

OBSTACLES AND IMPROVEMENTS IN MATHEMATICS TEACHING FOR ENGINEERING STUDENTS – A REVIEW

¹Deven J. Ramani, ²Hardik C. Majiwala, ³Divyang U. Gor
¹Assistant Professor, ²Assistant Professor, ³Assistant Professor
¹Science and Humanities,
¹P P Savani University, Kosamba, India

Abstract: The coaching of mathematics to engineering college students is an open-ended problem in education. The main goal of mathematics learning for engineering college students is the capacity to apply a wide range of mathematical strategies and skills of their engineering classes and later in their expert work. Most of the undergraduate engineering college students and faculties sense that no efforts and tries are made to demonstrate the applicability of numerous subjects of mathematics that are taught as a result making mathematics unavoidable for some engineering faculty and their college students. The lack of expertise in concepts of engineering mathematics can also hinder the knowledge of other concepts or even subjects. However, for most undergraduate engineering college students, mathematics is one of the tough courses in their subject of look at. Most of the engineering students in no way understood mathematics or them in no way favored it as it became too abstract for them and they could never relate to it. A proper balance of application and idea based coaching can handiest satisfy the objectives of teaching mathematics to engineering students. It will honestly enhance and improve their hassle solving and innovative thinking skills. In this paper, a few sensible (informal) ways of creating the mathematics-teaching application base for the engineering college students are discussed. An attempt is made to recognize the present state of teaching mathematics in engineering schools. The weaknesses and strengths of the present day coaching method are elaborated. A number of the reasons for the unpopularity of mathematics problem are analyzed and a few pragmatic suggestions had been made. Faculty in mathematics courses need to spend more time discussing the applications as well as the conceptual underpinnings instead of awareness entirely on strategies and strategies to solve the problem. They should additionally introduce extra 'word' problem as these issues are normally encountered in engineering courses. Overspecialization in engineering schooling does not arise at the price of (or via diluting) mathematics and basic sciences. The role of engineering training is to provide the essential (fundamental) knowledge and to educate the students with a simple method of self-gaining knowledge of and self-improvement. A majority of these problems would be higher addressed if mathematics and engineering faculty be a part of arms collectively to plan and design the learning experiences for the students who take their classes. When faculties forestall competing towards every different and start competing against the scenario, they'll carry out higher. Without creating any administrative hassles these guidelines may be utilized by any younger inexperience faculty of mathematics to encourage engineering college students to learn engineering mathematics successfully.

IndexTerms – Engineering Mathematics, Difficulty of Teaching .

I. Introduction

Mathematics is a high constituent and infrastructure of the education of engineering students. The fundamental aim of arithmetic studying for engineering college students is the ability to use a wide range of mathematical techniques and skills of their engineering instructions and later of their expert paintings [1]. Calculus as an essential course for engineering students, allow them to work with several mathematical ideas and additionally use this information of their engineering fields [2].

But, for masses of engineering university student calculus is one of the toughest guides in their field of study. Many college students will conflict as they come across the non-ordinary troubles in calculus that is not solved via ordinary strategies of problem-solving. some students' obstacles inside the teaching and getting to know of primary calculus in undergraduate mathematics are [3] – [6]:

- The specific events in earlier experiences of students,
- The mathematics standard which carries complex meaning,
- The way of transferring of mathematics:
 - the usage of the ambiguities of language,
 - the ideal learning sequence-studying easy thoughts,
 - translating real-world problems into calculus formulation,
- Limiting mental images of few principles,
- Selecting and the use of appropriate representations,
- Confusion within the specific concepts,
- Poor ability in algebraic manipulation – or lack of it,
- Soaking up complex new thoughts in a limited time,
- Focusing on procedural and ordinary techniques instead of conceptual knowledge,

- Poor problem-solving skills,
- Students beliefs and learning styles.

Fundamental calculus is an important path for engineering students this is presented as pre-requisite direction to other advanced mathematics courses. The lack of knowledge of principles in basic calculus may avoid the understanding of other standards. On this feel, simple calculus *like evaluation is a "pop up" situation, in that, if the difficulty is smoothed over in a single region it's going to pop up elsewhere* [7]. Research has been executed on students' *learning difficulties and on coaching challenges* in multivariable calculus (Engineering Mathematics) classroom suggest that knowledge basic calculus as a pre-requisite play a critical position for the expertise of Engineering mathematics. Based totally on their findings, *some college students' obstacles* within the learning of Engineering Mathematics are from fundamental calculus and some of them are new. A few coaching challenges in Engineering Mathematics classroom primarily based on their examine are [8,9]:

- Mathematics isn't always a concern to engineering students,
- The wide variety of mathematical capabilities and unique levels of mastery of prior understanding which includes:
 - algebraic talents (manipulating symbols in a bendy way),
 - information primary talents,
 - recalling of understanding reality,
 - the ingrain students gaining knowledge of conduct and styles,
- Coordinating more than one procedures,
- Answering non-routine questions

Certainly, talent in mathematics is a fundamental necessity for any a successful engineer in any era. The speedy pace of technological development constantly needs common updating from engineers in their discipline of interest. This will be being familiar with the brand new technology and understanding of the latest technical standards. Clarity and affinity with mathematics is a vital sturdy weapon inside the armory of today's graduate engineers. In general, grown-up educated humans consider that mathematics isn't always taught properly in the primary standards. The syllabus of mathematics in school is repeatedly far removed from reality. The syllabus expects (and compels) students to decide to rote mastering or encourages them to adhere to the technique which kills the creativity and creativeness, that is considered as a soul of mathematics. This also results in college students hating mathematics which in addition compounds the hassle. From a long time, mathematics has been supposed as a dry subject. From the first semester onwards, degree course students begin losing interest in mathematics. This influences their overall performance in other courses also. Engineering college students regularly increase a bad attitude towards mathematics. For an expansion of motives, students do not attain the expected degree of success [10]. Whilst asked approximately the reasons why they do no longer get inquisitive about the subject or why they have been not a hit in learning mathematics, maximum of the scholars reply that they never understood mathematics or they by no means liked it as it turned into to summary for them and they may in no way relate to it. This truly implies that mathematics coaching has a vital function in engineering education.

Any scholar becoming a member of engineering university within the first year could be very excited and keen to have engineering experiences, (these college students are shiny, keen and inspired to research) acquiring mathematics skills to revel in this thrilling engineering enjoy that's driven to the background. The keenness to excel in engineering guides creates a mental blockade in the minds of students towards mathematics, in addition, gaining knowledge of as it becomes a secondary or unimportant subject. Faculty of mathematics and engineering courses ought to join hands to carry to college students that mathematics is a language to apprehend engineering. Without mathematics, they cannot enjoy, feel and recognize engineering. The need of the hour is that greater practical and an effective technique to the coaching of mathematics in school and engineering colleges must be made, thinking about its importance in making honestly effective engineers. Engineering college students are not expected to understand mathematics as professional mathematicians do, yet the professional engineer needs to gather not most effective computational information about mathematics however additionally summary information of mathematics. Right stability of utility and idea-based coaching can simplest fulfill the goals of coaching mathematics to engineering students. A summary knowledge of mathematics can be taught. It'll really improve their hassle solving and innovative thinking skills [11].

II. The Teaching Method and Variations

The learning model has been developed and applied their model of active learning in the coaching of Engineering Mathematics at UTM. They were taken into consideration the following factors inside the implementation of energetic mastering in Engineering mathematics lecture room [12].

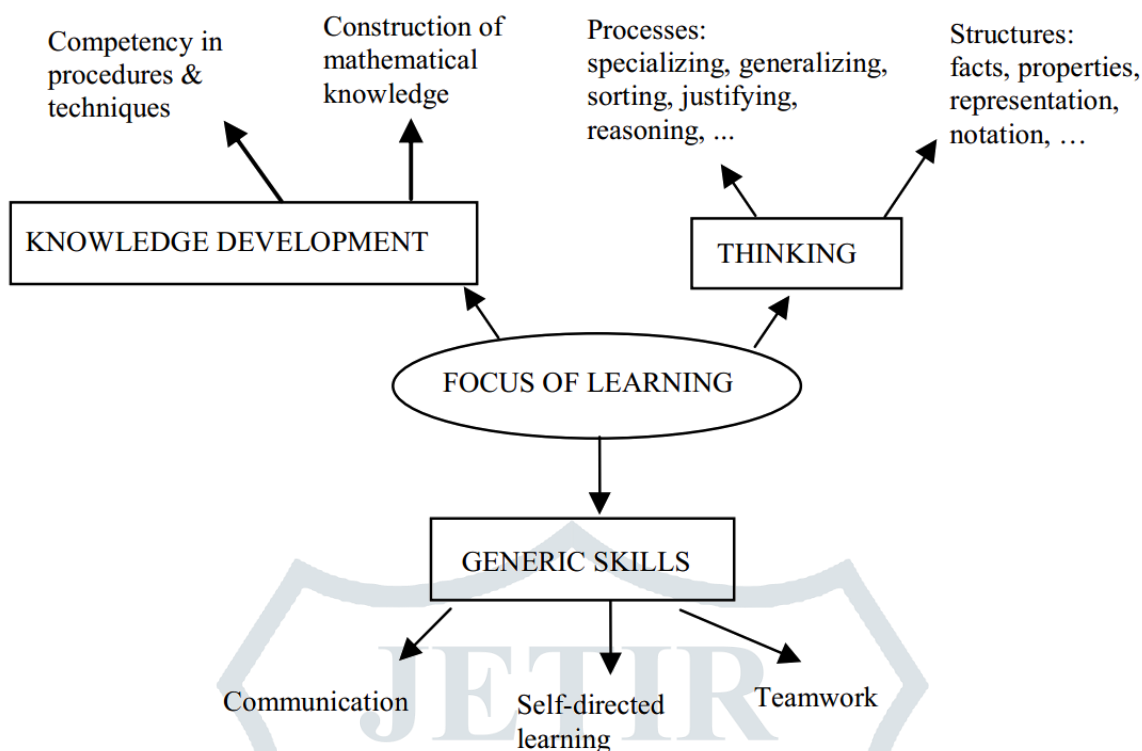


Figure 1. Mathematical Learning

- I. Classroom tasks- through categorizing the workbook as *Illustrations, Structured Examples* and *Reflection with Prompts and Questions*.
- II. Classroom activities (techniques)- by running in pairs, small group, short feedback, students' personal examples, peer-teaching, dialogue and think-pair-share, directed studying and writing to analyze.
- III. Encouraging communication- by using designing prompts and questions to provoke mathematical conversation.
- IV. Helping self-directed studying- by developing established questions to make stronger the students' expertise in mathematical standards and techniques.
- V. Identifying types of evaluation- via incorporating both summative and formative types.

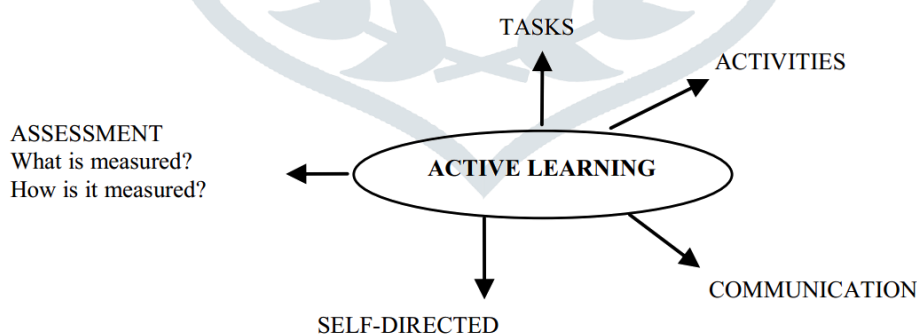


Figure 2. Active Learning Model

Figure 2 gives a summary of the model for active learning. In short, that they had furnished and promoted a getting to know surroundings in which the mathematical powers are used in particular and explicitly, toward supporting students (i) to end up extra aware of the mathematical structures being found out, (ii) to understand and use their mathematical wondering powers, and (iii) to modify their mathematical getting to know conduct [13].

Lopez discovered a huge frame of research highlighting the need for educators of engineers to adapt to the changing nature of both the engineering career and the student populace in the Twenty-first Century [11]. A more diverse scholar populace calls for a more complete gaining knowledge of the support system. consequently, there is tons of debate as to how those changes should be addressed [12].

A few issues which engineering institutions faced are listed below:

- A weakening inside the mathematical ability to entering engineering students,
- The lowering of entry standards and multiplied variety of international students (it has also caused the elevated variety of students' mathematical backgrounds),
- The reduction of mathematical content material and direction hours,
- To cater to mathematical wishes for all engineering disciplines in a single concern and the difficulty of reaching shared know-how among the mathematics and engineering departments approximately what's to be included in the curriculum,
- The difficulty of teaching large classes with inadequate facilities,
- The lack of mathematics staff.

To clear up these issues, institutions and educationalists have begun to apply new strategies. Some examples of these are problem/project-based gaining knowledge of, Support programs for the scholars, online guide, visual assets, mathematical software program packages, online instructional substances, computer-aided assessment, flexible, formative and summative evaluation [12]. To overcome the difficulties faced by the students in mathematics lessons, many engineering establishments have provided educational guide offerings. The mathematical support facilities (Math Centre) of many universities in England give online courses, lecture notes, tests, lecture video for mathematics coaching at their web website free of charge (e.g. University of Loughborough, Coventry and Leeds). Loughborough, Manchester, studying, Hull and Sunderland university has made the HELM project (helping Engineers examine mathematics) among 2002–2005 years to beautify the mathematical training of engineering undergraduates through the provision of a range of flexible learning and teaching resources (Green at al, 2003). Engineering students also can use the mathematics laboratories of a number of universities within the US. Examples also can accept from Australia inclusive of Adelaide University Math Drop-In Centre, Queensland Technology University Math access Centre, and so forth [13].

Two major components of teaching mathematics to engineering student's needs to be addressed what to teach, and who must educate engineering mathematics? In some engineering colleges, mathematics courses are offered and taught by branch or area-particular faculty. Some of the engineering students sense that in this way they are able to study mathematics greater comfortably and in a better manner. Engineering students prefer the examples used to give an explanation for the numerous principles of mathematics ought to be from their department specific courses. Typically, mathematics in engineering colleges is taught with the aid of faculty from mathematics branch, occasionally engineering colleges do not forget the mathematics branch as service branch and deal with mathematics faculty as outsiders. Many mathematics colleges dislike being referred to as a service department. Conversely, if engineer colleagues teach mathematics, mathematics faculty look down upon their functionality. The teaching of any challenge is not a monopoly of any department. A competent faculty with proper schooling and proper flair can educate any difficulty however a school with a specialization in the course can do better justice to it. Overall performance within the magnificence must be the sole standards to decide. Often a threat of mathematics topics being taken over by using engineering departments is likewise perceived by mathematics faculty. Because of this, an invisible divide gets created in the organization (The whole surroundings receives vitiated due to this) and step by step its miles reflected in the college students also vis mathematics [14]. These system faults can effortlessly rise up wherein there may be a lack of dialogue approximately mathematical teaching between engineering and mathematical departments, it may take the form of together supportive to opposed. The educational interaction among mathematicians and engineering faculty could be very poor. There may be a want to bridge the distance that exists between them to enhance the change of pedagogical and research ideas.

Each engineering institute ought to have a platform or discussion board for dialogue, disseminating and interchanging instructional and pedagogical thoughts among and amongst mathematics and engineering faculty. Visitor lectures by engineering college ought to be organized to reinforce the significance of mathematics in engineering and it will enhance engineering pupil's appreciation of mathematics [15]. Additionally, engineering faculty can complex to the students approximately what arithmetic is required to apprehend and do the engineering. Implementing a completely bold and huge syllabus of mathematics on college students will not rework them into mathematics wizards. The extensive syllabus kills the student's hobby in mathematics and makes him greater careworn and averse to mathematics. Often engineering scholar lacks information about the fundamental subjects which can be essential to comply with a course. The best way out is to make our syllabus extra practical and compact. Breadth and intensity each are crucial components of the mathematics curriculum however it's miles turning into difficult to acquire the proper balance of them. Whilst framing the curriculum of engineering mathematics, essential parameters like wishes of engineering courses, enterprise desires, and lifetime learning must be given high significance. To accommodate new topics, subjects that are now not of sensible use or are taught in the earlier training can be dispensed with (dropped). All the educators of engineering training want to change their strategy of coaching engineering as nature of each the engineering profession and scholar becoming a member of engineering colleges in the 21st century is changing. Similarly, the requirement of the enterprise (Engineering & Technology based as well as software program based totally industries) recruiting majority of these engineering college students is converting, the enterprise prefers at once deployable scholar inside the enterprise with management and communication topics in the curriculum. How to put in force these changes without diluting the engineering curriculum has come to be an open-ended problem global for the educators. A few institutes reduce the mathematical content material in the curriculum to cater to the industry needs. There's usually a problem of achieving common thoughtful between mathematics and engineering departments approximately how much mathematics to be included inside the curriculum and what subjects to be trained. Overspecialization in engineering training should no longer occur on the fee of mathematics and fundamental sciences [16], [17].

From time to time a dispute may also occur about whether a course should be taught by a problem based or project-based method, these terms are often used interchangeably. Problem-based learning is more intensive towards gaining knowledge, whereas project-based learning is focused on the way to the application of knowledge. Mostly in engineering subjects, it is difficult to separate between problems based or project-based subjects as most of the subjects contain essentials of both. Project-based learning allows students to put into exploit the knowledge attained in the foundation courses to solve real-world problems. To solve these problems new knowledge is also mandatory. In engineering colleges, students are very approachable and use these approaches to understand or learn any new subject by solving a real-world problem. Use of problem-based or project-based approach in mathematics will allow students to develop communication skills, teamwork, research skills and an appreciation of the interdisciplinary nature of mathematics [18], [19].

III. Acceptable Emphasis on Word Difficulties in Engineering Mathematics

The essence of mathematics is the potential to simplify and solve troubles in each day existence. Most engineering college students are known to find phrase issues hard. By using career, engineers are problem solvers; they're hired in particular for his or her trouble-fixing capabilities. It is not possible to train a well-known approach so one can usually cause a solution to a problem. Engineers use common sense, science and common experience to remedy troubles. The smooth and simple manner of problem-fixing is to do it, for that reason engineering education must inspire students to clear up an expansion of issues. Engineers describe bodily phenomena correctly with mathematical fashions. With the help of strong mathematics theorems and results, the hassle receives solved. With accurate expertise, vital-questioning and trouble-solving competencies word problems can be tackled. One has to study word problem numerous instances to recognize it, not like computational mathematics issues. The pupil has to recognize the hassle absolutely to determine out the solutions. Engineering mathematics courses do now not deal a lot with word problems due to the fact they are very time ingesting and from time to time they're given as project work. [19].

In a lifespan of an engineer, era keeps converting dramatically. It isn't possible for any professor to train each truth (factor) of it; today's state of the art technology becomes obsolete tomorrow. As a way to put together a day after today's engineer, we want to teach their mind to suppose and resolve the problem. Mathematics plays a completely critical position in this enterprise. These problem-solving abilities never emerge as obsolete. Real-world problems do not occur within the form of equations. Comparatively, word problem is in the direction of real-world issues. The answers to actual real-world issues are not given behind the textbook. The effects of making a mistake in engineering are catastrophic. One of the most critical talents in the armory of an engineer is the potential to estimate answers even from incomplete records. Hardly ever engineers get all the data required to solve a problem. In most cases, the engineering problem is visible as an approximate or estimate problem. The degree of uncertainty is constantly very up and around.

IV. Can Mathematics be Taught in Isolation for Engineering Students?

In India, historically engineering mathematics is taught as a separate course in engineering colleges. More often than not, the first-semester course of engineering mathematics is joint for all engineering branches. The actual problem starts from right here; through separating mathematics, engineering college students discover it tough to see mathematics as in context to their respective engineering department. As a result, if mathematics faculty do not provide enough examples of respective branches to the scholars, the topic will become beside the point and remotened. Regularly many students lose relevance of getting to know mathematics. While college students are treated as clients or customers by means of the management of engineering institutes, management takes a lively interest in making sure that student's benefits are met. The expectations of engineering college students are converting, they may be watching for to realize (or to be informed) immediately about the relevance of every subject matter this is taught within the class. All engineering faculties are affiliated to some university and there's a commonplace mathematics examination at the end of the first semester. Continuously students are prepared and taught courses retaining this commonplace end semester exam in mind. Extra emphasis is laid in getting ready the students to answer this exam properly. For instance, Taylor and Maclaurin's series is taught to each engineering scholar in the first semester. Allow us to analyze how this topic is taught. College students are taught to locate Taylor's series of various function, without making them recognize how and why it's far essential to have a look at Taylor series. The idea of the Taylor series is taught but the real applicable application of it isn't always taught. College students are taught most effective the computational thing. Greater attention is on concepts and visualization [20]. Further, because the first-semester mathematics exam is commonplace for college kids of all branches, a scholar of Civil engineering branch, possibly never gets a risk to learn the utility or relevance of engineering mathematics. On the whole department, explicit of the topics are not taught. Leaving college students stressed the relevance of gaining knowledge of the topic of their department or discipline. As engineering college students, they would love to see how mathematics is used to remedy realistic engineering issues, more mainly in their branch of engineering.

Taylor series is widely utilized in mathematics. It's far widely known that polynomial functions are easy to deal with, i.e. algebraic operations can be without problems executed on them, and that they may be without difficulty differentiated and integrated. Taylor series may be used to symbolize a (complicated) function in a chain form (infinite polynomial). This could assist to study the residences of hard function. Further, a completely critical truth has to be kept in thoughts is that engineering college students do no longer have plenty of publicity to the department of engineering until their 2nd or 3rd year. As an example, Taylor series expansion might be used for error reimbursement in bi-axis CNC machines [21]. However, it's miles doubtful, if Mechanical engineering college students can comply with something approximately the functioning of CNC machines inside the first semester of engineering. The query arises, while not having a proper background of engineering, how to train relevant (branch particular) application of Taylor series to engineering college students? Differential Equations are the most beneficial subject matter of (Civil) engineering mathematics course. This subject matter is abstract and hard to apprehend, many college students struggle to do nicely in this topic.

Differential equations describe the connection between the rates of change in a single variable as compared to any other. Differential equations rise up in an try to describe or model physical phenomena in mathematical terms. Differential equations are used by Civil engineers to modeling a skyscraper's vibration in response to an earthquake to ensure a building meets required protection overall performance. The query is how a faculty of mathematics can give a utility of differential equation applicable to Civil engineering while the students are ignorant about the theory of vibrations and structural engineering in the first semester of engineering? Teaching common subject of mathematics to all branches of engineering is efficient from an administrative perspective but the pedagogical advantages to the students are arguably or questionable. Designing of mathematics syllabus tailor-made to a specific engineering branch is a far off dream. It's miles critical to observe that our curriculum heavily emphasizes on teaching and getting to know via problem-solving. Problem sheets are distributed each week and some of decided on questions are discussed within the following week throughout the tutorial session. The type of questions within the problem sheets tiers from simple to greater hard ones. The applied coaching and academic sessions still rely heavily on the conventional technique, where the faculty or instructor has a tendency to dominate the entire coaching consultation. Despite the fact that the students are also strongly recommended to participate actively in the course of the academic consultation, it stays a venture to have an interactive teaching consultation, on the grounds that many college students are timid by nature [14].

V. Conclusion

To be a successful expert engineer in future, engineering college students need to have a good grounding in mathematics and technology. We must undergo in mind that the strong basis of mathematics and technological know-how is also a step in the proper course for lifelong getting to know. The near liaison between mathematics and engineering departments can play a crucial role in this attempt. To allow more pupil expertise, allow all mathematics in engineering gain knowledge of through mathematics department the use of department precise engineering examples and troubles, assist on this effort may be sought from the various engineering departments. The goal is to educate the students, examples that are applicable to their department of engineering to help them in know-how the principles and its application. Students will begin feeling an attachment with mathematics if they see the relevance of what they're doing with mathematics, as a consequence, it will inspire them to take mathematics more seriously. Collaborative coaching should be advocated; inter-branch rivalry needs to not bog down the coaching. A few skilled engineering colleges can educate engineering mathematics courses and a few mathematics colleges can educate engineering like Mechanics, Dynamics, Statics, Fluid Mechanics, sign Processing, and so forth. Success in mathematics frequently increases self-belief and results in a fine attitude ensuing in extra success. We need to motivate and inspire engineering students in doing mathematics. We need to constantly take into account that if a pupil with a median intelligence does now not apprehend the idea of any subject after making a very good variety of attempts, we have to now not doubt his capacity, the opposite possibility that a faculty or an e-book or textbook has no longer given a terrific explanation and example of the idea will be true. Every so often mathematics will become hard to recognize because the concepts are defined in terms of a few other ideas. Engineering education in distinct countries has been advanced with specific traditions, making it tough to pick the first-rate model for all. The role of engineering training is to offer the essential (simple) know-how and to train the students the basic method of self-learning and self-improvement.

References

- [1] Croft, A., & Ward, J. A. (2001). Modern and Interactive Approach to Learning Engineering Mathematics, *British Journal of Educational Technology*, vol.32, no.2, pp 195-207
- [2] Roselainy Abd. Rahman, Sabariah Baharun., & Yudariah Mohammad Yusof. (2007). Enhancing Thinking through Active Learning in Engineering Mathematics. In CD Proceedings of Fourth Regional Conf. on Engineering Educ., Johor Bahru, 3–5 Dec.
- [3] Tall, D. O. (1988). Inconsistencies in the Learning of Calculus and Analysis, The Role of Inconsistent Ideas in Learning Mathematics, AERA, New Orleans April 7, 1989, published by Department of Math Ed, Georgia, 37-46.
- [4] Tall, D. O. (1992). Current difficulties in the teaching of mathematical analysis at university: an essay review of Victor Bryant Yet another introduction to analysis, *Zentralblatt für Didaktik der Mathematik*, 92/2, 37-42.
- [5] Tall, D. O. (1995). Mathematical Growth in Elementary and Advanced Mathematical Thinking, plenary address. In L. Meira & D. Carraher, (Eds.), *Proceedings of PME 19*, Recife, Brazil, I, 61-75.
- [6] Tall, D. O. (1993). Students' obstacles in Calculus, Plenary Address, Proceedings of Working Group 3 on Students' obstacles in Calculus, ICME-7, Québec, Canada, 13-28.
- [7] Schwarzenberger, R. L. E. (1980). Why calculus cannot be made easy, *Mathematical Gazette*, 64, 158–166.
- [8] Yudariah Mohammad Yusof., & Roselainy Abd. Rahman. (2004). Teaching Engineering Students to Think Mathematically. Paper presented at the Conference on Engineering Education, Kuala Lumpur, 14-15 December.
- [9] Sabariah Baharun., Yudariah Mohd Yusof., & Roselainy Abdul Rahman. (2008). Facilitating Thinking and Communication in Mathematics. Paper presented at ICME11th, Mexico, 6 – 13 July
- [10] C. Johnson, K. Eriksson, M. Larson, M. A. Levenstam. (1998) "A Reform of Engineering Mathematics Education" Chalmers University of Technology Report.
- [11] A. Lopaz. (2007). "Mathematics Education for 21st Century Engineering Students" Literature Review, Australian Mathematical Science Institute, pp. 2-34
- [12] Broadbridge, P. & Henderson, S. (2008). Mathematics education for 21st century engineering students. Final Report. *Australian Mathematical Sciences Institute*. Available: <http://www.amsi.org.au/>.
- [13] Green, D., Harrison, M. & Ward, J. (2003). Mathematics for engineers - the helm Project. *Conference on Strategies for Student Achievement in Engineering*. UK. Available: http://www.hull.ac.uk/engprogress/prog3papers/progress3_HELM_final.pdf

- [14] K. Willcox, G. Bounova (2004) "Mathematics in Engineering: Identifying, Enhancing and Linking the Implicit Mathematics Curriculum," Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition.
- [15] R. Schwieger (2003) "Why is teaching Problem Solving So Difficult?," Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition.
- [16] Karen Willcox, Gergana Bounova (2004) "Mathematics in Engineering: Identifying, Enhancing and Linking the Implicit Mathematics Curriculum", Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition.
- [17] Elliott, B., Oty, K., McArthur, J., and Clark, B. (2001). The Effect of an Interdisciplinary Algebra/Science Course on Students' Problem Solving Skills, Critical Thinking Skills and Attitudes Towards Mathematics. *International Journal of Mathematical Education in Science & Technology*, 32(6), pp.811-816.
- [18] LTSN MathsTeam Project, Mathematics for Engineering and Science.
- [19] Bajpai, A., Mustoe, L., and Walker, D. (1975). Mathematical Education of Engineers: Part 1. A critical appraisal. *International Journal of Mathematical Education in Science & Technology*, 6(3), pp.361-380.
- [20] C. Varsavsky (1995) "The Design of Mathematics Curriculum for Engineers: A Joint Venture of Mathematics Department and the Engineering Faculty," *European Journal of Engineering Education*, pp.341-345.
- [21] Xue-Cheng Xi, Aun-Neow Poo, Geok-Soon Hong (2008) "Taylor Series Expansion Error Compensation for a Bi-axial CNC Machine" *IEEE International Conference on Systems, Man and Cybernetics*, pp. 1614-1619.

