Mathematical Learning of Engineering Undergraduates

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***Abstract*- Much research has been conducted on the teaching and learning of mathematics forengin eeringunder graduates.Thispaper reportson a preliminarystudy in an investigation on the mathematics curriculum of engineering students, a studyof engineering students and lecturers'perceptions about the mathematics curriculum, teaching and learning that have been carried out.The research instrument was aset of questionnaire that the respondents consist of lecturers and students from engineering faculties of UTM in Johor, Malaysia. The in formation highlights issues of concern inthe developmentof the mathematics curriculum for engineering students based on data of implemented curriculum ascompared tothedesired curriculum.**

***Index Terms*- mathematics curriculum; mathematical skills; engineering undergraduate**

I. INTRODUCTION

Mathematics is a difficult subject and students have difficulty because of different perceptions of mathematicalwords andconcepts.Therearesomevariousfactorsthatinfluence students' performance(Ihejieto,1995).Thesefactorsare:
i.Students'lackofeagernesstomathematicsmaystemfrom psychologicalincidencessuchasfear,tolerancethreshold, andperseveranceandassociatedfactors.
ii.Themathematicscurriculummaynotberelevanttoreallif e.
iii.Mathematicsinstructorswerenotkeenonteachingthec ourseanddidnothelptheirstudentsbycatering individualdifferences.
iv.Otherreferencessuchastextbookswere missingfrombothschoolsand homes.
Moreoverthemathematicscurriculumforengineeringispre sentedbyidentifying thecomprehensive listof topicsinmathematics(Roselainyet.al.2005).
Theengineeringstudentsareexpectedtofindouttheimporta nce ofmathematicsintheirfuturecarriers(Sazhin1998). As aresult, whatmathematicalskills areexpectedand what mathematicstopicsandwhereintheengineeringcurriculum theseskillsandtopicsaregainedareconsidered veryimportant.Whilethere were manysuppositionsregardingtheseissuesinengineeringfac ultiesatUTM,such identificationhadnotbeenformallycarriedoutordocument ed.Thecurrentstudyisbasedonthemathematics curriculumin theundergraduatedegree programandtriestolinkthemathematicscurriculumtothem athematics isusedbyengineeringstudents.
Mathematicsskillsareconsideredasapart ofrequiredmathematicscoursesinUTM.Inadditionthediff iculty ofcertainmathematicaltopicswhichhavecausedsomepro blems amongstudents isdescribedinthisstudy. The feedbackandinputwassoughtfromengineeringfaculties.

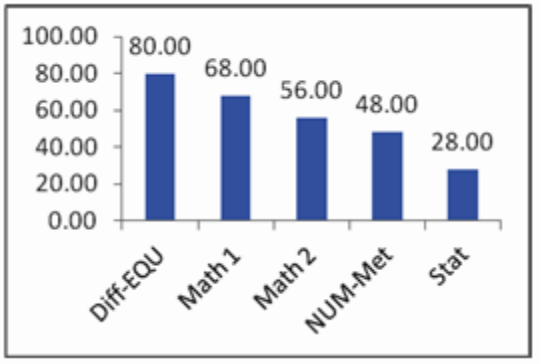
II. PROBLEM STATEMENT

InUTM,someeffortatimprovingstudents'understandinga ndenhancingtheirmathematicalthinkinghasbeencarriedo utaswell(Yudariah&Roselainy2004).However, therehasbeenresearch(WillcoxandBounova2004)thatha sidentifiedthatthereispoorinteractionbetweenthefacultie sofmathematicsandengineeringin coordinatingandconsolidatingthemathematicsneededine ngineeringeducation(Roselainy,Yudariah&Mason2002).Thecommunicationgapsofknowledgesharingbetween mathematicsandengineeringfacultywere identified.
Mathematicswastaughtasservicesubjectsin UTMwiththe expectationthattheengineeringstudents should havesufficientskillsinmathematicssothat theywerecapableofsolvingproblemsinengineering.How ever,it is realizedthattheengineeringstudentshadnotachievedthepr oficiencyasexpectedintheusageoftheskillsand thetransferofthemathematical knowledge.Thispaperwhichisapartofadoctoralstudyofth emathematics curriculum forengineeringundergraduates,aimstodescribemathemat icaltopicsthatareconsidereddifficultby thestudentsandmathematicslecturers;also,therelevancyo feachmathematicstopictotheunderstandingofthe engineeringcore and electivecourses.The surveyconsistsofquestionsthat

lookattheutilizationofmathematics coursesthatarederivedfromengineeringlecturers.PartBof thisquestionnaireisattachedinappendix.

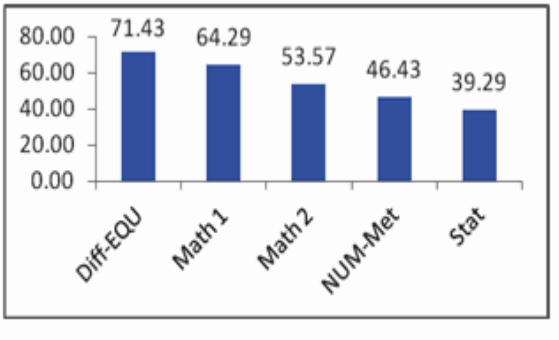
III. METHODOLOGY

Thisstudyisaninitialstudyonthestudentsandlecturersofth reeengineering facultiesinUTMnamely; ElectricalEngineering (FKE),CivilEngineering (FKA)andMechanicalEngineering (FKM).Someissuesare explored byusingquestionnairesbased onthestudents'andlecturers'conceptionsofmathematics. Three setsof questionnaire(seeAppendixA)forthisstudyweredesigned according topreviousresearchessuchasWillcoxworkin2004. Thedifficulty,relevancyandtheapplicationofmathematic ssubjectsandtheirsubtitles,hasbeen describedaccording



tostudents' andlecturers'view.Aswellas,theparticipantswereaskedw hichmathematics topicsneedtobere-taughtorreviewedforengineeringcourses.

Thethreesetsofquestionnaireforthisinvestigationwere handedouttothreegroupsofrespondentsconsisting of mathematicslecturersteachingmathematicssubjectsto engineeringstudents,engineeringundergraduatestudents,



wereaddressedbyoneset,andengineering lecturersteachingsubjectswithasignificantneedof mathematics wereaskedby anotherset.Allthreesetsconsistedoftwopartsinwhich, PartAisabouttheprofile ofparticipantsworkingaslecturersindifferentfieldsofengi neering andusingmathematics intheirengineering coursesandtheiracademicbackground. However, PartBaimstoinvestigatetheutilizationofmathematics knowledgebyselecting thecoursesmentionedinalist.27itemswerelistedinatableb asedondifficulty and relevancyofmathematics topicstoengineering courses.Forexample,someofthetopicssuchasmatrices, differentiation,integration,series,andvectorswerecovere d.

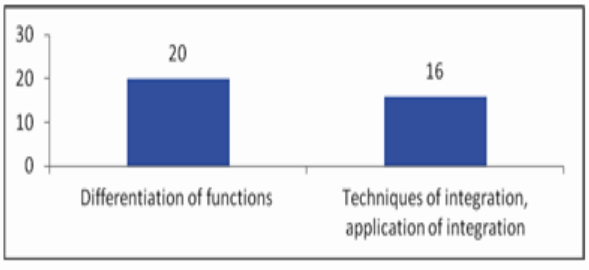
Thequestionnaire isdesignedforengineeringlecturersaimstoelicitinformat ionaboutwhichmathematical topics needed tobere-taughtduringthecourse,whichtopics neededtobereviewedanditalsoelicitinformation forinvestigating theutilizationofeachmathematics subjectinidentifiedengineeringcourses.Inaddition,four open-endedquestionsaredesignedattheendofpartB. Thedatawhichisgatheredfrom 4open-endedquestions attheendofquestionnaire istoidentifythemathematical skillsneededinthecoursesandtheexpectationsof engineeringlecturerstowardsthemathematicscourses. Mostofthelecturersgenerallyfacewithdifficulties andchallengesintheclassroomsoquestionnumber1 enquiredparticipants' perceptionstowardsthedifficultskillsofmathematicsfore ngineeringstudents.Thenext questionidentifiesthelecturers'perspectivesaboutengine ering students'problemsolvingskills.Anopen-ended questionnumber3wasdesignedtoinvestigatethesedifficu lties amongundergraduate students.Theaimof question4istodeterminehowteachingmathematics canbeformedaccording totheneedsoftheengineering curriculum.Questionnumber5isanopenendedquestionth atenquiresparticipants'suggestionsforimproving theteachingofmathematics toengineers.Inordertoqualify theanalysis,listingtheproblems encounteredby studentsintheirexplanationwasanalysedfromthewritten responsesofthestudents.

Thequestionnairewasdistributedto80respondentsmade upofmathematics lecturers andbothengineering studentsandlecturers.The questionnairesweredistributedtoa totalof30studentsfromthe engineering departments.Atotalof25students,submittedtheirrespons es.Finally,thesemi-structured questionnaireswere giventoatotalof30engineeringlecturers and30mathematics lecturers.25engineeringlecturers and25 mathematicslecturersreturnedthequestionnaires. ThesoftwareSPSSPC hasbeenusedtoanalyzesomeofthedata.Thestatistical analyseswereexpressed frequency,percentage,reliabilityindex.Thereliabilityin dex(Cronbachα)forallrespondentsequaled0.92. Thedatathatisextractedfromthequestionnairewould enhancemathematicslecturers'awarenessofwhere themathematicsisusedandtheviewsoftheirengineeri ngcolleaguesaboutstudents'mathematicaldifficultie s.

IV. FINDING

Fromthedataobtainedbyquestionnaires itwasinferredwhichtopicsaredifficultforlearningand understanding.Figure1illustratesthepercentageofdifficul tyofeachmathematicssubjectintheperspectiveof undergraduateengineeringstudentsinUTM.Basedonthisf igureonstatisticalinformation,itcanbeinferredthat instudents'pointofviewthecourseswhicharearrangedfro mDifferentialEquations,Mathematicsengineering1,toM athematicsengineering2arethemostdifficultsubjectsinlea rning.MathematicsSubjectsDifficultyaccordingto Students'point of view

Ascanbeobservedintheabovefigure,71.43percentof studentsconsideredthat theDifferentialEquationsis themostdifficultsubject,while64.29percentofstudentssel ectedMathematics1asthedifficultcourseand 53.57percentofstudentsbelievedthatMathematics2 isthedifficultsubjectforlearning.



ThedifficultyofeachMathematicssubjectintheperception ofMathematicslecturers.

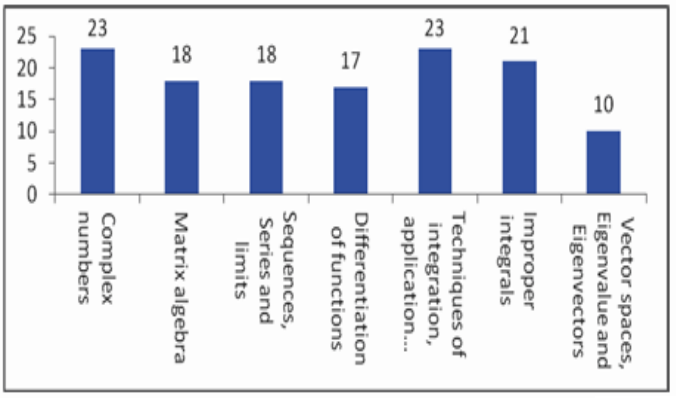
MathematicsSubjects' DifficultyaccordingtoMathematicsLecturers' pointof view

Mathematics lecturershavesimilarviewstothestudentsabouttopicsthat theythoughtweredifficult.80 percentofthemathematicslecturersconsideredthat'Diffe rentialEquations' isthemostdifficultsubject. 68 percentofthemathematics lecturersselected'MathematicsI'asthemostdifficultsubj ect;while56percentof themconsideredthat 'MathematicsII'isverydifficultforlearning. Ingeneralsense,basedonwhatisextractedfromthreegrou psofrespondents, twooftheminclud ing, mathematicallecturersand engineeringlecturersconsideredthatDifferentialEquatio nscourseashavingahigher levelofapplication.Moreoverboth mathematicslecturersandstudentsoutofthreegroups ofrespondentsagreed that 'therelevancyofMathematicsII'isquitehightoengineeri ngcourses.

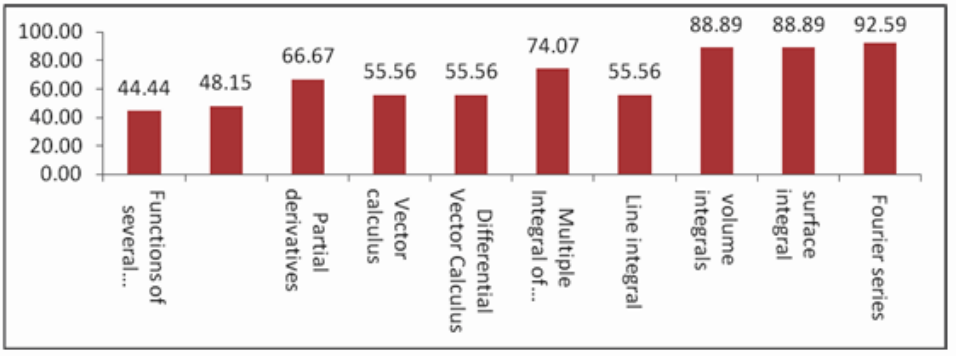
Accordingtotheresultobtainedfromthequestionnaireofen gineeringlecturerswhichisshowninfigure3it wasdemonstratedthatDifferentialEquations,Mathematic sIandMathematicsIIhave88.89%,70.37%and 55.56%percentageofapplicationinengineeringcoursesre spectively.

UtilizationofMathematics subjects fromEngineeringLecturers pointof viewNotethatverticalaxisisthenumberofrespondentsout oftotal30engineeringlecturers whowereparticipant inthissurvey.Forinstance 24engineeringlecturerswereagreed'Differential Equations'isthemostdifficult subjectforengineeringstudentstoleanand understand. Accordingtotheengineeringlecturers:

1)Someofthesub-topicsinEngineeringMathematicsIneedtobereviewedbyt hecurriculumdesigners whichisshowninfollowedfigure):



TheapplicationofsubtopicsofMathematicsIaccordingtoengineeringlecturers'pointof view.Thevertical axisshowstheamountofrespondentswhosaidtheiropinion abouttheutilization ofeach mathematicstopic.Thehorizontalaxisshowsmathematics topicsareincludedinMath

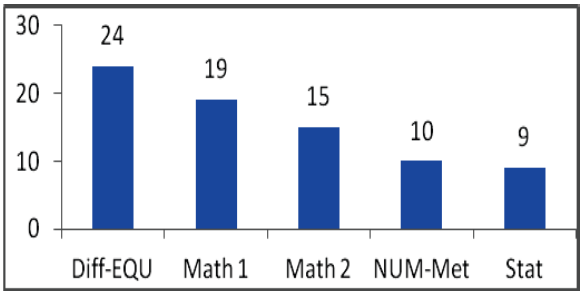


Mathematics Isubtopicswhichneedtobe reviewedduring engineeringcourses

Utilization ofMathematics IsubtopicsaccordingtoEngineeringLecturers' pointof view

Utilization ofMathematicsII subtopicsaccordingtoEngineeringLecturers' pointof view

2) Someofthesub-topicsinMathematics IIshouldbere-



taught bythelecturers. Thesubjectssuchas: FourierSeries,surfaceandvolumeintegral,MultipleIntegralofRealFunctions andpartialderivatives areinagroupofsubjectswhichshouldbepaystrongattentio nNotethattheverticalaxisisthepercentageofrespondents totheapplicationofmathematicssubtopics throw engineeringcoursesthiscomesoutofUtilizationcolumno fquestionnaire.

Theopen-endedquestionscomeattheendofquestionnaireindicateth edifficultiesoflearningand the teachingmethodsforengineering studentsandwhatthey askforbetterment basedontheirpointofview inthe questionnaire. TheQuestionnaire alsotriedtoaskwhatkindofmathematicaldifficultieswereo nthewayof engineeringstudents.Toanswerthesequestionlotsofstude ntsblamedthevastnumberofformulasas oneof the difficulties.Someblamedthedifficultyofunderstanding themathematics itself.Carelessmistakesmade by studentswereanotherdifficulty.Calculatingprobabilityof certaineventsandalsonotsufficientteachinghours ofmathematicswereconsideredasotherfactorsbysomestu dents.

What students suggested about improvement of learning process were: Using software to aid the mathematical problemsweface,doingalotofexerciseandassignment,de dicatingmoretimeformathclass, understanding theconcepts,lawsandprinciplesofthemathematics,applic ationofmathematicalissuesinother subjectsandsoon. Theanswertothequestionofwhatskillsarethemostusefulo neinmathematicsintheeyeofstudentswere: Problemsolving,translation,modellingand formulatingandsoon.

Lastbutnotleastwasthequestionofwhatstudentsexpectto receivefrommathematics. Somestudents believedthatthemostimportantroleofmathematicsoffere dinthecurriculum istobeusefulandthemore applicableitisthemoreinterestingitwouldbeforthem.So meotherexpectedtoputmathematicalcalculation intopractice inthereallifeandotherswerekeen onlearningmathematicalskills.

"Mathematicshastobeableto solvetheproblemswithminimalreferences."

Onestudentsaidaccording tothestudentsanswerstotheabove open-endedquestion.

V. DISCUSSIONANDCONCLUSION

Accordingtotheabovediscussiononthedifficultyof Mathematicssubjectsinthe perspectiveofthe lecturers,itshouldmentioned thatthetimeofsubjectswhichofferedshouldbeaddedt omakeitpossibleto studentsforbettercomprehensioninthesubjects.Apar tfromthis,itsuggeststhatthelecturersshouldusethe effectivemethodofteachingsuchas;usingstudent-centred activitieswiththeaimofimprovingthelevelof understandinganddecreasingthedifficultiesoflearni nginthestudents.

The findings of this paper are helpful for suggesting a decent and proper curriculum to cover the mathematical needsofengineering studentsviadistributionofquestionnaire andinordertodoso,ratherthan whatisdiscussedinthispaper,oneshouldconsiderotherasp ectssuchasstudents'post-graduationissuestobe aneligibleengineerinthefuture.Asnotedby(Henderson andBroadbridge 2007),"Studentshaveahigher satisfactionratingwherethereisregularconsultation betweenMathandEngineeringfacultiesoncurriculum planningand wherespaceandtimeareprovidedfordrop-inassistance."

Theresultsshowthattheperceptionandunderstanding ofengineeringcoursesarerelatedtolearningthe mathematicalsubjectsbothbeforeand duringthelearningofengineeringcoursesand theyarenot separatedfrom eachotherandhaveagreatdealofimportance.

Thepaperalsotriestoshowthelinkofmathematicswhichis includedintheengineeringfaculties'curriculumtothemat hematicswhichisrequiredinengineeringcourses.

Itshouldbenotedthatlearning themathematical coursesalsoisrelatedtosomevariables.Suchasthe difficultylevelsoflearningissueswhichisnotidentifyinthi sresearchalsotheteachingmethod,andthelearning inclination ofstudentsandinhigherlevelthecurriculum ofmathematicswhichincludesalltheaspectsof teachingandlearninginordertogetthemostoutofit.

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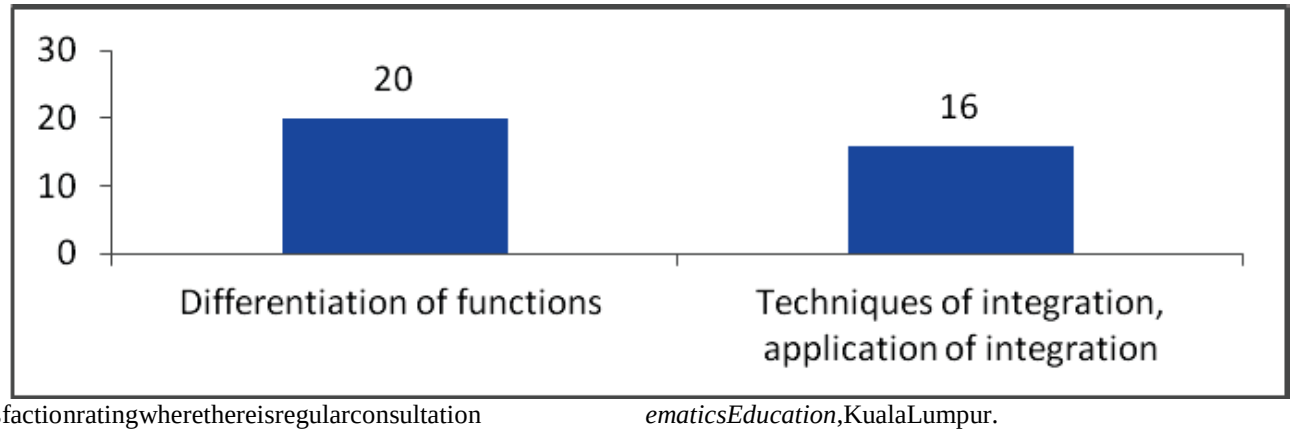

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