Course: Teaching of Mathematics (6409)
Semester: Spring, 2021

ASSIGNMENT No. 1

Q. 1 Discuss the value of mathematics in school curriculum. Why education is considered incomplete without mathematics?

Mathematics is a fundamental part of human thought and logic, and integral to attempts at understanding the world and ourselves. Mathematics provides an effective way of building mental discipline and encourages logical reasoning and mental rigor. In addition, mathematical knowledge plays a crucial role in understanding the contents of other school subjects such as science, social studies, and even music and art. The purpose of this TSG is to investigate the role of mathematics in the overall curriculum. Due to the wide range of possible issues that could be addressed in this TSG, we plan to organize the papers and accompanying discussions into three key strands. Firstly, we ask the question: why does mathematics hold such an important and unique place among other subjects? That is, what is the significance of mathematics in the overall school curriculum? As a point of departure we offer a few thoughts on why mathematics should be treated as an important subject in overall curriculum. Mathematics has a transversal nature. If we reflect on the history of curriculum in general, then mathematics (geometry and algebra) were two of the seven liberal arts in Greek as well as in medieval times. This historical role supports the notion that mathematics has provided the mental discipline required for other disciplines. Mathematical literacy is a crucial attribute of individuals living more effective lives as constructive, concerned and reflective citizens. Mathematical literacy is taken to include basic computational skills, quantitative reasoning, spatial ability etc. Mathematics is applied in various fields and disciplines, i.e., mathematical concepts and procedures are used to solve problems in science, engineering, economics. (For example, the understanding of complex numbers is a prerequisite to learn many concepts in electronics.) The complexity of those problems often requires relatively sophisticated mathematical concepts and procedures when compared to the mathematical literacy aforementioned. Mathematics is a part of our human cultural heritage, and we have a responsibility to develop that heritage. Secondly, since mathematics provides foundational knowledge and skills for other school subjects, such as sciences, art, economy, etc., the issue of how mathematics is intertwined with other school subjects deserved to be addressed. In some curricula, mathematics is offered independently to support the study of other school subjects as an ‘instrumental subject’, and in other curricula, integrated courses which combine mathematics and other fields are offered. Thirdly, we may wish to reflect on the number of hours (proportion of hours) and/or courses allocated to mathematics when compared to the other school subject in the curriculum of each country. In addition to this quantitative analysis, information about the qualitative description of school mathematics in relation to other subjects also needs to be gathered. Although this comparison won’t show us the whole picture of why different countries attach the importance that they do to mathematics, the comparison may nonetheless provoke further discussion.

Mathematics learning in Indonesia remains below average compared with developing countries in Asia, such as China, Singapore and Malaysia. In the past, China surpassed other western countries in internationally scaled mathematics achievement, such as in PISA and International Mathematical Olympiads (IMO). One of the

challenges faced by mathematics teaching is the constantly changing curriculum. Traditional mathematics teaching persists in secondary schools. If the paradigm is to be changed, then teachers must find a teaching and learning approach that is consistent with the constructivist approach. One of these teaching and learning approaches is Realistic Mathematics Education (RME), which was introduced in 2001 in Indonesia by the Realistic Mathematical Education of Indonesia (known as Pendidikan Matematik Realistik Indonesia or PMRI). The goal of PMRI is to revolutionise and improve mathematics education.

The RME approach was first developed by the Freudenthal Institute in the Netherlands in 1971. The RME approach for mathematics is widely known as the best and most detailed approach, which was expanded from the problem-based approach for mathematics education. Teaching and learning RME have five main criteria, namely, students' experience in daily life; changing reality to a model and changing the model through a mathematical vertical process before turning it into a formal system; use of students' active style; use of discussions and question and answer methods to cultivate the mathematics skills of students and formation of a connection between concepts and topics until learning becomes holistic and complete. Since 2001, many teachers in Indonesia have been trained to use the RME approach. RME has been implemented in 13 of 33 provinces. On the basis of this finding, a study is conducted to develop a teaching module that uses RME and to examine the effects of teaching and learning using the mathematics learning module for secondary schools in Indonesia. Teaching and learning via RME aim to solve the problems faced by teachers and students.

The purpose of RME is to transform mathematics learning into a fun and meaningful experience for students by introducing problems within contexts. RME starts with choosing problems relevant to student experiences and knowledge. The teacher then acts as a facilitator to help students solve contextual issues. This contextual problem-solving activity brings positive impact to the mathematical representation of students, which is related to their problem solving skills. The best way to teach mathematics is to provide students with meaningful experiences by solving the issues they face every day or by dealing with contextual problems. Realistic mathematics education enables the alteration of the mathematical material concept and its relationship. Realistic mathematics education changes the culture towards a dynamic one, but still in the corridor of the educational process. Therefore, realistic mathematics education is an innovative learning approach that emphasises mathematics as a human activity that must be associated with real life using real world context as the starting point of learning.

Mathematical belief is the key idea in the application of mathematical teaching approaches. The mathematical belief of a student is formed from his or her attitude towards his or her mathematical knowledge, thereby enhancing one's mathematical value. This view is supported by Anderson, Roger and Klinger, who found that positive mathematical belief influences the performance of secondary school students in Canada. According to The National College of Teachers of Mathematics (NCTM), this belief influences the ability of students to evaluate their skills, desire to perform mathematical tasks and mathematical disposition. Knowledge of these steps is not enough in performing mathematical tasks because students must also believe in the truth of concepts

and procedures. The mathematical belief of students consists of three main factors, namely, students' belief in their ability, in the mathematical discipline and towards mathematical teaching and learning.

Q. 2 Describe different strategies to make mathematics meaningful. Enlist the example of anyone of your teachers who tries to make mathematics meaningful.

Motivating students to be enthusiastically receptive is one of the most important aspects of mathematics instruction and a critical aspect of any curriculum. Effective teachers focus attention on the less interested students as well as the motivated ones. Here are nine techniques—based on intrinsic and extrinsic motivation—that can be used to motivate secondary school students in mathematics.

Extrinsic motivation involves rewards that occur outside the learner's control. These may include token economic rewards for good performance, peer acceptance of good performance, avoidance of "punishment" by performing well, praise for good work, and so on.

However, many students demonstrate intrinsic motivation in their desire to understand a topic or concept (task-related), to outperform others (ego-related), or to impress others (social-related). The last goal straddles the fence between intrinsic and extrinsic.

With these basic concepts in mind, there are specific techniques that might be expanded, embellished, and adapted to the teacher's personality and, above all, made appropriate for the learner's level of ability and environment. The strategies are the important parts to remember—examples are provided merely to help understand the techniques.

STRATEGIES FOR INCREASING STUDENT MOTIVATION IN MATH

1. Call attention to a void in students' knowledge: Revealing to students a gap in their understanding capitalizes on their desire to learn more. For instance, you may present a few simple exercises involving familiar situations, followed by exercises involving unfamiliar situations on the same topic. The more dramatically you reveal the gap in understanding, the more effective the motivation.

2. Show a sequential achievement: Closely related to the preceding technique is having students appreciate a logical sequence of concepts. This differs from the previous method in that it depends on students' desire to increase, not complete, their knowledge. One example of a sequential process is how special quadrilaterals lead from one to another, from the point of view of their properties.

3. Discover a pattern: Setting up a contrived situation that leads students to discover a pattern can often be quite motivating, as they take pleasure in finding and then owning an idea. An example could be adding the numbers from 1 to 100. Rather than adding the numbers in sequence, students add the first and last (1 + 100 = 101), and then the second and next-to-last (2 + 99 = 101), and so on. Then all they have to do to get the required sum is solve $50 \times 101 = 5{,}050$. The exercise will give students an enlightening experience with a truly lasting effect. There are patterns that can be motivating, especially if they are discovered by the student—of course, being guided by the teacher.

4. Present a challenge: When students are challenged intellectually, they react with enthusiasm. Great care must be taken in selecting the challenge. The problem (if that is the type of challenge) must definitely lead into the lesson and be within reach of the students' abilities. Care should be taken so that the challenge does not detract from the lesson but in fact leads to it.

5. Entice the class with a "gee whiz" mathematical result: There are many examples in the mathematics realm that are often counterintuitive. These ideas by their very nature can be motivating. For example, to motivate basic belief in probability, a very effective motivation is a class discussion of the famous birthday problem, which gives the unexpectedly high probability of birthday matches in relatively small groups. Its amazing—even unbelievable—result will leave the class in awe.

6. Indicate the usefulness of a topic: Introduce a practical application of genuine interest to the class at the beginning of a lesson. For example, in high school geometry, a student could be asked to find the diameter of a plate where all the information he or she has is a section of the plate that is smaller than a semicircle. The applications chosen should be brief and uncomplicated to motivate the lesson rather than detract from it.

7. Use recreational mathematics: Recreational motivation involves puzzles, games, paradoxes, or the school building or other nearby structures. In addition to being selected for their specific motivational gain, these devices must be brief and simple. An effective execution of this technique will allow students to complete the recreation without much effort. Once again, the fun that these recreational examples generate should be carefully handled, so as not to detract from the ensuing lesson.

8. Tell a pertinent story: A story of a historical event (for example, the story of how Carl Friedrich Gauss added the numbers from 1 to 100 within one minute when he was a 10-year-old in 1787) or a contrived situation can motivate students. Teachers should not rush while telling the story—a hurried presentation minimizes the potential motivation of the strategy.

9. Get students actively involved in justifying mathematical curiosities: One of the more effective techniques for motivating students is to ask them to justify one of many pertinent mathematical curiosities, like the fact that when the sum of the digits of a number is divisible by 9, the original number is also divisible by 9. The students should be familiar and comfortable with the mathematical curiosity before you challenge them to defend it.

Teachers of mathematics must understand the basic motives already present in their learners. The teacher can then play on these motivations to maximize engagement and enhance the effectiveness of the teaching process. Exploiting student motivations and affinities can lead to the development of artificial mathematical problems and situations. But if such methods generate genuine interest in a topic, the techniques are eminently fair and desirable.

Q. 3 Differentiate between meaningful learning and rote learning, also explain the importance of patterns in mathematics.

Rote learning is the memorization of information based on repetition. Examples of rote learning include memorizing the alphabet, numbers, and multiplication tables. Some consider rote learning to be a necessary step in learning certain subjects.

Memorization isn't the most effective way to learn, but it's a method many students and teachers still use. A common rote learning technique is preparing quickly for a test, also known as cramming.

ADVANTAGES OF ROTE LEARNING

There are some benefits of Rote Learning, including:

- Ability to quickly recall basic facts
- Helps develop foundational knowledge

DISADVANTAGES OF ROTE LEARNING

The drawbacks of learning by memorization include:

- Can be repetitive
- Easy to lose focus
- Doesn't allow for a deeper understanding of a subject
- Doesn't encourage the use of social skills
- No connection between new and previous knowledge
- May result in wrong impression or understanding a concept

While being able to quickly recall pieces of information is helpful, to understand information on a deeper level students must use a different method of learning: meaningful learning.

Meaningful learning involves understanding how all the pieces of an entire concept fit together. The knowledge gained through meaningful learning applies to new learning situations. This type of learning stays with students for life.

Meaningful learning is **active**, **constructive**, and **long-lasting**, but most importantly, it allows students to be **fully engaged** in the learning process.

Two important goals of all types of learning include retention and transfer. "Retention" is the ability to remember the material at a later time. "Transfer" is the ability to use prior knowledge to solve new problems. Students achieve meaningful learning when both of these goals are fulfilled.

ADVANTAGES OF MEANINGFUL LEARNING

Meaningful learning helps students achieve success in the classroom by:

- Encouraging understanding, not memorization
- Encouraging active learning techniques
- Focusing on the outcome of the learning process
- Relating new information to prior knowledge

DISADVANTAGES OF MEANINGFUL LEARNING

The challenges associated with meaningful learning include:

- Takes longer to achieve
- Should be tailored for different types of learners

Some students may face challenges with meaningful learning, as it requires building off previous knowledge. This is where dedicated teachers and tutors can help ensure students understand concepts so that meaningful learning can continue to happen.

Experts emphasize the importance of deep understanding over the recalling of facts. Students who learn with meaningful learning are able to problem solve better than those who learn by rote.

Meaningful learning teaches students important cognitive skills they will use throughout their life. Cognitive skills are what students use to evaluate, analyze, remember and make comparisons. In the long run, meaningful learning is the most effective way for students to engage in learning.

With our **Cognitive Learning** approach to teaching, Oxford Learning emphasizes the importance of meaningful learning. Our programs don't focus on memorization or repetition—they teach students the fundamentals of lifelong learning. Your child will develop learning skills and strategies that will help him or her on the way to better grades in school.

Q. 4 Identify different objectives of contextual teaching and learning and also suggest techniques to and methods to achieve these objective.

In the beginning, contextual teaching and learning approach was derived from the theory of behaviorism and then continued with the theory of constructivism. Behaviorism is teaching and learning theory that was proposed by E.L Thorndike who suggested that learning resulted from links formed between stimuli and response through the application of rewards. It means that learners study behaviorism theory that emphasized in the observable behavior produced by a learner in order to response to the stimuli. The theory was applied in the form of conventional way that emphasized in drill or memorization. Then, a new theory was born that is constructivism in order to response to the behaviorism theory. In constructivism, students could construct their own knowledge by testing ideas based on the prior knowledge and experience, applying these ideas to a new situation and integrating the new knowledge gained with the pre-existing intellectual construct. In this case, constructivism as learning theory emphasized in the role of students rather than the teacher. In order they can find the solution from their problem that produce students' critical thinking. This theory consists of authentic learning activity that is conducted in group. Both the theory of behaviorism and constructivism include the direct instruction in teaching and learning process. In this case, the positions of behaviorism and constructivism theories related to the development of contextual teaching and learning were behaviorism as a means for measure the students' observable behaviors when they took apart in teaching and learning process while constructivism as a way to help them connect the content could be used. That is the reason why CTL has the abbreviation of contextual teaching and learning because it is a learning activity based on life context. Contextual teaching and learning is a learning philosophy that emphasizes the students' interest and experiences. It provides the means for reaching learning goals that requires higher order thinking skills.

Contextual teaching and learning is an approach of learning that can't be separated with behaviorism and constructivism theories. It is a conception of teaching and learning that helps teachers relate subject matter content to real world situation and its application to their lives as family, citizen, and workers and engage in the hard work that learning requires. This theory emphasizes students' interest and experience. Overall, contextual teaching and learning is an approach that focuses on the students' center. The purpose of the approach is to motivate the learners to take charge of their own learning and to relate between knowledge and its application to the various contexts of their lives.

PRINCIPLES OF CONTEXTUAL TEACHING AND LEARNING

Contextual teaching and learning as one of approaches for teaching and learning has scientific principles. According to Johnson (2002:26) there are 3 principles of it. They are principles of interdependence, the principles of differentiation, and the principles of self-regulation.

Principles of Interdependence

Human being could not establish intimacy with one another (Johnson, 2002:28). It means that although the approach consists of authentic learning activity that is conducted group, there is no one can intimidate the other's to follow the certain students. It is a sharing and discussing section when it is conducting in group, so the principle stresses that all of the learners have the interdependence.

Principle of Differentiation

When the students are different in their creativity, they could be free to explore their individual talents, cultivate their own learning styles, and progress at their own pace(Johnson, 2002:31).It means that contextual teaching and learning approach can be conducted to the students with different characters, talents, and ability. The importance of the principle is how the contextual teaching learning helps the students to explore their own talent and can have a big motivation to study based on their life context.

Principle of Self-Regulation

Self-regulation means everything is set up, maintained, and recognized by yourself. The principle motivates the students to show all of their potentials. Moreover, it also explores them to get the new talents. The teacher should give them belief by giving responsibility for taking the decision, behavior, choice, plan, solution etc.

COMPONENTS OF CONTEXTUAL TEACHING AND LEARNING

Contextual teaching and learning also consists of some components that must be conducted as the part of its application. There are seven components of contextual teaching and learning that are useful to gain success in applying it (Wijarwadi, 2008:27).

Constructivism

From the history of contextual teaching and learning, constructivism is a theory that emphasizes the way how the students construct their own knowledge. It has five steps of learning. They are activating knowledge, acquiring knowledge, understanding knowledge, applying knowledge, and reflecting knowledge.

Inquiry

The principle shows how learning is conducted by including the process of discovery that needs critical thinking. In this case, knowledge as the part of learning does not get by considering a number of facts but also from stimulating learning that allows the students to find their own material in the real context.

Questioning

Questioning is one of the parts in teaching learning process. The students' ask something because they want to know something that they do not know. They are curious to get the answer of their problem. That's why they ask to the teacher or others.

Learning Community

Contextual teaching and learning is conducted in group because its purpose is wants the students to have sharing and discussing section without the intimacy of others. The other purpose is the students can help the others who need their help in positive way.

Modeling

Modeling is derived from the word "model". Model means example. The component of modeling means the teacher gives example to the students if they find difficulties in real way. For example the English teacher gives the example to pronounce certain words.

Reflection

Reflection is the ways of thinking about what the students have learned and thinking about what they have done in the past. In this case, the teacher can do about the information that acquired in the action.

Authentic Materials

It is important to have assessment for the teacher in order to check whether the students have learned the material or not. The assessment is done in authentic form in order to reduce the students do copy paste to the other friends' work. According to Ketter & Arnold (2003:36) authentic assessment as a means of documenting content mastery. Assessment is authentic when we direct examine student performance on worthy intellectual task.

Q. 5 Explain the advantages and disadvantages of learning aids in teaching of mathematics.

For most of us, our first visual and sensual contact with a learning tool begins at an age when we did not say a word, leave aside knowing an alphabet. At that impressionable age, we twisted a crayon or a pencil between tiny fingers, not quite being able to grasp it, but succeeding in tentatively touching it with our tongue. We thus literally got our first taste of a learning tool! We made wild doodles with chalks, crayons, coloured pens, etc on just about any surface (when nobody was looking naturally!). This progressed to learning how to hold a pencil & trying to draw a line or a circle & later to actually writing our ABCs. The older generation still fondly remembers their first black rectangular slates & sticks of white chalk they took to school. These are used even today in India's rural areas and municipal schools & are often a child's first learning tools. From a teacher's point of view, the slate is a teaching aid, as the larger version of it – the blackboard – is used to show the children how to write the alphabets and copy it on the slate in the exact same manner. Starting with the

blackboard, let's have a look at the different types of teaching tools used in the classroom, ranging from the traditional blackboard to e-learning packages.

A blackboard

As implied by the name, it is a board which is black in colour. Blackboards come in a variety of sizes and shapes, not just in the traditional square or rectangular shape but also shaped like an apple or a flower. Then there are blackboards which are not just fixed to a classroom wall, but could be the type set up on an easel. There are even the portable, rolled-up types which you unroll and hang by a string on a convenient hook. Besides the inevitable chalks needed in various colours, a blackboard's constant companion is a duster. This could be one with a wood base or a simple cloth.

A whiteboard

In many classrooms, the blackboard and chalk has been replaced by a white board and thick-tipped pen. The whiteboard enables a teacher to create a lesson plan & teach it in a way that is easy for students to understand.

A PC tablet

This is a good interactive teaching aid as it is a touch-screen device which is easy to use. A device like an Apple iPad or a Samsung Galaxy tab can be used for educational apps, such as multiple-choice questions, science quizzes, puzzles, a textbook chapter's summary, etc. Even diagrams are easy to learn on such a gadget.

Touch screen board with electronic pen

This is an interactive board on which the student uses an electronic pen to answer a question & gets a quick feedback about whether it is right or wrong. It makes the student understand a mathematical problem faster.

Slideshows & Power Point presentations

These teaching aids are effective in graphically explaining a subject & also encourage a student to do a lot of research for presenting a project. Audio-visual equipment which involves projectors is effectively used to present diagrams, animated images, graphs, etc.

Portable white screen

A simple portable white screen can be set up just about anywhere indoors or outdoors (weather permitting!) to impart educational lessons.

E-learning packages

A few schools utilize pre-pared e-learning packages for subjects such as history, maths and science. There are even pre-programmed audio-visual packages for music & sport!

Accessories

Let's not forget some useful accessories: The teaching aids used for children first learning their numbers, alphabets, names of animals & birds, etc. span a wide variety: beads, flash cards, cardboard-cut outs, toys, even matchsticks and shells.

At the higher classes, globes, prisms, magnets, stop watches, compasses, laboratory equipment & various sundry devices can be effectively used to convey information on a subject.

A majority of modern teaching aids are technology-based as can be seen in the list above.

Let's now discuss the benefits & drawbacks of such teaching aids

Benefits of modern teaching aids

Keeping in mind a child's exposure to video games, iPads and smart phones, it is not surprising that as a student the child takes to technological teaching tools like the proverbial duck to water.

Teaching & learning are both made more enjoyable through modern teaching aids of the technological kind. Children do tend to be more attentive as the audio or visual or audio-visual aids makes them engrossed in what is being taught.

Devices like touch-screen gadgets makes learning more accessible and helps a child to understand a subject as complex as a Shakespearean play easy to understand thanks to the summaries of such subjects provided by the device's apps.

Teaching aids like animated slide shows saves time for subjects like botany and biology. For example, instead of the teacher constantly drawing a diagram of a flower to explain the parts of the flower or of the brain to explain its various features, time is saved by showing a slide show and simply explaining.

Drawbacks of modern teaching aids

It does seem increasingly clear that many companies which manufacture modern teaching aids are pulling out all the stops towards marketing their products aggressively. It is true that a student is no longer a mere passive learner. They are eager to learn with more involvement. However, are such technological devices really necessary? Some schools get carried away by the hype & herd mentality of "Other schools are using them; so should we".

Here's why modern teaching aid can be ineffective:

- The modern technological teaching aids which are used in the classroom today are a barrier to student-teacher interactions. Learning, like these aids, is not automated. Quite often, clarity can be lost & essential details overlooked while explaining a topic with a technological teaching aid.
- The biggest drawback to the use of modern teaching aids is the investment costs. These costs can be really huge as it is not a question of simply setting up the equipment on a one-time basis. Any technological equipment needs to be maintained. Quite often, the budget for such teaching aids can overshoot the mark. This has repercussions, with school fees being hiked to astronomical proportions. Moreover, in the case of using software teaching aids, the software needs to be constantly upgraded.
- Then there is the factor of learning how to use the teaching aids properly & effectively. Not all teachers can grasp technology very quickly so this involves a need to train them first. Both the hardware & software industry is developing at a furious pace. In the blink of an eye, software can become redundant as a new one takes over or some hardware's feature can become more sophisticated. Hence the need to also constantly train teachers to understand new developments of teaching aids.

- One also tends to forget that teaching aids used generally may be ineffective for children with special learning needs. It is important to have **unique teaching aids for autistic children**, those who are slow learners, those with visual disabilities and the like. Such children often get left out of the enjoyable process of learning because they may not be able to quickly grasp what is being taught through fancy gadgets & devices.
- Finally, for schools which download & use direct Internet teaching software there is the constant threat of what affects anything in e-space: viruses & hackers. Also, when giving access to the Internet to school children to encourage them to do research, it is essential to teach them cyber security & monitor the sites they visit.