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The Beauty of Mathematics: Learning Mathematics by Questioning

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Abstract

Mathematics problems may seem to have no real use in life, but this could be further from the truth. The use of mathematics is everywhere in our daily lives and, without discovering it; we apply mathematics ideas, as well as the skills we learn from executing mathematical challenges every day. Unfortunately, mathematics feedback at national examinations is deficient. A mean of between 23 to 29 percent for 5 years in a row from 2014 to 2018 is a clear indication that the training of students today for tomorrow's workplace with concept development in context, problem solving through interactive experiences and understanding through application is missed. Over this period, the evaluation of the outcome has also shown a standard deviation almost equal to the mean or even greater than the mean for instance 2016 for paper 2 (refer to Kenya National Examinations Council Report) is a clear sign that there is a big disparity from the mean and a likelihood of a number of students scoring zeros or below 10 percent. This dismal performance in national examinations particularly in mathematics demonstrates that contextual curricula and instructions that encourage numerous structures of learning like relating, transferring, applying, experiencing and collaborating are not achieved. Therefore, this article looks into different contexts in which students learn and how they broaden their abilities to make connections, enjoy discovery, and apply the knowledge learnt. These are abilities they will need throughout their daily lives and careers. Being able to do arithmetic is of little ultimate use to an individual unless he or she can apply it. Each arithmetic operation is explored in detail for its applications in the real world problems. Real life challenges motivate ideas and provide additional settings for practice.

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1. INTRODUCTION

1.1 Why Mathematics?

All calculations used to build the beautiful Pyramids, Suspended bridges, Construction of roads and bridges, landing on the moon are all possible due to application of mathematics. Mathematicians have been resolving humanity's biggest puzzle for many years by coupling the faculty of mathematics. With mathematics, intolerable problems such as building of tallest towers, beautiful roads without forgetting beautiful pyramids are possible. Mathematics is a vital gear that assists in simplifying daily challenges. Despite mathematics being all around us, it is also an important tool required in furthering different careers and solving other challenges thereafter. Mathematics rules and laws are applied throughout our daily lives. The skills obtained from mathematics training and learning can help in solving problems in other areas of our lives. Mathematical skills are very useful in daily activities and without a good understanding of these skills; one can encounter significant difficulties in their daily activities. Mathematics may be tedious, complicated or even tiring, but the truth of the matter is that mathematical skills make life and the world around us much more interesting and fun living.

1.2 Why is Mathematics So Important?

Mathematics is a basic element of human understanding and judgment. It provides a constructive way of building mental order and motivates straight thinking and mental thoroughness. Furthermore, mathematical command plays a pivotal role in comprehending the contents of other disciplines such as Science and Engineering. Mathematics significance can be seen in a number of areas like, Engineering, Body Scanners, Software, Coding, and much more. Literacy in mathematics such as basic computational skills, quantitative reasoning, and spatial ability is an important trait to productive lives as profitable, concerned and reflective people.

Mathematics always comes first and it is at the centre of any flourishing career and productive lives. Careers in Science, Technology and Engineering are so crucial and the future victory of any country can thrive with educators having a concrete mathematics basis. A solid foundation in mathematics education goes much beyond the present day gossip of upgraded competence on examination scores. Skills in mathematics give learners the evaluative potential to learn and think objectively in any field.

A good foundation in mathematics grows and sharpen the skills of creating hypotheses, scheming experiments and checks, data analysis, patterns recognition, evidence verification and coming up with clear conclusions but still open to new sets of knowledge. Mathematical competency will not only give rise to prominent Mathematicians, Engineers and Scientists, but it will also nurture more people who can grasp and think creatively, regardless of the field they are in.

Mathematics is crucial in creative thinking and streets ahead in reasoning potentials. The aspect of being critical about the world and the surrounding is known as faultfinding. Deducing on the other hand is the aptitude to think coherently about a particular situation. Faultfinding and deducing competencies are crucial since they assist in clearing up challenges while coming up with remedies. Solving a linear motion problem for instance, can help one in tackling up a problem in life; remember the expertise used in conceiving the challenge, recognizing the familiar and unfamiliar, and following guidelines to unravel the challenge can be a salient blueprint that is usable in real life situations.

In undertaking a mathematical challenge: data is fetched, simplified, plans sought, relationships observed or systematically solved in a rational technique. A good mastery of mathematics and ability to meander through mathematical problem and arrive at sensible responses, can put together the mind in real life challenges, that is, one can seek best reasoning, see the available options and relate to available data to draw a perfect conclusion.

Living in a mathematically-driven society and be devoid of mathematical skills is like a having a tour guide in beautiful scenery with language barrier. Appreciating mathematics can help you appreciate things around you and the world since mathematics is everywhere and in everything we come across and do.

Lastly, the sweetness of mathematics is also found in its universal language it possesses. A mathematics problem does not need to be translated to another language to be comprehended. The universality of mathematics is one of the many things that makes it such a powerful tool and, indeed, essential life skill. Further, choosing mathematics as a degree path can lead to surprising, and fulfilling, career paths.

2 Is Mathematics Anxiety The Cause of This Dismal Performance in Mathematics?

Mathematics anxiety may be a feeling of tension that interferes with mathematics learning and performance. Having mathematics anxiety does not necessarily indicate inability in mathematics; rather, one cannot perform to maximum potential due to interfering symptoms of anxiety [1]. Majority of students feel helpless immediately they come across any Mathematical challenge. Scores in mathematics are very low which is evident of mathematics dislike. Mathematics anxiety leads to less exposure to mathematics practice, leaving students more anxious and mathematically unprepared to realize learning goals.

Mathematics anxiety is gained not from personal experience but from the surroundings such as parents, peers and even teachers. A surrounding with majority being mathematics avoiders can unintentionally or even knowingly convey the idea that mathematics is difficult and thereby provoking mathematics anxiety feelings. Mathematics anxiety is mostly conceived in schools from teachers and peers who suffer from the same challenge.

Teaching exclusively from a textbook, relying on memorizing facts, and employing drill and practice to reinforce the lesson creates mathematics anxiety amongst students. Examinations stress and public embarrassment resulting from poor performance have lead to unproductive fears amongst learners. Teaching mathematics in a right or wrong approach has accelerated the fear toward learning of mathematics [1]. The expectation of a fixed answer from the learners and sometimes this rigidity is so high that it blocks any alternative thought or approach. Indeed, mathematics anxiety is among the major causes of this dismal performance in mathematics (three other causes are discussed in section (3) of this article).

Motivating learners to embrace mathematics by staying positive and enthusiastic should be the mandate of all mathematics educators. They should motivate the alternative (wrong) answer, since they literally help learners' brains to expand. Mathematics core objective is to groom learners to confront daily challenges. Mathematics is a creative field as opposed to the labeled true or false subject. Approaching mathematics with open ended challenges not only motivates learners but also boosts their critical thinking and reasoning skills.

Students are motivated once they realize where all the concepts they learn in mathematics are applied. Teaching of mathematics must be accompanied by everyday life experiences so as to escalate curiosity of learners. Learning mathematics by experimenting helps learners to master the concepts and makes the learning of mathematics enjoyable. To learn mathematics in-depth, students should be engaged in exploring, conjecturing, thinking and experimenting. Studies have shown that students learn best when they are active rather than passive learners.

To overcome mathematics nightmare, the signs of mathematics dislike should be known and addressed at an early stage. Panic, docile behavior and lack of confidence toward learning mathematics are signs of mathematics anxiety building up. Mathematics anxiety is not the cause of poor performance, but failure to address it contributes to this dismal performance. Learning mathematics while motivating students to question whatever they are learning not only makes mathematics interesting but also enhances mastery of the content being taught. Working in group of peers can sometimes help mastery of mathematics concepts better than struggling alone. Peer group discussion is more useful especially to the learners who suffer from mathematics anxiety.

Parents taking part in the education of their children is quite relevant. Participation of parents can greatly change perception of mathematics [2]. Parents have to monitor their children's behavior and identify any sign of mathematics anxiety earlier and counter it with positive reinforcement to help them overcome this challenge. Parents should always discuss the challenges their children face in learning mathematics and emphasize the significance of the subject in their daily activities. Students should be reminded that learning mathematics skills is a process and that everyone learns

differently. In addition, learners need to appreciate that mathematics is not a competition and statements about learners that may give them the impression that parents are comparing them to their classmates or siblings should be avoided. A positive and supportive attitude towards students can result in overcoming mathematics anxiety from parents, peers and teachers.

3. HOW CAN WE IMPROVE MATHEMATICS ACHIEVEMENT?

The challenges mathematics educators are struggling to unravel are, first how to develop the best way of thinking and the understanding in which application depends upon and secondly is finding out what mathematics educators are currently doing wrong. Seemingly there is consensus over three main causes of this dismal performance. These include but are not limited to;

- Too many topics that are taught to a shallow degree.
- Most mathematics teachers have less mastery of mathematics as a subject.
- Mathematics is taught in a rigid, rule-based approach that blocks any other alternative views.

Of course, teaching mathematics in an interactive approach requires teachers with more mathematical mastery than does the traditional approach (where a mathematics instructor with a weaker background can simply meander through the textbook and achieve whatever the objectives is disregarding the students' interest). It is also much more demanding to teach mathematics this way, which makes it a job that demands higher status of qualifications, perfect mastery of the subject and a higher remuneration [1]. This approach of teaching mathematics beefed with well trained mathematics instructors will make mathematics more interesting and easy to grasp.

Poor mastery of basic arithmetic skills could disadvantage students in their daily life making it impossible for them to appreciate the subject. Teaching methods used today (as stated above) put emphasis on memorization of concepts disregarding alternative views. However, mathematics should be taught from the point of analysis and understanding, with the primary focus placed on application. Of course test scores are essential but not sufficient. The objective of quality education should be to develop the skills associated with learning and thinking, teaching approaches must be changed if this objective is to remain a priority. Innovative learning programs such as integrating available technology to stimulate students' creativity, imagination and confidence need to be implemented in teaching as well as learning of mathematics. Students need more hands-on and effortful learning in order to spark their curiosity as well as enjoyment of learning mathematics.

4. MATHEMATICS CLASSROOM SETUP

It's really important that we change the message students get in mathematics classes. We know that anybody can grow in brain and that brain is elastic to learn any level of mathematics. Mathematics classroom has to change in many ways not only in message but also change what happens in class. Mathematics teachers need to open up mathematics questions so that there is a space inside for learning. Teachers should know that if they rush to the answer they rob their students' opportunity to learn.

Collaboration, communication, Critical thinking and creativity should be present in all mathematical classrooms. Mathematics classroom requires a shift from teacher centered to student centered. This gives the teacher opportunity not teach but to coach, mentor and inspire. Mathematics teachers ought to know as affirmed by Plutaech (AD46- AD120) that the mind of the students is not a vessel that needs filling, but wood that needs ignition. Students love having choices and therefore an interactive approach that allows varied opinion makes learning of mathematics interesting. A mathematics classroom is active when the presence of a teacher is unnoticed. Seeing students working in groups, reflecting on the learnt skills, self evaluating their effort and using past knowledge in the current situation is a clear indication that learning is going on. Student centered approach is not only effective but it is fun, because it allows the teacher to sit down with a small group of students and respond to the questions they initiate. It also gives the instructor opportunity to listen to their thinking.

Mathematics lessons are characterized with neatly organized rows, facing the board with the instructor as a sole source of information. Examples are demonstrated on the board, thereafter students are required to follow the same procedures in doing class work as demonstrated by the instructor in silence.

Students are required to work out most of the questions individually, and when stuck, they are required to call upon the instructor for help, not the peers. This cycle is repeated over again across the course. This teaching approach ends up producing graduates who are robot like in that they cannot think on their own. In addition, their problem solving skills and reasoning are much lower if at all they are there.

The interactive approach to learning mathematics which appears chaotic is much more interesting. It provokes curiosity and leaves students motivated. Imagine students sitting in groups within the classroom setting chewing over how to work out a particular challenge, or even standing at the board arguing about the best way to proceed. The instructor's responsibility is scaled down to monitoring and guiding for harmonization purpose. The instructor can occasionally call upon the entire group to order and sometime to explain their responses to the rest of the class, or to give a short summary about a particular concept in question.

4.1 The Love of the Subject and the Students by Mathematics Teachers

The most powerful teaching technique a mathematics teacher can use is 2- love, that is;

- The teacher love for the subject and passion for the subject.
- The teachers' genuine love for kids/learners.

The teacher's passion for the subject can inspire learners to have passion in that particular subject. Teachers' love for the students (genuine decisional love) that is putting them first is the kind of love that not only motivates but also inspires learners to greater height. This kind of love is self-sacrificial and committed to the well being of the students. This love is not always emotional but it is always decisional. This therefore means a teacher can love his students even if they are not likeable because this love is not emotional but decisional and it motivates and inspires the students in powerful way and always heals.

When students are not comfortable with mathematics, they don't question the authority of numbers. Any competent mathematics teacher must employ the following three principles to invite thinking in his/her class;

- Start with questions
- Give the students time to struggle
- The teacher is not the answer key

Actual classroom starts with answers and questions are never arrived at. For instance, here are steps to multiply, you repeat, here are steps to divide, you repeat until mastery is achieved. In this model what happens is memorizing the steps there is no room to doubt or imagine or even question and therefore there is no real thinking here. Mathematics teachers should avoid rushing to the answer because it will rob the learners' opportunity to learn. Remember thinking only happens when students have time to struggle. Teachers need to teach students to be tenacious and courageous to persevere in time of difficulty. The only way to teach perseverance is to give students time to think and grasp the real problem. Struggling with genuine questions deepens students' curiosity and their power of observation. A student who is inquisitive is a wonderful thing to have in your classroom. Learners should appreciate that not knowing the answer is not failure but it's the first step to understanding.

Finally, effective use of technology is important but what the learners will remember is the caring of their teacher. The students will remember how you struggle to grasp their names, your transparency and your laughter and how you laughed with them.

Improving mathematics skills requires a flexible and interactive approach as opposed to commonly used rigid and rule-based method. This can be achieved in the following ways:

4.2 Learning to Apply Strategies

Learning mathematics in the absence of application is incomplete and can lead to students avoiding mathematics. If the connection between the mathematics content and the learners' experience is missing, mathematics can be extremely difficult. Dewey [3] and many others researchers over the past years have a firmed that learning is boosted when students are guided on how new knowledge applies to their daily lives. Apart from creating curiosity to learn new concepts [4], learning to apply also increases critical thinking [5], and thereafter enables students to recall the learnt content [6]. The entire constructivist view of learning is predicated on the concept of guiding as learners discover for themselves. That is, they use the information they have obtain to construct

meaning in their lives, and use previously learned information and experiences to build a framework for effectively incorporating new information. Adoption of instructional methods that help students answer their own questions, demonstrate importance of mathematics, stimulate intellectual effort, introduce stimulating ideas and inspire students to set challenging goals should be the focus of any mathematics instructor.

Active involvement of students in the learning process and to assist them to notice relevance and importance of the information involved should be the goal of all mathematics instructors. Teaching methods used are also strongly related to several other learning objectives pertaining primarily to developing solid foundational knowledge and skills, and an interest of the subject. It appears that learning relevant foundational information and skills and seeing how these are used in class is more critical to applying the learnt concept for improved thinking and decision making. Understanding a concept does not by itself ensure the content can be applied in an appropriate manner and hence it is important to help students to learn by helping them to practice recalling and using the information and skills as often as possible.

Helping students to learn so that they can apply is closely related to the seven principles of using active learning in the classroom [7]. Active involvement through applying new information is crucial to real-life problem solving, and connecting learning to something directly relevant to the student as a person is a basic concept in creating an active environment.

Teaching approaches that allow students to involve themselves in their own learning processes should be implemented. Students must be given chances to construct, question, transfer and apply their new knowledge. Students understanding improve when they actively construct meaning and try to make sense out of the new mathematics skills learnt. There are many ways to assist students to learn applications of new knowledge in mathematics. This article will focus on four methods; Deeper learning process, Critical thinking skills, Problem-based learning approach, and Community service -learning.

4.2.1 Critical Thinking skills

Testament of critical thinking in mathematics is to register relevant expertise and experiences to the solutions of the issues or challenges encountered in our daily lives. Use of questions to prompt the application of existing or new knowledge is one strategy used to improve critical thinking in mathematics. Investigative questions motivate students to cogitate more remuneratively and to judge the evidence more coherently. Model critical thinking and application thinking in your classes by asking questions that encourage students to evaluate alternative and make educated choices [5]. The type of questions and how the questions are asked should intrinsically motivate students to think critically and provide clever feedback. Framing a question in such a way that it answers the Why and How motivates students to think critical and provide creative responses.

The technology changes rapidly and daily, therefore, mathematics facilitators must not only really on mathematics textbooks, or seeking simple correct answers to validate student learning rather they should incorporate an open ended approach to foster thinking outside the normal mathematics classrooms. The right or wrong approach of teaching mathematics only strengthens student trust that there is a correct solution and the work of a mathematics instructor is to find it and then proceed to a different new area. Instead, we need to ask questions and speculate beyond what is known to create new ideas and information. Probing questions will automatically ignite discussions; this will be a proof to students that their questions, critique and their alternative points of views are valued and relevant as well.

Providing opportunities for students to relate the mathematical skills to their life experiences and challenges and also to evaluate and critique what is taught in class, than accepting it as truth will encourage creativity and to a higher extend critical thinking amongst the students. A critical thinker will argue both sides of problem, balance feedback and decide the best alternative based on available proofs. Students who have mastered the skills of critical thinking will always encourage their peers to engage in educated arguments in a reasoned approach while avoiding emotions. Critical thinking strategies encourage students to use new mathematical skills and apply them to the knowledge acquired previously.

4.2.2 Transfer Learning Practices.

Competency skills are required by the modern young people in order to be effective workers

and citizens in the current society. Development of better understanding of interplay competency in cognitive domain supports deeper understanding. Pellegrino and Hilton [8] define deeper learning as the process by which students are able to take what was learnt in one situation and apply it to new situations. This approach encourages students in developing the knowledge, skills, altitudes and characteristics that will give rise to successful, economically productive and actively engaged citizens.

Relating recently learned mathematics skills to new situations is an intricate and critical cognitive goal. Transfer learning is the cognitive process of involving last training and knowledge to learning or problem solving in a different or new situation [9]. These are fundamental skills we must teach our learners. Cognitive transfers can be illustrated using three sets of views: near transfer is what is required for activities that are routine and consistent or far transfer which is learning used in a real life situations that are different from the learning contexts [10]; high-road or low-road; and forward or backward [11]. An example of near transfer is a student who learns to type on a typewriter and applies that knowledge to a computer keyboard. An example of far transfer is where a student applies knowledge of percentages to determine the discount on sales.

Mindful transfer (High road transfer) and reflex transfer (Low road transfer) refers to the cognitive energy required to make connections. A reflex transfer (Low road transfer) occurs when previous learning automatically, often un-consciously transfers to another situation (for example being able to solve all simultaneous equations after knowing how to solve one). The key to a reflective (low road transfer) is practicing a skill often and in several situations until your performance become automatic. Mindful transfer (High road transfer) involves conscious application of abstract knowledge to a new situation (for example learning mathematics prepares students to study physics).

Forward-reaching is a situation where one learns something and abstracts it in preparation for application elsewhere and backward-reaching transfer is where one finds oneself in a problem situation, abstracts key characterizes from the situation and reaches backward into one's experience for matches. Both forward and backward transfers are concerned with the timing of the application. When teaching for transfer, it is important to ground the concept you are teaching in some applied context. Introduce your topic, briefly discuss it, and then ask students to generate examples of the concept. As you do this, notice the type of transfers they are using. Challenge them to apply the concept to their personal and professional lives as well as to other contexts. As you teach concepts for application, you will also want to remember that teaching for depth of meaning and understanding increases students' ability to transfer information. Students will need time to construct meaning and consider the implications of the new knowledge. They will also need assistance to first see how information can be transferred to a variety of settings. By encouraging students to make a variety of transfers, you will be increasing the likelihood of deeper learning.

4.2.3 Problem-Based Learning

Too much of traditional teaching involves giving students isolated bits of information to be memorized and then demanding that it be retrieved for examinations. Problem-based learning is an alternative approach whereby students are given a real world scenario that is often structured to be complex and ill defined. Students are required to use specific course material and concepts to solve the problem at hand, thereby setting up a situation in which students are directly applying course material to a real-world problem. Working in groups, students strive to solve the problems while the instructor serves as a facilitator and a guide. Instructors who use problem-based learning report that this approach helps students to develop critical thinking skills, improves retention of material, demonstrates the values of working with others, and provides a framework for solving problems that persists after the course has ended [12]. This approach also facilitates transfer of learning as described above.

4.2.4 Service-Learning

Service-learning is a pedagogy that integrates community service with academic study, reflection and analysis to enrich the learning experience, teach civic responsibility and strengthen communities. The theory of service-learning begins with the assumption that experience is the foundation for learning; and various forms of service activities are employed as the experiential basis for learning [13]. It gives students opportunities to directly apply course material to meet a community need, and is based heavily on the suggestions for good instruction

and learning [3], [14]. It reflects the belief that education must be linked to social responsibility and that learning must be meaningful and active [14], [15]. Service-learning has many of the same benefits of an apprenticeship, with students learning directly applicable skills from course content, and the community receiving assistance at very little cost. With respect to academic development in the area of the course content, reflection on the project is vital to learning. Evidence of student learning and future civic engagement by those participating in well-organized service-learning activities is overwhelming [16].

5. CONTEXTUAL LEARNING STRATEGIES

Contextual Learning Strategies is a proven way to improve learning for students with multiple intelligences and different learning styles. Putting contextual learning together with cooperative learning can greatly facilitate students' efforts in linking new concepts to existing knowledge and to the world away from classroom.

5.1 Diversity in Learning Style

A number of teachers apparently understand how to instruct and teach concepts so that all learners can clutch them through example, illustration, and hands-on application. These teachers seem to acknowledge that human capacity for learning is much wider than traditional measurements of intelligence (verbal and analytical) would specify.

In reference to [17], learners have as many as seven forms of intelligence: linguistic, logical/mathematical, musical, special, kinesthetic, interpersonal, and interpersonal. Gardner [17] further observed that every learner has some measure of each of the seven intelligences, and specific strengths and combinations of intelligences vary for each learner. This theory of multiple intelligences by Gardner [17] specifies a need to address diverse learning styles in classroom. His views are reinforced by David Kolb [14]. According to Kolb [14] learners tend to perceive information either abstractly (by conceptualizing and thinking) or concretely (by experiencing and feeling) then they process that information either actively (by experimenting and doing) or reflectively (by observing and watching).

Kolb's approaches, like Gardner's plainly demonstrate that majority of learners do not fit neatly into one category or the other. Majority of students can learn by and benefit from all four experiences and all contribute to the process of effective learning. Nevertheless, most students will show preference for one or two particular kinds of learning, and this preference will indicate the individual's primary learning style. Furthermore, Kolb's analysis points to only a small percentage of students that have a strong ability to learn by perceiving abstractly and processing reflectively -precisely the learning style rewarded in the traditionally used lecture method of teaching. Nevertheless, majority of learners tend to perceive and process information concretely and actively. This is an indication that most learners are extroverted learners, that is, they learn best through interpersonal communication, group learning, sharing, mutual support, team processes, and positive reinforcement.

5.2 Making Connections

Amidst of individual differences in learning styles and intelligences, nearly if not all learning requires strives for connectedness. Broken or isolated bits of information normally are not processed and retained by the mind for usefulness unless connections are made and points of reference or relationships are established between what is known and the unknown. In most cases students are expected to make all these connections on their own. Furthermore, few teachers are now discovering that most students' interest and achievements in mathematics improves dramatically when they are directly assisted in making connections. Teachers now than ever must facilitate their students' efforts in connecting new information, or knowledge, to experiences they have had or other knowledge they have already grasped or mastered. Students' involvement in their schoolwork increases greatly when they are learning the concepts and how those concepts can be used outside the classroom, more so in the work place. Furthermore, students learn much more efficiently when they are allowed to work cooperatively with other students in groups or teams and to learn from one another. Cooperative learning greatly facilitates making connections. A curriculum that uses contextual learning strategies and demonstrates the connections and usefulness of the curriculum should require the average student to develop a stronger academic foundation, higher caliber of work skill, and a better understanding of how academic concepts relate to his or her

environment outside the classroom and to the workplace. This is the higher level of learning that is not usually taught to the above average, much less to the average students who need it the most.

5.3 Contextual Learning

The premise of contextual leaning theory is that learning occurs only when students process new information or knowledge in such a way it makes sense to them in their frame of reference their own inner world of memory, experience and response. This approach to learning and teaching assumes the mind naturally seeks meaning in the context; that is, in the learner's own environment. In a contextual learning environment, students discover meaningful connections between abstract ideas and practical applications in the context of the real world. The students internalize concepts through the process of discovering, reinforcing, and interrelating the ideas and applications. Using formulae for instance, introduce the concept of volume of a sphere by describing spheres as familiar objects, footballs, basketballs, globes, ball bearing and balloons. Then the formula is stated in highlighted areas within the text. The formula is immediately tied to the real application with an example of a technician who must calculate the number of cubic meters of helium required to inflate a weather balloon. The students apply the concept in a hands-on activity in which they measure the diameters and volume of sphere and compare their measurement to calculations using the formula. The students further reinforce the concept by applying the formula in assessment, discussion, and practice problem and then interrelate the formula with other formulae for volume and area.

This example demonstrates that contextual curricula and instruction encourage many forms of learning.

1. Relating: Learning in the context of life experiences
2. Transferring: Leaning in the context of existing knowledge using and building upon what a student already knows
3. Applying: Learning in the context of how the knowledge or information can be used
4. Experiencing: Learning in the context of exploration, discovery, and invention.
5. Cooperating: Learning in the context of sharing, responding, and communicating with others.

Exercising the different contexts in which students learn will broaden their abilities to make connections, enjoy discovery, and use knowledge. These are abilities they will need throughout their lives and careers.

6. ASSESSMENT ISSUES

In order to apply course material, it is important that students have a strong foundation of basic information. As an instructor or a teacher, you should first assess for critical aspects of foundational knowledge in the course. This can be done through examinations, written or oral quizzes, and class discussions. The important issue here is that students have appropriate and accurate material as the basis for reasoned applications to new problems. It is relevant that students master the importance of application in the course being taught. Make the students to appreciate that they will be expected to apply course material to real world problems and that they will be tested on their ability to solve problems in the course being taught.

Students should realize that there are critical steps to logical problem solving and application of course material. Let students know that responses will not be given full credit just because they have opinions and attempted to answer. To assess the extent to which students have learned to apply course material to improve thinking, problem solving, and decision making, ask students periodically to express their perception of the value of applying course material to new problems. Students who are in class with the expectation that there is one correct answer and simply desire for you as the instructor to give them the answer will be frustrated by a course in which they are asked to do extra work, such as applying information to seemingly extraneous situations. It is important for the instructor/teacher to be aware of such students and the possible resistance. As an instructor do not be discouraged if at first, students' object to your evaluation as this process takes some time for learners to master.

In reference to transfer, start with applications that are very close to the learned material (what is known to students) and then increase the distance from the learned material to that which they are applying their new knowledge (the unknown applications). This shift from near to far transfer will assist the students in understanding not only how to apply the current information, but the process of learning to apply information in an increasingly wide range of situations. For

instance, students in a calculus mathematics course may first be asked to differentiate a particular function. Later, they may be asked come up with general formulae for differentiating different functions.

Problem-based learning focuses on applying learnt skills. Having students solve problems (alone or as a group) either in class or through home assignments, better prepares them for not only their final examinations but also for their future endeavors. For critical thinking assessment, the teacher should be certain to ask questions at a higher cognitive level analysis, synthesis, and evaluation [18]. These questions are good for testing students on both forward and backward transfer.

There are also a number of classroom assessment techniques that can be used to document the extent to which students are learning to apply course material [8], [19]. As an example, Application Cards may be used whereby students write down one unique real world application of the material covered. This is a quick and easy method to determine whether the student understands the material and how it can be applied. This technique may be broadened to include aspects of problem solving and critical thinking.

7. CONCLUSION

Mathematics is the forbearer of the very tag “difficult”. In fact, it has become acceptable for certain students to perform poorly in this subject. If examined carefully, one cannot deny that it is a very negative trend that should be discouraged. Why should any student be poor in any subject? Especially when the subject deals with logic and reasoning! Students fail to grasp mathematical concepts due to a number of reasons which include but is not limited to poor altitude, wrong approach to teaching (method of teaching), lack of connectivity between students and subject, self doubt, low IQ, attention span, failure to understand signs and symbols and teacher student ratio. Many mathematics teachers are not well versed in the subject and there are poor and inaccessible textbooks.

A place filled with puzzles, games and open questions is where mathematical thinking can flourish. The mathematics teachers have power to help mathematics thinking to flourish everywhere. Mathematics teachers can’t afford to misuse mathematics and create passive groups of followers. Mathematics has potential to be the greatest assert in teaching the next generation to meet the future with courage, curiosity, and creativity. If all students get the chance to experience the beauty and power of authentic mathematics thinking maybe it won’t sound strange when they say ”we actually love mathematics”.

8. RECOMMENDATION

Giving learners opportunities to construct, question, transfer, critique and apply their new skills is a sure way of overcoming this poor performance and negative attitude towards mathematics. Secondly, as recommended by Nathan et al. [1], the qualification and training process of mathematics teachers is paramount in overcoming this problem and for that matter higher qualification levels for mathematics tutors make it easier for them relate a particular learnt skill to its relevant area of application from an early stage.

Effective instruction approach may salvage most learners from this negative altitude, poor performance and disconnect between students and learning materials. Any effective approach should be student centered, teaching for understanding, and assessment for learning, rigor and relevance and teaching for learner differences.

If the goal in a course is to teach students to apply course material for improved thinking, problem solving, and decision making, it is imperative to give the students multiple opportunities to practice that behavior. Additionally, if these forms of thinking and problem solving are important aspects of the course, they should be demanded of the students as part of the course. Students quickly determine that issues of importance to the instructors are related to the grading process, and that attention to these issues is important for better learning and better grades.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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