythagorean triples, basic trigonometry ratios (sine, cosine and tangent).						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have studied Pythagoras's rule and can relate angles in right-angled triangles. They can also recognise the measure of angles in the various quadrants of a circle.						
Possible barriers to learning in the lesson	**Different entry behaviours:** Some student teachers come with different learning needs and diversity where some have strong background in mathematics from their previous Senior High Schools whiles others may have weak background knowledge which will be a vital requirement in understanding of basic trigonometry concepts. **Socio-cultural issues:** Student teachers' cultural settings such as predominant farming/ mining or business community where attention of parents is exclusively on money / trade related concepts than other mathematical concepts can affect their learning of trigonometry. **Misconceptions:** Student teachers may hold a strong view that mathematics is for male learners only, adding that trigonometry is meant for elective mathematics students only, may affect the understanding of the basic concepts in trigonometry.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery - chosen to support students in achieving the outcomes	**Face-to-face:** There is the need for tutors to engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions. **Independent study:** Student teachers need to be given independent group or individual assignment to be presented in class employing think-pair- share techniques. **e-learning opportunities:** Student teachers should be introduced to IT and e-learning opportunities, such as the use of geometry sketch pad, math lab, Scientific calculators, etc, to facilitate their understanding the concept of trigonometry and its applications to real life situation.						

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes.
An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• Introduce student teachers to the concept of basic Pythagoras theorem which will eventually enhance student teachers' knowledge and experiences on the concept of trigonometry and its applications to real life situations.
• Introduce student teachers to the available e-learning opportunities and other ICT tools to investigate the relationships among the various trigonometry ratios and how to apply these to the basic school curriculum.
• Consciously lead student teachers to develop problem solving strategies to include introduction and application of right-angled triangles, Pythagorean triples, basic trigonometry ratios (sine, cosine and tangent).
• Tutors should make sure that the above purposes are achieved and properly tailored to form a necessary basis for further studies and applications of trigonometry to real life situations.</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes: By the end of the lesson, the student teacher will be able to:</td><td>Learning Indicators</td><td>Identify which cross cutting issues – core and transferable skills, equity and addressing diversity. How will these be addressed.</td></tr>
<tr><td>• Demonstrate the development and understanding of the Pythagoras' theorem in the basic school mathematics curriculum.
• Use manipulatives and other TLMs in a variety of ways in learning Pythagoras' theorem.
• Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.</td><td>• Establish the relationship among the three basic trigonometry ratios (sine, cosine and tangent) and how they are applied to real life situations such as finding the height of vertical objects without measuring, through investigations.
• Establish the relationship among the basic trigonometry ratios using right-angled triangles from sketch pads and other IT related support and to share their results with colleagues.
• Identify and demonstrate the need for diversity in their collaborative group work and sharing of their results when dealing with and applying trigonometry ratios.</td><td>• Background of student teachers: Student teachers' knowledge on properties of right-angled triangle will enable them to participate effectively in the lesson.
• Problem solving, critical and creative thinking: conscious efforts should be made to encourage student teachers to develop critical thinking with respect to solving problems on right-angled triangles, Pythagorean triples, basic trigonometry ratios (sine, cosine and tangent).
• Social and communication skills are needed to promote effective group activities that can enhance participation by all.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 5: **Basic trigonometry 1: Learning, teaching and applying**	Misconceptions and barriers in teaching and learning of Pythagoras Theorem.	3 Hours	Engage student teachers in introductory activities for Pythagoras Theorem using graphs sheets and square grids on linoleum. (PD Theme 1)	Use appropriate activates/ games for introducing Pythagoras Theorem in order to address their misconceptions.
	Pythagorean triples.		Assign student teachers to small groups to explore the relationship between Pythagorean triples and to list a few examples. (PD Theme 1 & 4)	Explore models and strategies to establish a relation between the Pythagorean triples as in opposite, adjacent and hypotenuse of the right-angled triangle, and list examples such as; {3,4,5}, {6,8,10}, {5,12,13}, etc.
	Right-angled triangle.		Initiate discussions on strategies to apply the idea of Pythagoras's Theorem to solving right-angled triangle related problems. (PD Theme 3)	Brainstorm on how to solve related problems by identifying the various sides of the right-angled triangle and relate them to a given angle; ie. opposite, adjacent and hypotenuse.

Lesson assessments – evaluation of learning: of, for and as learning within the lesson (link to Learning Outcomes)	**Think-pair-share** Student teachers to outline definitions and properties of given polygons in class. (Assessment for learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. Formative assessment Summary of assessment Method: (Group and individual presentation) Student teachers to produce a reflective paper on the misconceptions of Pythagoras Theorem based on discussion of their past experiences. (Assessment as learning) Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class exercise) Student teachers to do class exercises based on application of Pythagoras' Theorem to right-angled triangles. (Assessment as learning) Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as graph board, geometry sketch pad, math lab, etc.,
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 6

DUPLICATE THE PLANNER FOR EACH LESSON

Plans for each lesson in the semester.
The following format should be completed for each lesson in the semester.

Year of B.Ed.	LEVEL 100	**Semester**	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	**Basic trigonometry 2: Learning, teaching and applying**					**Lesson Duration**	**3 hours**
Lesson description	This is the sixth lesson which is designed to introduce student teachers to the concept of basic trigonometry 1. The areas to be covered include introduction and application of right-angled triangles to special trigonometry angles such as 30 °, 45 °, 60 °, 90 °						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have studied Pythagoras' theorem and can apply these to the basic trigonometry ratios. They have also learnt surds and can apply it to rational trigonometry equations of the form; $= \frac{sin\theta}{cos\theta}$, $\underline{sin^2\alpha}$, etc using right-angled triangles. Their experience in handling right-angled triangles and basic trigonometry ratios will aid them to apply trigonometry to real life situations.						
Possible barriers to learning in the lesson	**Different entry behaviours:** Some student teachers come with different learning needs and diversity where some have strong background in mathematics from their previous Senior High Schools whiles other may have week background knowledge which will be a vital requirement in understanding basic trigonometry concepts. **Socio-cultural issues:** Student teachers' cultural settings such as predominant farming/ mining or business community where attention of parents is exclusively on money/ trade related concepts than other mathematical concepts can affect their learning of trigonometry. **Misconceptions:** Student teachers may hold a strong view that mathematics is for male learners only, adding that trigonometry is meant for elective mathematics students only, may affect the understanding of the basic concepts in trigonometry.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face:** There is the need for tutors to engage student teachers in a head-on (or teacher-led) discussions or activity-oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions. **Independent study:** Student teachers need to be given independent group or individual assignment to be presented in class employing think-pair- share technique. **e-learning opportunities:** Student teachers should be introduced to IT and e-learning opportunities, such as the use of geometry sketch pad, math lab, scientific calculators, etc, to facilitate their understanding of the concept of trigonometry and its applications to real life situation.						

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes.
An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• Introduce student teachers to the concept of basic trigonometry 1 which will eventually enhance student teachers' knowledge and experiences on the concept of trigonometry and its application to real life situations.
• Introduce student teachers to the available e-learning opportunities and other ICT tools to investigate the relationships among the various trigonometry ratios and how to apply these to the basic school curriculum.
• Consciously lead student teachers to develop problem solving strategies to include introduction and application of right-angled triangles, Pythagorean triples, basic trigonometry ratios (sine, cosine and tangent).</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes: By the end of the lesson, the student teacher will be able to:</td><td>Learning Indicators</td><td>Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?</td></tr>
<tr><td>• Demonstrate the development and understanding of the concept of trigonometry in the basic school mathematics curriculum.
• Use manipulatives and other TLMs in a variety of ways in learning trigonometry.
• Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.</td><td>• Establish the relationship among the three basic trigonometry ratios (sine, cosine and tangent) and how they are applied to real life situations such as finding the height of vertical objects without measuring.
• Establish the relationship among the basic trigonometry ratios using right-angled triangles from sketch pads and other IT related support and to share their results with colleagues.
• Identify and demonstrate the need for diversity in their collaborative group work and sharing of their results when dealing with and applying trigonometry ratios.</td><td>• Background of student teachers: Student teachers' knowledge on properties in basic trigonometry ratios will enable them to solve trigonometry related problems.
• ICT needs: Integration of ICT is critical for exploring trigonometry identities and therefore cconscious efforts should be made for its integration.
• Inclusivity, equity and addressing diversity: To promote effective group activities that can enhance participation by all, conscious efforts should be made to promote social and communication skills.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study				
WEEK 6: **Basic trigonometry 1: Learning, teaching and applying**	Misconceptions and barriers in teaching and learning of Trigonometry ratios.	3 Hours	Engage student teachers in introductory activities for trigonometry using concrete materials and other models. (PD Theme 5)	Use appropriates activates/ games for introducing the concept of trigonometry in order to address their misconceptions.
	Trigonometry ratio (sine, cosine and tangent).		Guide student teachers to establish that: $sin\theta = \frac{opposite}{hypotenuse}$, $cos\theta = \frac{adjacent}{hypotenuse}$ and $tan\theta = \frac{opposite}{adjacent}$ (PD Theme 4)	Involve student teachers in group activities to establish the relationship among sine, cosine and tangent.
	Trigonometry applications to real life.		Assign student teachers to pose and solve word problems based on the application of trigonometry ratios. (PD Theme 2).	Pose and solve word problems based on trigonometry ratios.

Lesson assessments – evaluation of learning: of, for and as learning within the lesson (link to Learning Outcomes)	**Group work** Assign student teachers to outline the relationship among the basic trigonometry ratios using right-angled triangle from sketch pads and other IT related support and to share their results with colleagues. (Assessment for learning) Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 3h) Sets meaningful tasks that encourages learner collaboration and leads to purposeful learning (Group and individual presentation) Student teachers to establish the relationship among the three basic trigonometry rations (sine, cosine and tangent) and to explain their applications to real life, through small groups projects. (Assessment as learning). Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (short mid semester test) Write a short teacher made test on lessons covered in lessons 1-5. (Assessment of learning) Related CLOs: 1, 3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as number grids, spreadsheets, game cards, calendars, etc.
Required Text (core)	• Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 7

DUPLICATE THE PLANNER FOR EACH LESSON

Plans for each lesson in the semester.
The following format should be completed for each lesson in the semester.

Year of B.Ed.	LEVEL 100	**Semester**	2	Place of lesson in semester	1 2 3 4 5 6 **7** 8 9 10 11 12

Title of Lesson	**Vectors and Bearing: Learning, teaching and applying**					**Lesson Duration**	**3 hours**
Lesson description	This is the seventh lesson which is designed to introduce student teachers to the concepts of Vectors and Bearing. The areas to be covered include algebra of vectors, vector representation, notation components of vector, vector operations, magnitude and direction of a vector.						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have studied Coordinate Geometry and can determine the magnitude of a line. This will aid their understanding of magnitude of a vector. They have studied basic trigonometry ratios in lesson 6 and will be able to apply these in computing direction of a given vector. i.e. = $tan\theta = \frac{dy}{dx}$, or $\theta = tan^{-1}\left(\frac{dy}{dx}\right)$. Their experience in Number and Algebra in year 1 semester 1 will be a necessary requirement for their understanding of vector operations.						
Possible barriers to learning in the lesson	**Different entry behaviours:** Some student teachers come with different learning needs and diversity where some have strong background in mathematics (especially, vectors and bearings) from their previous Senior High Schools whiles other may have week background knowledge which will be a vital requirement in understanding of basic trigonometry concepts. **Socio-cultural issues:** Student teachers' cultural settings such as predominant farming/ mining or business community where attention of parents is exclusively on money/ trade related concepts than vectors and bearings concepts, can affect their learning of trigonometry. **Misconceptions:** Student teachers may hold a strong view that mathematics is for male learners only, adding that vectors is meant for elective mathematics students only, may affect the understanding of the basic concepts in trigonometry.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery - main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face:** there is the need for tutors to engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions about vectors. **Independent study:** student teachers need to be given independent group or individual assignments to be presented in class employing think-pair- share techniques. **e-learning opportunities:** student teachers should be introduced to IT and e-learning opportunities, such as the use of geometry sketch pad, math lab, scientific calculators, etc., to facilitate their understanding of vectors and its applications to real life situations.						

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes.
An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• introduce student teachers to the concept of Vectors and Bearing which will eventually enhance their knowledge and experiences in Algebra of vectors, vector representation notation and components of vector, vector operations, magnitude and direction of a vector.
• introduce student teachers to the available e-learning opportunities and other ICT tools to investigate the relationships among the various trigonometry ratios and how to apply these to the basic school curriculum.
• consciously lead student teachers to develop problem solving strategies to include introduction and application of right-angled triangles, Pythagorean triples, basic trigonometry ratios (sine, cosine and tangent).</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes: By the end of the lesson, the student teacher will be able to:</td><td>Learning Indicators</td><td>Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?</td></tr>
<tr><td>• Demonstrate the development and understanding of the concept of vectors in the basic school mathematics curriculum.
• Use manipulatives and other TLMs in a variety of ways in learning vectors.
• Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.</td><td>• Establish Algebra of vectors by outlining vector representation, notation and components, and how they are applied to real life situations such as construction and sailing.
• Find magnitude and direction of given vectors using manipulatives such as sketch pads and other IT related support and to share their results with colleagues.
• Identify and demonstrate the need for diversity in their collaborative group work and sharing of their results when dealing with and applying vectors to real life.</td><td>• Background knowledge of student teachers in related topics such as right-angled triangles is essential for the understanding of Algebra of vectors. Instructional practices and policies should therefore be designed to include and take care of student teachers' background and needs.
• Problem solving, critical and creative thinking: This can be achieved through mathematical investigations and explorations.
• ICT and communication needs are essential for promoting the understanding of concepts such as magnitude and direction of vectors, using manipulatives, and should therefore be promoted.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 7: **Vectors and Bearing: Learning, teaching and applying**	Misconceptions and barriers in teaching and learning of vectors.	3 Hours	Engage student teachers in introductory activities for vectors using sporting and other cultural activities. (PD Theme 1)	Involve in appropriates activities/games for introducing vectors in order to address their misconceptions.
	Algebra of vectors, vector representation notation.		Guide student teachers to establish the concept and algebra of vectors. (PD Theme 1) Represents vectors as $\overrightarrow{AB}$, $\overrightarrow{OA}$ $\overrightarrow{OB}$ etc.	Involve in group activities to establish that vectors are physical quantities with magnitude and direction and can be thought of as a translation or displacement of a certain distance in a certain direction.
			Outline the various forms of vectors as: • Distance-bearing (k, θ) • Component $\begin{pmatrix} x \\ y \end{pmatrix}$, and • Cartesian form $xi + yj$ • by connecting the knowledge of trigonometry and angle measurement (PD Theme 1)	Engage in collaborative class activities to establish forms of vectors as: • Distance-bearing (k, θ),) • Component $\begin{pmatrix} x \\ y \end{pmatrix}$, and • Cartesian form $xi + yj$
	Vector operations		Outline the various operations of vectors to include; addition, subtraction, scalar/ multiplication. (PD Theme 1)	Engage in group activities to outline the various vector operations and apply them to solving related problems.
	Choice of TVET Domains		Assign student teachers to pose and solve word problems based on the magnitude and direction of vectors. (PD Theme 2)	Pose and solve word problems based on magnitude and direction of vectors and present their results in the form (k, θ).

Lesson assessments - evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** Student teachers to complete worksheet problems on operations and properties of vectors. (Assessment of learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. (Group and individual presentation) Write and present a reflective paper on notation, components, and Algebra of vectors, (Assessment as learning). Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class exercise) Student teachers to solve a few problems relating to resolution of vectors. (Assessment of learning) Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as number grids, spreadsheets, game cards, calendars draught boards, linoleum etc.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 8

Year of B.Ed.	LEVEL 100	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 **8** 9 10 11 12

Title of Lesson	Mensuration: Learning, teaching and applying					Lesson Duration	3 hours
Lesson description	This is the eighth lesson which is designed to introduce student teachers to the concepts of Mensuration. The areas to be covered include teaching parts of a circle, teaching measurement of length (arc length, radius, diameter, chord), teaching area of a sector, area of segment, volume of cone, cylinder as well as application of mensuration to real life problems. It will also include Mathematical vocabulary related to vectors and bearing.						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have studied circle theorem and can identify parts of the circle. This will aid in the effective teaching and learning of measurement of length (arc length, radius, diameter, chord). They are able to find areas and volumes of plane and solid shapes respectively. These will enable them to extend their knowledge onto how to calculate areas of sector, segment and volume of cones and their applications to real life.						
Possible barriers to learning in the lesson	**Different entry behaviours:** Some student teachers come with different learning needs and diversity where some have strong background in mathematics (especially, mensuration) from their previous Senior High Schools whiles other may have week background knowledge which will be a vital requirement in understanding of basic concept of mensuration. **Socio-cultural issues:** Student teachers' cultural settings or community where learners are not exposed to concepts other than mensuration. **Misconceptions:** Student teachers may hold a strong view that mathematics is for male learners only, adding that mensuration is meant for elective mathematics students only, may affect the understanding of the basic concepts in trigonometry.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face:** engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions about mensuration. **Independent study:** give independent group or individual assignments to be presented in class employing think-pair- share technique. **e-learning opportunities:** introduce to IT and e-learning opportunities, such as the use of geometry sketch pad, math lab, Scientific calculators, etc., to facilitate their understanding of mensuration and its applications to real life situation.						

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes.
An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• introduce student teachers to the concept mensuration which will eventually enhance their knowledge and experiences of teaching and learning of area of a sector, area of segment, volume of cone, cylinder as well application of mensuration to real life problems.
• introduce student teachers to the available e-learning opportunities and other ICT tools to investigate the relationships among the various aspects of mensuration and how to apply these to the basic school curriculum.
• consciously lead student teachers to develop problem solving strategies to include introduction and application of area of a sector, area of segment, volume of cone and cylinder as well as application of mensuration to real life problems.</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification
• Learning indicators for each learning outcome</td><td>Learning Outcomes: By the end of the lesson, the student teacher will be able to:</td><td>Learning Indicators</td><td>Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?</td></tr>
<tr><td>• Demonstrate the development and understanding of the concept of mensuration in the basic school mathematics curriculum.
• Use manipulatives and other TLMs in a variety of ways in learning mensuration.
• Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.</td><td>• Outline length of arcs and chords, area of sector and of segment and how they are applied to real life such as construction.
• Develop models of cones and cylinders using odds and bits and establish relationship between the cone and cylinder of the same base and height.
• Identify and demonstrate the need for diversity in their collaborative group work and sharing of their results when dealing with and applying mensuration to real life.</td><td>• To develop effective understanding of mensuration, conscious efforts should be made to connect student teachers background knowledge of properties circles and their applications.
• Problem solving, critical and creative thinking: This can be achieved through mathematical investigations and explorations of basic concepts of mensuration.
• ICT and communication needs are essential for promoting the understanding of concepts of mensuration, using manipulatives, and should therefore be promoted.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
WEEK 8: **Mensuration: Learning, teaching and applying**	Misconceptions and barriers in teaching and learning of mensuration.	3 Hours	Engage student teachers in introductory activities for mensuration. (PD Theme 1)	Involve in appropriate activates/games for introducing mensuration in order to address their misconceptions.
	Teaching measurement of length (arc length, radius, diameter, chord).		Guide student teachers to establish the concept of length with respect to; radius, chord and arc (Length of arc = $\frac{\theta}{360^o} \times 2\pi r$). (PD Theme 1).	Involve in group activities to establish the lengths of radius, chords and arcs from circles through the use of worksheets and to present their findings in class.
	Teaching area of a sector, area of segment.		• Establish the difference, relationship as well as areas of sectors and segments of given circles. • (Area of sector = $\frac{\theta}{360^o} \times \pi r^2$) • (PD Theme 3)	Engage in collaborative class activities to establish: • The differences and similarities between sectors and segments of given circles. • Procedures for solving given problems under areas of length of arcs and segments.
	Teaching volume of cylinder		Establish the volume of a cylinder as Volume = , where r is radius and h is the height of the cylindrical object. (PD Theme 1).	Engage in group activities to outline the various procedures for identifying and solving problems relating to volume of cylinders.
	Teaching volume of cone		Establish the volume of a cone as a third of the volume of cylinder of the same height and base radius. That is volume of cone = $\frac{1}{3}\pi r^2 h$ where **r** is radius and **h** is the height of the cylindrical object. (PD Theme 1).	Engage in practical activities to establish the relation between cylinders and cones and to solve a practical problem using manipulatives such as model cylinders and cones.
	Application of mensuration to real life problems		Assign student teachers to pose and solve word problems based on how to apply mensuration in teaching real life phenomena (PD Theme 1).	Pose and solve word problems based on mensuration and present their results in class, using think-pair-share strategies.

Lesson assessments – evaluation of learning: of, for and as learning within the lesson (link to Learning Outcomes)	**Think-pair-share** Student teachers to solve real life problems based on length of arcs and chords, area of sector and of segment. (Assessment of learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. (Group and individual presentation) Student teachers to develop and present models of cones and cylinders using odds and bits and establish relationship between the cone and cylinder of the same base and height (Assessment as learning) Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class project exercise) Student teachers to write a reflective paper on the need for participating in a collaborative group work. (Assessment as learning) Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as, game cards, models, IT support, etc.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 9

DUPLICATE THE PLANNER FOR EACH LESSON

Plans for each lesson in the semester.
The following format should be completed for each lesson in the semester.

Year of B.Ed.	LEVEL 100	**Semester**	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	**Global Mathematics: Learning, teaching and applying**					**Lesson Duration**	**3 hours**
Lesson description	This lesson is an introductory lesson that seeks to audit content knowledge and experiences of student teachers to establish and address their learning needs, perceptions and misconceptions in Global Mathematics. The areas to be covered include the concept of the earth as a sphere, great and small circles on the earth, lines of longitude, lines of latitude, location of points on the earth's surface, distance between two points on the same longitude, distance between two points on the same latitude. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of the surface of the earth by using globe. The main lesson focuses on reviewing the student teachers' conceptual understanding of great and small circles on the earth and how to calculate distances on any latitude or longitude.						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have learned about a circle and its properties and how to find the length of an arc, which is a portion of the circumference of a circle in both JHS mathematics and SHS Core Mathematics.						
Possible barriers to learning in the lesson	Different entry behaviours, socio-cultural issues, different learning needs, different teaching styles from previous teachers.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face:** there is the need for tutors to engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions about vectors. **Independent study:** student teachers need to be given independent group or individual assignments to be presented in class employing think-pair- share techniques. **e-learning opportunities:** student teachers should be introduced to IT and e-learning opportunities, such as the use of geometry sketch pad, math lab, scientific calculators, etc., to facilitate their understanding of vectors and its applications to real life situations.						

<table>
<tr><td>• Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes.
An expanded version of the description.</td><td colspan="3">The purpose of the lesson is to:
• Audit content knowledge and experiences of student teachers to establish and address their learning needs, perceptions and misconceptions in global mathematics.
• Develop student teachers' understanding of properties of great and small circles (Latitudes and Longitudes) leading to calculations of distances on the earth.</td></tr>
<tr><td rowspan="2">• Learning Outcome for the lesson, picked and developed from the course specification.

• Learning indicators for each learning outcome.</td><td>Learning Outcomes: By the end of the lesson, the student teacher will be able to:</td><td>Learning Indicators</td><td>Developing and addressing Cross cutting issues - core and transferable skills, inclusivity, equity and diversity.</td></tr>
<tr><td>• Demonstrate the understanding of global mathematics.
• Use manipulatives and other TLMs in a variety of ways in learning global mathematics concepts.
• Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.
• Demonstrate awareness of core skills, individual characteristics and socio-cultural issues in teaching and learning mathematics in the content domains.</td><td>• Explain the terms longitudes and latitudes and the notion of small and great circles, as well as, their relationships.
• Illustrate points (eg. P $30°N, 60°W)$ $45°S, 60°W))$ on the model of a globe by drawing latitudes and longitudes to describe points and to share their results with colleagues.
• Identify and demonstrate the need for diversity in their collaborative group work on number systems.
• Highlight the potential socio-cultural issues (i.e. different places people stay on the earth with time difference) and misconceptions they hold about the global mathematics through think-pair-share.</td><td>• Background of student teachers: Instructional practices and policies will be designed to take care of student teachers' background knowledge of the earth as a sphere, mensuration and trigonometry.
• Problem solving, critical and creative thinking: This can be achieved through mathematical investigations, explorations and practical activities on locating points on the globe.
• ICT, social and communication needs are necessary for promoting the learning of concepts of earth through drawing latitudes and longitudes and to share their results with colleagues.</td></tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
Global Mathematics: Learning, teaching and applying.	Misconceptions and barriers in teaching and learning of global mathematics. Concept of the Earth as a Sphere, Great and Small circles on the earth, Lines of Longitude, Lines of Latitude, Location of points on the earth's surface. Distance between two points on the same longitude. Distance between two points on the same latitude.	3 Hours	Initiate discussion on student teachers' misconceptions. (PD Theme 1)	Student teachers discuss the perception and misconceptions about concepts in global mathematics.
			Put student teachers into groups for collaborative activities to come out with properties of lines and points on the earth's surface. (PD Theme 1 & 4)	Use various collaborative activities to address their misconceptions and barriers in teaching and learning global mathematics. Use diagrams, the globe and TLMs to describe the various properties of lines and points on the earth's surface.
			Lead discussion on locating or indicating a point (ie. T(75°S, 55°E) on the earth's surface. (PD Theme 3)	Draw lines of latitude and longitude to locate a point.
			Initiate discussion on which common line two points can be found. E.g. Points M(45° N, 60° E) and N(75° S, 60° E) are on the same longitude 60° E (PD Theme 3)	Engage in collaborative activities including think-pair-share, group work and role play that will lead to finding out two points on the same latitude or longitude.
			Engages student teachers in a discussion on how to find distances between places on same latitudes but different longitudes and vice versa.	Use diagram and the concept of length of an arc to find a distance on longitude. E.g. Distance between points M(45° N, 60° E) and N(75° S, 60° E) is on longitude 60oE and is calculated as $\frac{(45+75)}{360} x 2\pi R,$ where is the radius of the earth or of any great circle.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
			Use verbal exposition interspersed with questioning (and with the aid of an appropriate diagram) to establish the relationship between radius of a small circle and that of a great circle, using previous knowledge of trigonometry and plane geometry. (PD Theme 3). Provides an example to explain the concept. Example: Find the distance between points M(45° N, 85° E) and N(45° N, 60° E). Assigns student teachers to pose similar problems and to discuss in groups. (PD Theme 1, 3, & 4) Monitor group presentations and refine student teachers' results on global mathematics. (PD Theme 4)	Pay attention to the exposition and participate in the discussion to deduce the relationship between radius of a small circle and great circle which is expressed as: $r = Rcos\theta°$, with θ being the angle of the common latitude of the two locations under review. Use diagram and the concept of length of an arc to find a distance between two places which are located on the same latitude. But different longitudes Pay attention to the explanation and participate by asking questions for clarification. The discussion should reveal that the two points are on the same latitude (Lat 45° N) but on different longitudes which are on the same side the Greenwich Meridian. The distance between the points is calculated as $\frac{(85-60)}{360} x 2\pi Rcos45°$, where is the radius of the earth or of any great circle. Pose problems, solve, and present their results/ observations in small groups based on the discussions.

Lesson assessments – evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** Have student teachers identify and demonstrate the need for diversity in their collaborative group work on global mathematics. (assessment for learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. (Group and individual presentation) Assign student teachers to explain the terms longitudes and latitudes and the notion of small and great circles, as well as, establishing their relationships. (Assessment as learning) Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class project exercise) 1. Assign student teachers to solve worksheet problems based on latitudes and longitudes to share their results with colleagues. (Assessment of learning) Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Globe, mathematical set, manila cards, permanent markers, oranges and a knife.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers.
CPD Needs	• See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 10

Year of B.Ed.	LEVEL 100	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	Introductory Statistics I (Data Handling): Learning, teaching and applying					Lesson Duration	3 hours
Lesson description	This is first lesson in Statistics and it seeks to build on student teachers' knowledge and experiences on introductory statistics. The areas to be covered include data collection, organization of data (single and group data), frequency table, statistical charts/graphs- pie chart, line graph, bar chart, histogram, cumulative frequency graph, stem and leaf. It is intended to expose student teachers to drawing and use of various statistical charts/ graphs.						
Previous student teacher knowledge, prior learning (assumed)	Students have been exposed to some of the statistical charts / graphs at both JHS and SHS.						
Possible barriers to learning in the lesson	Different entry behaviours, socio-cultural issues, different learning needs. Some student teachers may come from SHS schools where they did not have teachers or good mathematics teachers to support them understand concepts in statistical charts / graphs.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	• **Face-to-face:** there is the need for tutors to engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions about vectors. • **Independent study:** student teachers need to be given independent group or individual assignments to be presented in class employing think-pair- share techniques. • **e-learning opportunities:** student teachers should be introduced to IT and e-learning opportunities, such as the use of geometry sketch pad, math lab, scientific calculators, etc., to facilitate their understanding of vectors and its applications to real life situations.						
Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description.	**The purpose of the lesson is to:** • Build on student teachers' knowledge and experiences of the statistics. • Expose student teachers to use variety of methods in handling statistics problems.						

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
Introductory Statistics I (Data Handling): Learning, teaching and applying	Data Collection Organisation and Presentation of Data Pie Chart Line graph, Bar Chart and Histogram Cumulative Frequency Curve Stem-and-Leaf	3 Hours	Engage student teachers in data collection activities. (PD Theme 1)	Discuss and actively participate in data collection activities. Use information in the classroom or the environ to collect data.
			Lead student teachers to build frequency tables (single and group data).	Use raw data available to construct frequency tables.
			Demonstrate how data is presented in a Pie Chart.	Use the concept of constructing sectors in a circle to construct Pie Charts.
			Initiate the drawing of Line graph, Bar chart and Histogram and discus their differences. (PD Theme 1) Lead student teachers to construct a cumulative frequency table and draw its curve. (PD Theme 2) Discuss the concept of Stem-and-Leaf and the Stem-and-Leaf plot with student teachers. (PD Theme 1) Mathematical problem-solving strategies to study and discuss concepts in a given task on the topic. (PD Theme 3)	Use graph sheets to draw line graph and bar chart. Find class boundaries and use them to draw histogram. Work in groups to discuss differences in line graph, bar chart and Histogram. Interpret and analyse graphs Find upper class boundaries and use it to construct cumulative frequency table. Use the cumulative frequency table and a graph sheet to draw cumulative frequency curve. Discus, interpret and analyse the cumulative curve. Present numbers on stem-and-leaf table and discuss the significance of stem-and-leaf. Use problem-answer questions to enhance their understanding on stem-and-leaf concept. E.g. How do stem and leaf plots work? How do you find the stem and leaf plot? How do you use stem-and-leaf to find a range?

Lesson assessments – evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** Through collaborative group work, student teachers outline the importance of the mean, median, mode. (Assessment for learning). Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning. b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. (Group and individual presentation) Independent assignment to solve problems relating to graphical presentation of data; construction of pie chart, bar chart, histogram, cumulative frequency curve and stem-and-leaf. (Assessment as learning). Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class project exercise) Student teachers to write class exercise on concepts of statistics. (Assessment of learning). Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Mathematical instruments, graph sheets, manila cards, graphical board.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 11

Year of B.Ed.	LEVEL 100	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 **11** 12

Title of Lesson	Introductory Statistics II (Data Handling): Learning, teaching and applying					Lesson Duration	3 hours
Lesson description	This is the eleventh lesson and it seeks to improve the knowledge of student teachers in statistics with reference to measures of central tendency and measures of dispersion. The areas to be covered include: central tendencies: - methods of finding mean, median and mode. Measures of dispersion: - range, quartiles, standard deviation, variance and mean deviation.						
Previous student teacher knowledge, prior learning (assumed)	Student teachers have been exposed to the concepts of average / mean, median, mode and standard deviation at Senior High School (SHS).						
Possible barriers to learning in the lesson	**Different entry behaviours:** Some student teachers come with different learning needs and diversity where some have strong background in mathematics from their previous Senior High Schools whiles other may have week background knowledge which will be a vital requirement in understanding of basic concept of data. **Socio-cultural issues:** Student teachers' cultural settings or community where learners are not exposed to concepts other than mensuration. **Misconceptions:** Student teachers may hold a strong view that mathematics is for male learners only which may affect the understanding of the basic concepts of statistics.						
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities** √	**Practicum**
Lesson Delivery - main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face:** engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions about mensuration. **Independent study:** give independent group or individual assignments to be presented in class employing think-pair- share technique. **e-learning opportunities:** introduce to IT and e-learning opportunities to facilitate their understanding statistics and probabilities.						
Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description.	**The purpose of the lesson is to;** • build on student teachers' knowledge and experiences on measures of central tendency and measures of dispersion. • expose student teachers to the calculation and application of the concepts of measures of central tendency and measures of dispersion to real life situation						

• **Learning Outcome for the lesson, picked and developed from the course specification.** • **Learning indicators for each learning outcome/**	**Learning Outcomes: By the end of the lesson, the student teacher will be able to:**	**Learning Indicators**	**Identify which cross cutting issues – core and transferable skills, equity and addressing diversity and how these will be addressed.**
	• Demonstrate the understanding of measure of central tendency and measures of dispersion in the basic school mathematics curriculum. • Use manipulatives and other variety of methods in learning measures of central tendency and measures of dispersion concepts. • Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.	• Identify and explain the various components of measures of central tendency and of dispersion, through interactive activities. • Illustrate the various methods of finding mean, median and mode; calculate standard deviation and establish its relationship with variance. • Show how to calculate mean deviation of a given data set. • Identify and demonstrate the need for diversity in their collaborative group work on measures of central tendency and measures of dispersion activities	• Since student teachers come with different background knowledge of averages, instructional practices and policies will be designed to review and streamline their understanding of measures of central tendency and measures of dispersion through activities. • Problem solving, critical and creative thinking: This can be achieved through analysis and interpretation of real data of standard deviation and its relationship with variance. • Knowledge of statistical software (e.g., Excel, SPSS, etc.) is necessary for promoting the analysis and interpretation of data.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
Introductory Statistics II (Data Handling): Learning, teaching and applying	Measures of central tendency - Mean, median and mode.	3 Hours	Engage student teachers in a game involving mean, median and mode as a starter.	Actively participate in mental activities to prepare for the learning of the concept of measures of central tendency.
			Initiate discussion to explore misconceptions of central tendencies. (PD Theme 3).	Brainstorm to explore their misconceptions about central tendencies, in groups.
	Mean		Present various methods of calculating the mean of numbers $x_1, x_2, x_3, \ldots, x_n$ (PD Theme 1)	Use their initial concept of $\bar{x} = \frac{x_1+x_2+\cdots+x_n}{n} = \frac{\sum_{i=1}^{n} x_i}{n}$ When finding the mean from frequency distribution table, use $\bar{x} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$ or the assumed mean method $\bar{x} = A + \frac{\sum_{i=1}^{n} f_i d_i}{\sum_{i=1}^{n} f_i}$ where assumed mean, $d_i = x_i - A$.
	Median and Quartiles		Initiate paper folding method to establish the concept of median and quartiles (PD Theme1).	Use paper (graph sheet of grid paper) folding method to establish the concept of median and quartiles.
	Mode		Finds the median of a set of odd numbers and a set of even numbers and deduce quartiles. (PD Theme 1).	When a set of numbers are arranged in order of magnitude, the median is the middle number, if the numbers are odd. If the numbers are even, the median is the mean of the two middle numbers.
	Measures of dispersion or variability.		Estimate from cumulative frequency curve the median and quartiles.	Draw a cumulative frequency curve and use it to estimate median and quartiles.
	- Range, quartiles Interquartile Range and semi-interquartile range.			State the mode in a set of numbers. Eg. The mode among these set of numbers 2,4,5,2,3 is 2.

<table>
<tr><th>Topic Title</th><th>Sub-Topic:</th><th>Stage/ time</th><th>Teacher Activity</th><th>Student Activity</th></tr>
<tr>
<td></td>
<td>Mode

Measures of dispersion or variability

– Range, quartiles Interquartile Range and semi-interquartile range.</td>
<td></td>
<td>Introduce the concept of mode and how to estimate the mode on the histogram (PD Theme 3).

Introduce the concepts of range, quartiles (lower quartile and upper quartile), interquartile range (upper quartile - lower quartile) and semi-interquartile range (interquartile range divided by 2) and come out with their definitions.
(PD Theme 3)

Introduce the concepts of standard deviation and variance and establishes their meaning and application.
(PD Theme 1).

Lead student teachers to understand absolute mean deviation and its application.

(PD Theme 1).</td>
<td>Draw histogram and use it to estimate the mode.
Study this example and use it as an activity.
Examination marks for 20 students are arranged in order of magnitude in the table below.

<table>
<tr><td>Student</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td>Mark</td><td>43</td><td>48</td><td>50</td><td>50</td><td>52</td><td>53</td><td>56</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Student</td><td>H</td><td>I</td><td>J</td><td>K</td><td>L</td><td>M</td><td>N</td></tr>
<tr><td>Mark</td><td>58</td><td>59</td><td>60</td><td>62</td><td>65</td><td>66</td><td>68</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Student</td><td>O</td><td>P</td><td>Q</td><td>R</td><td>S</td><td>T</td><td></td></tr>
<tr><td>Mark</td><td>70</td><td>71</td><td>74</td><td>76</td><td>78</td><td>80</td><td></td></tr>
</table>

The range = 80 – 43 = 37.
The median lies at the mid-point between central values (10th and 11th) = half-way between 60 and 62=(60+62)/2=61

The lower quartile lies at mid-point between the 5th and 6th values = half-way between 52 and 53=(52+53)/2=52.5

The upper quartile lies at mid-point between the 15th and 16th values = half-way between 70 and 71=(52+53)/2=70.5

The interquartile range for this dataset = upper quartile – lower quartile= 70.5 – 52.5 = 18

The semi- interquartile range =18/2 = 9

Use cumulative frequency curve to estimate the median, the quartiles, and find the inter-quartile range and semi-interquartile range.

Use the following standard deviation formula to organise activities that can involve the calculation of standard deviation and variance of a distribution.
Variance is the square of standard deviation.</td>
</tr>
</table>

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
	Variance and Standard Deviation		Lead student teachers to understand absolute mean deviation and its application. (PD Theme 1)	Formulae for Standard deviation: 1. The standard deviation of an entire population (σ) is calculated using: $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\mu)^2}{N}}$ where x_i represents each value in the population, μ is the population mean and $N = 1 + 2 + \cdots + n$ is the number of values in the population. 2. The standard deviation of a sample (S) is calculated using: $S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$ where x_i represents each value in the population, $\bar{x}$ is the sample mean and n is the number of values in the sample. Use the Absolute mean deviation formula $\frac{\sum_{i=1}^{n}\lvert x_i - \bar{x}\rvert}{n}$ to do various activities.

Lesson assessments - evaluation of learning: of, for and as learning within the lesson	**Think-pair-share** Student teachers to identify and explain the various components of Measures of Central tendency and of dispersion, through interactive activities. (Assessment of learning) Related CLOs: 1, 2. NTS: 1a) Critically and collectively reflects to improve teaching and learning b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. (Group and individual presentation) Student teachers to make group presentations on how to teach various aspects of measures of dispersion or variability. (Assessment as learning): Related CLOs: 2, 3 NTS: 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) (class project exercise) Student teachers are assigned to find mean, median, mode, standard deviation and variance and mean deviation of a given data set, to be presented later. (Assessment of learning). Related CLOs: 1,3 (NTS: 2 b) Has comprehensive knowledge of the official school curriculum, including learning outcomes. 3j) Produces and uses a variety of teaching and learning resources including ICT, to enhance learning 2f) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom (knowledge) Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Manipulatives such as number grids, spreadsheets and graph sheets.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.

LESSON 12

Year of B.Ed.	LEVEL 100	Semester	2	Place of lesson in semester	1 2 3 4 5 6 7 8 9 10 11 12

Title of Lesson	Probability: Learning, teaching and applying				Lesson Duration	3 hours
Lesson description	This is the twelfth lesson and it seeks to expose the concept of probability and its applications to student teachers. The areas to be covered include: Basics of probability, axioms of probability, basic properties of probability conditional probability, the general multiplication rule and independent events.					
Previous student teacher knowledge, prior learning (assumed)	Student teachers have been exposed to some concepts of probability and operations and properties of rational numbers.					
Possible barriers to learning in the lesson	**Different entry behaviours:** Some student teachers come with different learning needs and diversity where some have strong background in mathematics from their previous Senior High Schools whiles other may have week background knowledge which will be a vital requirement in understanding of basic concept of data. **Socio-cultural issues:** Student teachers' cultural settings or community where learners are not exposed to concepts other than mensuration. **Misconceptions:** Student teachers may hold a strong view that mathematics is for male learners only which may affect the understanding of the basic concepts of statistics and probability					
Lesson Delivery - chosen to support student teachers in achieving the outcomes	**Face-to-face** √	**Practical Activity**	**Work-Based Learning**	**Seminars**	**Independent Study** √	**e-learning opportunities**	**Practicum**
Lesson Delivery - main mode of delivery chosen to support student teachers in achieving the learning outcomes.	**Face-to-face:** engage student teachers in a head-on (or teacher-led) discussions or activity oriented lesson delivery procedures in order to offer student teachers first-hand experience in the learning process. This will enable them to obtain immediate feedback to address their difficulties and misconceptions about mensuration. **Independent study:** give independent group or individual assignments to be presented in class employing think-pair- share technique.					
Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description. Write in full aspects of the NTS addressed	**The purpose of the lesson is to;** • Build on student teachers' knowledge and experiences in probability. • Expose student teachers to the development of activities that can aid establishment of the concepts of probability and to apply such concepts to real life situations.					

• **Learning Outcome for the lesson, picked and developed from the course specification.** • **Learning indicators for each learning outcome.**	**Learning Outcomes: By the end of the lesson, the student teacher will be able to:**	**Learning Indicators**	**Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?**
	• Demonstrate the development and understanding of the probability in the basic school mathematics curriculum. • Use manipulatives and other TLMs in a variety of ways in learning probability concepts. • Demonstrate value as well as respect for equity and inclusion in the mathematics classroom. • Demonstrate awareness of core skills, individual characteristics and socio-cultural issues in teaching and learning mathematics in the content domains.	• Outline and explain probability concepts such as event, outcome, sample space, etc. through collaborative activities. • Illustrate probabilities on Venn diagrams and to share results with colleagues. • Identify the appropriate probability concept to apply in solving probability problems • Identify and demonstrate the need for diversity in their collaborative group work on probability activities. • Highlight the potential socio-cultural issues (i.e. Examples and question contents should cut across cultural areas) and misconceptions they hold about probability through think-pair-share.	• Problem solving, critical and creative thinking: This can be achieved through analysis and interpretation of various concepts of probability as chance using variety of experiments. • Background knowledge: Since student teachers come with different background knowledge of probability, conscious efforts should be employed to cater for such diversity. • Knowledge of statistical software (e.g., Excel, SPSS, etc.) is necessary for promoting the collection, analysis and interpretation of data.

Topic Title	Sub-Topic:	Stage/ time	Teacher Activity	Student Activity
Teaching and learning to achieve learning outcomes: depending on delivery mode selected. Teacher led, collaborative group work or independent study.				
Probability: Learning, teaching and applying	Probability basics Axioms of probability, basic properties of probability Mutually Exclusive Events, Non-Mutually Exclusive Events, The General Addition Rule Mutually Independent Events and Non-Independent Events The General Multiplication Rules, and, Conditional probability	3 Hours	Engage student teachers in a probability game as a starter.	Actively participate in probability game leading to learning of probability. E.g. Coin game – a coin is thrown from a student to a student. The receiver of the coin predicts a head or tail before the coin is thrown.
			Demonstrate how to establish a concept of probability such as sample space through activity methods.	Explore through activities (dice and coin throwing) to established sample spaces and the meaning of probability. Axioms and basic properties of probability should be explored.
			Initiate a process to explore the connections between set theory and probability to explain mutually exclusive events and non-mutually exclusive events leading to the general addition rules.	Use Venn diagram with disjoint subsets and Venn diagram with joint subsets to establish respectively the General Addition Rules of probability $P(A \cup B) = P(A) + P(B)$ and $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
			Use throwing of a coin (C) and a dice (D) together to explain mutually independent events leading to the general multiplication rules of probability $(P(A \cap B) = P(A) \text{x} P(B)$ (Replacement Event) and $P(B/A) = P(B)$. Non-Independent Event lead to General Multiplication Rules of probability $P(A \cap B) = P(A) \text{x} P(B/A)$ (Non replacement event) and $P(B/A) = \frac{P(A \cap B)}{P(A)}$ (Conditional probability rule) Use these rules established appropriately to solve probability problems on Mutually Independent Events and Non-Independent Events.	Use throwing of a coin (C) and a dice (D) together to explain mutually independent events leading to the general multiplication rules of probability $P(A \cap B) = P(A) \text{x} P(B)$ (Replacement Event) and $P(B/A) = P(B)$. Non-Independent Event lead to General Multiplication Rules of probability $P(A \cap B) = P(A) \text{x} P(B/A)$ (Non replacement event) and $P(B/A) = \frac{P(A \cap B)}{P(A)}$ (Conditional probability rule) Use these rules established appropriately to solve probability problems on Mutually Independent Events and Non-Independent Events.

Lesson assessments - evaluation of learning: of, for and as learning within the lesson	**Review of semester one course** Student teachers to review the semester one course with tutor. (whole class activity) Student teachers discuss and submit their learning journals for considerations (whole class activity) Student teachers to discuss end of semester examination issues with tutor, submit projects Note: The assessment procedures should make room for differentiation - gender, equity, SEN, and inclusivity.
Instructional Resources	Coins, dice, playing cards, marbles of different colours, game cards, etc.
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra: Sam-Woode Ltd.
Additional Reading List	Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Tutor notes. Accra: Unimax Publishers. Martin, J. et. al. (1994). Mathematics for teacher training in Ghana: Students activities. Accra: Unimax Publishers. Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education. Ministry of Education. (2010). Teaching syllabus for core mathematics (Senior High School). Accra: Ministry of Education, Science and Sports.
CPD Needs	See PD Material on Year 1 Semester 2 Course on Learning, Teaching, and Applying Number and Algebra.