

Four-Year B.Ed. Course Manual

MATHS: FURTHER 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 meet 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 these sets 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 copies 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 is approach used to produce these manual.

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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 and 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 codes 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 strands 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 strands for weekly Pd meetings where tutors/lecturers will situate the lessons in the contexts of their colleges and their student teachers, 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

Course Manual Writing Guide

Resources for Course Manual Writing

- Soft copies of the CWG, New Four-Year B.Ed. Curriculum introduction
- Soft and hard copies of the course specifications for the subject for year one and two
- Soft and hard Course Manual Writing Guide (CMWG)
- Relevant subject texts

Target Audience

• College of Education Tutors

Teacher Education University Lecturers

- Student Teachers
- Mentors

The purpose of course manuals

- To provide a lesson by lesson overview of the course, building on, adapting and developing the material in the course specifications
- To provide a resource to support professional development sessions for tutors/lecturers on how to plan for and teach courses from the New Four-Year B.Ed. Curriculum
- To inform tutors /lecturers, student teachers and others working with student teachers about:
 - ✓ what is to be taught and why
 - ✓ how it can be taught
 - how it should be assessed
- To support consistency in the implementation of the New Four-Year B.Ed. across institutions who train teachers
- To ensure that all **training** information on skills, processes, and other information necessary to perform the teaching task are together in one place.
- To operationalize the Teacher Education Reform Policy; the requirements of the NTS & NTECF and the Four-Year B.Ed.

Guiding principles of course manual writing

- 1. They are written with the learner, the student teacher, in mind: what they will *be able* to cope with and only include what student teachers need to know, understand, be able to do and be as a basic school teacher
- 2. They take in to consideration the learner's, the student teacher's, context and possible barriers to, and enablers for, learning
- 3. They are written with the tutors /lecturers who are going to teach the course in mind. Tutors must be able to adapt and develop the plans in course manuals to fit the context they are teaching in and to support their teaching
- 4. They are aligned to the key principles and practices of the Teacher Education Reform Policy: the NTS, the NTECF and the New Four-Year B.Ed.
- 5. They are written to provide opportunities for student teachers to develop and apply knowledge during supported teaching in school
- 6. They are written to reflect the stage of student teacher development, set out in the model for progress in the New Four-Year B.Ed.
- 7. They are written to support progress in student teacher learning, including building on prior learning from the previous programme or course/s and supporting progress to the next course.
- 8. They are to be used as self-study tools.
- 9. They are written to have the following characteristics: easy to read; uses active voice and avoids jargon; uses bullet points to offset text; uses images

What a teacher educator needs to know, understand and use to inform what they do

- The aims and structure of the education system and Education strategic Plan
- The Basic School Curriculum
- The Inclusion Policy
- The teacher education system: The National Teacher's Standards, the vision for teacher education and the core principles of the New Four-Year B.Ed.
- Andragogy, effective methods and practices for teaching adult learners
- Assessment Literacy. Assessment for, of and as learning -Educative Assessment

Guidance for completing the course manual writing format: two sections

A. Course Information

Title Page

Course name: as in course specification unless important reason why not

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. "

Course Details: as in course specification unless important reason why not

Pre-requisite/s	The programme / previous semester courses studied.					
Co-Requisites	Links to other cou duplication	urses being tau	ght, support coherence	in student experien	ce and av	oid
Course Level		Course Code		Credit Value	3	

Table of contents

Each manual will include:

- 1. The goal for the subject or learning area
- 2. Course description
- 3. Key contextual factors
- 4. Core and cross cutting issues, including equity and inclusion
- 5. Course Learning outcomes
- 6. Course content
- 7. Teaching and learning strategies
- 8. Course Assessment components
- 9. Reading and reference list
- 10. Handouts, power points and other resources for lessons
- 11. Plans for each lesson in the semester

A. Course information

1. Goal for the Subject or Learning Area

This can be found in subject goal document. It should be a short statement which captures what new teachers will know, understand and be able to do in this subject at the end of their training. This statement should be linked to achieving the vision for the curriculum.

2. Key contextual factors

This can be found in the course specification. It should address what needs are to be considered to reflect the Ghanaian context at local and national levels.it includes potential knowledge and skills gaps and any specific: gender, cultural, linguistic, conceptual, infrastructural issues, for example, that might be barriers to learning forstudent teachers and eventually basic school children? E.g. issues of subject related bias that need addressing. Potential barriers to learning must be explicitly addressed to enable student teachers to achieve the learning outcomes.

3. Course Description

This can be found in the course specification. This brief statement should provide a clear understanding of what studying this course involves, what student teachers will get out of studying this course.

4. Core and transferable skills and cross cutting issues, including equity and inclusion

This can be found in the course specification. Which core and transferable skills or cross cutting issues will be applied or developed through this course? This needs to be made explicit to student teachers. Are there specific issues to do with equity and inclusion which must be addressed so that all student teachers can fully take part? For example, issues related to gender and mathematics or science.

6. Learning indicators

5. Course Learning Outcomes

· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
These are in the course specification. The course	• Measurable/assessable/observable performances that
learning outcomes should specify the expectations of	provide evidence of learning or other changes taking
what the student teachers will know, understand and	place in student teachers' behaviour which
be able to do at the end of the course <i>not</i> what student	demonstrate that they have met the learning
teachers will do on the course. They must be	outcome/s.
appropriate and realistic to the learner's abilities,	• What the student teacher will need to do to show they
experience, the identified level of the course and	have achieved the learning outcome. (in an inclusive
<i>content.</i> They must be measurable – allowing	lesson, this should vary and be responsive to student

assessment of student teacher achiever	ment	teacher's indivi	dual characteristic)	
7. Course content				
In the course specification. This should should be clear how this content relat unit in the course should be <i>briefly</i> set of	provide an outli es to the achiev out – the name s	ne of the academic an ement of the intende hould make it clear wl	d / or practical content of the course. It d learning outcomes.The name of each hat the unit is about.	
Unit	Торіс	Sub-topic (If any)	Teaching and learning activities to	
	-		achieve the learning outcome	
8. Course Assessment Component	ts			
 In the course specification. The NTS and to strategies to enable assessment of outcomes and through these the agains There should be a maximum of 3 a tutors/ lecturers The learning outcomes to be assess Each assessment component should Each assessment component should ✓ The category or type, for exa project or presentation, poster ✓ The type of assessment: of, for ✓ An indication of the size of e submissions, length of present ✓ The weighting of each assess 	d the NTECF requ student teache at the NTS ssessment comp ed by each asses d explicitly refere d include: mple: written, c r, TLM and /or as. each assessment ations; whether ment component assessment of co	uire a move away from rs' skills, knowledge a onents per 3 credit-co ssment component sho ence the NTS or aspect coursework or practica component (e.g. du presentations have an c should be expressed urse work. 40% exami	n largely examination-based assessment and understanding against the learning burse; to avoid over loading student and ould be identified. ts of the NTS it will assess. al, teaching, examination, collaborative ration of exams, word limit of written individual or group etc.). I as a % of total course mark (overall in nation of course work).	
 Each assessment should be manageable and relevant to supporting the student teachers' development. The guidance on assessing student teachers from the NTS, the NTECF the CWG and the New Four Year B.Ed. should be used. 				
Detail in this section should show how the total learning hours will be used to achieve the intended learning outcomes, to provide a guide to the teaching and learning strategies to be used. Each teaching strategy should be selected as most appropriate to achieving the learning outcomes. This may include team teaching or additional tutors. As stated in the B.Ed. experiential learning and interactive teaching approaches are encouraged				
10. Required Reading and reference list				
e or two compulsory texts which must be made available to the student teachers and a SHORT list of 5 relevant references. These lists should be annotated with the key value of each text. Use APA style of writing.				
11. Teaching and Learning Resource	ces			
Instructional resources required to supply videos, projectors	port learning dur	ing the course e.g.: TL	Ms, lab and workshop equipment,	
Course related professional developme	ent for tutors/ le	cturers		
This is not included the course manual lecturers are prepared to teach the coulecturers.	but professional rse identify any s	development needs r specific topics or issue	must be identified to ensure all tutors / s which may be challenging for tutors /	
B. Semester lesson plans				
Guidance for Lesson planning				
 The expanded format is ddesigned to support The completed format will be an import Things to consider when writing and review Will all student teachers be able to ach activities set out in the lesson? What might be barriers to learning? Here 	ort writing lessons tant piece of evide ving lessons: ieve the learning o ow can you addres	which address the key fr ence for CoE in being aw outcomes and demonstra as these barriers?	eatures of the new B.Ed. curriculum varded Transitional Support Funding (TSF) ate the indicators by undertaking the	

- How does the lesson support progress in and or consolidate student teacher learning; including building on prior learning and supporting progress to next lessons?
- How will you can address transition from school to CoE in the first semester?
- Are there explicit links between learning outcomes, learning indicators and assessments?
- Do all activities support student teachers in achieving the lesson learning outcomes?

- Is there an emphasis on interactive, learner focused approaches to training new teachers?
- Does it explicitly address cross cutting -issues: equity and inclusion, gender, SEN,ICT?
- Does it explicitly develop core skills, including: professional values and attitudes, classroom enquiry and reflection?
- Overall the lesson must be 'do-able' for the student teacher
 - in the time available
 - ✓ with the skills, knowledge and understanding they have

Title of Lesson		0					
Lesson Duration							
Lesson description	It is essential the should be shore	at student , clear, and	teachers know accessible to	w what this l all students.	esson is about.	The lesson descri	otion
Previous student teacher knowledge, prior learning (assumed)	 What links Prior learni supported from previo If you are u as part of t peed to mo 	to previous ing could be teaching in ous lessons unsure abou he activity in odify the less	knowledge / j e from: this cc school/practi ut previous kn in the lesson/s	prior learning purse and pro cum; from o owledge or p s.If the expect	g need to be bui evious lessons; ther courses. N prior learning h sted prior know	It in to the lesson from senior high s B important to bu ow you need to cl ledge is not adequ	school; from iild on work neck for this nate you will
Possible barriers to learning in the lesson	 What species might learning? How will you Does this learning plan to sup 	ific concep nt stop stud ou address t esson requir port and ad	tual, linguistic ent teachers i hese? re that studen ldress this	c, social, cul n achieving t t teachers ex	tural, conceptu he learning out xamine their ow	ial, gender, or ab comes; act as bari n bias? If so, you	ility related iers to their will need to
Points on equity, inclusivity (gender, SEN), and addressing diversity	 You need to issues (see How would own learnin How are iss teachers cate How are iss teachers cate For examp mathematic 	o represent diversity wh d these issung and the l sues of dive sues of dive sues of dive n learn how le: gender	t and address heel) ? les be address earning of the rsity (equity an sity modelled rsity (equity an v to address it stereotype is	diversity in y sed with stud students the nd inclusion) during this te nd inclusion) with the stud sues related	your lesson-plan dent teachers of ay will teach? addressed in yo eaching and lean addressed in yo dents they will t to: PE, literac	n. Are there multi during activities fo our lesson plan so ming activity? our lesson plan so teach? ty and language,	ple diversity r both their that student that student science and
Lesson Delivery – chosen to support students in	Face-to-face	Practical Activity	Work- Based	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: of brainstorming, not usually be t Practical Activit and materials, a Work based lead development w Seminars: to get tutor led Independent st promote individ be part of any of E-learning opport environments. mode in its own Practicum (sup learn from the lead teaching in and	 Leaning Geter and the students of an extended and coherent line of argument. It includes discussion, prainstorming, question and answer, etc. This can be tutor and / or student teacher led. It should not usually be the main mode. Practical Activity: enabling experimentation and the analysis and discussion of issues, documents and materials, as well as physical activities. Work based learning: to allow students to undertake observation, enquiry and/or hands-on development work (mostly TVET) Geminars: to generate group and individual creativity, discussion and reflection: student and / or cutor led Independent study: to enable students to engage with relevant and appropriate materials to promote individual and collaborative enquiry, more in-depth analysis and development. This can be part of any of the above modes E-learning opportunities — involving the use of interactive packages and virtual learning environments. This can be part of any of the above modes of delivery. It is unlikely to be a delivery mode in its own right. Practicum (supported teaching in school): support to enable student teachers to experience and earn from the basic school context by doing observations and child study in Y1 to full class teaching in and action research in Y4. 					
 Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An 	 wnat is the result of th Is this les Understand Practicing t This will rel 	e main thing is lesson? son aimed ding how va he applicat ate back to	at: Learning at: concept ion of new kno the overall inf	or embed s or embed s and skills co pwledge? tention and lo	is to know, und ding a new c ome together to earning outcom	erstand and be ab concept? Develop o create a body of les for the course.	ie to do as a ing a skill? knowledge?

expanded version of the description.Write in full aspects					
of the NTS addressed				1	
 Learning Outcome for the lesson, picked and developed from the course specification Learning indicators for each learning outcome 	 Learning Outcomes The learning or enable student purpose for the learning or are prepared to operation. In outcomes would would need to ke to teach the ope What the stude able to do as a monof the lesson the Learning outcom visited over a nu Be realistic in ter any one lesson Some learning or student teacher 	putcomes for the t teachers to a lesson. mathematics: stude teach a specific n this instance, th d be the things th mow and do in orde eration. ent teacher will kn result of this lesson. e student will' nes may be develop imber of lessons rms of what can be putcomes may addr	lesson will chieve the ent teachers nathematics ne learning ne students er to be able now and be 'By the end ped and re- achieved in ress specific	 Learning Ind Measuraperform learning in stude demons learning What the do to selearning lesson, respons individu 	licators able/assessable/observable hances that provide evidence of g or other changes taking place ent teachers' behaviour which trate that they have met the goutcome/s. he student teacher will need to show they have achieved the g outcome. (in an inclusive this should vary and be ive to student teacher's al characteristic)
Content of lesson picked	Time or stage	needs	Teaching a	nd learning t	to achieve learning outcomes:
and developed from the	Identify how to	opics (if any):	depending	on deliver	y mode selected. Teacher
course specification	much time will		led,collabo	rative group w	vork or independent study
Unit/s covered from the	each part of the		Teacher Act	tivity	
course specification:	lesson		 Plan to is ex student Plan fr to supp teacher toward demon achievi learning Where up act student particip Make li aspects Four-Ye progran betwee and knowle State teachin or addi contrib 	pected of t teachers or activities oort student rs in working s and / or strating ng the g outcomes. possible set civities with ts as active pants inks to other of the New ear B.Ed. mme or en subject pedagogic dge if team g involved tional tutors uting	 collaborative group and pair work, e.g., identifying, developing, presenting and evaluating suitable resources and materials picking out key points from education texts, raising questions and issues sharing practice and experience preparing for school visits self and peer assessment Other examples Student teacher led seminars ICT e.g. discussion using VLE Video observation of and analysis of teaching Role-play
Which core or transferable skills will be used or developed and how	Core and transferable and communication s	e skills include: criti skills, use of ICT	ical thinking,	problem solviı	ng, social skills, creative thinking
Which cross cutting issues will be addressed or developed and how	Cross cutting issues i values and attitudes,	include: assessment , reflection and class	t literacy and sroom enquir	assessing stud Y	dents' progress and professional

Lesson assessments – evaluation of learning: of, for and as learning within the lesson	 Assessment as learning: ongoing self-assessment by student teachers reflecting on their own learning and making adjustments so that they achieve deeper understanding, occurs throughout the learning process. This needs to be planned for in the lesson. Assessment of learning: is usually summative and is mostly done at the end of a task, unit of work, placement etc. Weighted Assessment Components in course outlines. This needs to be planned for in the lesson. Assessment for learning: is using assessment as a means of finding out what students know, understand and are able to do and using that information to adapt teaching approaches and to differentiate according to different student needs, it occurs through the learning process, may be part of the Assessment components, and it occurs when assessing prior learning Differentiation in lessons (UDL guidelines): the lesson needs to include a range of teaching and assessment strategies to motivate and reach all learners The approach to assessment in lessons must be appropriate to the teaching and learning strategies
Instructional Resources	This may include: handouts, power points, examples of children's work, video, ICT activities,
	examples of previous student teachers' work
Required Text (core)	
Additional Reading List	

Year of B.Ed.	2 Se	mester	Place	e of lesson ir	n semester	1234567	789101112
Title of Lesson	Binary Op	peration: Learn	ing, teaching	and applying	Lesson Dur	ation	3 Hours
Lesson description Previous student teacher knowledge, prior learning (assumed)	This is a first lesson under the topic Further Algebra in Year two Semester 1. Number and Algebra treated in Year one Semester two is a pre-requisite ofthis lesson. General introduction of course manual will be discussed to enable student teachers to audit their content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions in Binary Operation. Conscious effort should be made to create awareness in student teachers the course is the first content course in the JHS mathematics specialism. The areas to be covered include the concept and definition of Binary Operations, Evaluation of a Binary Operation, Properties of the Binary Operations – Closure, Associative, Commutative, Distributive, Identity Element and Inverse. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of operation of Binary Operations and its properties. Student teachers have knowledge on operations of numbers and their properties from Basic School mathematics, JHS mathematics and SHS Core mathematics.						
Possible barriers to learning in the	Different entry behaviours, Socio-cultural issues, different learning needs, different teaching styles from previous teachers which may not support the student teachers to acquire the concept of Binary						
lesson	operation	ns.					
Lesson Delivery –	Face-	Practical	Work-	Seminars	Independent	e-learning	Practicum
chosen to support students in achieving the outcomes	to-face	Activity 🔀	Based Leaning		Study	opportunities	
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	 Face-to-face: opportunity for an extended and coherent line of argument. It includes discussion, brainstorming, question and answer, etc. This can be tutor and / or student teacher led. It should not usually be the main mode. Practical Activity: enabling experimentation and the analysis and discussion of issues, documents and materials, as well as physical activities. Independent study: to enable students to engage with relevant and appropriate materials to promote individual and collaborative enquiry, more in-depth analysis and development. This can be part of any of the above modes E-learning opportunities – involving the use of interactive packages and virtual learning environments. This can be part of any of the above modes of delivery. It is unlikely to be a delivery mode in its own right. 						
 Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded 	 The purp build comperce deve conce to de able 	ose of the less d on the cont petence in ha eptions and mis- elop student te epts in other fi- evelop student to handle conc	on is to; ent knowle andling Bina sconceptions eachers' unc elds of mathe teachers' co epts in Binar	dge and expension of the provident of th	eriences of stud problems and rations. f Binary Operati vledge in order to as required by the	dent teachers address their ons and apply prepare them JHS curriculum	to establish their r learning needs, Binary Operation well enough to be n.
version of the description.	year	1 semester 1 (l	Number and	algebra)			

• Learning Outcome for the lesson, picked and	Learning Outcomes	i i	Learning Indicators	Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?
developed from the course specification • Learning	 Demonstrate the understanding Operations (NT NTECF Pillar 1) 	ne of Binary S 2c, 3i,	 Identify and analyse the characteristics and the properties of Binary Operations 	 Problem solving, critical and creative thinking:through objective analysis of facts and concepts
indicators for each learning outcome	 Use a variety of or ways in learn Operations con 3e, 3f, 3g, 3k, 3 3o, 3p NTECF p Demonstrate va as respect for eco inclusion in the mathematics cla (NTS, 2f) 	f activities ning Binary cepts. (NTS I, 3m, 3n, illar 4) lue as well quity and assroom.	 Evaluate a defined binary operation within a set of numbers and illustrate the results on a table. (The table assists in discussing the properties of Binary Operations). Engage all student teachers in collaborative group work on Binary operations. 	 Communication skills: through discussion, critiquing and presentations of results Respect and diversity: designing lesson for diverse learners with different learning styles Personal development: Through presentation and developing of arguments to ensure the development of conceptual understanding Equity and inclusivity: by providing equitable learning opportunities for all learners
Торіс	Sub-topic(s)	Stage/	Teaching and learning to a depending on delivery mod groupwork or independent.	ctivities to achieve learning outcomes le selected. Teacher-lead collaborative
			Teacher Activity	Student Activity
		10 t mins d	Introduce student teachers to the Course Manual and discuss the various components including assessment procedures (See Course Assessment Components) , (PD Theme 1)	Participate in the discussion of various components of the course manual, take opportunity to ask questions about the Course Manual including assessment procedures. Outline their expectations and views about the mathematics course.
	Misconceptions and barriers in teaching and learning of Binary Operations	20 mins	Initiate discussion on students' previous knowledge and experiences on binary operations to explore their misconceptions	Student teachers discuss their perception, misconceptions and barriers about concepts in Binary Operations
Binary Operations: <i>Learning</i> , teaching and applying.	Operations, definition and evaluation of two numbers under a		Put student teachers into groups for collaborative activities to evaluate binary operations	Evaluate binary operation defined on a set of numbers. Eg. A binary operation * is defined on a set of real numbers by x * y = x + y + xy, evaluating 3 * 5 = 3 + 5 + 3(5) = 23
	defined binary system. Properties of Binary Operations	50 mins	Lead discussion on closure, commutative and associative and distributive properties	Fill binary operation Cayley table to establish the concepts of closure, commutative and associative properties. Eg. The binary operation * is defined on the set $Q = \{0, 1, 2, 3, 4\}$ modulo 5by x * y = x + y + 2xy.
		60 mins		

			Fill the Cayley table and use it to
			investigate closure, commutative and
			associative properties
			* 0 1 2 3 4
			0 0 1 2 3 4
			1 1 4 2 0 3
			3 3 0 2 0 1
			4 4 3 2 1 0
			le.
			Closure Property: The set Q is closed
			under the operation * since for
			$a, b \in Q, a * b \in Q$
			Commutative Property: Let $a, b \in Q$
			and investigate from the table whether
			a * b = b * a
			Associative Property: Let $a, b, c \in Q$
			and investigate from the table whether
			(a * b) * c = a * (b * c) [and
			investigate further whether is equal
			to(a * c) * b].
			Distributive Property: To investigate
			distributive property, the binary
			operations should be two distinct
			definitions. Eg. Define binary
	40		operations $*$ and Δ on the set
	mins		$Q = \{0, 1, 2, 3\}$ modulo 4 by
			$x * y = x + y$ and $x\Delta y = x - y$
			respectfully.
			* 0 1 2 3 Δ 0 1 2 3
			0 0 1 2 3 0 0 3 2 1
			1 1 2 3 0 1 1 0 3 2
			2 2 3 0 1 2 2 1 0 3
			3 3 0 1 2 3 3 2 1 0
			Liso those tables to investigate the
			distributive property $(a \wedge b) * c - (a * b)$
			distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$ where $a, b, c \in O$
			distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$
		Initiate discussion on how to	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$
		Initiate discussion on how to	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group
		Initiate discussion on how to find or identify an identity	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the
		Initiate discussion on how to find or identify an identity element of a binary operation	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined
		Initiate discussion on how to find or identify an identity element of a binary operation	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation
Lesson assessments	1. Student teachers	Initiate discussion on how to find or identify an identity element of a binary operation	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation
Lesson assessments – evaluation of	1. Student teachers	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with ad with time lines.
Lesson assessments – evaluation of learning: of, for and	 Student teachers respect to Further Student teachers 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with nd with time lines.
Lesson assessments – evaluation of learning: of, for and as learning within	 Student teachers respect to Further Student teachers of binary operatio 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar are assigned to outline and analy ns for peer review in class	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with ad with time lines.
Lesson assessments – evaluation of learning: of, for and as learning within the lesson	 Student teachers respect to Further Student teachers of binary operatio (Assessment as learning) N 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar are assigned to outline and analy ns for peer review in class. TS 3h - Sets meaningful tasks that	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with ind with time lines. As the characteristics and the properties
Lesson assessments – evaluation of learning: of, for and as learning within the lesson	 Student teachers respect to Further Student teachers of binary operatio (Assessment as learning) N leads to purposeful learning 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar are assigned to outline and analy ns for peer review in class. TS 3h - Sets meaningful tasks that	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with ad with time lines. yse the characteristics and the properties encourages learner collaboration which
Lesson assessments – evaluation of learning: of, for and as learning within the lesson	 Student teachers respect to Further Student teachers of binary operatio (Assessment as learning) N leads to purposeful learning Graph sheets mathematic 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar are assigned to outline and analy ns for peer review in class. TS 3h - Sets meaningful tasks that g	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with and with time lines. use the characteristics and the properties encourages learner collaboration which manent markers, calculators, mobile
Lesson assessments – evaluation of learning: of, for and as learning within the lesson Instructional Resources	 Student teachers respect to Further Student teachers of binary operatio (Assessment as learning) N leads to purposeful learnin Graph sheets, mathematic phones Geogebra Apps 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar are assigned to outline and analy ns for peer review in class. TS 3h - Sets meaningful tasks that g. al set, manipulative materials, per	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with nd with time lines. //se the characteristics and the properties encourages learner collaboration which manent markers, calculators, mobile
Lesson assessments – evaluation of learning: of, for and as learning within the lesson Instructional Resources Required Text	 Student teachers to respect to Further Student teachers of binary operatio (Assessment as learning) N leads to purposeful learnin Graph sheets, mathematic phones, Geogebra Apps.; Gordor B, K, Naandam S 	Initiate discussion on how to find or identify an identity element of a binary operation o discuss the nature of their profe Algebra in terms of its content ar are assigned to outline and analy ns for peer review in class. TS 3h - Sets meaningful tasks that g. al set, manipulative materials, per	distributive property $(a\Delta b) * c = (a * c)\Delta(b * c)$, where $a, b, c \in Q$ Engage in collaborative activities including think- pair-shareand group work that will lead to finding out the identity element from a defined operation essional teaching portfolios (PTP) with and with time lines. Use the characteristics and the properties encourages learner collaboration which manent markers, calculators, mobile

	https://amsi.org.au/teacher_modules/Indices_and_logarithms.html. Retrieved 20-06-2019
Additional Reading	Ministry of Education (2015). Core mathematics modules for SEIP. Accra: Ministry of Education.
List	Ministry of Education. (2010). <i>Teaching syllabus for core mathematics</i> (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	How to design and/or use some innovative materials and ideas for teaching selected concepts in
	binary operations
	Instructional strategies needed to consciously connect mathematical ideas, as well as, connect
	mathematics to other curriculum areas and to the world outside

Ye	ar of B.Ed. 2	2 Sem	ester 1	Place of	lesson in s	semester ₁ 2	34567893	10 11 12		
Titl	e of Lesson	Sequences applying	and Series: Le	earning, teachi	ng and	Lesson Duratio	n 3H	ours		
Les	son description	This is the second lesson under the topic Further Algebra in Year two Semester 1. Number and Algebra treated in Year one Semester two is a pre-requisite of this lesson. General introduction of course manual has been discussed in lesson one to enable student teachers to audit their content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions in sequences and series. The areas to be covered include the concept and definition of sequences and series, establishing the nth term and sum of an AP, establishing the nth term and sum of a GP, and application of sequences and series to solving real life problems. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of operation of numbers. The main lesson focuses on reviewing the student teachers' conceptual understanding of sequences and series.								
Pre tea pric (ass	vious student cher knowledge, or learning sumed)	Student teachers have knowledge on operations of numbers and their properties from Basic School mathematics, JHS mathematics and SHS Core mathematics.								
Pos leai less	sible barriers to ning in the on	Different e Some stud mathemati	ntry behaviou lent teachers ics teachers to	rs, Socio-cultui may come support them	ral issues, diff SHS schools understand l	erent learning need where they did pasic concepts in Se	ds, not have teache equences and Ser	ers or good ies.		
Les	son Delivery –	Face-to-	Practical	Work-	Seminars	Independent	e-learning	Practicum		
cho stuo ach out	sen to support dents in ieving the comes	face	Activity	Based Leaning		Study	opportunities			
mai deli sup tea the out	in mode of very chosen to port student chers in achieving learning comes.	brainstorm not usually Independe promote ir part of any E-learning environme	ing, question be the main r nt study: to odividual and c of the above opportunitie nts. This can b	and answer, e node. enable stude collaborative e modes s – involving pe part of any	ents to engagenquiry, more the use of the above	be tutor and / or s ge with relevant a in-depth analysis a of interactive pao modes of delivery.	and appropriate and development ckages and virtu	ad lt should materials to This can be ual learning be a delivery		
•	Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description.	 mode in its own right. The purpose of the lesson is to; build on thecontent knowledge and experiences of student teachers to establish their competence in handling sequences and series problems and address their learning needs, perceptions and misconceptions about it. develop student teachers' understanding of sequences and series and how to apply these concepts in other fields of mathematics. to develop student teachers' conceptual knowledge in order to prepare them well enough to be able to handle concepts sequences and series as required by the JHS curriculum. To create awareness of the student teachers in building on what has been learnt previously in 								
•	Learning Outcome for the lesson, picked and developed	Learning O	utcomes	Learning Ind	icators	Identify Which and transferal and addressing addressed or d	n cross-cutting i ble skills, inclusi g diversity. How v eveloped?	ssues- core vity, equity vill these be		
•	trom the course specification Learning indicators for each learning outcome	 Demo under Seque Series NTEC Use a 	onstrate the rstanding of ences and 6 (NTS 2c, 3i, F Pillar 1) variety of	 Identify a the chara the prop sequence Evaluate sequence 	and analyse acteristics and erties of es and series a defined	 Problem s thinking:th facts and c Communic discussion, of results 	solving, critical a prough objective concepts ation skills: , critiquing and p	and creative analysis of through resentations		
				sequence	es anu series	 Respect an 	iu ulversity: desig	ning lesson		

	 activities or ways in learning Sequences and Series concepts. (NTS 3e, 3f, 3g, 3k, 3l, 3m, 3n, 3o, 3p NTECF pillar 4) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom. (NTS, 2f) 	 strategies and illustrate how these concepts are applied in real lie situations, as well as, in teaching Identify and outline strategies used in the basic school curriculum for teaching the development of sequences from number arrays in their collaborative group work on sequences and series Stage/ Teaching and learning 		 Personal development: Through presentation and developing of arguments to ensure the development of conceptual understanding Equity and inclusivity: Providing equitable learning opportunities for all learners. 		
Торіс	Sub-topic(s)	Stage/ Teaching and learnin		ng to activities to achieve learning outcomes lelivery mode selected. Teacher-lead		
		collaborative groupw		work or independent. Student Activity		
			I eacher Activity	Evolore the concept of sequences through		
	Meaning and types of arithmetic sequences and series;	40 mins	concept of sequence using counting, skip counting, calendar and other number arrays.	Line content of sequences through counting, skip counting, calendar and other number arrays. Eg. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 1, 6, 11 ,; 6,7,8,; 3,9,15, etc.		
Arithmetic Sequences and Series: Learning	Finding the general (nth) term of arithmetic sequences and series	40 mins	Model exploration of types (finite and infinite) arithmetic sequences and series,	Use interactive and collaborative group work, with the aid of ICT tools and other manipulatives to explore the types of arithmetic progression (AP).		
Arithmetic Sequences and Series: Learning and applying	40 mins Finding sum of n terms of arithmetic sequences (series)		Initiate an investigation to establish the rule for finding the nth term of arithmetic progression. Eg. Find the 7 th term of 3,9,15, Assign student teachers to work more examples on AP.	Use interactive and collaborative group work, with the aid of ICT tools and other manipulatives to explore the nth term of arithmetic progression. (ie. $U_n = a + (n - 1)d$, Where "a" is the first term, n is number of terms, d common difference and U_n the general or indicated term. Work more examples on APs.		
	Application of	40 mins	investigation to establish the rule for finding the sum of the first <i>n</i> terms	work, with the aid of ICT tools and other manipulatives to explore the sum of the first <i>n</i> terms of arithmetic progression. (ie. $S_n = \frac{n}{2} \{2a + (n-1)d\}$, where a is		

	arithmetic sequences and series		of arithmetic progression Assign student teachers to work more examples on	first term, n is number of terms, d common difference and S_n the sum of the first "n" terms of the given sequence. Work more examples on sum of Aps				
		20 mins	AP. Assign student teachers to pose and solve real life problems.	Pose and solve real life problems on AP for peer review.				
Lesson assessments – evaluation of learning: of, for and as learning within the lesson	 Group assignment for 1 Students teachers series to be submitasks that encouration for learning) NTS 2 economic and edutes Student teachers to design worksheets uses a variety of teachers to be submit as a series of teachers to be submit as a s	nent for PTP teachers are assigned to complete exercises on types of arithmetic sequences and be submitted for peer review (Assessment for learning) NTS 3h - Set meaningful encourages learner collaboration and leads to purposeful learning. (Assessment ng) NTS 2f - Takes accounts of and respects learners' cultural, linguistic, socio- and educational backgrounds in planning and teaching eachers to outline real life applications of arithmetic sequences and series and to prksheets for presentation in class. (Assessment for learning) NTS 3j - Produces and riety of teaching and learning resources including ICT, toenhance learning.						
Instructional Resources	Globe, mathematical se	et, manila	cards, permanent mai	rkers, oranges and a knife.				
Required Text (core)	Gordor, B. K., Naandam Accra: Sam-Wo <u>https://amsi.org.au/tea</u>	n, S. M., 8 oode Ltd. acher mo	k Nkansah, B. K. (2012) odules/Indices and log	. Core mathematics for senior high schools. garithms.html. Retrieved 20-06-2019				
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	 How to design and/ in arithmetic seque Instructional strate, mathematics to otl Design and use of n 	or use so ences and gies need her curric number a	me innovative materia d series. ded to consciously com culum areas and to the rrays to generate arith	Is and ideas for teaching selected concepts nect mathematical ideas, as well as, connect world outside metic sequences				

Ye	ar of B.Ed. 2	Semes	iter 1	Place of	lesson in s	emester	2 3 4 5 6 7 8	9 10 11 12			
T:+	la of Losson	Seguene	as and Sarias	Loarning to	aching and	Losson Durati	on 2	Hours			
III	e of Lesson	applying	2	Learning, teo	icning ana	Lesson Durati	on 3	Hours			
Les	son description	This is th	e third lesson	under the to	pic Further A	gebra in Year t	wo Semester 1. N	lumber and			
		Algebra	treated in Year	one Semest	er two as wel	l as SHS mathe	matics curriculur	n are pre-			
		requisite	of this lesson.	The concep	t of sequence	es and series ha	is been discussed	in lesson one,	,		
		with em	onasis on arith	metic progre	ession, to enal	ole student tea	chers to audit th	eir content			
		misconce	ge and experie	inces to esta	orios Tho aro	ress their learn	d include review	of arithmetic			
		sequenc	sequences, establishing the <i>nth</i> term and sum of a Geometric Progression (GP) and application								
		of geom	of geometric sequences and series to solving real life problems.								
		The less	The lesson begins with starters or mental mathematics games, reinforcement games and								
		activities	activities about knowledge of sequences. The main lesson focuses on reviewing the student								
		teachers	' conceptual u	nderstanding	g of sequence	s and series.					
Pre	vious student teacher	Student	teachers have	e knowledge	on operation	ns of numbers	and their prope	erties from Ba	sic		
kno	owledge, prior	School m	nathematics, JH	IS mathemat	tics and, sequ	ences and serie	es from SHS Core	mathematics.			
lea	rning (assumed)	D://			1. 1.						
Pos	ssible barriers to	Different	t entry behavio	ours, Socio-ci	ultural issues,	different learn	ing needs,	anchara ar an	ad		
iea	rning in the lesson	some st	atics teachers	s may come	e to SHS SCho Sem understa	nd advanced or	y did not nave t	eachers or go	ou		
les	son Delivery – chosen	Face-	Practical	Work-	Seminars	Independen	t e-learning	Practicu	3. m		
to	support students in	to-face		Based	o cilinai o	Study	opportunit	es			
ach	nieving the outcomes			Leaning							
	-										
Les	son Delivery – main	Face-to-	face: oppo	rtunity for	an extended	and coheren	t line of argum	ent. It includ	les		
mo	de of delivery chosen	discussic	on, brainstorm	ing, questior	and answer,	etc. This can l	pe tutor and / or	student teach	ner		
to	support student	led. It sh	ould not usual	ly be the mai	in mode.						
tea	chers in achieving the	Practical	Activity: en	abling expe	erimentation	and the ana	lysis and discu	ssion of issue	es,		
iea	rning outcomes.	Indepen	dent study. t	ais, as well as o enable stu	s priysical acti idents to eng	villes. age with relev	ant and annronr	iate materials	to		
		promote	individual and	d collaborativ	ve enquirv. m	ore in-depth ar	alvsis and devel	opment. This c	an		
		be part o	of any of the ab	ove modes			,				
		E-learnir	ng opportunit	<i>ies –</i> involv	ing the use	of interactive	e packages and	virtual learni	ing		
		environr	nents. This ca	n be part of	any of the	above modes	of delivery. It is	unlikely to be	e a		
		delivery	mode in its ow	n right.							
•	Purpose for the	The	purpose of the	e lesson is to:							
	lesson, what you	• build	d on the cont	ent knowled	lge and expe	eriences of stu	dent teachers t	o establish the	eir		
	want the students to	com	petence in na	isconception	ences and ser	les problems a	ind address thei	r learning need	as,		
	basis for the learning	e deve	eptions and m	eachers' und	lerstanding o	f sequences ar	d series and ho	w to apply the	250		
	outcomes. An	cond	cepts in other f	ields of mat	nematics	i sequences u					
	expanded version of	• deve	elop student to	eachers' con	ceptual know	ledge in order	to prepare then	n well enough	to		
	the description.	be a	ble to handle o	concepts seq	uences and s	eries as require	d by the JHS curi	iculum.			
٠	Learning Outcome	Learning	Outcomes	Learning In	dicators	Identify W	hich cross-cutt	ng issues- co	ore		
	for the lesson,					and transf	erable skills, in	clusivity, equi	ity		
	picked and					and addres	sing diversity. H	ow will these	be		
	developed from the	e Dom	anstrata	• Identif		addressed	f ICT: USO [vool and oth	r		
•	Learning indicators	 Definition know 	vledge and	 fundar 	y allu allalyse nontal idoas		sheets to evolor	e different typ			
•	for each learning	conc	entual	underl	ving the	of sec	suences to dis	cover the ne	ed.		
	outcome	unde	erstanding of	princip	les of	forInte	grating ICT in de	veloping numb	ber		
		fund	amental	geome	tric	and	algebraic con	cepts in t	he		
		idea	s underlying	sequer	nces and	mathe	matics classroom	. (CLO 2)			
		the	orinciples of	series a	and to	Proble	m solving, criti	cal and creati	ive		
		geor	netric	presen	t their	thinkir	g:through objec	ctive analysis	of		
		sear	iences and	finding	s	facts a	nd concents				

	series; (NTS 2c, 3i, NTECF Pillar 1) Demonstrate knowledge and understanding of how to use a variety of activities or ways in learning concepts based on geometric sequences and series, including finding the general (nth) term of geometric sequences and series N(TS 3e, 3f, 3g, 3k, 3l,	 Make of between mather concep geome sequer series and to teachir real-lift as we concep mather curricut 	connections en matical ots in etric nces and apply them in ng and solving e problems, ill as, similar ots in JHS matics ilum	 Personal development: Through presentation and developing of arguments to ensure the development of conceptual understanding Equity and inclusivity: Providing equitable learning opportunities for all learners 		
	 3m, 3n, 3o, 3p NTECF pillar 4) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom.(NTS, 2f) 	 Participate in collaborative group work on geometric series and sequences and support others in their groups who might need it 				
Торіс	Sub-topic(s)	Stage/ Time	Teaching and	l learning to activities to achieve learning pending on delivery mode selected. Teacher- ative groupwork or independent.		
			lead collabora	tive groupwork or independent.		
			lead collabora Teacher Activity	Student Activity		
	Meaning and types of geometric sequences and series;	40 mins	lead collabora Teacher Activity Introduce the concept of geometric sequence using the notion of repeated multiplication	Explore the concept of geometric sequences through using the notion of repeated multiplication. Eg. The repeated factors 2, 2 × 2, 2 × 2 × 2, 2 × 2 × 2 × 2, will lead to the sequence 2,4,8,16, which satisfies the rules of a GP		
Geometric Sequences and Series: Learning and applying	Meaning and types of geometric sequences and series; Finding the general (nth) term of geometric sequences and series	40 mins 40 mins	lead collabora Teacher Activity Introduce the concept of geometric sequence using the notion of repeated multiplication Model exploration of types (finite and infinite) geometric sequences and series,	tive groupwork or independent. Student Activity Explore the concept of geometric sequences through using the notion of repeated multiplication. Eg. The repeated factors 2, 2 × 2, 2 × 2 × 2, 2 × 2 × 2 × 2, will lead to the sequence 2,4,8,16, which satisfies the rules of a GP Use interactive and collaborative group work, with the aid of ICT tools and other manipulatives to explore the types of geometric progression. Eg divergent, convergent, etc		

			Eg. Find the	Work more examples on GPs.
			3,9,15,	
			Assign	
	Application of		teachers to	
	geometric sequences		work more	
	and series		examples on	
			GP.	
			Initiate an	Use interactive and collaborative group
		10	investigation	work, with the aid of ICT tools and other
		40 mins	to establish	manipulatives to explore the sum of the first n terms of a progression
			finding the	(i.e. $S = \frac{a(r^n - 1)}{r}$, $r > 1$
			sum of the	$\sum_{n=1}^{n} \sum_{r=1}^{n} \sum_{r$
			first <i>n</i> terms	or $S_n = \frac{1}{1-r}$, $r < 1$, where <i>a</i> is first torm <i>n</i> is number of terms <i>r</i> common
				ration and S_n the sum of the first <i>n</i> terms
				of the given sequence.
			Accien	Work more examples on sum of GPs
			student	
			teachers to	
			work more	
			examples on	
			GP.	
		20 mins	Assign	Pose and solve real life problems on AP for
			student	peer review.
			pose and	
			solve real life	
			problems	
			involving GP.	
Lesson assessments –	Class discussions		1	
evaluation of learning:	1. Students teache	rs are assign	ed to complete e	exercises on geometric sequences and series
of, for and as learning within the lesson	uses a variety of	teaching an	d learning resour	rces including ICT, toenhance learning.
	2. Student teachers	s to outline r	real life application	ons of geometric sequences and series and to
	design workshee	ets for prese	ntation in class. (Assessment for learning) NTS 3j - Produces
Instructional Resources	Graph sheets, mathem	atical set. m	anipulative mate	rials, permanent markers, calculators, mobile
	phones, Geogebra App	s.;		
Required Text (core)	Gordor, B. K., Naandan	1, S. M., & N · Sam-Wood	kansah, B. K. (20: Io I td	12). Core mathematics for senior high
	https://amsi.org.au/tea	acher modu	iles/Indices and	logarithms.html. Retrieved 20-06-2019
Additional Reading List	Ministry of Education (2015). Core	mathematics mo	dules for SEIP. Accra: Ministry of Education.
	Accra: Ministr	y of Educatio	on, Science and S	ports.
	Martin, J. et. al. (1994).	Mathemati	ics for teacher tro	ining in Ghana: Tutor notes. Accra: Unimax
	Publishers.	Math		ining in Change Chudants within Assu
	Unimax Publishers.	. iviatnemati	us jor teacher tro	inning in Griana: Students activities.Accra:
CPD NEEDS	 How to design and/ 	or use some	e innovative mate	erials and ideas for teaching selected
	concepts in geome	etric sequenc	ces and series.	
	Instructional strate	gies needed	to consciously c	onnect mathematical ideas, as well as,
	connect mathemat	tics to other	curriculum areas	s and to the world outside

Year of B.Ed. 2	Semeste	e r 1	Place of I	esson in se	emester	123	3 4 5 6 7 8	910111	2	
Title of Lesson	Quadratic	functions: <i>Le</i>	arnina teach	ing and appl	vina L		ration	3 Hours		
	Quadratic	unctions. Ec	unning, teach	ing and apply				STIGUIS		
Lesson description	understanding of concepts acquired by studying Number and Algebra treated in Year one Semester two, as well as, topics covered in SHS core mathematics curriculum are pre-requisites for this lesson. To help student teachers develop conceptual understanding of concepts in this lesson, some fundamental concepts in quadraticequations (studied at the SHS) will be reviewed. This will enable student teachers to audit their content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions in quadratic equations and to support them continue to keep them in focus about their journey of becoming mathematics teachers at the JHS level. The areas to be covered include Nature and types of quadratic functions; Forming quadratic functions, expressing a quadratic function in the form: $y = ax^2 + bx + candf(x) = a(x - b)^2 \pm c$. Methods of solving quadratic equations, graphs of quadratic functions; application of quadratics to solve real life problems. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of sequences. The main lesson focuses on reviewing the student teachers' conceptual understanding of quadratic equations in order to prepare them to handle future mathematics classroom with respect to quadratic equations, their applications and other related concepts.									
Previous student teache knowledge, prio learning (assumed)	r Student te r School mat	Student teachers have knowledge on operations of numbers and their properties from Basic School mathematics, JHS mathematics and, sequences and series from SHS Core mathematics.								
Possible barriers t learning in the lesson	Different e Some stud	ntry behavio ent teachers cs teachers t	urs, Socio-cu s may come	ltural issues, to SHS scho em understar	different l ols where	earning r e they di ed conce	needs, id not have t opts in Quadra	eachers or a	good	
Lesson Delivery – choser to support students in achieving the outcomes	Face-to- face	Practical Activity	Work- Based Leaning	Seminars	Indepe Stue	ndent dy]	e-learning opportunit	g Practi es	icum	
Lesson Delivery – mai mode of delivery chose to support studen teachers in achieving th learning outcomes.	 Face-to-face brainstorm not usually Practical A and materi Independe 	Face-to-face: opportunity for an extended and coherent line of argument. It includes discussion, brainstorming, question and answer, etc. This can be tutor and / or student teacher led. It should not usually be the main mode. Practical Activity: enabling experimentation and the analysis and discussion of issues, documents and materials, as well as physical activities. Independent study: to enable students to engage with relevant and appropriate materials to								
	be part of a E-learning environme mode in its	any of the ab opportuniti nts. This can own right.	ove modes ies – involvi be part of ar	ing the use of the abov	of interview of of interview of of of the official offici	active p of delive	ackages and ry. It is unlikel	virtual lea y to be a del	rning ivery	
 Purpose for th lesson, what yo want the students t achieve, serves a basis for the learnin outcomes. A expanded version o the description. 	 The purpose build t their of concept develop concept to develop to develop build t 	se of the less hepedagogic competencie ots to addres p student t ots in other a elop student le to handle ilum.	son is to; cal content kr s and level s their learni eachers' und reas of math t teachers' co e concepts o	nowledge and of confidenc ng needs, per lerstanding c ematics nceptual kno f quadratic e	l experien e in hand rceptions a of quadrat owledge in equations	ces of stu dling qua and misco tic equat order to as requ	udent teacher adratic equat onceptions ab ions and how prepare the ired by the J	s to help dev ons and re out it. v to apply t n well enou HS mathem	velop lated :hese gh to natics	

 Learning Outcome for the lesson, picked and developed from the course specification Learning indicators for each learning outcome 	 Learning Outcomes Demonstrate knowledge and the understanding of quadratic functions (NTS 2c, 3i, NTECF Pillar 1) Use a variety of activities or ways in learning quadratic functions concepts. (NTS 3e, 3f, 3g, 3k, 3l, 3m, 3n, 3o, 3p NTECF pillar 4) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom. (NTS, 2f) 	 Identify charact propert functio Use ag subjec pedag knowl used t relate functi Basic 1 in a br releva mann Identi demo for pa suppo succeo group quadr 	dicators y and analyse the teristics and the ties of quadratic ns ge appropriate ct knowledge, togical content ledge that can be to teach concepts d to quadratic ons found in the School Curriculum road, balanced, int and creative er. fy and nstrate the need rticipating and orting others to ed in collaborative work on atic functions	 and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed? Digital literacy: doing internet search for relevant information on strategies for exploring the properties of quadratic functions Deep understanding of the subject content and ability to teach this using teaching and assessment strategies appropriate for JHS. Consideration for formal abstract teaching Collaboration between teachers of other subjects (e.g. Mathematics teaching vectors or trigonometry in collaboration with ICT teacher) Equity and inclusivity: Providing equitable learning opportunities for all learnersand Identifying student teachers who might need intensive interventions and plan accordingly (identify support human resources) rning to activities to achieve learning ing on delivery mode selected. Teacher- 		
Торіс	Sub-topic(s)	Stage/Ti Teaching a		arning to activities to achieve learning		
		me	outcomes depend lead collaborative	ling on delivery mode selected. Teacher- groupwork or independent.		
			Teacher Activity	Student Activity		
Quadratic functions: Learning, teaching and applying	Nature and types of quadratic functions;	40 mins	Engage student teachers to give their past experiences of how they were taught quadratic functions previously.	Outline and discuss the learning trajectory their mathematics teachers at the SHS used in teaching quadratic functions and to suggest strategies that can be used to model effective teaching.		
	Forming quadratic functions expressing a quadratic function in the form: $y = ax^2 + bx + c$, and $f(x) = a(x - b)^2$ $\pm c$.	60 mins	Introduce student teachers to practical everyday activities to generate sequences that can be used to form quadratic expressions, e.g., handshake problem, algebraic tiles, etc., (PD Theme 1)	Use handshake and other practical activities to explore sequences that form quadratic expressions. No. of people 1 2 3 4 5 No. of hand 0 1 3 6 1 shakes 5 The sequence 0, 1, 3, 6, 15, above can be used to form quadratic function of the form $f(n) = \frac{n(n+1)}{2}$ Or $f(n) = \frac{1}{2}(n^2 + n)$		

			Lead an	Explore the nature of quadratic
		40 mins	investigation to	expressions by finding common differences
			explore the	between consecutive terms, using
			nature of	differentiated teaching with the aid of aid
			quadratic	of ICT tools such as Geogebra (software).
			expressions by	<u> </u>
			finding common	
			differences	
			between	
			consecutive	
			terms, as well as.	
			using ICT tools.	
			Engage student	Use group activities, supported by ICT
			teachers to use	tools to explore the roots of quadratic
			interactive	equations, finding sums and products of
			group work	given equations and to establish other
			using ICT to	quadratic equations based on the given
		40 mins	explore the	roots.
			roots of	Solving quadratic equations by
			quadratic	factorization, completing the square, the
			equations,	general quadratic formula and graphical
			finding sums and	approach, through student-teacher
			products of	initiated and tutor supported
			given equations	presentations.
			and to establish	Expressing quadratic function in the form
			other quadratic	$f(x) = a(x-b)^2 \pm c$ by method of
			equations based	completing the square in small groups.
			on given roots.	
Lesson assessments –	Student teachers to disc	cuss and begi	in building their prot	fessional teaching portfolios (PTP) to be
evaluation of learning:	presented at end of the	10 th week of	the semester. Stud	ent teachers are assigned to complete
of, for and as learning	exercises on quadratic f	unctions to b	be submitted for pee	er review (Assessment for learning) NTS 3j-
within the lesson	Produces and uses a var	riety of teach	ing and learning res	ources including ICT, to enhance learning.
Instructional Resources	Graph sheets, mathema	itical set, ma	nipulative materials	, permanent markers, calculators, mobile
	phones, Geogebra Apps	i.;		
Required Text (core)	Gordor, B. K., Naandam	, S. M., & Nki	ansah, B. K. (2012).	Core mathematics for senior high schools.
	Accra: Sam-Wo	ode Ltd.		
	https://amsi.org.au/tea	cher module	es/Indices and loga	irithms.html. Retrieved 20-06-2019
Additional Reading List	Ministry of Education (2	2015). Core m	athematics module	s for SEIP. Accra: Ministry of Education
5	Ministry of Education. (2	2010). Teach	ina svllabus for core	mathematics (Senior High School). Accra:
	Ministry of Edu	ucation. Scier	ice and Sports.	
	Martin. J. et. al. (1994).	, Mathematic	s for teacher trainin	a in Ghana: Tutor notes. Accra: Unimax
	Publishers.			5
	Martin, J. et. al. (1994).	Mathematic	s for teacher trainin	g in Ghana: Students activities.Accra:
	Unimax Publishers.		,	5
CPD NEEDS	• How to design and/o	or use some i	nnovative materials	and ideas for teaching selected concepts in
	quadratic equations	s, e.g., hands	hake problem, algel	braic tiles
	 Instructional strateg 	ies needed t	o consciously conne	ct mathematical ideas, as well as, connect
	mathematics to oth	ner curriculur	n areas and to the w	vorld outside
	How to use Geogebr	ra (software)	to explore concepts	based on quadratic functions.

Year of B.Ed. 2	Semest	ter 1	Place of	ace of lesson in semester		1234	567891	0 11 12	
Title of Lesson	Quadratic	functions: <i>L</i>	earning, teac	hing and	Lesson Durat	ion	3 Hours		
Lesson description	This is the fifth lesson under the topic Further Algebra in Year two Semester 1. Quadratic equations in lesson four of year two semester 1, as well as SHS mathematics curriculum are pre-requisite of this lesson. Basic concepts in quadratic equations studied at the SHS will be reviewed to enable student teachers to audit their content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions in quadratic equations. The areas to be covered include Roots of quadratic equations; nature of roots, quadratic inequalities and application of quadratics to solve real life problems. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge gained from the previous lessons. The lesson focuses on reviewing the student teachers' conceptual understanding of quadratic equations in order to prepare them to handle future mathematics classroom with respect to quadratic equations and their applications.								
Previous student teacher knowledge, prior learning (assumed)	Student teachers have knowledge on operations of numbers and their properties from Basic School mathematics, JHS mathematics and SHS sequences and series from SHS Core mathematics.								
Possible barriers to learning in the lesson	Different e Some stue mathemat	entry behavi dent teache tics teachers	ours, Socio-c rs may come to support th	ultural issues, e to SHS sch hem understa	different lear ools where th nd advanced o	ning need ney did no concepts i	s, ot have teach n Quadratic fu	iers or good inctions.	
Lesson Delivery – chosen to support students in achieving the outcomes	Face-to- face	Practical Activity	Work- Based Leaning	Seminars	Independe Study	ent op	e-learning oportunities	Practicum	
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	Pace-to-fa brainstorn not usuall Practical A and mater Independe promote i be part of E-learning environme mode in it	ning, questic y be the mai Activity: ena rials, as well ent study: t ndividual an any of the a g opportunit ents. This ca s own right.	unity for an e on and answe in mode. bling experim as physical ac o enable stuc d collaborativ bove modes ies – involving n be part of a	xtended and er, etc. This can nentation and ctivities. dents to engag ve enquiry, m g the use of ir any of the abo	the analysis a the analysis a with relevant ore in-depth a nteractive pack ve modes of d	of argume d / or stude and discuss nt and app analysis an kages and delivery. It	nt. It includes ent teacher le sion of issues, propriate mate d developmer virtual learnir is unlikely to l	discussion, d. It should documents erials to nt. This can lg be a delivery	
 Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description. 	 mode in its own right. The purpose of the lesson is to; build the pedagogical content knowledge and experiences of student teachers to help develop their competencies and level of confidence in handling quadratic equations inequalities and related concepts to address their learning needs, perceptions and misconceptions about it. develop student teachers' conceptual understanding, procedural fluency, and strategic competence needed to apply the knowledge gained in this lesson in other areas of mathematics to develop student teachers' conceptual knowledge in order to prepare them well enough to be able to handle concepts of quadratic equations and related concepts as required by the JHS 							help develop qualities and about it. and strategic ner areas of ell enough to ed by the JHS	
• Learning Outcome for the lesson, picked and developed from the course specification	Learning (Dutcomes	Lear	ning Indicato	rs	Identify V core and inclusivity diversity. addresse	Which cross-c nd transfer y, equity and How will d or develope	utting issues- able skills, d addressing these be ed?	
 Learning indicators for each learning outcome 	Dem know unde quad and i 2 c 3	onstrate vledge and erstanding of lratic equation inequalities	f ons (NTS ar 1)	Identify and strategies fo problems in equations in and discussin neers	analyse r solving quadratic equalities ng with	 Social throug literad mathe learne mathe 	and commun gh developing cy and languag ematics to sup ersto commun ematical think	ication skills: specific ge of pport licate their	

	 Demonstrate competencies in t use of variety of v designed activities based on multiple representations in hands-on learning mode to develop concepts based on quadratic equatio and inequalities. (3e, 3f, 3g, 3k, 3l, 3 3n, 3o, 3p NTECF 4) Demonstrate valu well as respect for equity and inclusi the learning and teaching of conce based on quadrat equations and inequalities (NTS, 	the vell- s a a g n ons NTS Bm, pillar e as r on in pts ic 2f)	 Explation for some sequation of the sequatio	in the strategies olving quadratic tions and ualities using iple representation estrate well- ned instructional ities in a hands-on ing mode, using iple esentations ding the use of ICT to develop epts based on ratic equations and ualities ify gender roles e in the curriculum over- esentation of boys aths), personal bias stereotypes as well stitutional imination within ubject	•	coherently for academic purposes Use of ICT: Integrate ICT in developing number and algebraic concepts in the mathematics classroom Personal development: Through presentation and developing of sound arguments Inclusion and Equity:by producing learning opportunities that target specific themes in the subject matter, and encouraging all to participate
Торіс	Sub-topic(s)	Stage/	/Time	Teaching and learn outcomes depend Teacher-lead collab	ing ling ora	to activities to achieve learning on delivery mode selected. tive groupwork or independent.
				Teacher Activity		Student Activity
Quadratic functions: Learning, teaching and applying 2	Methods of solving	10	mins	Engage student teachers to give the knowledge on the previous lesson (quadratic function	eir s)	Discuss and supply feedback on their knowledge on quadratics during the previous lesson.
	quadratic equations			Lead discussion on		Participate in discussions for
		40 mir	ns	methods of solving quadratic equations	5	finding appropriate strategies for solving quadratic equations.
	Graphs of quadratic functions;	40 mir 40 mir	ns	methods of solving quadratic equations Supply student teachers with manipulative materials including graphs and graph sheets to analyze the relationships between the	5 ne	Engage in interactive activities to explore relationships between the functions $y = x^2$ and $y = ax^2 + bx + c$, as transformations
	Graphs of quadratic functions; Roots of quadratic equations;	40 mir	ns	noting the various methods of solving quadratic equations Supply student teachers with manipulative materials including graphs and graph sheets to analyze th relationships between the function $y = x^2$ and $y = ax^2 + bx + c$, as transformations.	ne d	Engage in interactive activities for solving quadratic equations. Engage in interactive activities to explore relationships between the functions $y = x^2$ and $y = ax^2 + bx + c$, as transformations Use group activities, supported by ICT tools to explore the roots of quadratic equations, finding sums and products of given equations and to establish other quadratic equations based on

				inform the selection of solution			
			Task student teachers	strategies			
			to discuss the nature	00.000			
			of roots of given				
			quadratic equations				
			and how this can				
			inform the selection				
	Quadratic		of solution				
	inequalities		strategies				
	inequalities		(PD Theme 1)				
			Lead an investigation	Explore the strategies for solving			
		50 mins	to explore the	problems based on quadratic			
		50 11115	strategies for solving	inequalities including algebraic			
			nrohlems based on	and granhical with the aid of ICT			
			quadratic	tools using differentiated			
			inequalities including	teaching			
			algebraic and	teaching.			
			graphical with the				
			aid of ICT tools				
Lesson assessments –	Project work for the se	emester	I				
evaluation of learning:	1.						
of, for and as learning	a. Identify real li	fe or practical ac	tivities that can generat	te quadratic sequences. Example,			
within the lesson	comparing n	umber of people	to number of handsha	ake or the use of floor tiles and			
	linoleum, etc						
	b. Outline the ap	propriate proced	ures for designing your	model and explain how to use it			
	with specific	example outlined.					
	c. State and justify which learning outcome(s) the design and use the TLMs will satisfy.						
	2 2 Design mode	ls for teaching ou	adratic expressions and a	auation			
	NTS 3i - Produces and u	ises a variety of te	eaching and learning reso	ources including ICT toenhance			
	learning NTS 3h - Sets r	neaningful tasks t	hat encourages learner o	collaboration and leads to			
	nurnoseful learning N	ricaringraficasio (S 2f - Takes accou	ints of and respects lear	ners' cultural linguistic socio-			
	economic andeducatio	nal backgrounds i	n planning and teaching				
Instructional Resources	Graph sheets, mathem	atical set. manip	ulatives, permanent ma	rkers, calculators, mobile phones.			
	Geogebra Apps.;						
Required Text (core)	Gordor, B. K., Naandan	n, S. M., & Nkansa	h, B. K. (2012). <i>Core ma</i>	thematics for senior high schools.			
	Accra: Sam-W	oode Ltd.					
	https://amsi.org.au/tea	acher_modules/In	dices_and_logarithms.ht	tml. Retrieved 20-06-2019			
Additional Reading List	Ministry of Education (2015) Core math	ematics modules for SEID	Accra: Ministry of Education			
Additional Reading List	Ministry of Education ((2013). Core mutine (2010) Teaching s	cullabus for core mathem	atics (Senior High School) Accra:			
	Ministry of Ed	ucation Science a	nd Sports	and senior right schooly. Accia.			
	Martin L et al (1994)	Mathematics for	teacher training in Ghar	a: Tutor notes Accra: Unimax			
	Publishers	. Wathematics joi					
	Martin L et al (1994)	Mathematics for	teacher training in Ghan	a. Students activities Accra			
	Unimax Publishers.	i mathematics jor	teacher training in Onan				
CPD NEEDS	• How to design and/o	r use some innova	ative materials and ideas	for teaching selected concepts in			
	further algebra						
	Instructional strategi	es needed to cons	ciously connect mathem	atical ideas, as well as, connect			
	mathematics to othe	r curriculum areas	and to the world outsid	е			
	 Using Geogebra and 	other resources to	explore concepts in qua	adratic equations and inequalities.			

Year of B.Ed. 2	Seme	ster 1	Place of	Place of lesson in semester			123456789101112			
Title of Lesson	Polynomia	s: Learnina. te	eachina and ar	oplvina		Lesson Dura	tion	3 Hou	ırs	
			y							
Lesson description	This is the s treated in v quadratic e content kn misconcep operations application mathemati lessons. Th polynomial polynomial	This is the sixth lesson under the topic Further Algebra in Year two Semester 1. Number and Algebra treated in Year one Semester two is a pre-requisite of this lesson. Basic concepts in algebra and quadratic equations studied at the SHS will be reviewed to enable student teachers to audit their content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions in quadratic equations. The areas to be covered include nature of polynomials, operations on polynomials; factorization of polynomials, The Remainder and Factor theorems and applications of polynomial functions to real life situations. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge gained from the previous lessons. The lesson focuses on reviewing the student teachers' conceptual understanding of polynomials in order to prepare them to handle future mathematics classroom with respect to polynomials and their applications.								
Previous student	Student te	achers have l	knowledge on	operations	of numb	ers and thei	r propertie	es. The	v have also	
teacher knowledge,	studied qu	adratic funct	ions which is	a type of	polynor	nial functior	n. Student	teach	ers studied	
prior learning	algebraic (expressions a	is part of the	e mathemat	tics they	/ did in JHS	5, as well	as, in	SHS Core	
(assumed)	mathemati	CS.								
Possible barriers to	Different e	ntry behaviou	irs, Socio-cultu	ral issues, di	fferent l	earning need	s,			
learning in the lesson	Some stud	lent teachers	may come t	0 SHS school	ois whe	re they did	not have	teache	ers or good	
Lesson Delivery –	Face-to-	Practical	Work-	Seminars	Inde	nendent	e-learn	ing	Practicum	
chosen to support	face		Based	Jenniars		Study	opportur	nities	riacticum	
students in achieving			Leaning			\square				
the outcomes						-				
Lesson Delivery –	Face-to-fac	e: opportun	ity for an exte	nded and col	herent li	ne of argume	ent. It inclu	des dis	cussion,	
main mode of delivery	brainstorm	ing, question	and answer, e	tc. This can b	be tutor	and / or stud	ent teache	r led. It	should not	
chosen to support	usually be	the main mod	e.							
student teachers in	Practical A	ctivity: enabli	ng experiment	tation and th	ie analys	is and discus	sion of issu	es, doo	cuments	
achieving the learning	and materi	als, as well as	pnysical activi	ties.	with role	want and an	aropriato m	atoria	le to	
outcomes.	nromote in	dividual and o	filable student	nauiry more	• in-dent	h analysis an	d developr	nent T	his can he	
	part of any	of the above	modes	ingun y, more	e in acpt	in analysis an	u ucvelopi	incinci i		
	E-learning	opportunities	– involving th	e use of inte	ractive p	ackages and	virtual lear	ning		
	environme	nts. This can b	pe part of any	of the above	modes	of delivery. It	is unlikely	to be a	delivery	
	mode in its	own right.								
• Purpose for the	The purpos	se of the lesso	on is to;							
lesson, what you	 build of the second seco	of content kno	owledge and e	xperiences o	of studer	it teachers to	o establish	their c	competence	
students to	in nar miscor	contions in n	roperties of po	midis dilu o	aduress	their learni	ng neeus,	perce	puons and	
achieve, serves as	 develo 	n student tea	ichers' concen	tual underst:	anding c	of nolvnomial	s so they c	an and	annly such	
basis for the	knowle	edge and und	erstanding in	other areas	of mathe	ematics, as w	ell as, plan	and te	ach related	
learning	concer	ots in the JHS	mathematics o	urriculum.		,	<i>·</i> ·			
outcomes. An										
expanded version										
of the										
description.	Loorning O	utcomos	Loorning Indi	cators	Ida	ntify Mhich		ting i		
Learning Outcome for the	Learning O	utcomes	Learning mu	cators	an	d transferah	le skills i	inclusiv	vity equity	
lesson, picked					an	d addressing	diversity.	How w	vill these be	
and developed					ad	dressed or d	eveloped?			
from the course			Identify a	ind analyse	•	Social and	communic	ation s	kills:	
specification	• Demon	strate	equation	s that define		through d	eveloping s	specific	: literacy	
Learning	knowle	dge and	polynom	ial functions		and langua	age of math	nemati	cs to	
indicators for	the und	lerstanding	and expla	ain to membe	ers	support le	arnersto co	ommur	icate their	
	i or tund	amenial	τη τηθις α			mainemat	n ar minkin		TIME TO THE TAXES OF TAXES OF THE TAXES OF TAXES	

outcome	 concepts of polynomials. (NTS 2c, 3i, NTECF Pillar 1) Demonstrate knowledge and understanding of how to connect concepts in polynomial functions to other mathematics concepts, other disciplines, and to real-life situations. (NTS 3e, 3f, 3g, 3k, 3l, 3m, 3n, 3o, 3p NTECF pillar 4) Demonstrate value as well as respect for equity and inclusion in the mathematics classroom. (NTS, 2f) 	 characteristics and properties of graphs of polynomial functions using ICT tools and other manipulatives and communicate ideas to peers Compare the properties of operations on polynomial functions to those on numbers, e.g., commutative, associative, etc. Identify how concepts in polynomials can be connected to other areas both within and outside mathematics Solve problems based on polynomials using manipulatives and/or technology related strategies in a variety of ways to plan micro lessons that can support pupils with SEN in order to achieve their potential. Stage/Time 		acade Use o numb mathe Perso prese argun Respe solvin divers styles Proble creati solvin instru comp	emic purposes f ICT: Integrate ICT in developing per and algebraic concepts in the ematics classroom nal development: Through ntation and developing of sound nents ect and diversity: using problem ng strategies appropriate for se learners with different learning em solving, critical and ivethinking:Making problem- ng a central focus of mathematics ictions as well as an integral onent of assessment.
Торіс	Sub-topic(s)	Stage/Time	Teaching and	learning to	activities to achieve learning
			lead collaborat	ending on d ive groupwo	lelivery mode selected. Teacher- ork or independent.
			Teacher Activit	ïγ	Student Activity
Polynomials: <i>Learning,</i> teaching and applying	Nature of polynomial functions;	30 mins 30 mins	Engage student in a review of t previous knowl polynomial fun audit their expe and misconcep Initiate a discus explore the nat	t teachers heir edge on ctions to eriences tions ssion to cure of	Participate in a review of their previous knowledge on polynomial functions to audit their experiences and misconceptions to enable them to appreciate what they are likely to learn in the lesson, as well as, develop positive attitude towards the learning of
			polynomial fun Assign student	ctions. teachers	mathematics as developing teachers.
	Operations on	40 mins	with the aid of and other mate models to explo operations on p functions and t	ICT tools erials and pre polynomial heir	polynomial functions up to cubic functions through a collaborative work with the aid of manipulatives and/or relevant ICT tools.
	polynomials;		properties. Engage student	teachers	Explore operations and
		20 mins	to evaluate give polynomial fun	en ctions	properties on polynomial functions using appropriate supporting materials, in groups.
			Lead student te explore the Rer and Factor the	eachers to mainder prems	

	Factorization of		using the concept of	Evaluate a function at a point,					
	polynomials		Factor theorem to	$x_{o,i}e. f(x_{o,i}) = k$ through small					
		50 mins	factorize cubic functions	group activities.					
			leading to finding of roots						
			or zeros of given cubic	Explore the Remainder and					
			equations, using	Factor theorems using the					
	The Remainder and		independent study and	concept of factor theorem to					
	Factor theorems;		group work	factorize cubic functions leading					
				to finding of roots or zeros of					
			Assign student teachers	given cubic equations, using					
		10 mins	to explore applications of	independent study and group					
			polynomial functions to	work.					
			real life problems.						
				Use directed and guided					
				independent study or seminar					
	Applications of			to explore applications of					
	polynomial functions.			polynomial functions to real life.					
Lesson assessments –	1. Student teachers a	re assigned to	outline and analyse thenatur	re of polynomials. (Assessment as					
evaluation of	learning) NTS 3j - P	Produces and us	ses a variety of teaching and	learning resources including ICT,					
learning: of, for and as	to enhance learnin	g.							
learning within the	2. Student teachers a	re assigned, in	small groups, to do a brief ir	ternet search on the following:					
lesson	(to be presented for	(to be presented for peer review)The Remainder Factor Theorem, Factorization of polynomials							
	and Operation on polynomials. (Assessment as learning) NTS 3j - Produces and uses a variety of								
	teaching and learning resources including ICT, toenhance learning. NTS 2b - Has comprehensive								
	knowledge of the official school curriculum, includinglearning outcomes, NTS 2f - Takes								
	accounts of and re-	accounts of and respects learners' cultural, linguistic, socio-economic and educational							
	backgrounds in pla	nning and tead	hing.						
	Student teachers a	are assigned, in	small groups, to reflect on th	neir own learning experiences and					
	understanding of p	polynomials an	d how to apply it in real-life	problem-solving. (Assessment for					
	learning) NTS 1a- C	Critically and co	llectively reflects to improve	teaching and learning.					
Instructional	Graph sheets, mathem	atical set, mai	nila cards, permanent mark	kers, calculators, mobile phones,					
Resources	Geogebra Apps.;								
Required Text (core)	Gordor, B. K., Naandam,	, S. M., & Nkan	sah, B. K. (2012). <i>Core mathe</i>	ematics for senior high schools.					
	Accra: Sam-Wo	ode Ltd.							
	https://amsi.org.au/tead	<u>cher modules/</u>	Indices and logarithms.htm	l. Retrieved 20-06-2019					
Additional Reading	Ministry of Education (2	015). <i>Core mat</i>	hematics modules for SEIP. A	Accra: Ministry of Education.					
List	Ministry of Education. (2	2010). Teaching	g syllabus for core mathemat	ics (Senior High School). Accra:					
	Ministry of Edu	cation, Science	and Sports.						
	Martin, J. et. al. (1994).	Mathematics f	or teacher training in Ghana:	Tutor notes. Accra: Unimax					
	Publishers.								
	Martín, J. et. al. (1994).	Mathematics fo	or teacher training in Ghana:	Students activities.Accra: Unimax					
	Publishers.	-							
CPD NEEDS	How to design and/or us	se some innova	itive materials and ideas for	teaching selected concepts in					
	polynomial functions.								
	Instructional strategies	needed to cons	ciously connect mathematic	al ideas, as well as, connect					
	mathematics to other cu	urriculum areas	and to the world outside						

Year of B.Ed. 2	Seme	ster 1	Place of	lesson in s	emester 12	23456789	10 11 12		
Title of Lesson	Indices and applying	d Logarithm:	Learning, teacl	hing and	Lesson Dura	ation 3 Ho	urs		
Lesson description Previous student	This is the seventh lesson under the topic Further Algebra in Year two Semester 1. Number and Algebra treated in Year one Semester two is a pre-requisite of this lesson. The areas to be covered include the definitions of indices and logarithms establishing relationship between Indices and Logarithms, Laws of indices and logarithm. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of indices and logarithms. The main lesson focuses on reviewing the student teachers' conceptual understanding of indices and logarithms. Traditionally, indices and logarithms are taught as separate entities with emphasis on developing and using procedures. In this lesson, conscious effort will be made to connect related concepts using interactive pedagogy using appropriate tools to ensure effective participation by all student teachers.								
prior learning (assumed)	Different e	ntr (hahavia			fferent learning n				
learning in the lesson	Some stud mathemat	lent teacher ics teachers t	s may come t s support ther	o SHS schoo n understand	ls where they di concepts in Indic	d not have tead es and Logarithn	thers or good		
Lesson Delivery – chosen to support students in achieving the outcomes	Face-to- face	Practical Activity	Work- Based Leaning	Seminars	Independent Study 🔀	e-learning opportunities	Practicum		
mode of delivery chosen to support student teachers in achieving the learning outcomes.	brainstorm not usually Practical A and mater Independe promote in be part of E-learning environme mode in its	the opportunition of the main activity: enab ials, as well a ent study: to adividual and any of the ab opportunitie ents. This can s own right.	and answer, e mode. ling experimen s physical activ enable studen collaborative e ove modes s – involving th be part of any	tation and th ities. ts to engage enquiry, more of the above	e tutor and / or s e analysis and dis with relevant and e in-depth analysis ractive packages a modes of deliver	tudent teacher lo cussion of issues appropriate mat s and developme and virtual learni y. It is unlikely to	documents , documents rerials to nt. This can ng be a delivery		
 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 thecontent knowledge and experiences of student teachers to establish their competence in handling problems based on indices and logarithms and to address their learning needs, perceptions and misconceptions, as well as, develop the ability to plan a lesson on indices to be peer reviewed and included in a portfolio. develop student teachers' conceptual understanding of indices and logarithms and how these concepts can be applied in other areas, as well as, plan micro lessons based on related concepts in the JHS mathematics curriculum develop student teachers' conceptual knowledge in order to prepare them well enough to be able to handle concepts in indices and logarithms as required by the JHS curriculum. 								
 Learning Outcome for the lesson, picked and developed from 	Learning C	Outcomes	Learning Ir	ndicators	Identify core and equity a will these	Which cross-cu transferable ski nd addressing d e be addressed c	Itting issues- lls, inclusivity, iversity. How r developed?		
the course specification • Learning indicators for each learning	 Demorunders indices Logarit 3i, NTE 	nstrate the tanding of and hm(NTS 2c, CF Pillar 1)	 Identif charac proper logarit 	y and analyse teristics and t ties of indice hm	e the Soc the thro s and liter mat to c	ial and communi bugh developing racy and languag chematics to sup ommunicate the	cation skills: specific e of port learners ir		

outcome	 Use a variety of activities or wallearning indicellogarithm cond (NTS 3e, 3f, 3g 3l, 3m, 3n, 3o, NTECF pillar 4) Demonstrate as well as r for equity inclusion in mathematics classroom. (NT 	of ays in es and cepts. , 3k, 3p value espect and the TS, 2f)	 Re e> ru gr as a lo fr sy m re th Re ar fu ru O m re cc w ac ac<th>ecogr (pone (p</th><th>nise an ential function r applying a nor decay fa as, the inve ithmic function umerical date lic rules using le entation(incle e of ICT tools nise exponent garithmic ons from symptotic symptotic symptotic participate (based on hom and indire</th><th>on as a ctor, rse of ion; and ns a and g luding b) htial bolic for a o work in an</th><th>•</th><th>mathematical thinking coherently for academic purposes Use of ICT: Integrate ICT in developing number and algebraic concepts in the mathematics classroom Personal development: Through presentation and developing of sound arguments Respect and diversity: using problem solving strategies appropriate for diverse learners with different learning styles Problem solving, critical and creative thinking: Making problem-solving a central focus of mathematics instructions as well as an integral component of assessment.</th>	ecogr (pone (p	nise an ential function r applying a nor decay fa as, the inve ithmic function umerical date lic rules using le entation(incle e of ICT tools nise exponent garithmic ons from symptotic symptotic symptotic participate (based on hom and indire	on as a ctor, rse of ion; and ns a and g luding b) htial bolic for a o work in an	•	mathematical thinking coherently for academic purposes Use of ICT: Integrate ICT in developing number and algebraic concepts in the mathematics classroom Personal development: Through presentation and developing of sound arguments Respect and diversity: using problem solving strategies appropriate for diverse learners with different learning styles Problem solving, critical and creative thinking: Making problem-solving a central focus of mathematics instructions as well as an integral component of assessment.
Tonic	Sub-tonic(s)	Stage/	IU Time	garit Tea	ching and	learnin	og to	activities to achieve learning
Торіс	500-topic(3)	Jlage	iiiie		comes dene	nding o	n deliv	very mode selected Teacher-lead
				coll	aborative g	oupwoi	rk or in	idependent.
				Tea	cher Activity	<u>v</u>	<u>k er n</u>	Student Activity
Indices and Logarithm:	Definitions of	20 min	c .	100	Engago stu	dont		Darticipate offectively in the
	indiana and	50 1111	3	•	Lingage Stu	uent	4 ha a 1 ha	
Learning, teaching and	indices and				teachers to	review	their	discussion by posing
applying	logarithms;				previous kr	nowledg	e	questions and giving
					and experie	ences in	their	comments to review their
					nre-tertiar	/ institut	ions	previous knowledge and
								previous knowledge and
				•	Encourage	student		past experiences with
					teachers to	define	the	respect to indices and
		40 min	s		concepts in	dices ar	nd	logarithms.
					logarithms	in	-	 Discuss and present
								Discuss and present
					collaborativ	ve group	05	definitions of indices and
					and to prov	/ide		logarithms in their groups.
					appropriate	<u>e fee</u> dba	ick.	
				•	Lead a disc	ussion to)	• Engage in internet search for
					Actablich ar	nd analy	- ເ_	literature on the manings
	Establishing					iu diidiy	3C	
					the relation	isnip		and computations of
	relationship	50 min	IS		between th	e conce	pts;	logarithm and indices as the
	between Indices				logarithm a	nd indic	es	basis for establishing the
	and Logarithms				and how th	is can be	e	relationships between these
					used to pla	n a micr	0	concents in the form of
					lesson base	a on sin	nilar	collaborative works.
					concepts in	the JHS		 Outline properties relating
					mathemati	cs curric	ulum	the exponential and
				•	Assign stud	ent tead	chers	logarithmic functions with
					to outline r	ronertie	20	the aid of manipulatives
		20 min	s		rolating the		ntial	and/or ICT tools
			-			expone	nudl	
					and logarit	nmic		
					functions			
				٠	Initiate a di	scussior	n to	• Explore the laws of
	Laws of indices				explore the	laws of	-	logarithms and indices using
	and logarithms				logarithma	and ind:	coc	with omphasis on analysis
		40 min	c		iogarithms		Les	with emphasis on analysing
					through pro	oblem		the inverse principle that
					solving.			connects logarithm to
								indices and vice versa.

Lesson assessments –	1. Student teachers are assigned to complete worksheet problems based on indices and
evaluation of learning:	logarithms to be submitted for peer assessment (Assessment of learning) NTS 3j -
of, for and as learning	Produces and uses a variety of teaching and learning resources including ICT, toenhance
within the lesson	learning.
	2. Presentations of self-prepared notes on the concepts of indices and logarithms (
	Assessment as learning) NTS 1a - Critically and collectively reflects to improve teaching and
	learning, NTS 2f - Takes accounts of and respects learners' cultural, linguistic, socio-
	economic and educational backgrounds in planning and teaching
	3. Student teachers to embark on group authentic assignments/in the form of project with
	presentations on the concept of indices and logarithms to promote creativity, innovation,
	critical thinking and problem- solving.(Assessment of learning) NTS 2f - Takes
	accounts of and respects learners' cultural, linguistic, socio-economic and educational
	backgrounds in planning and teaching
Instructional	Graph sheets, mathematical set, manipulative materials, permanent markers, calculators, mobile
Resources	phones, Geogebra Apps.;
Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools.
	Accra: Sam-Woode Ltd.
	https://amsi.org.au/teacher modules/Indices and logarithms.html. Retrieved 20-06-2019
CPD NEEDS	How to design and/or use some innovative materials and ideas for teaching selected concepts
	in indices and logarithms.
	• Instructional strategies needed to consciously connect mathematical ideas, as well as, connect
	mathematics to other curriculum areas and to the world outside

Year of B.Ed.	2 Se	emester	1	Plac	Place of lesson in semester 123456			234567	89101112	
Title of Lesson	Indices a	and Logarith	m: <i>Learn</i>	ing, te	aching and app	olying Less	son Dura	ation	3 Hours	
Lesson description	This is the Algebra include applicat games, f lesson fo logarith develop concept student	This is the eighth lesson under the topic Further Algebra in Year two Semester 1. Number and Algebra treated in Year one Semester two is a pre-requisite of this lesson. The areas to be covered include the operations on indices and logarithms, solving indicial and logarithm equations and applications of Indices and Logarithms. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of indices and logarithms. The main lesson focuses on reviewing the student teachers' conceptual understanding of indices and logarithms. Traditionally, indices and logarithms are taught as separate entities with emphasis on developing and using procedures. In this lesson, conscious effort will be made to connect related concepts using interactive pedagogy using appropriate tools to ensure effective participation by all student teachers.								
Previous student teacher knowledge, prior learning (assumed)	Student have kn indices f	teachers ha nowledge an from their Ba	ave knov d under asic Scho	vledge standi ol mat	on fundamen ng of some co hematics, and	tal concepts oncepts bas SHS Core ma	s in loga sed on c athemat	rithms and in perations or ics.	ndices. They also logarithms and	
Possible barriers to learning in the lesson	Some some some some some some some some s	it entry beha tudent teacl natics teache	viours, S hers mai rs to sup	ocio-ci y com port tl	ultural issues, c e to SHS schc hem understan	bifferent lear ools where id advanced	they dic concept	eds, I not have t is in Indices a	eachers or good nd Logarithms.	
Lesson Delivery – chosen to support students in achieving the	Face- to- face	Practical Activity	Work- Based Leanin	g	Seminars	Independe Study	ent e-l op s	earning portunitie]	Practicum	
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	Face-to- brainsto not usua Practica and mat Indeper promoto part of a E-learni environi mode in	-face: oppo orming, quest ally be the m al Activity: er terials, as we ndent study: e individual a any of the ab ng opportun ments. This con its own righ	rtunity fo tion and ain mod nabling e II as phy to enab and colla ove moc <i>ities</i> – in can be pa t.	or an e answe e. xperim sical ac le stuc borativ les volving art of a	xtended and co er, etc. This can nentation and t ctivities. dents to engage ve enquiry, mo g the use of int any of the abov	oherent line be tutor an he analysis a e with releva re in-depth a eractive pac e modes of a	of argur d / or stu and discu ant and a analysis ckages ar delivery.	ment. It includ udent teacher ussion of issu appropriate m and developn nd virtual lear It is unlikely	des discussion, r led. It should es, documents naterials to nent. This can be ning to be a delivery	
 Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description. 	 mode in its own right. The purpose of the lesson is to; build of content knowledge and experiences of student teachers to establish their competence in handling problems based on indices and logarithms and to address their learning needs perceptions and misconceptions, as well as, develop the ability to plan a lesson on indices to be peer reviewed and included in a portfolio develop student teachers' conceptual understanding of indices and logarithms and how these concepts can be applied in other areas, as well as, plan micro lessons based on related concepts in the JHS mathematics curriculum develop student teachers' conceptual knowledge in order to prepare them well enough to be able to handle concepts in indices and logarithms as required by the JHS curriculum. 							heir competence r learning needs, n on indices to be as and how these based on related rell enough to be ulum.		
• Learning Outcome for the lesson, picked and developed from the course specification	• Dem unde	g Outcomes	the	Learning Indicators Identify Which cross-cutting is: core and transferable inclusivity, equity and addre diversity. How will these addressed or developed? he Identify strategies for solving problems based • Problem solving, critical and creative thinking: Making						
 Learning indicators for 	strat expo	tegies for onential	solving and		on exponen logarithmic eq	tial and uations	pr of	oblem-solvin mathematics	g a central focus s instructions as	

each learnin outcome	g	 logarithm (NTS 2c, 3 1) Demonstike knowledge understare inverse prostrategy findicial are equations 3g, 3k, 3l, 3p NTECF Demonstike to communite (NTS 2c, 3 2) 	ic problems Bi, NTECF Pillar rate ge and nding of the rinciple as the for solving nd logarithmic s(NTS 3e, 3f, 3m, 3n, 3o, pillar 4) rate readiness unicate ideas ematics ty of practice. Bi, NTECF Pillar	 Use the inverse principle as a basis for solving indicial and logarithmic equations Recognise and apply appropriate problem solving techniques and exhibiting confidence in explaining such strategies Participate in the community of practice by sharing by findings in discussions Participate in the community of practice by sharing by findings in discussions Personal development: Through presentation and group discussion. Respect and diversity: designing activities and presentations suitable for diverse learners with different learning styles
Торіс	Sub	-topic(s)	Stage/Time	Teaching and learning to activities to achieve learning outcomes depending on delivery mode selected. Teacher-lead collaborative
				groupwork or independent.
				Teacher Activity Student Activity
Indices and Logarithm: Learning, teaching and applying	Ope indid loga	rations on ces and rithms;	30 mins 30 mins	 Engage student teachers to review their previous knowledge and experiences in the previous lesson logarithms and indices. Assign student to outline and analyse the properties of operations on logarithms and indices Assign student to outline and analyse the properties of operations on logarithms and indices Outline and analyse the properties of operations on logarithms and indices Outline and analyse the properties of operations on logarithms and indices Outline and analyse the properties of operations on logarithms and indices
	India loga equa	cial and rithm ations;	40 mins 60 mins	 Assign student teachers to Identify and use the inverse principle as a basis for solving exponential equations using logarithm and vice versa. Engage student teachers in problem solving activities in small groups to be Identify and use the inverse principle as a basis for solving exponential equations using logarithm and vice versa. Solve given problems and present their solutions for peer review. Work on the assignment and present the work later for grading and feedback.

	Applications of Indices and Logarithms.	20 mins	 submitted for peer review. Assign student teachers to answer worksheet problems involving logarithms and indices. Task student teachers to outline areas including real life situations where logarithms and indices are applicable. 	 Search on the internet and other sources on the application of logarithm and indices to real life situations business, economics, planning, and to write a reflective paper on their findings to be discussed later in class. 				
Lesson assessments – evaluation of learning:of, for and as learning within the lesson Instructional	 Student teachers take a short (tutor-made) quiz based on exponential and logarithmic equations to be submitted for grading and feedback (Assessment of learning) NTS 3j– Student teachers to embark on group project with presentations on the application of Indicial and logarithm equations to real life situations business, economics, planning, and to write a reflective paper on their findings to be discussed later in class. (Assessment of learning) NTS 2f - Takes accounts of and respects learners' cultural, linguistic, socio-economic andeducational backgrounds in planning and teaching 							
Resources Required Text (core)	Geogebra Apps.; Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). <i>Core mathematics for senior high schools</i> . 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	 How to design further algebra Instructional st mathematics t Identifying and and logarithm 	and/or use some i a. rategies needed to o other curriculum using mobile pho	nnovative materials and ideas for consciously connect mathema n areas and to the world outside nes and other innovative resour	or teaching selected concepts in itical ideas, as well as, connect e rces in teaching concepts in indices				

Yea	ar of B.Ed. 2	Semeste	er 1	Place of	f lesson in se	mester	12345678	9 10 11 12			
	<i>.</i>										
Title	e of Lesson	Binomia	al expansions	s: Learning,	teaching and a	pplying	Lesson Duration	3 Hours			
Less	son description	This is requisi The au Binom with s knowle the st binom partici	This is the ninth lesson under the topic Further Algebra in Year two Semester 1. The pre- requisite of this lesson "Number and Algebra" which was treated in Year one Semester two. The areas to be covered in this lesson include Binomial expansions, Pascal's triangle, Binomial theorem, and the applications of Binomial theorem to real life. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of algebraic expansion and factorisation. The main lesson focuses on reviewing the student teachers' conceptual understanding of Binomial theorem which includes binomial expansion and its applications. Interactive pedagogy will be used to encourage participation by all.								
Prev	vious student teach	er Student	t teachers ha	ve knowled	dge on operatio	ns of numl	pers and their prope	rties from Basic			
kno (ass	wledge, prior learnii umed)	ig School	mathematics	, JHS math	ematics and SHS	S Core mat	hematics.				
Pos	sible barriers to learning	Differer	nt entry beha	iviours, Soc	io-cultural issue	es, differen	t learning needs,				
in ti	ne lesson	mather	natics teach	ers may co ers to suppo	ort them unders	tand conce	epts in Binomial expa	ansions.			
Less	son Delivery – chosen to	Face-	Practical	Work-	Seminars	Independ	le e-learning	Practicum			
sup	port students in	to-	Activity	Based		nt Study	opportunities				
ach	leving the outcomes										
Less mod sup achi outo	on Delivery – ma de of delivery chosen port student teachers ieving the learnin comes. Purpose for the lesson what you want the	in Face-to co discussi in teacher docume indepent to prom This car E-learni environ delivery The pur • bui	-face: oppo ion, brainstor led. It should al Activity: er ents and mat ndent study: note individu be part of a ing opportun ments. This o mode in its rpose of the ild on conte	rtunity for rming, ques d not usual nabling exp erials, as w to enable al and colla ny of the a hities – invo can be part own right. lesson is to nt knowlee	an extended an stion and answe ly be the main r erimentation ar ell as physical a students to eng borative enquir bove modes olving the use of of any of the al of any of the as	d coherent er, etc. This mode. nd the anal ctivities. gage with ro ry, more in interactive bove mode	can be tutor and / c ysis and discussion c elevant and appropr depth analysis and c packages and virtua s of delivery. It is un	includes or student of issues, iate materials development. al learning likely to be a establish their			
	serves as basis for the learning outcomes. An	cor pei • dev	rceptions and velop studen	t teachers'	ptions in binom understanding	eorem an ial theoren of binomi	a address their in ns and related conce al theorems and ho	pts. w to apply the			
	expanded version of the description.	e kno • dev to rec	owledge and velop studen be able to l juired by the	understand t teachers' handle con JHS curricu	ding in other ar conceptual kno cepts related t ilum.	eas of mat owledge in to binomia	thematics and beyor order to prepare the l theorem and its	applications as			
•	Learning Outcome for the lesson, picked and developed from the course specification	Learning Outcomes Learning Indicators Identify Which cross-cutti core and transferable skills, equity and addressing dive will these be addressed or c									
•	Learning indicators for each learning outcome	Den kno con und bino (NT: Pilla Den	nonstrate wledge a ceptual erstanding omial theore S 2c, 3i, NTE ir 1) nonstrate	Ide nd pa de of exi m. sol CF inv exi	entify and analys tterns for veloping binomi pansions and ving problems volving binomial pansions scuss how the	se • ial •	Problem solving, creativethinking:Ma solving a centr mathematics instru- as an integral assessment. Communication so critiquing and prese	critical and akingproblem- ral focus of uctions as well component of skills: through entations			

	differentiated instructional strategies, to cater for the needs of all student teachers including those with SEN (NTS 3f, pg. 14)		 be used for modelling and solving problems involving Binomial expansion Undertake small scale classroom enquiry focussed on children's learning and progress, demonstrating an emerging ability to reflect on their developing understanding of teaching, learning and assessing adolescents in Junior High School mathematics. (equity and inclusion) Use a variety of manipulatives and other TLMs to promote differentiated learning of concepts based on binomial theorem and its application. Teaching and learni 		 Assessment for as and of learning: byprovidingstudent teachers an opportunity to develop strategies to guide adolescent children to engage in self-assessment, as well as, use other age-appropriate and learner-friendly assessment formats Communicative skills: would be enhanced through the examination, interrogation and presentation of the various principles in developing and using varying multimedia
Торіс	Sub-topic(s)	Stage/	Time	Teaching and learn	ing to activities to achieve learning
				lead collaborative gr	oupwork or independent.
				Teacher Activity	Student Activity
Binomial expansions: Learning, teaching and applying	Binomial expansions; Binomial	20 m	ins	Lead student teachers in a discussion to review their knowledge and experiences on factoring and expanding algebraic expressions.	Participate in a discussion to review their previous knowledge on algebraic expansion and factorisation. Develop the concept of binomial expansion through discussions and presentations, using the knowledge and understanding of indices e g
	theorem. $(x + a)^n$, where <i>n</i> is rational and n > 0; Pascal's	40 m	ins	Engage student teachers in an interactive group activity to develop the concept of binomial expansion through discussions and presentations, using the knowledge of algebraic tiles and	$(x + a)(x + a) = (x + a)^{2} = x^{2} + 2ax + a^{2}.$ (x+1) Area= (x+1)(x+2) (x+2) algebraic tiles
	triangle;	40 mir	15	Provide student teachers with isometric grid papers or any other manipulatives, including ICT tools to	Use the isometric grid, algebraic tiles or any other manipulatives, including ICT tools to generate or build the Pascal's triangle. Express the coefficients of simple binomial expansions using the Pascal's triangle.

	1					
	Applications of binomial theorem to real life.	20 mins 20 mins	generate or build the Pascal's triangle Task student teachers to identify some cultural products and artefacts with designs that can be used to model Pascal's triangle Assign student teachers to determine the coefficients of simple	Search for designs in fabrics and other cultural products or artefacts that possess such characteristics and use them to model pascal's triangle.		
			binomial expansions using the Pascal's triangle and/or any other relevant tool including ICT			
			Engage student teachers to use the Pascal's triangle as a tool for expanding binomials with higher powers through			
Lesson assessments – evaluation of learning: of, for and as learning within the lesson	1. Assign binom 3j - Pro enhand	 student teach ial expansions oduces and use ce learning	presentations ers to identify and analys to be submitted for peer es a variety of teaching an	se the patterns characteristics of review (Assessment of learning) NTS nd learning resources including ICT, to		
Instructional Resources	Graph sheets, n markers, calcula	nathematical s ators, mobile r	et, manipulative materia phones, Geogebra Apps.:	ls, isometric grid papers, permanent		
Required Text (core)	Gordor, B. K., N school: https://amsi.org	aandam, S. M. s. Accra: Sam-V g.au/teacher	, & Nkansah, B. K. (2012) Woode Ltd. modules/Indices and log	. Core mathematics for senior high garithms.html. Retrieved 20-06-2019		
Additional Reading List	 <u>https://amsi.org.au/teacher_modules/Indices_and_logarithms.html</u>. <i>Retrieved 20-06-2019</i> Ministry of Education (2015). <i>Core_mathematics_modules_for_SEIP</i>. Accra: Ministry of Education. Ministry of Education. (2010). <i>Teaching syllabus for core mathematics</i> (Senior High School). Accra: Ministry of Education, Science and Sports. Martin, J. et. al. (1994). <i>Mathematics for teacher training in Ghana: Tutor notes</i>. Accra: Unimax Publishers. Martin, J. et. al. (1994). <i>Mathematics for teacher training in Ghana: Students activities</i>.Accra: Unimax Publishers. 					
CPD NEEDS	How to design concepts in bin Instructional s connect mather	n and/or use omial theorem trategies need matics to othe	some innovative mater ns. ded to consciously con r curriculum areas and to	rials and ideas for teaching selected nect mathematical ideas, as well as, o the world outside		

Year of B.Ed. 2	Semester 1 Place of lesson in semester 123456789 10 12			9 10 11 12				
Title of Lesson	Simultaneous equations: <i>Learning, teaching and</i> Lesson Duration 3 Hou <i>applying</i>						3 Hours	
Lesson description Previous student	This is the this lessor offered to learning r covered in equations The lessor about kno reviewing equations Student te mathemat	This is the tenth lesson under the topic Further Algebra in Year 2 Semester 1. The pre-requisite of this lesson is "Number and Algebra" which was treated in Year one Semester two. Opportunity is offered to audit student teachers' content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions about simultaneous equations. The areas to be covered include the concept and nature of simultaneous equations, evaluation of simultaneous equations and application of simultaneous equation to real life situations. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of algebraic expansion and binomial theorem. The main lesson focuses on reviewing the student teachers' conceptual understanding of concepts based on simultaneous equations. Student teachers have knowledge on operations of numbers, and their properties from Basic School						
prior learning	mathemat					ienaties.		
(assumed) Possible barriers to learning zin the lesson Lesson Delivery –	Different of Some stu mathemat	entry behavio dent teacher tics teachers t Practical	urs, Socio-cultu s may come to o support them Work-Based	ral issues, di o SHS schoo understand Seminars	fferent learning ols where the concepts in Si Independent	g needs, / did not have te multaneous equat e-learning	eachers or good ions. Practicum	
chosen to support students in achieving the outcomes	face	Activity	Leaning		Study	opportunities		
Lesson Delivery – main mode of delivery chosen to support student teachers in achieving the learning outcomes.	 Face-to-face: opportunity for an extended and coherent line of argument. It includes discussion, brainstorming, question and answer, etc. This can be tutor and / or student teacher led. It should not usually be the main mode. Practical Activity: enabling experimentation and the analysis and discussion of issues, documents and materials, as well as physical activities. Independent study: to enable students to engage with relevant and appropriate materials to promote individual and collaborative enquiry, more in-depth analysis and development. This can be part of any of the above modes E-learning opportunities – involving the use of interactive packages and virtual learning environments. This can be part of any of the above modes of delivery. It is unlikely to be a delivery mode in its own right. 							
 Purpose for the lesson, what you want the students to achieve, serves as basis for the learning outcomes. An expanded version of the description. 	 Ine purpose of the lesson is to; build on content knowledge and experiences of student teachers to establish their competence in handling simultaneous equation and address their learning needs, perceptions and misconceptions about simultaneous equation and related concepts. develop student teachers' understanding of simultaneous equation and how to apply the knowledge and understanding in other areas of mathematics and beyond. develop student teachers' conceptual knowledge in order to prepare them well enough to be able to handle concepts related to simultaneous equations and its applications as required by the JHS curriculum. 							
Learning Outcome for the lesson, picked and developed	Learning (Learning OutcomesLearning IndicatorsIdentify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these						
 from the course specification Learning indicators for each learning outcome 	LearningLearningDemonstrate1.Identify and analyse the nature and the properties of simultaneous equations• Problem solving, critical a thinking: Making problem central focus of mathema instructions as well as an component of assessmer			al and creative blem-solving a ematics an integral nent				

		 Use active ways simule quation of the varial equation o	a variety of vities or s in learning ultaneous ations and er multiple able ations and cepts in hematics. erstand, gnise, make le and ress stigma, and other as of rimination other usion ced matters e iculum, iol and grooms.	2. 3.	Evaluate a given set of multiple equations a the same time and illustrate the results aid in understanding the nature of simultaneous equations Develop strategies to recognise, make visit and address stigma, bias and other forms discrimination. Pose problems that cater for diversity, equity and inclusivity	of t to ble s of	 Social and communication skills: through developing specific literacy and language of mathematics to support learnersto communicate their mathematical thinking coherently for academic purposes Respect and diversity: designing activities and presentations suitable for diverse learners with different learning styles Equity and inclusivity: Providing equitable learning opportunities for all learners Personal development: Through presentation and group discussion.
Торіс	Su	b-topic(s)	Stage/Time	Tea de	aching and learning pending on delivery	to a	ctivities to achieve learning outcomes de selected. Teacher-lead collaborative
				gro	oupwork or independe	ent.	dent Activity
Simultaneous	Na	ture of	40 mins	Tea	acher Activity	Darti	icinate in a discussion to review their
equations: Learning, teaching and applying	sin	nultaneous uations;	40 mins	in a rev kno cor uno nat equ	ad student teachers a discussion to view their previous owledge and nceptual derstanding of the ture of simultaneous uation	previ facto unde JHS n	ous knowledge on algebraic expansion, risation, binomial expansion, and rstanding of simultaneous equation in the nathematics curriculum.
	sin eq	nultaneous uations,	40 mins	Ass tea use teo stra and of s equ	sign student achers in groups to e differentiated chniques or ategies to evaluate d analyse given sets simultaneous uations	Use ⁻ techr simu	think pair share session to brainstorm niques to explore the concept of Itaneous equations.
	Ap to	plications real life.	60 mins	Ass tea use teo stra elir sub gra in s bas	sign student achers in groups to e differentiated chniques or ategies such as mination, ostitution and aphical approaches solving problems sed on simultaneous	Solvi elimi appro equa solut	ing simultaneous equations by method of nation, substitution and graphical oaches and to analyse given systems of tions as having no solution, a unique ion, or infinitely many solutions.

		40 mins	Engage student-	Engaging student-teachers in applying			
			teachers to pose	simultaneous equations to real life situations			
			problems based on	such as determination of national income,			
			simultaneous	household consumption, equilibrium prices,			
			equations from other	using small group projects.			
			disciplines such as				
			Economics and				
			Business real life				
			situations using small				
			group projects				
Lesson	1. Student te	achers to emba	ark on group classroom exe	ercise outline and discuss types and application			
assessments –	of simultar	neous equation	is to real life to real life situ	uations business, economics, planning, and to			
evaluation of	write a reflective paper on their findings to be discussed later in class. (Assessment of learning) NTS						
learning: of, for	3h - Sets meaningful tasks that encourages learner collaboration and leads to purposeful learning.						
and as learning							
within the lesson							
Instructional	Mathematical set, manila cards, permanent markers, graph sheets.						
Resources							
Required Text	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools. Accra:						
(core)	Sam-Woode Ltd.						
	https://amsi.org.au/teacher_modules/Indices_and_logarithms.html. Retrieved 20-06-2019						
Additional	Ministry of Edu	cation (2015).	Core mathematics modules	s for SEIP. Accra: Ministry of Education.			
Reading List	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). <i>Mathe</i>	ematics for teacher training	g in Ghana: Students activities.Accra: Unimax			
	Publishers.						
CPD NEEDS	How to des	ign and/or use	some innovative materials	s and ideas for teaching selected concepts in			
	simultaneo	us equations					
	Instructiona	al strategies ne	eded to consciously conne	ect mathematical ideas in simultaneous			
	equations t	o the world ou	tside				

Year of B.Ed.	2	Sem	ester 1	Place o	f lesson in	seme	ster	123456789	9 10 11 12
Title of Lesson		Matrices	Looming to		luin a		Lassan	Numerican.	2.11.0.000
The of Lesson		Matrices: Learning, teaching and applying Lesson Duration 3 Hours						3 Hours	
Lesson descriptio	n	This is the	e eleventh les	son under the	topic Furthe	r Algebi	ra in Yea	r two Semester 1.	The pre-
		Activities	outlined in th	is number an	nable studer	vilicii w ht teach	as taugn	dit their content	ester two.
		experience	es to establis	h and address	their learnin	g needs	s, percep	tions and miscond	ceptions in
		matrices.	The areas to	be covered inc	lude the Cor	ncept ar	nd definit	tion of matrices, t	ypes of matrices,
		and opera	ations on mat	rices. The less	on begins wit	th starte	ers or me	ental mathematics	s games,
		reinforce	ment games a	and activities a	bout knowle	dge of o	operatio	n of numbers. The	main lesson
		focuses o	n reviewing t	he student tea	chers' conce	ptual ur	nderstan	ding of matrices a	nd operations
		narticinat	ion by all irre	espective of th	e entry heha	viour of	f student	teachers especia	lly those who
		have offe	red to pursue	e mathematics	in the JHS sp	ecialisn	n.		ily those who
Previous stu	udent	Student t	eachers have	knowledge on	operations	of numl	bers and	their properties f	rom Basic School
teacher knowl	edge,	mathema	tics, JHS mat	hematics and S	HS Core mat	hemati	cs.		
prior lea	rning								
(assumed)	c to	Different	ontry hohavi	ours Socio cult	tural iccuos	difforon	tloornin	a poods	
learning in the learning	son	Some stu	ident teache	rs may come	to SHS scho	nols wh	nere they	y did not have t	eachers or good
		mathema	tics teachers	to support the	m understan	nd funda	amental	concepts in Matri	ces.
Lesson Delivery –		Face-	Practical	Work-	Seminars	Indep	penden	e-learning	Practicum
chosen to suppor	t	to-face	Activity	Based		t St	tudy	opportunities	
students in achiev	ving	\bowtie	\bowtie	Leaning		L		\bowtie	
the outcomes	v _	Face-to-f	ce: opportu	unity for an ext	ended and c	ohoront	t line of a	rgument It inclu	les discussion
main mode of de	y livery	brainstor	ming. questic	in and answer.	etc. This can	be tuto	or and $/a$	or student teache	led. It should
chosen to su	pport	not usual	ly be the mai	n mode.					
student teacher	rs in	Practical	Activity: enal	oling experime	ntation and t	the anal	lysis and	discussion of issu	es, documents
achieving the lea	rning	and mate	rials, as well	as physical acti	vities.				
outcomes.		Independent study: to enable students to engage with relevant and appropriate materials to							
		promote individual and collaborative enquiry, more in-depth analysis and development. This can be							
		E-learning opportunities – involving the use of interactive packages and virtual learning							
		environments. This can be part of any of the above modes of delivery. It is unlikely to be a delivery							
		mode in its own right.							
		Practicum (supported teaching in school): support to enable student teachers to experience and							
		learn from the basic school context by doing observations and child study in Y1 to full class teaching							
Purnose for	the	The r	ourpose of th	e lesson is to:					
lesson, what	t vou	 build 	the conter	nt knowledge	and experi	iences	of stud	ent teachers to	establish their
want	the	comp	etence in h	andling concer	ots based or	n matri	ices and	to address their	learning needs,
students	to	perce	eptions and n	nisconceptions	about matrie	ces and	related	concepts	
achieve, serv	ves as	• deve	lop student t	eachers' under	standing of r	matrice	s and ho	w to apply concep	ots in matrices to
basis for	the	othe	r areas of ma	thematics and	beyond.				
iearning	Δn	deve	lop student t	eachers' conce	eptual knowl	edge in	order to	o prepare them w	ell enough to be
expanded ve	ersion	able	to nativie cor		to matrices a	siequi	ieu by th		
of	the								
description.									

Learning Outcome for the lesson, picked and developed	Learning Outcomes	Learning Indicators	Identify Which cross-cutting issues- core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed?
Outcome for the lesson, picked and developed from the course specification • Learning indicators for each learning outcome	 Demonstrate knowledge and understanding of fundamental concepts and principles of matrices needed by developing teachers to build their confidence in planning and teaching some groups of adolescents. (NTS 2c, 3i, NTECF Pillar 1) Demonstrate the core and transferrable skills like problem solving and creativity and taking advantage of the affordances of ICT integrating it into teaching and learning (NTS 3j, NTECF pillar 4, Demonstrate knowledge of age appropriate assessment strategies and recognise and support children's progress against appropriate developmental milestones and the expectations of the Junior High School mathematics Curriculum (NTS 3k,pg. 14) Demonstrate knowledge and understanding about how adolescents grow, develop and learn mathematics in Junior High School 	 Identify and analyse the fundamental concepts and principles of matrices needed by developing teachers to build their confidence in planning and teaching some groups of adolescents Determine age and level appropriate assessment strategies and recognise and support children's progress against appropriate developmental milestones and the expectations of the Junior High School mathematics Curriculum Select and use appropriate ICT tools for modelling and solving problems involving matrices and related concepts. Select and use developmentally appropriate strategies for teaching and assessment that emphasize the physical, cognitive, emotional and social development of the child. recognise and support children's progress against appropriate developmental milestones critique the expectations outlined for the Junior High Schoolmathematics Curriculum 	 core and transferable skills, inclusivity, equity and addressing diversity. How will these be addressed or developed? Commitment and passion for teaching: through developing student teachers' curriculum leadership and the holistic understanding needed for managing transition of learners from middle childhood (primary) to early adolescent (JHS) Assessment for as and of learning: by providingsstudent teachers an opportunity to develop strategies to guide adolescent children to engage in self-assessment, as well as, use other age-appropriate and learner-friendly assessment formats Use of ICT: Integrate ICT in developing number and algebraic concepts in the mathematics classroom Respect and diversity: designing lesson for diverse learners with different learning styles Equity and inclusivity: Providing equitable learners. Communication skills: through critiquing and presentations.
	knowledge & practice) (NTS, 2b)		

Торіс	Sub-topic(s)	Stage/Time	Teaching and learning to activities to achieve learning outcomes depending on delivery mode selected. Teacher-lead collaborative groupwork or independent.				
			Teacher Activity Student Activity				
Matrices: <i>Learning,</i> teaching and applying	The concept of matrices;	30 mins	Engage student teachers in a review of the previous lesson based on simultaneous equations by writing given simultaneous equations as coefficient matrices.	Participate in the review of the lesson on simultaneous equations by asking questions and giving comments to prepare their minds for the work ahead.			
		60 mins	Introduce the lesson by describing real life contexts that can be modeled using matrices, e.g., arrangement of seats in the lecture hall, classroom, or other relevant places; the arrangement of louvre blades in buildings, etc.,	Pay attention to the narratives that prepare the ground for the development of the lesson based on matrices. Use investigations to explore fundamental concepts of matrices;			
	Types of matrices; Symmetric	30 mins	Engage student teachers in a discussion to explore how to use matrices to represent data.	Participate actively in the discussion to explore representation of data using matrices.			
	Operations and properties of matrices	30 mins	Provide opportunity for student teachers to identify, outline, and discuss the types of matrices using interactive pedagogy.	Explore the types (zero, unit, square etc.), properties and operations of matrices, using independent study and/or collaborative mixed-ability group work			
		30 mins	Engage student teachers through interactive pedagogy to discuss the various operations and properties of matrices	Explore and discuss the various operations and properties of matrices and outline their implications for teaching matrices and related concepts found in JHS mathematics curriculum.			
Lesson assessments –	Student teachers to submit the following;						
evaluation of learning: of, for and	 a final portfolio in mathematics, with emphasis on Early Grade Curriculum and relative to theories of learning. (Course work) (Assessment as learning) NTS 3k - Integrates a variety of 						
as learning within the	assessment modes into teaching to support learning. (30%)						
lesson	2. Proje	ct work report	on designing TLMs for teaching	numeracy in early grade. (Project)			
	(Assessment as learning) IS 3N - Sets meaningful tasks that encourages learner collaboration and leads to purposeful learning. (30%)						
Instructional	Graph sheets, mathematical set, manipulative materials, permanent markers, calculators, mobile phones,						
Resources Required Text (core)	Geogebra App	s.; Naandam S M	& Nkansah B K (2012) Core	mathematics for senior high schools Accra			
Required Text (core)	Sam-	Woode Ltd.		mathematics for senior myn schools. Acta.			
	https://amsi.o	rg.au/teacher	modules/Indices and logarithm	ns.html. Retrieved 20-06-2019			
Additional Reading	Ministry of Ed	ucation (2015).	Core mathematics modules for	SEIP. Accra: Ministry of Education.			
	Minis	try of Educatio	n, Science and Sports.				
	Martin, J. et. a Martin, J. et. a Publishers.	l. (1994). Math l. (1994). Math	ematics for teacher training in (ematics for teacher training in (Ghana: Tutor notes. Accra: Unimax Publishers. Ghana: Students activities.Accra: Unimax			
CPD NEEDS	How to design	and/or use so	me innovative materials and ide	as for teaching selected concepts in further			
	algebra.	strategies need	ed to consciously connect math	rematical ideas, as well as connect			
	mathematics to other curriculum areas and to the world outside						

Year of B.Ed. 2	Semester	1	Place of les	son in semest	er 123	45678910	11 12	
Title of Lesson	Matrices: Lear	ning, teachir	ng and applying	g 2	Lesson Du	ration 3 Ho	ours	
Lesson description	This is the twe of this lesson outlined in the experiences to matrices. The applications. and activities a student teached nature of the the entry beha- in the JHS spec	This is the twelfth lesson under the topic Further Algebra in Year two Semester 1. The pre-requisite of this lesson is "Number and Algebra" which was taught in Year one Semester One. Activities outlined in the lesson will enable student teachers to audit their content knowledge and experiences to establish and address their learning needs, perceptions and misconceptions in matrices. The areas to be covered include the transpose, adjoint, determinants, inverse and applications. The lesson begins with starters or mental mathematics games, reinforcement games and activities about knowledge of operation of numbers. The main lesson focuses on reviewing the student teachers' conceptual understanding of matrices and operations on matrices. The interactive nature of the instructional strategies is meant for encouraging participation by all, irrespective of the entry behaviour of student teachers, especially those who have offered to pursue mathematics						
Previous student teacher knowledge, prior learning (assumed)	Student teach mathematics, series from SH	ers have kno JHS mathen S Core math	wledge on openatics and, qu ematics.	erations of numb adratic function	pers and their s, simultaned	properties from ous equation, se	Basic School quences and	
Possible barriers to learning in the lesson	Some student mathematics t	behaviours, teachers m eachers to sr	, Socio-cultural hay come to support them u	issues, different SHS schools wh nderstand advar	t learning nee ere they did nced concepts	ds, not have teach in Matrices.	ers or good	
Lesson Delivery –	Face-to-face	Practical	Work-	Seminars	Indepen	e-learning	Practicum	
chosen to support		Activity	Based	_	dent	opportunities		
students in achieving the outcomes			Leaning		Study			
Lesson Delivery – main	Face-to-face: opportunity for an extended and coherent line of argument. It includes discussion,							
mode of delivery	brainstorming, question and answer, etc. This can be tutor and / or student teacher led. It should							
chosen to support	not usually be the main mode.							
student teachers in	practical Activity: enabling experimentation and the analysis and discussion of issues, documents							
	independent study: to enable students to engage with relevant and appropriate materials to							
outcomest	promote individual and collaborative enquiry. more in-depth analysis and development. This can be							
	part of any of the above modes							
	E-learning opportunities - involving the use of interactive packages and virtual learning							
	environments. This can be part of any of the above modes of delivery. It is unlikely to be a delivery							
	mode in its own right.							
Purpose for the losson what you	The purpose of the lesson is to;							
want the students	competen	ce in matr	ices problem	s and address	their learni	ng needs, perc	captions and	
to achieve, serves	misconceptions about matrices.							
as basis for the	• develop student teachers' understanding of matrices and apply matrix concepts in other fields							
learning outcomes.	of mathematics							
An expanded	• develop student teachers' conceptual knowledge in order to prepare them well enough to be							
description.	able to native concepts in matrices and its application as required by the JHS curriculum.							
Learning Outcome	Learning Outcomes Learning Indicators Identify Which cross-cutting issues- core							
for the lesson,	-		-		and transfer	able skills, inclu	sivity, equity	
picked and					and address	ing diversity. Ho	w will these	
developed from		-			be addressed	d or developed?		
the course	3. Demonstra	te	 Identify an function 	nd analyse	Commiti	nent and passion	I for	
Learning indicators	understand	ling of	and princi	nles of	teaching	' curriculum lead	ershin and	
for each learning	fundament	al	matrices r	needed by	the holis	tic understandin	g needed for	
outcome	concepts a	nd	developin	, g teachers to	managin	g transition of le	arners from	
	principles o	of	build their	confidence	middle c	hildhood (primai	y) to early	
	matrices ne	eded by	in plannin	g and	adolesce	ent (JHS)		

Торіс	developing teachers to build their confidence in planning and teaching some groups of adolescents.		 teaching some groups of adolescents Evaluate student teachers views on the fundamental ideas of matrices in the previous lesson based on varieties of strategies ge/Time Teaching and lear 		 Problem solving, critical and creative thinking: Making problem-solving a central focus of mathematics instructions as well as an integral component of assessment 	
				outcomes depending collaborative group	on delivery mode selected. Teacher-lead work or independent.	
				Teacher Activity	Student Activity	
Matrices: Learning and applying	Transpose,			Engage student teachers in a review of the fundamental ideas of matrices in the previous lesson	Participate in the review of fundamental ideas of matrices	
	Adjoint,	30	mins	Lead student teacher in a discussion to collect their views and experiences about the previous lesson(s) and how they were bandled	s Provide feedback by giving comments and questions for clarification and further explanation.	
	Determinants;	40	mins	Engage student teachers through interactive pedagogy to discuss concepts such as transpose	Use activity based techniques to introduce and treat the concepts of transpose; adjoint; determinants of matrices	
	Inverse and applications.			adjoint and determinant of matrices.	Evelope and use manipulative and ICT	
		60	mins	teachers to explore and use manipulative and ICT tools to find inverses of matrices and to solve simultaneous equations.	tools to find inverses of matrices and to solve simultaneous equations	
				Assign student teachers to solve simultaneous equations using Cramer's rule.	Solve simultaneous equations using Cramer's rule	
	Review of lessons in the course	60 m	iins	Engage student teachers in a review of the lessons in this course to ensure mathematical connection	Participate in the review of the lessons in this course to ensure mathematical connection	
Lesson assessments – evaluation of learning:of, for and as learning within the lesson	1. Review of semester e	previo examir	us lessor ation 40	ns and preparation for %)	end of the semester examination. (End of	
Instructional Resources	Graph sheets, math Apps.;	emati	cal set, n	nanipulative materials,	permanent markers, calculators, Geogebra	

Required Text (core)	Gordor, B. K., Naandam, S. M., & Nkansah, B. K. (2012). Core mathematics for senior high schools.
	Accra: Sam-Woode Ltd.
	https://amsi.org.au/teacher_modules/Indices_and_logarithms.html. Retrieved 20-06-2019
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	How to design and/or use some innovative materials and ideas for teaching selected concepts in
	further algebra.
	Instructional strategies needed to consciously connect mathematical ideas, as well as, connect
	mathematics to other curriculum areas and to the world outside

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