MODULE 3 INSTRUCTIONAL METHODS INMATHEMATICS

Unit1 FactorsAffectingLearning
Unit2 AnalysesoftheTeachingMethods
Unit3 FacilitatingDevelopmentofMathematicalKnowledgefor Teaching

UNIT 1 FACTORSAFFECTINGLEARNING CONTENTS

1.0 INTRODUCTION

Thesearchfor aneffectiveteaching methodis aperennialconcern and goal for a responsible educator. Teaching is not an end in itself, butrather a means to an end. Therefore, the effectiveness of a teachingmethodhastobeevaluatedbythedegreeofits attainmentofspecifiedgoals.However, this means-end relationship is nota direct, linear one,butisintervenedbyathirdvariable, i.e. thelearner andasetofelementsassociatedwiththelearner'slearning.
Thechoiceofthemostpreferredinstructional methodistobemadeon thebasisofcertain criteria,namely:

(i) the objectivesofthelesson,
(ii) thenatureofthetopic, and
(iii) factorsaffectinglearning.

2.0 OBJECTIVES

Attheendofthisunit,you shouldbeableto:

- identify several factors affecting the teaching and learning of mathematics
- statethecomponentsofalessonplan.

3.0 MAINCONTENT

3.1 FactorsAffectingLearning

Teachingandlearningaretwosidesofacoin.Theunderstandingofthe complex process of learning and some significant factors affecting learning will, therefore, enable a teacher to select a teaching methodmostsuitableforproductivelearningonthepartofhispupils.

(A) Motivation

The desire to learn is the primary p r e r e q u i s i t e to the pursuit of knowledge in any field. Pupils with that desire will learn. However,pupils differ in motivation to fulfill the learning requirements. Pupils'motivationcanbesustainedwhenthelearnersconsider learningtasksas having intrinsic worth or practical usefulness. Motivation is alsoimprovedwhenlearnersareencouragedand supported bycompliments,evaluative comments, constructive suggestions andother forms ofverbal feedback. Most students want to be liked by the teacher. Theteacher'sfriendlyapprovalandsympathetic understandingcangoalong waytoreinforcethepupil'sefforttolearninthefaceofgreatdifficulty. Tosum up, motivation is important forlearning. A teaching methodshould therefore possess, among other things, elements conducive togeneratingstrongdesiretolearninthelearners.

(B) IntellectualAbility

Pupils vary widely in intellectual abilityand aptitude forsuccess inmathematics education.It is not inaccurate to expectpupils in primary schools ingeneralwithintelligenceaboveaverageonaccountofa series of differential exposure prior to theiradmission to school.To havea knowledgeof thedistribution and rangeof intellectual abilities in theclasswillenabletheteachertopitchtheinitiallevelatwhichthe subjectshouldbetaught,tounderstandthepaceoflearningofhis pupils, andtoindividualiseinstructionforpupilsofvaryingability, whennecessary.

(C) Background,ExperienceandAttitude

Pupils'variations in social, economicandculturalbackgroundgiverise to their different reactions to certain learning situations. Wholesomerespectfor andasympatheticunderstandingofthelearner's attitudewillresultinaspeedierchangeoftheerroneousattitudethan disrespectandcoercion.Theinstructor who notes andstudiessuch differences amonghispupilswillbeabletoadjustcourseactivitiesand teachingtechniques inthe interest oftheclass learning. Research shows that past learning experiencesand personality differences also account for different responsestolearningstimuli.Threetypesofpersonalityareidentified:

i) Thosepupilswhoareinsecureandwhowantmoredirection,
ii) Thosepupilswhoareindependentandwhowantmoreautonomy, and
iii) Thosepupilswhoaresatisfiedandadjustable.

The"insecure"pupilissaidtobeless favourablydisposedtowardnon-directive, non-guided

teaching than either of the other two types. The"satisfied" pupil is amenableto both directive and permissive teachingmethods. The "independent" pupil is confident, verbal and prefers tohave permissiveteachingandautonomy.

(D) Communication

Learningwillbeenhancedwhenwhatissaidanddemonstratedis clearand unambiguous.Effectiveteachingis determinedingreatmeasurebytheartof communication,thetransmissionofthought fromonemindtoothers. The importance of clear communication for teaching is propoundedbyGilbertHighetwhoremarkedthat,"lethim(theteacher)be goodatcommunication,andevenifheisamediocrescholar,hecan be an excellent teacher."In anothersense, communication a l s o means theflow ofinteraction from the students to the instructor. Pupil participationinclasswillcertainlyservetoclarifypointsofambiguity, disagreement, and misunderstanding. Differentkinds of teaching proceduresaffordvariousamountofopportunityforpupilparticipation.Teaching techniques vary in the extent to which a genuine two-way communicationbetweentheteacher andtheclass is permitted.Findingsin research studiestend toshow a high positive correlation between communicationandeffectiveteaching-learning

(E) Anxiety

Theeffect of anxiety upon learning has attracted t h e attentionof many educators. Spence and Taylor concluded in their research thata high levelof anxietywillfacilitatesimplelearning, butbeyondanoptimalpoint, willhamper complexlearning.Sinceacademicsituationssometimesproducehighlevel of anxiety, we might expect damaging effects. Anxiety i s related to uncertainty. We therefore expectthat anxious people workmost effectivelyinahighlystructuredsituation.Susceptibilitytoanxietyvaries from individual to individual. For some students,certain courserequirements and assignment demands may provoke anxiety of a disabling proportion, and their learning progress will consequently becomeseriouslyretarded.Theteacher,sensitivetotheanxietylevelofhis class, willalertlymatchlearningsituationtoanappropriatechoiceofteaching methods.

SELF ASSESSMENT EXERCISE

On what criteria is thechoiceofthemostpreferredinstructional method based?

3.2 Components ofathoroughLessonPlan

For everylesson,carefulconsiderationshouldbegiventothefollowing:

- The mathematical content of the lesson- what skills orconcepts arebeingdevelopedormasteredas aresultofthelesson?Often,teachers who plan effective lessons back-map the content fromasking “exactlywhatdoIexpectmystudentstoknoworbeable todoattheendofthis lesson?”
- The mathematical t a s k s of the lesson - whatspecificquestions, problems, and tasks, investigations, or activities willstudents be working on during the lesson? Often,

this includes the worksheetsthatarepreparedforthelessonandthereferencesor materials thatareneeded.

- Evidencethatthelessonwassuccessful-deliberateconsideration of what performanceswill convince you (and any outside observer) that most if not all, of your studentshave accomplishedyour objective.

4.0 CONCLUSION

The teacher wishing to dohis best willhave discovered that thereisa larger aim – thatof awakening the interest of the students, of bringing themtoreactandtodelightintheuseofthemind, toenjoytheprocess of gaining information in order to follow ideas to seewhere they lead.Thetrueteacherwillacceptthisashisresponsibilities-toincreasehis capacitytoleadthestudentthroughhis subject, notmerelytoknow,not merelytoparrot, buttouse hismindandtofeelcomfortableindoingso, sothathe canmore effectively magnetiseyoung minds and give themthatelectric current of curiosity and questioning that is the precious possessionofthetrulyeducatedman.

5.0 SUMMARY

There is no doubt that severalfactors militate againstthe teaching andlearning of mathematics These lead topoor performanceinmathematics andother physicalsciences and some have indirectanddirect influences. Factors with a directinfluence related to teaching strategies, content knowledge, motivation, laboratoryuse,and non- completion of thesyllabus contentovera year.On the other hand,indirectinfluencesmaybeattributedto (a)the roleplayedbyparents intheir children'seducation,and(b)generallanguageusage.

6.0 TUTOR-MARKEDASSIGNMENT

Identify and discuss fivefactors militating againstthelearningof mathematics.

7.0 REFERENCES/FURTHERREADINGS

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UNIT 2 ANALYSISOFTHETEACHINGMETHODS

CONTENTS

1.0 INTRODUCTION

The traditional passive view of learning involves situations where the material is delivered to students using a lecture-based format. In contrast, a more modern view of learning is constructivism, where students are expected to be active in the learning process by participatingindiscussionand/orcollaborativeactivities(Fosnot,1989). Results of recent studies concerning the effectiveness of teaching methods favourconstructivist and active learning method and it is importantthatmathematicsteachersareexposedtoalltypesofteaching methods.

2.0 OBJECTIVES

Attheendofthisunit,you shouldbeableto:

- listmethodsofteachingmathematics
- employthevariousmethods inteachingprimarymathematics
- distinguishbetweenthevariousmethods
- state the advantagesanddisadvantages ofeach methodsin the teachingofmathematics.

3.0 MAINCONTENT

Having discussed thecriteria for evaluating teaching methods, namely:
(i) objectivesof a mathematics education and
(ii) factorsaffectinglearningelsewhereinthismodule, itisimportanttodiscusssomemost commonly used methods of teaching.Mathematics can present an overwhelming challengeforsome students, while others may breezethrough mathematics-related course

work. Usea variety of teachingmethodstopresentmathematicslessonsthatwillhelp studentsof variedbackgrounds and learning stylescomprehend theinformation beforethem.

3.1 TheLectureMethod

Themosttraditional, long-establishedmethodofteachingislecturing. It is alleged to have firstbeenemployed by the Sophists who travelledthroughoutGreecespeakingonvarious topics uponrequest. Nowadays, this methodis universal atalllevels of teaching-learning situations. In thismethod, theteachertalksmoreorless continuouslytotheclass.The class listens, takes notes ofthefactsand ideasworthremembering, thinksoverthemlater;buttheclassdoesnotconversewiththeteacher.

G. J. Umstattd described thistype of lecturing asan "uninterruptedverbal presentation by aninstructor." In the less formallectures, theclassisinvitedtoaskafewquestionsbuttheseare largelyforthesake of clarification, not ofdiscussion.The essence ofthiskind of teachingand itspurposeare fora steadytransmission of information from theteachertothestudents.

Theadvantagesofthelecture methodare:

i) itgivesstudentstheinformationnotelsewhereavailable.Thisisespecially true when thelectures are based on the unpublished research projects and on the crystallisedwisdom out of the life- longacademicpursuitsoftheinstructor
ii)itsummarises, synthesisesand organisesfor the students the contentofnumerousarticles andbooks, whichrepresentsyears of laboriousworkonthepartoftheinstructor
iii) itpoints out relationships and salient points that even ablerstudentsmightnotsenseornotfullycomprehenduntilamplifiedby the instructor. Thus, the student's learning progress will be acceleratedandtheirlevelofunderstandingwillbeelevated
iv)itwidens the intellectual horizons of the student, making itpossible for the learner to gradually move toward acquisition ofself-discoveryandself-understanding
v) itenables the instructor to correct error in literature and articles readbythestudent
vi) itaffordsopportunities for aninstructorto explainaparticularlyequivocal ambiguous point of idea, or a complicated, difficult,abstract process or operation, thus unnecessary obstacles tolearningareremoved
vii)itresolves conflicting points of view and clarifies misunderstandingofdifferent schoolsofthought
viii) itenlivensthelearningsituationbyaddingthevoice, gestureandthe personalityoftheteacher.

Limitationsof thelecturingprocedure:

i) itwastesthestudent'stimeifthelecturesarerepetitiveofwhatis found in the assigned reading or textbooks, or if the lecturescontainobsoletematerials.This ismostlikelywhenthe instructor is overburdened with a multitude of administrative responsibilities and community commitmentsoristoo preoccupiedwithhisownresearchtobringhis lecture-notesup-to- date
ii) itgivesthestudentsnoopportunitytoexpresstheirreactionsandis therefore less

"democratic"thanother proceduresin teaching. This lackofclassparticipation dampensthelearner'smotivationtolearnandimpedeslearningprogress

iii) it promotes the authoritarian role of instruction and.Minimizesthe importance of the student's spiritof curiosity and scientificinquisitiveness.Itdiscouragescriticalthinkingand initiative.Theresultmight turn thelearnerintoapassive, apathetic individual;being satisfied todominimalwork necessary for passing thecourse

iv) ittendstowidenthegapbetweentheinstructorandthestudents bysettingthemapartandondifferentlevelsintheclassroom

v) itbores thestudents, especially when the instructor hasa hypnotic, monotonousvoicewhichlullstheclassintosleep. Thismay resultindistasteforlearningonthepartofthestudents.

Theshortcomingsofthelecturingmethodarequiteseriousandit'snot especiallygoodforteachingmathematics.It, asaninstructionaldevice, is far from being ableto realisethe widely accepted objectives of mathematics education. The one-way processof formal lecturing is the sourceofallitsdemerits.Itignoresallimportantprinciplesoflearning,from starting"wherethestudentsare"to"involvingthestudentsactively inthelearningprocess".Thelackofopportunityforstudentstoreceivefeedback weakens motivation and blockscommunication notonly between the teacher and the learners, but also among the fellow- students.

Due to such misgivings or criticisms, the lecturing method has been modified in order to better fulfill its educational mission. The modifications aim at dilutingthe authoritariannatureof the "one-way" lecturingbyallowingforsomesortofinteractionbetweentheinstructorand the class Thus, lectures are often interspersed by briefdiscussionperiods or followed by such innovations as buzz groups or brainstorming sessions. In effect, the efficacy oflecturing depends largely upon whodelivers the lectures, what information has to be imparted and how the instructor presents them. The well-prepared, sensitive, student-centredinstructor, whois familiar withthe backgroundandindividualisedneedsofhis students,for example, mayprovide through his presentation,uniqueandlasting contributions tolearning. He may selectfor emphasis pointshe knows to be needed byhis students. He may invite questions and comments to ensure that thestudentshavegraspedthemainthemeofhislectureandthat theirdesire tolearnis atleast sustained.

3.2 TheDiscussionMethod

The discussionmethod owes its origin again totheGreek philosopher-educators,particularlyPlato,whorebelledagainsttheauthoritariantypeof lecturingsystemofthe Sophists.Thisteachingdeviceis basictothedemocratic process and it involves an entire class in an extended interchange of ideas between the teacher and the learners and concurrently among the fellow-learners. Although the members in the class approach the discussion topic with many and varying points of view, the group leader, i.e. theinstructor, will tend to focus the discussion in the direction most conducive to effective and purposeful learning. The growing emphasison criticalthinking and problem- solvinginacademicinstructionaccountsinpartforthecurrentincreased

attentiontothediscussionmethodas amediumof instruction.

Letus examinethecharacteristicsofthisinstructionalprocedure,inthesame manner as we did for the lecturing method,in orderto assess its effectiveness.

Theadvantagesofthemethodare first summarisedforanalysis:

i) it promotes interest by giving the students a share in the responsibility for the courseand in search forknowledge. This compels thestudentstobeactivelearners,andis quitecontrarytothelecturingmethod
ii) itmotivates the learnersby keepingtheworkwithintheirintellectualboundsandbyallyingitwiththeir aptitude
iii) itenablestheinstructor to constantlyappraise the students' understandingoftheissuesunderdiscussion,asheleads theclassintothehigher levelsofthecourse
iv)itsharpens the students' ideas and concepts by forcing themtoexpress them in their own words. This facilitatesintellectual comprehension and application of new knowledgeto life-situations.Integrationoflearningwithexperiencewillbebroughtabout
v) it permits the students to challenge statements withwhichthey disagree or which they misunderstand, thereby facilitating the process of self-discoveryand self-understanding and developing thesenseofself-assertiveness
vi) it develops in the students the skills essential toeffectivegroupdiscussionandverbalcommunication.

The discussion method forces the students outoftheir classroom lethargy, so that every learner willreacteitherin support orin oppositiontotheissueunder discussion.

Eachstudentwilllearntofeel freetoexpresshisopinions,toarguewithmutualrespect andtodefendhis ownstandinthelightoflogicandrationality.This methodis ableto achieve more than thelecturing method interms of the objectives of a collegegeneraleducation.Itdevelopsfacilityinoralexpression,criticaland creativethinking, andintellectualandimaginativeproblem-solving ability.

The discussionmethodsustainsand strengthens most of the elements essential for productive learning. The provision of feedbackand class participation heightens the learner's motivation, facilitatesthe intellectual grasp ofabstract concepts and the learning of problem- solving skills. The movement inthe groupdiscussion sensitizes the instructortotheclassreactionstothelearningsituation,thus makingitpossible forhimtopitchaleveloflearning appropriatetothereadiness ofthemajority.

There is, however,a negative side to the discussion methodas an instructionaldevice.

i) It requires knowledge and skillof group dynamics and grouphandling in order to produce effective,orderly discussion. Thisskill takestimeandpracticetodevelop,andnot everyindividual can become a good discussion leader even given time and practice.
ii) It makes more demands on the instructor as a group leader thanas a lecturer. In the discussion, the role of the instructor

variesfromoneofauthoritytooneofamemberofthe group. Howtheinstructor interprets his role in any situation will depend on hisimage of himself from which his personality derives and fromwhichhisactionsfollow. The assumptionofaninappropriaterole bytheinstructorwillseriouslynegatethevalueofthediscussion method.

iii) It depends substantially for its success on the cultural, psychological and experiential backgrounds of the learners.

The free, open-minded interchange of ideas and opinions may not be evoked fromthe learners due to disadvantaged ethnical origin,emotionalinhibitionandinadequatelifeexposure.

Inanactualdiscussionsituation,anyoftheaforesaiddrawbacksislikely tooccurinvaryingdegreesandinvaryingcombination;theefficacyofthe discussion method as a teaching tool will accordingly be adverselyaffected. If,for example,adiscussiontopicis poorlychosen, thatis,itis notrelatedtothediscussants'background,experienceandinterestandit itselfnotcontroversialenoughtoevokeargumentsfromvariousangles,the discussion period will likely be characterisedby a low level ofintellectual exchange among the discussants, and interspersed with embarrassingpausesandsilences.Incasetheinstructor is anineefficientdiscussionleader,unabletodirectandcontrolthegroup,thediscussion willprobablyendupinadisorderly,chaoticbattleofverbalcomments,adding more confusion to the students than before the discussion. Should the instructor take an authoritarian role, on the other hand, the entireclasswillbesubmittedtohisdespoticdominanceandprejudices, with the resultant effect that the discussion is conducted in the instructor's interest rather than for the learning needs of the students. Under allthesecircumstances, littleornolearningmaytakeplace.

SELF ASSESSMENT EXERCISE

Briefly explain why no one single teaching method can sufficiently stand alone

3.3 TheTutorialMethod

ThismethodofteachingwassaidtohavebeeninventedbySocrates.Itsprang from the character of the Greek people who loved asking questions and arguing them out. Socrates thought that teaching might mean, notpouringnewideasintoanemptybrain,butdrawingoutfromthe mind those ideas that lay concealed. This was done by asking thestudent a series of questions. In the process of answering questions on thepartofthe student, hewasmadetorealisethatknowledgeandtruthwere in the student's own power to find, if he cares to searchlongandhardenough.Itisinthecombinationofthesetwoassumptions,namely:the criticalmethodandthepositivepurposeofselfassertion,wheretheessenceof thetutorialmethodlies.

In our contemporary u n i v e r s i t y o r college teaching, tutorial, according toG.J.

Umstattd,isinstructionfor anindividualoratmostforasmallgroup of students of three, withspecialattention topersonal interestsandabilities. This aim fortutorial is to provide challenges and stimulationinorderthatthestudentmaydevelophisoptimalpotentials.It is a two-way process inwhich the instructor,normally known asthe tutor andthestudentengageinarigorousintellectualexercise.Agreat amountofreading,thinking and independent work is done by the student, of course, with the assistance of the tutor. A written report ofconsiderable quality will be submitted to the tutor prior to the tutorialsession.Thetutor challenges,criticisesorstimulatesthestudentsduringthe regular tutorial sessions which are held at regular intervals. The meritsofsuchaninstructionaldevicearesummarisedbelow.

i) It provides a means through which the learner's individual needs, interests, aptitude and experience will be taken into accountinthe instructional process.This feature of the tutorialmethodishighly congruent withthe ethics of our democraticideologyandwiththeeducationalprinciplethat individualization ofthelearneris respected.
ii) Itpermitsthelearner toacquireagradual,orderlyand sequential progressionfrom a broad and relatively simple level to one of much greater depth and complexity. This is consonant with thelearning principle of sequential progression elaboratedby RaphW.Tyler.
iii) It makes possible immediate feedback, thereby promoting thelearner's motivation; and the tutor's comments stimulate thelearner'scapacityfor criticalandanalyticalthinking.
iv) Itencourages active, analytic, independent learning in the student.This is especiallyahighlyvaluedcontributionofhigher education to an individual in the contemporary society. The constantlyand rapidlychangingtechnologyandsocialconditions soonmakeobsolescentcertainconceptsthatarevalidashorttime ago and requires a dynamic, imaginative approach to problem- solving.
v) It trains oral presentation, articulation and intellectualself-defence. Under the relentless verbal bombardment of the tutorduring the one-hour tutorial session, the student is compelled to defend his assertions in the best manner his natural endowment, knowledge and humour permit him

vi) Itmagnetisesthelearner'simaginationandteachesthelearner to examineanyissuefromamuchbroaderperspective.Thistypeof intellectual training is extremely conducive to achievement of integrationoflearninginthetotalcurriculum.
vii) It enables the students to come to grasp more quickly with abstractconceptsandcomplicatedproblem-solvingskills.

Itisapparent that the tutorial method, as a teaching tool, is highly favourableinassuringtherealisationofthewidelyheldobjectivesofacollege general education, namely: acquisition of self-discoveryand self-understanding,critical and analyticalthinking, creative self- expression, intelligent application of knowledge to life-situations, andoral and written facility. It also measures wellagainst thecriteria necessary foran effective learning process.The tutor, by virtue of theone-to-one relationship with his student, is able to make appropriate demands on the learner in accordance with the latter's individualisedbackground,experienceandpotentials.Theincreasedpersonalattention

andcontactfromthetutorenablesthelearnertofeelthetutor'sconcern for his learning, thus heightening oratleastsustaining thelearner's desiretolearn.Thesourceofalltheseadvantagesofthetutorialmethod stemsfromthe very natureof itsteaching method, i.e. the one- to-onerelationship. However, it is this unique trait of the tutorial method thatconcurrentlygivesrisetosomedrawbacksforthis teaching device.

i) Itis anextremelyexpensivemethodintermsof money,timeand effort.Onetutor cannotideallyhandle morethan5studentsata time. Thequalityofteachingofthis instructionaldeviceinversely relatestothequantityof its output.Inthecontemporarycountries whereprimaryeducationis extendedtoas manyoftheircitizens, theclassroomsituationcannotafford suchanexpensiveteaching method.

Attheendofthetutorialsession, boththetutorandthe learnermaybeutterlyexhausted.

ii) Itmayunnecessarilyfosterunhealthyidentificationofthelearner withthetutor.Thetutorialsessionsprovideapermanent structurewhere the tutor and the learner meet in privacy at weekly or fortnightly intervals. Soon the tutor and the learner get to knoweach other very well. Often out of this intensity of relationship, the learner becomes identified with his tutor for an array ofreasons, from hero-worshipping of the charismatic idol topsychological mimicking of the oppressor out of the need for self-defenceand survival. Thus, the learner acts, thinks and behaveslikehistutor,imitatingallhismannerismsandlifestyle. However, the extent to which the tutor consciously or unconsciously creates situations which are favourablefor converting the student into his own image, depends on the maturityofthetutor'spersonality,emotionalmake-upandalsoon hisperceptionofhisrolein sucheducationalendeavour.

iii) It is liable to provoke an enormous amount of anxiety in thelearner; thereby retarding the latter's learning progress. The tutorial session is conducted under a one-to-one relationship imbued with an intense emotional overtone. The student, normally in an inferior intellectualposition, lays bare his weaknesses and biases for the tutor to criticiseand submits himself rather helplessly to the tutor's whims and personality idiosyncrasies. Under the pangs of anxiety, the learner developsvarious patterns of adaptation out of the need to survive thetrauma. He learns quickly about the tutor's preferred school ofthought, prejudices and likes, and attempts to shape his ownthinking accordingly. Or the student may retreat tosubmissiveness and passivity, agreeing with all the view points andarguments of thetutor. Somelearners'level of anxiety is so high in the tutorial sessions that they are literally paralysed,losingtheir capacityfororalandrhetoricexpression.Inshort,the emotional tension and nervousness on the part of the learnerinhibitsthespiritofactive,independentlearning,thecapacity forcriticalandcreativethinking,andtheabilityoforalanddebating facility, allofwhichthetutorialmethod,as ateachingdevice,is meanttodevelopinthelearner.

Inview of the impracticabilityand the demerits of thetutorial method, somemodifiedformsofthetutorialsystemhavebeendeveloped. Noneof these new innovations resembles the traditional tutorial in structuralappearance.Theone-to-onerelationshiphasexpandedtocover agroupof students; but the original emphasison independent and active learning, critical and analytical thinking, oral and written proficiency,and a deep and broad approach to a topic is all retained in varying degrees in these new teaching innovations. Some of these modified instructionalactivitiesare:

- smallgrouptutorial,seminar,colloquium,panelpresentation,and debatediscussion.

a) Small Group Tutorial: this bears the closest structural resemblance to the traditional tutorial. In this method, thetutortakes a small group of students, about five to seven, in his periodic tutorial sessions, where each studenttakes turn to prepare and to present his written report orally and theotherstudents, led by the tutor, will fire questions, comments andqueriestowardsthestudentchargedwiththepresentation.

b) Seminar: this form of teaching-learning activity is usuallyrestrictedtothegraduatestudentsortotheseniors inthecollege.

In the seminar, a student will take turn to deliver a paper on aparticular topic, carefully written after much thorough reading and critical reflections. The other students will listen to the presentation, make notes of his references and follow up by further reading. The role of the instructor is to direct the discussion, in which all students take part. In both the small- group tutorial andthe seminar, the instructor's presence and guidance are essential. However, in the colloquium, panel presentation and debate-discussion, theinstructor's role is becoming less and less in significance and in defectiveness in nature,whilethestudentsareexpectedtotakeonmoreandmore activeandindependentlearning.

c) Colloquium: the students meet in a group and talk abouttheirreading, confronting each other with challenges and questions,andprobingintothemultifariousfacetsofanissuewith intenttoseek depth and breadth in knowledge. The end product of suchtraining may result that realisationof the art of conversation, a sense of style in speaking, and the interplayofpoise, gravity, humourandcontroversywillbeachievedbythestudents.

d) Panel-Presentation: a groupof students, typically from 3 to 6, form a panel.Each panelistprepares a sub-part in a subject in some depthand thenpresents itbeforetheclass. The panelchairmanparticipatestokeepthediscussiontothepoint,to invitesilentclass memberstotalkortogiveanoccasionalsummaryto suggesthowthe discussion hasprogressed.Thepurpose is toprovideanopportunityforthepaneliststolearnrhetoricspeaking infrontofagroupandtopracticeintellectualdefence.

e) Debate-discussion: debate-discussionis relatedto thepanel- presentation, butwiththis

method,twoormorespeakersusuallytake definitepointsofview, presenttheiropinionsandfacts, andparticipate laterby responding toquestions andcomments fromothers inthe class. Quickness andsharpnessin thinking and the artofexposition anddiscourseare thefruits of such learningactivity.

3.4 CooperativeGroupLearning

Cooperative group learningallows students towork throughmathematics equations in a small group setting. To implement this teaching method, arrange students in groups of fourto six individuals. Afterthe basic information and assignment has been presented to the class,allow studentstobreakoffintotheir groupsandworkthroughtheassigned equations. Move aboutthe classroom to interactwith each group as they work on their projects and hold a presentation period at theendofthelessonfor eachgrouptopresentits conclusions.

3.5 LaboratoryMethod

Kinesthetic learners excel in environments where they can physically manipulate objects. Incorporatekinesthetic learning into mathematics instruction by holding mathematics labs. Within the lab setting, give students tangible objects to work through mathematics equations and testtheories.Teacher creativityisvitaltoteachingmathematicsviathe laboratorymethod, as you will be required to develop projects for the students to take on. Some examples may include using tiles for basic additionorusingtoothpicksfor examiningtheprinciplesofgeometry.

3.6 ExpositionMethod

Use this method to quickly and effectively expose students to new mathematical information. Beginby presenting students with a clearly defined explanation of the conceptyouare teaching, working sequentially through the steps required to complete anequation.

Facilitate discussion with the class by posing questions based on information the students have already learned and build on theirprior knowledge.Althoughthis methodisfocusedprimarilyontheinstructorrather than studentparticipation, you can help engage students bypresentingtheinformationinalivelymanner.

3.7 GuidedDiscovery

Guideddiscoveryis theoppositeoftheexpositionmethod,as itrequires students torecogniseprinciplesindependently.Tobeginalessonusing guided discovery, present students with a series of equations or scenariosthataresimilartooneanother.Ask studentstoidentifyhowto best solve the equations or to identify which mathematical concepts apply to each scenario. This method acts as aneffective reviewformaterial thathasalreadybeen taught. However, some students may become frustratedifthey are unable to discover the answers on their own. Be suretomake yourself available duringindependent workingtimetohelp studentsonanindividualbasis.

4.0 CONCLUSION

When measured against the two criteria, namely : (i) the objectives of teaching, and (ii) the common factors influencing learning, each of thethreewidelyusedteachingmethods-lecture, discussionandtutorial–is able to meet part, not the whole, of the two criteria.

One method may satisfyoneofthecriteriamorethantheothermethod. Itis alsoapparent from experience that none of the three teaching methods is used in its pure form. Each is supplemented by newer instructional innovations.

Forinstance, formallecturingisnotpredominantinprimaryschool. Itis augmented by discussion periods from the class, buzz groups andbrainstormingsessions. Discussionmethodismademoreproductiveby introducing some forms of lecture-presentation whichprecedes the discussionitself.Likewise,thetutorialhastransformedintoavarietyof activities. In some of them, the teacher retains his classical roleas the"charismaticleader"and"intellectualinspirer", whileinothers, hisrolehas the"peer"reducedtooneinthediscussion. Thesupplementationbynew auxiliary methods bespeaks that each of the three traditional teaching methods is not perfect intrinsically and that each is good for certainpurpose.

5.0 SUMMARY

These three instructionaldevices are all equally good for differentpurposes, and a good education exposes the pupil to them all. Each ofthem has its difficulties and its defects; each of them contains uniqueadvantages. A teacher, who uses only one method, is in danger of developing one group of skills in his pupils and only part of his own powers as an educator. A pupil who knows only one way of learning willfindithardtoconceivewhatrichpossibilitieslieunusedinhis own mind. All three are useful for some purposes, bad for others; all arevaluable.

There is no "one most preferred method of teaching". Whether a particular instructional medium is efficient or productive has to be assessed in the light of (a) the student's needs, (b) the teacher's personalityandskillsas aneducator,and(c)theadministrationandthe broadpurposeoftheclassroomwherethemethodis beingemployed.

Thestudents are humanbeings, with different socio-cultural background, intellectual and emotional endowments, educational aspirations and experience. All these will predetermine,ingreat measure, the individual student's reaction to and perception of the teaching-learningactivity.

Theteacherisalsoahumanbeing, uniqueinphysicalandpsychological constitution, personalitycharacteristics and social experiences. One teacher may be talented in utilisingone particular group of teachingtechniques and methods, butvery inadequate in others. Therefore, it is expressthattheeffectivenessofaparticularinstructional devicewillbegreatlyaffected by the teacher's skills and personality. Teachers teachwellbymanydifferentmethods.Noone methodis clearlysuperiorinall situations. Elementsof course content, background and group make-up ofthestudentsandtheteacher,

andrelationshipwiththeadministration, bearsignificancetowhichteachingmethodis tochoose.

6.0 TUTOR-MARKEDASSIGNMENT

i. Identify three main teaching methods and distinguish among them.
ii. Discuss teaching methods which can serve as adjunct to other teachingmethods and explain the ways by which they can be employedtogether.

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UNIT 3 FACILITATING DEVELOPMENT OF MATHEMATICAL KNOWLEDGEFOR TEACHING

CONTENTS

1.0 INTRODUCTION

Metacognition is one of the latest buzz words in educational psychology. We engage in metacognitive activities every day. Metacognition enablesus to be successful learners, and has been associated with intelligence (e.g., Borkowski, Carr, &Pressley, 1987;Sternberg,1984, 1986a, 1986b).Metacognitionreferstoahigherorder thinking whichinvolves active control over the cognitive processes engaged in learning. Activities such as planning how to approach agivenlearningtask, monitoringcomprehension,andevaluatingprogress toward the completion of a task are metacognitive in nature. Because metacognitionplays acriticalrolein successfullearning, itisimportant to study metacognitive activity and development to determine how studentscanbetaughttobetterapplytheircognitiveresourcesthrough metacognitivecontrol.

2.0 OBJECTIVES

Attheendofthisunit,you shouldbeableto:

- explainwhatmetacognitiveis allabout
- statethecriticalelementsofmetacognitive
- implementthestrategyinmathematicsclassroom
- applythestrategytohelppupils'withlearningdifficulties.

3.0 MAINCONTENT

3.1 MetacognitiveStrategies

Thepurposeofteaching metacognitivestrategiesistoprovidestudents explicit teacher instruction for a specific metacognitive (learning) strategy.

3.1.1Whatare they?

- First, a metacognitive strategy isa memorable "plan of action" that provides students an easy to follow procedure for solving a particular mathematicsproblem.
- Second, metacognitive strategies are taught using explicit teachingmethods.
- Metacognitivestrategiesincludethestudent'sthinkingas wellas their physicalactions.
- Someofthemostcommon metacognitivestrategiescomeinthe formofmnemonicswhicharemeaningfulwordswheretheletters inthewordeachstandforastepinaproblem-solvingprocessor forimportant pieces of information about a particular topic of interest.
- Metacognitive strategies are memorable and it must accurately representthelearningtask.

3.1.2Whatare theCriticalElementsofthis Strategy?

The following list includes critical elements of teaching metacognitive strategies:

- metacognitivestrategies are taught using explicit teaching methods(seeExplicitTeacherModeling)
- metacognitivestrategiesareaccurateandefficientproceduresfor specificmathematicsproblem-solvingsituations.
- metacognitivestrategiesarememorable
- metacognitivestrategies incorporate both student thinking and student actionsnecessaryforperformingtargetmathematicsskill
- studentsneed ample practice opportunities to master use of ametacognitivestrategy.
- students'memoryof a metacognitive strategy is enhanced when studentsare provided with individual strategy cue sheets and/or whenthemetacognitivestrategyispostedintheclassroom
- monitorstudents'useofstrategiesandreinforcetheir appropriateuse ofstrategies.

3.1.3 HowdoI implementthe Strategy?

1. Choose an appropriate metacognitive strategy for the mathematicsskill.
2. Describe and model the strategy atleast three times. Use those instructional components emphasisedin explicit teachermodeling (see the instructional strategy Explicit TeacherModeling.)
3. Check student understanding. Ensure they understand both the strategyandhowtouseit.
4. Provide ample opportunities for students to practice using the strategy.
5. Providetimelycorrective feedbackand remodeluseofstrategyasneeded.
6. Providestudentswithstrategycuesheets(or postthestrategyin theclassroom)as studentsbeginindependentlyusingthestrategy.Fade the useof cues as students demonstrate they have memorisedthe strategy and how (as well as when) to use it. (*somestudentswillbenefitfroma"strategynotebook"inwhichtheykeep both the strategiesthey have learned and the correspondingmathematicsskilltheycanuseeachstrategyfor.)
7. Makea pointof reinforcing studentsforusing the strategy appropriately.
8. Implicitly model using the strategy when performing thecorrespondingmathematicsskillinclass.

Self Assessment Exercise

What is metacognition? Why do you need to study it?

3.2 HowDoesMetacognitive Instructional Strategy PositivelyImpact Students who have Learning Problems?

Itprovidesstudentsanefficientwaytoacquire,store,andexpress mathematics-relatedinformationand skills.

Itprovidesstudentswhohavememoryproblemsanefficientwayto retrievefrommemoryinformationtheyhavelearned.

Itfacilitatesindependenceby those learners who aretypically dependentonhighlevels ofteachersupport.

Ithelps students move from concrete and representational understandingtoabstractunderstanding.

Weturn our attention to studies that notonlyidentify deficiencies in teacher knowledge but also carry out interventions to remedy them. Jaworski(2001)details the nature of the teacher educator action asfacilitating the connection between theoryand practice by developingeffectiveactivities that,in turn, promote teachers' ability to createeffective mathematical activities for their ownstudents. In a morespecific way, Cooney and Wiegel(2003) propose three principlesfor teaching teachers mathematics, addressing the kindsof mathematical experiences that promote an open and process-oriented approach to teaching, suggesting that pre-service teachers should: (i) experience mathematics as a pluralistic subject; (ii) explicitly study and reflect on schoolmathematicsand(iii) experiencemathematicsinwaysthat foster the development of process-orientedteaching styles. Cramer (2004), influenced by NCTM standards, also provides a pedagogical model to framemathematicscoursesforteacherswhichconsistsof:

- mathematics content is embedded in problem settings; learners collectdata, generatehypotheses,andverifyconjectures
- learners work in small groups to optimisethe opportunity for discourse
- questions are posed to help learners construct mathematical knowledge
- learners'language (oral and written) plays an important role in facilitatingthetransitionfromproblemsolvingandexplorationtoformal mathematicalabstractions
- connections within and among mathematical topics are emphasised
- technologyuseisintegratedintothedailyactivitiesofthecourse.

These three examples of how we can approach pre-service teachers' learning of mathematics for teaching support the view that there is noclear-cut approach to addressing the concerns about pre-service teachers' mathematicsknowledge.

4.0 CONCLUSION

Metacognition enablesstudents to benefit frominstruction and influences the use and maintenance of cognitive strategies. Whilethereareseveralapproachestometacognitiveinstruction,themosteffectiveinvolveprovidin g thelearner with bothknowledgeof cognitive processesandstrategies(to beused as metacognitive knowledge),andexperienceorpracticeinusingbothcognitiveand metacognitive strategies and evaluating theoutcomesof their efforts(developsmetacognitive regulation). Simply providing knowledge without experience or vice versa does not seem to be sufficientforthedevelopmentofmetacognitivecontrol.Thestudy ofmetacognition hasprovided educational psychologists with insight about the cognitiveprocesses involved in learningand what differentiatessuccessfulstudentsfromtheirlesssuccessfulpeers.Italso holdsseveralimplicationsfor instructionalinterventions,such as teaching students howto be more aware of theirlearning processes andproducts as wellas howtoregulatethoseprocesses formore effectivelearning.

5.0 SUMMARY

Stated very briefly, knowledge of person variables refers to general knowledge about how human beings learn and process information, as well as individual knowledge of one's own learning processes. Metacognitiveexperiencesinvolvetheuseof metacognitivestrategiesor metacognitive regulation. Metacognitive strategies are sequential processesthatoneuses tocontrolcognitiveactivities,andtoensurethata cognitive goal(e.g.,understanding a text) has been met. These processeshelpto regulateandoverseelearning,andconsistofplanningandmonitoringcognitiveactivities,as wellas checkingtheoutcomesofthose activities

6.0 TUTOR-MARKEDASSIGNMENT

i. Explaintheconcept "metacognitivestrategy"
ii. Whatarethecriticalelementsofmetacognitivestrategy?
iii. Picka mathematics topic and explain how you will use metacognitivestrategytoteachit.

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