COLLEGE FOR DISTANCE AND e-LEARNING

UNIVERSITY OF EDUCATION, WINNEBA

Year Two Semester One

THEORIES OF LEARNING MATHEMATICS FOR UPPER PRIMARY

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UNIT 1: TEACHING MATHEMATICS IN SCHOOLS

You are welcome to the first unit of this course in theories in the learning of upper primary mathematics. This unit looks at why we teach mathematics in schools. The unit is divided into six sections which you will work patiently and diligently through. Throughout the unit, you will be involved in a number of activities. You will be required to do some of these activities through reading the materials in the unit. In addition, you will be required to use your experience as a teacher to internalize what you have read. The essence of these activities is to enable you supplement the material here with your own efforts. In this way you will find the studies interesting. It is hope that you will have no difficulties in understanding the contents of the unit.

By the end of the unit, you will be able to:

- demonstrate knowledge and skill of the nature of mathematics and mathematical knowledge and context of teaching.
- demonstrate knowledge and understanding of the importance of mathematics and relationship between mathematics and society.
- demonstrate skills in learning and teaching Mathematics.

SECTION 1: **DEFINITION OF MATHEMATICS TO THE UPPER PRIMARY TEACHER**

You are welcome to the first section of Unit 1. In this section, you will learn the definition of mathematics. Knowledge gained in this section will enable you to understand the content in section two, as the section builds on whatever you learn from this section.

By the end of this section, you should be able to:

1. Explain the meaning of mathematics.
2. Analyze the various definitions of mathematics.
3. Explain teachers' views about the definition of mathematics.

What is Mathematics?

Mathematics is the science that deals with the logic of shape, quantity and arrangement. Mathematics is all around us, in everything we do. It is the building block for everything in our daily lives, including mobile devices, architecture (ancient and modern), art, money, engineering, and even sports. Since the beginning of recorded history, mathematics discovery has been at the forefront of every civilized society, and in use in even the most primitive of cultures. The need for learning mathematics arose based on the wants of society. The more complex a society, the more complex the mathematical needs. Primitive tribes needed little more than the ability to count, but also relied on mathematics to calculate the position of the sun and the physics of hunting.

The definition of mathematics as a science of pattern and order is taken from everybody counts. In recent years I have found it helpful to my own formulation of what mathematics is about to reflect on this idea. While incredibly simple sounding it fits beautifully with the four theme standards. The idea that mathematics is a science, speaks to the investigative nature of the discipline. The notions of pattern and order can be found in nearly every facet of mathematics from counting to fractals. It is a phrase we want to introduce to our students early on and have them hear it throughout the course as a "hook" for much of what is important.

Mathematics is a fundamental part of human thought and logic, and is 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 NTCM (2000) principles and standards describe problem solving, communication, reasoning, connections as processes of learning mathematics.

Mathematics as problem Solving: Teachers who view mathematics as problem-solving will include numerous and varied experiences with the problem solving as a method of inquiry and application so that learners can:

a. use problem-solving approaches to investigate and understand mathematical contents.
b. formulate problems from situations within and outside mathematics
c. develop and apply a variety of strategies to solve problems, with emphasis on multistep and nonroutine problems.
d. verify and interpret results with respect to the original problem situations
e. generalize solutions and strategies to new problem situation
f. acquire confidence in using mathematics meaningfully.

Mathematics as Communication: Teachers who view in mathematics as communication emphasise the development and use of language and symbolism to communicate mathematical ideas so that all learners can:

a. reflect upon and clarify their thinking about mathematical ideas and relationships.
b. formulate mathematical definitions and express generalization.
c. express mathematical ideas orally and in writing
d. read written presentations of mathematics with understanding
e. ask clarifying and extending questions related to mathematics they have read or heard about.
f. appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas.

Mathematics as Reasoning: Teachers who view mathematics as reasoning will emphasize that learners:

a. draw logical conclusions about mathematics
b. use models, known facts, properties, and relationships to explain their thinking
c. justify their answers and solution processes.
d. use patterns and relationships to analyze mathematical situations.
e. believe that mathematics makes sense.

Mathematical Connections: Teachers who believe in connecting mathematical ideas and also connecting mathematics to other disciplines will ensure that their learners:

a. see mathematics as an integrated whole
b. explore problems and describe results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations.
c. use mathematical idea to further their understanding of other mathematical ideas.
d. use a mathematical thinking and modeling to solve problems that arise in other disciplines, such as art, music, psychology, science and business.
e. Value the role of mathematics in our culture and society.

Activity 1.1

Why is mathematics considered a science?

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Activity 1.2

Some teachers view mathematics as problem solving, communication, reasoning and connections. Explain these beliefs in the lines indicated below:

a. Mathematics as problem solving

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b. Mathematics as Communication

c. Mathematics as Reasoning

d. Mathematics as Connection

Summary

You have done well for going through this section successfully. The main points you should remember and reflect on in this section are as follows:

- Mathematics is the science that deals with the logic of shape, quantity and arrangement.
- 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.
- Mathematical knowledge plays a crucial role in understanding the contents of other school subjects such as science, social studies, and even music and art.

SECTION 2: CONCEPTION OF THE NATURE OF MATHEMATICS

You are welcome to section 2 of Unit 1. In our previous section, we described and defined mathematics in various ways. In this section, you will learn about the nature of mathematics.

Feel relaxed as you journey through section 2 of Unit 1.

By the end of this Section, you should be able to:

1. describe the nature of mathematics.
2. explain the connection between teachers' beliefs and the nature of mathematics.

A teacher's belief system concerning the nature of mathematics as a whole form the basis of the philosophy of mathematics, although some of the views likely to be held by teachers may not have been elaborated into fully articulated philosophies. Teachers' conceptions of the nature of mathematics by no means have to be consciously held views; rather they may be implicitly held philosophies. The importance of such views of subject matter has been noted both across a range of subjects (Feinman-Nemser and Floden, 1986) and for mathematics in particular (Ernest 1985, 1987, 1988b; Lerman, 1983, 1986; Thom, 1973). Out of a number of possible variations, three philosophies of mathematics are distinguished because of their observed occurrence in the teaching of mathematics (Thompson, 1984), as well as for their significance in the academic study of the philosophy of mathematics (Benecerraf & Putnam, 1964; Davis and Hersh, 1980; Lakatos, 1976; Tymoczko, 1985). They are presented here in simplified form, and in practice teachers may combine elements from more than one of the views.

First of all, there is a dynamic, problem-driven view of mathematics as a continually expanding field of human enquiry. Mathematics is not a finished product, and its results remain open to revision (the problem-solving view).

Secondly, there is the view of mathematics as a static but unified body of knowledge, consisting interconnecting structures and truths. Mathematics is a monolith, a static immutable product, which is discovered, not created (the Platonist view).

Thirdly, there is the view that mathematics is a useful but unrelated collection of facts, rules and skills (the instrumentalist view).

Teachers' views of the nature of mathematics may also be compounded with additional constructs, such as views of the relationship between different subject matter areas, for example. Is mathematics entirely distinct from other disciplines? Or are mathematics and other areas of knowledge interrelated or partly integrated, sharing concepts and methods of inquiry? The conception of knowledge as integrated is often associated with a problem-solving view of mathematics, but there is no strict necessity behind this link.

The different philosophies of mathematics have practical classroom outcomes. For example, an active, problem-solving view of mathematical knowledge can lead to the acceptance of children's methods and approaches to tasks. In contrast, a static Platonist or instrumentalist view of mathematics can lead to the teacher's insistence on there being a single 'correct' method for solving each problem. Again, a teacher's view of knowledge as integrated can lead to teaching in which mathematics and other subject matter areas are interrelated. The opposite view can result in an insistence that questions of mathematics and geography, for example, are dealt with separately during mathematics lessons and geography lessons.

Some of the main curriculum reform movements in mathematics have been based on views of mathematics. The modern mathematics movement of the early 1960's can be likened to the Platonist view through its stress on structure, the laws of number, and central and unifying concepts of mathematics, such as sets and functions. A second parallel can be drawn between the instrumentalist view and that underlying the Back-to-Basics movement. This movement emphasizes basic numeracy as knowledge of facts, rules and skills, without regard for meaningful connections within this knowledge. More recently, the problem-solving view of mathematics has been reflected in the recommendations of official bodies. Namely, that the processes and strategies of mathematical activity are central, and that the main aim of

mathematics teaching is to empower children to become creative and confident solvers of problems.

Teachers' views of mathematics evidently affect the extent to which such curriculum innovations or movements take hold, through the way mathematics is taught (Cooney, 1988; Thom, 1973). For beliefs about mathematics are reflected in teachers' models of the teaching and learning of mathematics, and hence in their practices (Thompson, 1984)

Try the following activities.

Activity 2.1

Describe the nature of mathematics.

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Activity 2.2

Explain the connection between mathematics teachers' beliefs and the nature of mathematics.

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Summary

In section 2, you learnt that:

- Teachers' conceptions of the nature of mathematics by no means have to be consciously held views; rather they may be implicitly held philosophies.
- The beliefs about mathematics are reflected in teachers' models of the teaching and learning of mathematics, and hence in their practices.
- Teacher's belief system concerning the nature of mathematics form the basis of the philosophy of mathematics teaching.

SECTION 3: MATHEMATICAL KNOWLEDGE AND CONTEXT OF TEACHING MATHEMATICS

Welcome to section 3 of Unit 1. In section 2, you learnt about the nature of mathematics. In this section, we will discuss mathematical knowledge and context of teaching mathematics.

By the end of this section, you should be able to:

- Explain mathematics knowledge.
- Identify and describe the various knowledge of teaching mathematics.
- Identify and explain the various knowledge of context of teaching.
- Describe the impact of knowledge on teaching mathematics.

Mathematics Knowledge

Mathematical knowledge, unlike some of the other components in the model, is built up from early childhood onwards, and is often largely constructed before the end of the pre-service teacher education period. The teacher's knowledge of mathematics is a complex conceptual structure which is characterized by a number of factors, including its extent and depth; its structure and unifying concepts; knowledge of procedures and strategies; links with of other subjects; knowledge about mathematics as a whole and its history. This knowledge provides an essential foundation for the teaching of mathematics. The major goal of teaching is to facilitate the reconstruction of some portion of the teacher's knowledge of mathematics by the learner.

Whatever means of instruction are adopted, the teacher needs a substantial knowledge base in the subject in order to plan for instruction and to understand and guide the learner's responses. The teacher's knowledge of mathematics will underpin the teacher's explanations, demonstrations, diagnosis of misconceptions, acceptance of children's own methods, curriculum decisions (such as emphasizing central concepts), and so on. Thus, knowledge of mathematics provides a foundation for the teacher's pedagogical knowledge and skills for teaching mathematics.

Knowledge of Teaching Mathematics

Knowledge of teaching mathematics can be divided into two areas; pedagogical and curriculum knowledge of mathematics, after Shulman (1986a).

Pedagogical Knowledge of Mathematics: This is practical knowledge of teaching mathematics. It includes knowledge of approaches to school mathematics topics; different ways of presenting mathematics including problem solving; knowledge of children's methods, conceptions, difficulties and common errors; knowledge of mathematical tasks, activities, explanations, test items, and so on. It is this knowledge which a teacher uses to transform and represent knowledge of mathematics for teaching (Wilson, Shulman and Richert, 1987). Thus, it is central to the planning of instruction as well as, a means ofinteraction with individual learners and to other decision-making during teaching based on pedagogical (as opposed to managerial) grounds.

Curriculum Knowledge of Mathematics: This includes knowledge of texts and schemes used to teach mathematics, their contents and ways of using them; school produced curricular materials; other teaching resources such as computer software and teaching apparatus; examinations, tests and syllabuses. This is knowledge of the materials and media through which mathematics instruction is carried out and assessed. Shulman (1986a) refers to this as the knowledge of the 'materia medica' of teaching, in an analogy with the practice of medicine. Evidently this knowledge is vital to the planning and carrying out of mathematics teaching. Recent years have seen a growing acknowledgement of the importance of pedagogical subject matter knowledge in general and mathematics teaching knowledge in particular. It is increasingly recognised that this

knowledge forms the essential bridge between academic subject matter knowledge and the teaching of subject matter. For it is that knowledge which determines how mathematics is represented to students in their learning experiences, either directly by the teacher, or by means of instructional media. It includes the practical skills of transforming subject matter for teaching, and the pedagogical knowledge and skills for teaching it. Because of its largely practical origins, knowledge of teaching subject matter has been termed practical knowledge (Elbaz, 1981, 1983). Stones (1979) provides a three-fold analysis of the skills associated with such pedagogical knowledge. He suggests that the knowledge can be manifested in;

i. performance by the teacher
ii. recognition in others' performances
iii. explicit verbal description and explanation.

This analysis illustrates the complexity of such knowledge, since it comprises both practical skills, and general principles. Teachers begin to acquire their knowledge of mathematics teaching during their student years, on the basis of their learning experiences (Ball, 1987). They learn mathematics pedagogy during their preservice teacher education, in mathematics curriculum and methodology courses, which also extend, in varying degree, to curriculum knowledge of mathematics. However, the most significant part of teachers' learning of such knowledge probably takes place during teaching itself, either pre-service Teaching Practice or in service, being based on practical teaching experience.

This includes knowledge of organizing classes of students for mathematics instruction in cooperative groups, individually, or as a whole class; classroom questioning; the management of practical activities, as well as visits and excursions; control aspects such as keeping order and gaining attention; knowledge of classroom routines, access to resources, and managing classroom testing; the management of classroom resources such as furniture, computers and texts; and so on.

This knowledge is important because the teaching of mathematics to a group of children clearly requires organizational and managerial knowledge and skills, in addition to the types of knowledge and skill listed above (Bennett, 1987; Doyle, 1986). The assumption made here is the knowledge of organization and management for teaching that is specific to mathematics. For the

mathematics teacher, this knowledge is to a large extent acquired experientially during the teaching of mathematics, and is specific in that it is both acquired and employed in the teaching of mathematics. But this is not to say that it cannot be transferred to other areas of the curriculum, although a degree of transformation may be required. Clearly knowledge of managing a particular individualized learning scheme for mathematics is less transferrable than knowledge of organizing a display of children's mathematical work.

Knowledge of the Context of Teaching

During service at a particular site, teachers rapidly acquire specific knowledge of the context of teaching, which embraces the students, staff, and the whole social and material fabric of the school.

Knowledge of Students: This includes, knowledge of the classes of students taught: their group dynamics, group behaviour, how they interact and cooperate in groups, their responsiveness to learning tasks, their responses to the teacher's authority, and the steps that need to be taken to elicit their cooperation and to control them. It also includes knowledge of the children taught as individuals, both as learners, and as individual members of the school community.

Knowledge of School Context: This includes knowledge of other teachers; knowledge of the classroom, departmental and school location of teaching resources, such as computers, audio-visual and reprographic facilities; knowledge of school governance regulations, procedures, assessment systems, and policies; knowledge of out of class activities; knowledge of the school ethos, and of the school and departmental expectations concerning the role of the teacher, and so on. It also extends beyond the school, to knowledge of its broader social, cultural, ethnic and geographic contexts.

The impact of the context of teaching on teachers is noted by many authors (Clark and Peterson, 1986), although the importance of the teacher's knowledge of this area is given less recognition (but see Elbaz, 1983; Feinman-Nemser and Floden, 1986). Its import is that it provides the teacher with representations of the social context in all its multiplicity. Thus, it is through this knowledge that the constraints, pressures and opportunities afforded by the social context of teaching are mediated. It seems likely that knowledge of the students taught and knowledge of the school context are together among the most powerful determinants of the classroom approach

employed by the teacher. Studies of teacher socialization effects, both in general (Lacey, 1977), and in particular for mathematics (Brown, 1986), confirm this.

The Impact of Knowledge on Teaching Mathematics

Knowledge of mathematics, and other subject matter, has a key role to play in the teaching of mathematics, as has been discussed above. It is transformed by means of the practical knowledge of mathematics teaching (both pedagogical and curricular) into representations for the classroom use of content knowledge. In this way theoretical knowledge of the concepts and methods of mathematics relates to the use of mathematics content in teaching, mediated by practical knowledge of teaching mathematics

Knowledge of principles of education informs a number of aspects of practical knowledge of teaching, including knowledge of organization and management, the context of teaching, and practical knowledge of teaching mathematics, especially pedagogy. In particular, knowledge of educational psychology makes a key contribution, through mathematical pedagogy, to the understanding of children's learning, including the assessment of its outcomes. It contributes to the diagnosis of student levels of learning, and in matching tasks to individual learners. In this the teacher's knowledge of the context of teaching, especially knowledge of the learners, has an important part to play. It also underpins classroom relationships, through knowledge of individual learners and the matching of tasks to individual learners in upper primary. The teacher's knowledge of classroom organization is reflected in the organization and classroom procedures adopted in practice.

Well, you have successfully gone through the material in section 3 of Unit 1. Now try the following activities below.

Activity 3.1

Explain mathematics knowledge.

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Identify and describe the various knowledge of teaching mathematics.

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Activity 3.2

Identify and explain the various knowledge of context of teaching.

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Describe the impact of knowledge on teaching mathematics.

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Having finished the activities, you have to go through the summary and to reflect on what you have read.

Summary

In this section, you learnt that:

- The teacher's knowledge of mathematics is a complex conceptual structure which is characterized by a number of factors, including its extent and depth; its structure and unifying concepts; knowledge of procedures and strategies; links with of other subjects; knowledge about mathematics as a whole and its history.
- Mathematical knowledge is built up from early childhood onwards, and is often largely constructed before the end of the pre-service teacher education period.

- Knowledge of teaching mathematics can be divided into two areas, pedagogical and curriculum knowledge of mathematics.
- Knowledge of mathematics, and other subject matter, has a key role to play in the teaching of mathematics. It is transformed by means of the practical knowledge of mathematics teaching into representations for the classroom use of content knowledge.
- Teachers rapidly acquire specific knowledge of the context of teaching which embraces the students, staff, and the whole social and material fabric of the school.

SECTION 4: IMPORTANCE OF MATHEMATICS FOR THE UPPER GRADE TEACHER

Congratulations! You have successfully gone through section 3. In the preceding sections, you learnt about mathematical knowledge and the context of teaching mathematics. You will now turn your attention to some importance of mathematics to the upper grade teacher.

Let us get going. We believe you are ready to go!

By the end of this section, you should be able to:

- Identify and explain why the study of mathematics is important.

Importance of Mathematics

Take some few minutes to reflect on 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, a few thoughts on why mathematics should be treated as an important subject in overall curriculum are explained below.

Mathematics has a transversal nature. If we reflect on the history of curriculum in general, it becomes clear that 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.

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.

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 What is the role of mathematics in the development of a society?

A society, or a human society, is a group of people related to each other through persistent relations, or a large social grouping sharing the same geographical or virtual territory, subject to the same political authority and dominant cultural expectations. More broadly, a society may be described as an economic, social, or industrial infrastructure, made up of a varied collection of

individuals.

Mathematics occupies a crucial and unique role in the human societies and represents a strategic key in the development of the whole mankind. The ability to compute, related to the power of technology and to the ability of social organization, and the geometrical understanding of spacetime, that is the physical world and its natural patterns, show the role of Mathematics in the development of a Society. The society consists of its members (human being), who make government and organize the natural resources to develop infrastructure. The human beings are the one who develop the society. Therefore, we will discuss the role of mathematics in the development of an individual as well as the development of the society.

Try the following activities.

Activity 4.1

Why does mathematics hold such an important and unique place among other subjects?

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Activity 4.2

What is the significance of mathematics in the overall school curriculum?

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Summary

- Mathematics has a transversal nature.
- Mathematical literacy is a crucial attribute of individuals living more effective lives as constructive, concerned and reflective citizens.
- Mathematics is applied in various fields and disciplines, i.e., mathematical concepts and procedures are used to solve problems in science, engineering, economics.
- Mathematics is a part of our human cultural heritage, and we have a responsibility to develop that heritage.
- Mathematics provides foundational knowledge and skills for other school subjects, such as sciences, art, economy.
- Mathematics occupies a crucial and unique role in the human societies and represents a strategic key in the development of the whole mankind.

SECTION 5: RELATIONSHIP BETWEEN MATHEMATICS AND SOCIETY

Welcome to section 5 of Unit 1. You now understand the significance of mathematics. This indicates that you are making steady progress. Keep it up. In this section you will be introduced to another new and important concept known as the relationship between mathematics and society. The knowledge gain in this section will help you to appreciate the relationship between mathematics and society.

By the end of this section, you should be able to:

- Identify and explain the relationship between mathematics and society.
- Identify and explain the role of mathematics in societal development.

Relationship between Mathematics and Society

1. Role of Mathematics in the Development of Education System:

In education system, mathematics plays an important role in shaping the future probability of young people. Education is to develop an individual, to make her/him self-reliant, to make her/him wise, to make her/ him a social contributor and in our education system, for almost every subject, we study in school and university; we need to study mathematics too e.g., Physics,

Chemistry, Life-Science, Economics, Business and Accountancy, Geography, History, Psychology, Architect, Designing, Computes, Statistics, Commerce etc. Also in vocational areas like Tailoring, Carpenting, Cooking, Beauticians, Sportsperson, Farming etc, mathematical knowledge is needed. Even the professions like, Conductor, Shop Keeper, Drivers, Musicians, Magicians, Cashiers etc use basic mathematical concepts.

2. Role of Mathematics in Development of Economics:

Mathematics is of central importance to modern society. It provides the vital underpinning of the knowledge of economy. It is essential in the physical sciences, technology, business, financial services and many areas of ICT. It is also of growing importance in biology, medicine and many of the social sciences. Mathematics forms the basis of most scientific and industrial research and development. Increasingly, many complex systems and structures in the modern world can only be understood using mathematics and much of the design and control of high-technology systems depends on mathematical inputs and outputs. Economics of the society is developed by establishment of industries. The applied mathematics like computational science, applied analysis, optimization, differential equation, data analysis and discrete mathematics etc are essential in industrial field. By application of mathematical methods, the exploration cost of oil and communication cost of images could be reduced. Techniques of wavelets and fractals are used for this purpose. Numerical simulation of mathematical models helps to manufacture super conductor cables to reduce the cost of

electricity.

3. Role of Mathematics in Development of Infrastructure: In particular, mathematics has contributed to progress in science and technology for thousands of years and still continues to do so. It finds useful applications in development of infrastructure i.e., business, industry, music, politics, sports, medicine, agriculture, engineering, and the social and natural sciences. The physical appearance and development of infrastructure is crucial in a society. Thus, for the construction of roads, buildings, stadiums, flyovers, airports, dams, bridges, vehicles, airplanes etc. in mechanical engineering, civil engineering, electrical engineering etc

4. Role of Mathematics in Development of Science and Technology: The "functional" aspect of mathematics stems from its importance as the language of Science, Technology and Engineering,

and its role in their development. This involvement is as old as mathematics itself and it can be argued that, without mathematics, there can be neither science nor engineering. In modern times, adoption of mathematical methods in the social, medical and physical sciences has expanded rapidly, confirming mathematics as an indispensable part of all school curricula and creating great demand for university-level mathematical training. Much of the demand stems directly from the need for mathematical and statistical modeling of phenomena. Such modeling is basic to all engineering, plays a vital role in all physical sciences and contributes significantly to the biological sciences, medicine, psychology, economics and commerce. Mathematics has been successfully used in the development of science and technology in 20th – 21st century. The areas like advanced semi-conductor devices, bio-technology, digital image technology, Nano-technology, artificial satellites, and rockets all are based on mathematical concepts.

5. Role of Mathematics in Development of Medical Science and Agricultural field: Mathematics is applied to agriculture, ecology, epidemiology, tumor and cardiac modeling, DNA sequencing and gene technology. It is used to manufacture medical devices and diagnostics, opto-electronics and sensor technology. There are positive senses in which mathematics is special. First, by virtue of its fundamental nature as a universal abstract language and its underpinning of the sciences, technology and engineering, mathematics has a claim to an inherently different status from most other disciplines. Secondly, as we have set out above, mathematics is fundamentally important in an all-pervasive way, both for the workplace and for the individual citizen.

6. Role of Mathematics in Cultural and Moral Development: Mathematics has its own intrinsic beauty and aesthetic appeal, but its cultural role is determined mainly by its perceived educational qualities. The achievements and structures of mathematics are recognized as being among the greatest intellectual attainments of the human species and, therefore, are seen as being worthy of study in their own right, while the heavy reliance of mathematics on logical reasoning is seen to have educational merit in a world where rational thought and behaviour are highly valued.

Furthermore, the potential for sharpening the wit and problem-solving abilities fostered by study of mathematics is also seen as contributing significantly to the general objectives of acquiring

wisdom and intellectual capabilities. A cultured citizen is one who follows the norms of society and one who is a civilized person. A well-mannered person is always simple, original, patient, honest, accurate and disciplined. Mathematics is a subject which is exact, real, original and precise, and one who studies mathematics needs to follow the laws and rules. Thus, mathematics helps the people to be cultured citizens having sound morals.

7. Role of Mathematics in the Development of Living Standards: Since mathematics is used in almost every profession, it helps in improving the living-standards of a person. The developments in economics, science and technology, medicine in brief over-all development of society develops the standard of living. Thus, mathematics plays an important role in making the living standards high. Although the ubiquitous use of information technology in all sectors has changed the nature of the mathematical skills required, it has not reduced the need for mathematics.

8. Last but not the least any society can never be developed without the empowerment of women since women is the half part of the society. Therefore, we will also see the, role of mathematics education in women empowerment

The Role of Mathematics Education in Women Empowerment

The importance of Mathematics as a tool for science and technology is continually increasing. While science and technology have become so pervasive, mathematics education has continued to dominate the school curriculum and remains a key subject area requirement in high education and employment sector. The hue and cry which follows the publication of mathematics results has become an annual ritual. The postmortems about the results eclipse a number of areas where female students have lagged behind. This has also impacted on courses and careers sought by women in the working world. They have attributed their failure to perform to expected standards to lack of sound background knowledge of mathematics. It is this realization that the skills learnt at school have had very little if any, bearing on what society needs in terms of productive citizens. In this regard, the gender imbalances in enrolment, achievement at school level, colleges and universities and the employment sector were also issues of concern. Our societies are becoming more and more technological with a mathematical bias, more attention being focused on attainment of mathematical competencies. Empowerment provides opportunities to

increase knowledge and vocational skills for survival and also improves accessibility to more enterprising career paths for women. Imbalances in enrolment, performance, subjects and subsequent employment in jobs that have a mathematical inclination underscored the need for intervention programs to bridge the gap while it revealed the need for a further discussion

Activity 5.1

Explain in five sentences the relationship between mathematics and society.

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Summary

Mathematics is a subject which is exact, real, original and precise, and helps the people to be cultured citizens having sound morals. Society can never be developed without the empowerment of women since women is the half part of the society and the role of mathematics education in women empowerment cannot be underestimated. Mathematics is of central importance to modern society. It provides the vital underpinning of the knowledge of economy. It is essential in the physical sciences, technology, business, financial services and many areas

SECTION 6: LEARNING AND TEACHING MATHEMATICS

Welcome to the last section of Unit 2. Our focus of the unit has been why we teach and learn mathematics. I am sure you are convinced of the numerous reasons why we teach and learn mathematics. In this section, we will concentrate on how to effectively learn and teach mathematics.

By the end of this section, you should be able to:

- Explain what is meant by effective mathematics teaching.
- Identify and explain various ways of effectively teaching mathematics.

Effective Teaching of Mathematics

Mathematics teaching in the classroom involves the creation of opportunity for children to learn mathematics. Elements of this include: providing a supportive learning environment offering appropriate mathematical challenge; norming processes and strategies which foster learning. As a result of extensive observation of mathematics classrooms, I should like to offer the teaching triad, a synthesis of the three elements above, as a means of describing mathematics teaching

which I find pervasive and powerful. Elements of it appear throughout most of the teaching situations which I have analyzed, and it seems to illuminate and clarify the teaching process.

The classroom observations to which I shall refer, were made during a study of investigative approaches to the teaching of mathematics, and this in its turn was related to a constructivist view of knowledge and learning the old paradigm of balanced instruction focused on enabling children and teachers to achieve success at school. Today's paradigm focuses on students achieving college and career readiness in life, beyond school. The old paradigm of balanced instruction focused on enabling children and teachers to succeed at school. Today, the focus is for students to achieve college and career readiness in life beyond school.

The goal is for students to be literate in mathematics so that we can prepare them for a world where the subject is rapidly growing and is extensively applied to a diverse number of fields. Teaching mathematics can only be described as truly effective when it positively impacts student learning. We know that teaching practices can make a major difference to student outcomes, as well as what makes a difference in the classroom.

The Role of Teachers in Learning and Teaching Mathematics

Research and evidence from the field of mathematics lets us know, with a fair degree of certitude, how effective teachers of mathematics skillfully integrate a range of instructional approaches and resources to meet the diverse learning needs of their students. For the goal of learning and teaching mathematics to be achieved, teachers must take up certain roles. Some of these roles are:

Teachers know how students learn: Effective teachers of mathematics know the pedagogy that determines how their students successfully learn. Such teachers recognize that in order for students to effectively use mathematics they need to understand the concepts presented as well as become fluent with the skill taught. It is through the ongoing and increasingly complex application of concepts and skills that students become secure and competent in their use.

Teachers of mathematics are knowledgeable in the theory of learning their subject. They recognize the importance of using concrete materials and visual representations to develop a deep understanding of the subject. They have a clear picture of the learning progression that best

develops the knowledge base and skills of their students. They also have a broad palate of learning experiences they can use in the classroom, to meet the different learning needs of each student.

Teachers are able to look at student misconceptions. Teachers are able to look at student misconceptions, either in the classwork, through homework, or through assessments, and reteach the material using their understanding of the developmental nature of what becomes before or after the misconception. Deep understanding of the content enables teachers to directly address the specific misunderstandings that students may have. Such teachers need to be continual learners. Effective pedagogy is the subject of ongoing research and development, and the way to teach and learn mathematics is never static.

Teachers know what students need to know. Effective teachers know and understand the content and practices of the mathematics Standards framework that students need to know. Such teachers have deep understanding of concepts and utilize multiple ways to represent and explain them. They are also fluent with the procedures and practices their students will need in order to succeed in mathematics. The Common Core focus on career and college readiness requires that students be able to apply mathematics to complex problems in multiple contexts, both real and mathematical. As a consequence, this is also true for their teachers.

Teachers know their students as learners: Knowing a student as a mathematics learner is complex. An effective mathematics teacher quickly builds a picture of his/her students by progressively providing opportunities to demonstrate what he/she is learning. This way, teachers update and deepen their understanding of individual students. The effective teacher continuously uses this growing knowledge of students as learners to inform his/her instruction so they can better meet students' needs.

Assessment in mathematics is primarily formative. It involves collecting information from a range of sources, in a variety of ways. This includes information on students' strategies, understandings, attitudes, and prior knowledge and skills. Assessing a student involves making informed judgments about what the student knows. Hence, effective teachers not only monitor the performance of a student, but also their ability to show their understanding of the content that has been taught. Effective teachers:

Teachers integrate assessment into instructional practice. Acknowledge students' prior learning and help them make connections between what they already know and what they are currently learning. Gather information from a range of formal and informal sources using a variety of means, in particular written and verbal, and analyze the information presented. Use ongoing assessments to identify the learning needs of each student. This allows them to teach proactively, assisting students to meet articulated goals

Effective teachers know their students as learners. Knowing a student as a mathematics learner is complex. An effective mathematics teacher quickly builds a picture of their students by progressively providing opportunities to demonstrate what he/she is learning. This way, teachers update and deepen their understanding of individual students. The effective teacher continuously uses this growing knowledge of students as learners to inform their instruction so they can better meet students' needs.

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Effective teachers create challenge. Each student learns best within their 'Zone of Proximal Development.' The effective teacher is able to identify and keep track of a student's 'Zone' through ongoing formative assessment Provides each student with challenges that meet their own level through the careful use of investigative tasks. When referring to "challenges," it is meant that a student will need to experience some degree of struggle to achieve a learning goal. An effective teacher will challenge every student to consistently operate at the upper end of their 'Zone of Proximal Development. Many strategies introduce challenges into a lesson, including the use of a rigorous open task, the use of questioning strategies (such as turn and talk) that involve all students, asking exploratory and generative questions, and consistently requiring students to pose, reflect on, and justify arguments. Along with providing a challenge is the need to provide differing degrees of support for students. The greater the challenge, the greater the need for teacher support in a gradual release of responsibility from the teacher to the student.

Effective teachers create purposeful learning experiences: Effective teachers of mathematics create purposeful learning experiences for students through solving problems in relevant and meaningful contexts. There is ample evidence showing the need for problem-solving to be an integral part of all mathematics learning. Teaching through problem solving, however, means that students learn mathematics through real contexts, problems, situations, and models. The contexts and models allow students to build meaning for the concepts. This way, they can move on to increasingly more abstract concepts. Effective teachers will use such problems as starting points and an ongoing means for students to investigate and understand conceptual ideas so they can develop skills and procedures. Through such problems, all students are provided with appropriate entry points to progressively develop the understanding of concepts and increasingly more complex skills that facilitate efficient problem solving.

Activity 6. 1

What does it mean to effectively teach mathematics?

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Activity 6.2

How can you teach mathematics effectively? Explain in four lines.

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Summary

- Mathematics teaching in the classroom involves the creation of opportunity for children to learn mathematics.
- Creating opportunity for children include; providing a supportive learning environment offering appropriate mathematical challenge; norming processes and strategies which foster learning
- Research and evidence from the field of mathematics lets us know, with a fair degree of certitude, how effective teachers of mathematics skillfully integrate a range of instructional approaches and resources to meet the diverse learning needs of their students. For the goal of learning and teaching mathematics to be achieved, teachers must take up certain roles.

UNIT TWO: BELIEFS, ATTITUDES AND VALUES IN TEACHING MATHEMATICS

Dear learner,

Congratulations for successfully going through unit 1 on why we teach mathematics in schools. You are welcome to unit 2 which takes you to the world of beliefs, attitudes and values in teaching and learning mathematics. This unit is to assist you to develop a deeper understanding of beliefs, attitudes and values. It is my hope that after a careful study of this unit, you will appreciate the influence of teachers' beliefs, attitudes and values on the teaching and learning of mathematics. Enjoy your journey to the world of mathematical beliefs, attitudes, and values. Good luck.!

Learning Outcome

By the end of the unit, you will be able to:

1. Demonstrate knowledge and understanding of different perspectives (beliefs and values) of mathematics.
2. Demonstrate an understanding of relevant professional values and attitudes in teaching Upper Grade mathematics,
3. Demonstrate an understanding of the influence of teachers' beliefs, values and attitudes on teaching Upper Grade mathematics.

SECTION 1: DEFINITION AND INTERPRETATIONS OF BELIEFS

You are welcome to section one of unit 2. As we have said at the introduction of this unit, the whole unit will focus on mathematics teacher's beliefs, attitudes and values in teaching and learning mathematics. In this section, we are going to discuss mathematics teachers' beliefs and its influence on teaching practice. Before we proceed, let us ask ourselves: what are beliefs? How does teachers' beliefs influence practice?

I hope you will enjoy going through this section which will help you to appreciate teachers' beliefs and practices.

By the end of this section, you should be able to:

1. Explain mathematics teachers' belief.
2. Identify and explain the impact of beliefs on teaching mathematics

Concept of Belief

Beliefs represent our view of existence. They stand for what we hold to be true or probable; they are for what we agree with. Our beliefs range from things we believe to be absolutely true, through to things we are not sure about, to things we definitely believe to be false. Beliefs are invisible. Only when people express them or act in particular ways can you tell what their beliefs are.

Beliefs, in this broad definition, includes knowledge. A belief may arise from enduring and consistent evidence from our senses or experience that something is true, or from general agreement. We can say that we know that Accra is the capital of Ghana, or that 2+2=4. Fundamental convictions are, of course, difficult to change. Some of your fundamental beliefs may not be shared by others. You may be totally convinced that you cannot spell, do mathematics or sing, and so prevent yourself from making progress in these skills. But it is only when your personal experience is backed by gloomy opinions from everyday who matters that you can honestly say: I know I cannot do it. (And even that does not rule out the possibility that you will be able to do in future). As you grow up, understanding the world becomes less simple. Do you believe in the genesis story of the creation of the world or do you believe in evolution? Do you believe that technology will save or destroy the species you belong to? Do you believe in getting married? You may research for authorities-people whose opinion you respect. At first these are found in the family, then at school, and in the groups you belong to. Authority beliefs, unlike the central beliefs described in the second paragraph, are open to question. You expect to have them challenged by other authorities. We act on our beliefs. Our religious and political beliefs lead us to behave in particular ways and use particular registers of language. For example, we can go to church and talk about sin and salvation, or take part in street demonstrations and talk about the destruction of the countryside by new roads programmes. Our beliefs color the way we interpret events. A person with conservative beliefs would regards any threat to abolish private schools as an attack on her/his cherished beliefs in free enterprise and freedom of choice for parents. A socialist, on the other hand, would welcome a measure that conformed to her or his belief in equal opportunities in education for all members of society. But if we profess one thing and do another (like professed vegetarians who slip off to KFC), then of course we are hypocrites.

Clearly, your beliefs have a bearing on your communication with other people. Conversation with people whose opinions differ from your own maybe more difficult. You may conceal your views to avoid possible conflict or you may provoke an argument, which can be very stimulating as long as people keep their tempers.

The Impact of Beliefs on Teaching Mathematics

Teachers' beliefs shape the type, content and representation format of the activities used in the classroom. As Hersh (1986, p.13) put it, "one's conception of what mathematics is affects one's conception of how it should be presented. The teacher's view of the nature of mathematics provides a basis for his or her mental models of the teaching and learning of mathematics. For views of the nature of mathematics are likely to correspond to views of its teaching and learning. Thus, for example, the instrumental view of mathematics is likely to be associated with a transmission model of teaching, and with the strict following of a text or scheme. It may also be associated with the child's compliant behaviour and mastery of skills model of learning. Similar links can be conjectured between other views and models, for example:

1. Mathematics as a Platonist unified body of knowledge corresponds to a view of the teacher as explainer, and learning as the reception of knowledge, although an emphasis on the child constructing a meaningful body of knowledge, is also consistent with this view.
2. Mathematics as problem solving corresponds to a view of the teacher as facilitator, and learning as autonomous problem posing and solving, perhaps also as the active construction of understanding.
3. The teacher's mental or espoused models of teaching and learning mathematics, subject to the constraints and contingencies of the school context, are transformed into classroom practices. These are the enacted (as opposed to espoused) model of teaching mathematics, the use of mathematics texts or materials, and the enacted (as opposed to espoused) model of learning mathematics. The espoused-enacted distinction is necessary, because case-studies have shown that there can be a great disparity between a teacher's espoused and enacted models of teaching and learning mathematics (Brown, 1986; Cooney, 1985; Cooney and Brown 1986; Thompson, 1984).

4. Teachers who believe it is important for students to learn mathematics with understanding embrace the use of investigations, mathematical discourse, and appropriate mathematical notation and vocabulary.
5. Because a teacher's beliefs influence his or her instructional decisions, pedagogical choices will differ among teachers, yielding varied student achievement results. A teacher's belief in a blend of whole class, individual work, and small-group work on challenging and interesting problems results in improved student achievement.
6. Teachers who believe in the importance of providing all students the opportunity to learn mathematics with understanding employ strategies that promote student engagement in problem solving. They encourage students to make, test, and revise conjectures, and to support their reasoning with evidence

Activity 1.1

In four lines, explain teachers' beliefs in teaching mathematics.

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Activity 1.2

In four lines, explain the impact of teachers' beliefs on teaching mathematics.

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Activity 1.3

Summary

- They stand for what we hold to be true or probable; they are for what we agree with.
- Beliefs range from things we believe to be absolutely true, through to things we are not sure about, to things we definitely believe to be false.
- Beliefs color the way we interpret events.
- Beliefs are only visible when expressed.
- Teachers' beliefs shape the type, content and representation format of the activities used in the classroom.
- One's conception of what mathematics is affects one's conception of how it should be presented.
- The teacher's view of the nature of mathematics provides a basis for his or her mental models of the teaching and learning of mathematics.

SECTION 2: DEFINITION AND INTERPRETATIONS OF ATTITUDES

You are welcome to section two of unit 2. In section one, you were assisted to understand the concept of belief and the influence of teachers' belief on classroom practice. This section will assist you to develop an understanding of teachers' attitude and its influence on teaching.

By the end of this section, you will be able to:

1. Explain mathematics teachers' attitude.
2. Identify and explain the impact of attitudes on teaching mathematics.

Concept of Attitude

Attitude is often defined as a tendency to react favorably or uniformly towards certain stimuli, such as individuals, national or racial groups, customs and institutions. As such, attitudes cannot be directly observed, but must be inferred from the way people behave, both verbally and non-verbally. It is important to distinguish between attitude and opinion. An attitude is made up of three elements.

1. **Feelings**: which may be favorable, unfavorable or indifferent towards the person or
2. object in question. These feelings lead you to judge (or evaluated) the person or object positively or negatively.
3. **Knowledge or belief**: what you know or belief about the person or object.
4. **Behaviour**: whether you move towards the person or the object or move away (avoidance).

So, for example, when a girl examines her attitude towards her boyfriend, if the feelings are strongly in his favour (She is glad to see him and likes to be close to him) this means that she assesses him positively. She may also know that he is considerate, interesting, amusing and, moreover, interested in her. She may take steps to be with him more often and encourage activities which bring them closer together, even tell him she enjoys his company, showing by behaviour that her assessment is positive. Her opinion of him, which she might express a third person, would be an expression (verbal or non-verbal) of the feelings and beliefs of which she is aware. In short, opinions have two components: the conscious aspects of feelings and beliefs. Attitudes have three components: feelings and beliefs (which can be at least partly unconscious) and behaviour.

To be effective, competent and reflective citizens, who will be willing and capable of solving personal and societal problems, learners should be exposed to situations that challenge them to raise questions and attempt to solve problems. Learners therefore need to acquire positive attitudes, values and psychosocial skills that will enable them participate in debates and take a stand on issues affecting them and others. The mathematics curriculum thus focuses on the development of some attitudes. These attitudes are:

a. Commitment: determination to contribute to national development.
b. Tolerance: willingness to respect the views of others.
c. Patriotism: readiness to defend the nation.
d. Flexibility in ideas: willingness to change opinion in the face of more plausible evidence.

e. Respect for evidence: willingness to collect and use data on one's investigation, and also have respect for data collected by others.
f. Reflection: the habit of critically reviewing ways in which an investigation or observation has been carried out to see possible faults and other ways in which the investigation or observation can be improved upon.
g. Comportment conforming to acceptable societal norms.
h. Co-operation the ability to work effectively with others.
i. Responsibility: the ability to act independently and make decisions; morally accountable for one's action; capable of rational conduct.
j. Environmental Awareness: being conscious of one's physical and socio-economic surroundings.
k. Respect for the Rule of Law: obeying the rules and regulations of the land.

The teacher should ensure that learners cultivate the above attitudes and skills as basis for living in the nation as effective citizens.

The Impact of Attitudes on Teaching Mathematics

Teacher's attitudes to mathematics itself may affect the teacher's attitudes to the teaching of mathematics, which in turn have a powerful impact on the atmosphere and ethos of the mathematics classroom. In particular, the teacher's displayed attitudes to the teaching of mathematics, such as enthusiasm and confidence, can be expected be a major contributor to the ethos of the mathematics classroom. This in turn can be expected to have a powerful influence on pupils' perceptions of mathematics. Although it is, of course, the pupil's total classroom experience of learning mathematics which contributes to the pupil's learning of, and views and attitudes towards mathematics, and ultimately, to the pupil's achievement in mathematics.

The attitude of the mathematics teacher is a critical ingredient in building an environment that promotes problem solving and makes students feel comfortable talking about mathematics. Teacher feedback is an important factor in mathematics learning. Students who perceive the teacher's feedback as being "informational" and useful for improving their competence will increase their intrinsic motivation to learn mathematics.

While some mathematics teachers have beliefs, attitudes, and expectations that will positively affect their students' learning and achievement, others will need to change in order for their students to appreciate and understand mathematics. Therefore, specific professional development experiences need to be designed for these teachers that start with examining the impact of teacher beliefs, attitudes, and expectations on learning and achievement. It should include a self-examination, and incorporate continuing mentoring and support.

Teacher attitudes impact their daily choices of activities, the amount of effort expended on each, and their expectations of students' abilities to perform. Educational change depends on what teachers do and think, as does the success or failure of the educational process. Teachers mediate between the learner and the subject to be learned; consequently, teachers' beliefs, attitudes, and expectations have a major impact on student achievement.

Teacher attitudes impact their daily choices of activities, the amount of effort expended on each, and their expectations of students' abilities to perform.

Teachers who believe that computational prowess is the most important component of mathematics typically demonstrate procedures and provide students time in which to practice those steps. Students who experience a problem-solving approach to the teaching and learning of mathematics consistently outperform students in classrooms that focus on skills and procedures.

Activity 1.1

In four lines, explain teachers' attitude in teaching mathematics.

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Activity 1.2

In four lines, explain the impact of teachers' attitude on teaching mathematics.

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Summary

- Attitude is often defined as a tendency to react favorably or uniformly towards certain stimuli, such as individuals, national or racial groups, customs and institutions.
- Attitudes cannot be directly observed, but must be inferred from the way people behave, both verbally and non-verbally.
- Teachers' decisions and actions in the classroom directly affect how students will learn mathematics. Teachers need to understand the big ideas of mathematics and be able to represent mathematics as a coherent and connected enterprise.
- Teacher's attitudes to mathematics itself may affect the teacher's attitudes to the teaching of mathematics,
- Teacher's displayed attitudes to the teaching of mathematics, such as enthusiasm and confidence, can be expected be a major contributor to the ethos of the mathematics classroom. This in turn can be expected to have a powerful influence on pupils' perceptions of mathematics.

SECTION 3: DEFINITION AND INTERPRETATIONS OF VALUES

Well done for going through sections 1 and 2.

Welcome to section 3. Your knowledge of beliefs and attitudes is gradually improving to meet your classroom practices. In this section, you will learn about another important concept in teaching and learning mathematics known as values. As you progress through this section, you will appreciate the knowledge of values on the teaching and learning of mathematics.

By the end of this section, you will be able to:

1. Explain mathematics values.
2. Identify and explain the impact of values on teaching mathematics.

Concept of Values

Values are individual beliefs that motivate people to act one way or another. They serve as a guide for human behavior. Generally, people are predisposed to adopt the values that they are raised with. People also tend to believe that those values are "right" because they are the values of their particular culture. Ethical decision-making often involves weighing values against each other and choosing which values to elevate. Conflicts can result when people have different values, leading to a clash of preferences and priorities. Some values have intrinsic worth, such as love, truth, and freedom. Other values, such as ambition, responsibility, and courage, describe traits or behaviors that are instrumental as means to an end. Other values are considered sacred and are moral imperatives for those who believe in them. Sacred values will seldom be compromised because they are perceived as duties rather than as factors to be weighed in decision-making. For example, for some people, their nation's flag may represent a sacred value. But for others, the flag may just be a piece of cloth. So, whether values are sacred, have intrinsic worth, or are a means to an end, values vary among individuals and across cultures and time. However, values are universally recognized as a driving force in ethical decision-making.

At the heart of the mathematics curriculum is the belief in nurturing honest, creative and responsible citizens. As such, teaching and learning should include the related pedagogy should be consistent with the following set of values.

Respect: This includes respect for the nation of Ghana, its institutions and laws and the culture and respect among its citizens and friends of Ghana.

Diversity: Ghana is a multicultural society in which every citizen enjoys fundamental rights and responsibilities. Learners must be taught to respect the views of all persons and

to see national diversity as a powerful force for nation development. The curriculum promotes social cohesion.

Equity: The socio-economic development across the country is uneven. Consequently, it is necessary to ensure an equitable distribution of resources based on the unique needs of learners

and schools. Ghana's learners are from diverse backgrounds, which require the provision of equal opportunities to all, and that all strive to care for each other both personally and professionally.

Commitment to achieving excellence: Learners must be taught to appreciate the opportunities provided through the curriculum and persist in doing their best in whatever field of endeavour as global citizens. The curriculum encourages innovativeness through creative and critical thinking and the use of contemporary technology.

Teamwork/Collaboration: Learners are encouraged to be become committed to team-oriented working and learning environments. This also means that learners should have an attitude of tolerance to be able to live peacefully with all persons.

Truth and Integrity: The curriculum aims to develop learners into individuals who will consistently tell the truth irrespective of the consequences. In addition, be morally upright with the attitude of doing the right thing even when no one is watching. Also, be true to themselves and be willing to live the values of honesty and compassion.

Equally important, the ethos or culture of the work place, including integrity and perseverance, must underpin the learning processes to allow learners to apply skills and competencies in the world of work.

Activity 1.1

In four lines, explain values in teaching mathematics.

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Activity 1.2

In four lines, explain the impact of teachers' values on teaching mathematics.

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Summary

- Values are individual beliefs that motivate people to act one way or another. They serve as a guide for human behavior.
- Learners are from diverse backgrounds, which require the provision of equal opportunities to all, and that all strive to care for each other both personally and professionally.
- Learners must be taught to appreciate the opportunities provided through the curriculum and persist in doing their best in whatever field of endeavor as global citizens.
- The curriculum encourages innovativeness through creative and critical thinking and the use of contemporary technology.
- Learners should have an attitude of tolerance to be able to live peacefully with all persons.

SECTION 4: TEACHERS' ATTITUDE AND COMMUNICATION

Welcome to section four of unit 2. You are making progress in this course and I have to say well done! to you. In this section, we are going to discuss the impact of teacher attitude on communication.

By the end of this section, you should be able to:

1. Explain teachers' attitudes in teaching mathematics.
2. Identify and explain the impact of attitudes on classroom communication.

Attitudes and Communication

Attitudes are learned from childhood experiences in the home from friends from isolated but indelible experiences and from the groups you belong to. It is these reference groups that have strong influence on your attitudes and people turn to be judged by the company they keep. According to stimulus-response(S-R) theory, attitudes, like all learned things, are created and modified by towards and punishment. Once attitudes are formed, most people like to keep them stable. You can do this buy only entering situations where your attitudes and associated beliefs and values do not come under attack. You can choose friends, which by and large shares your views, you can read a paper that reflect your political outlook (and so reinforces your attitudes) and you may even reject leaflets, switch off party political broadcasts and avoid doorstop missionaries if you think they are going to challenge your beliefs. The behaviour described above is a typical attempt to keep some degree of consistency in attitudes; it is psychologically comfortable to have them in balance. If something happens to challenge your attitude (e.g. a politician you detest says or does something you judge sensibly) you are left feeling uncertain, trying to square this recent good sense with past wickedness. You may, of course, either play down the good in order to save your image of a detestable person, or revise your attitude towards the politician. The kind of oversimplification is referred to as "pigeon-holding".

David (1960) outlines how attitudes affect communication. If communicators have positive attitudes towards themselves (see self-concept), this self-confidence is going to help them communicate successfully (pleasantly, persuasively, etc) with others. Their attitude towards their subject matter is no less important: for instance, teachers who show little interest in their subject are likely to bore the class. And finally, their attitude to the listeners is of consequences, since if communicators can show that they care about their listeners, the latter will be readier to accept their messages. Social scientists have shown that for communicators to produce changes of attitude in their audiences, they must be perceived as expert and trustworthy (credible) they must be attractive and able to demonstrate a familiarity with the audiences' general background and

interest. There are many studies on the effect of mass media advertising and propaganda. From these it appears likely that advertising fairly trivial (for example, which magazine to buy), but it is less clear whether the voting habits of a lifetime can change after watching party political broadcast.

Students' attitudes toward mathematics have a great effect on student achievement. Attitudes are stable dispositions, affective responses, or beliefs individuals have that develop largely through experience. Students who enjoy mathematics tend to perform well in their mathematics course work and are more likely to enroll in the more advanced mathematics courses. Conversely, those students who dislike mathematics tend not to do well in these classes, and/or do not attempt the more advanced mathematics classes in secondary school. Negative attitudes about mathematics are learned, not inherited. Students enter school with a considerable amount of enthusiasm and curiosity that produces mathematical questions such as: What is the distance between my home and school? How likely am I to win this game?; and Do I have enough paint to finish this project? Students have positive emotions when they make mathematical conjectures, when they make breakthroughs as they solve problems, and when they see connections between important ideas. Of course, students can also experience frustration when not making progress toward solving a problem. Therefore, it is important that instruction provide appropriately challenging problems so students can learn and establish the norm of perseverance for successful problem solving.

A student with a productive attitude finds sense in mathematics, perceives it as both useful and worthwhile, believes that steady effort in learning mathematics pays off, and views him or herself as an effective learner and doer of mathematics. Research suggests that students of color and females often learn early to doubt their mathematical abilities, and as a consequence are more likely to attribute failure to lack of ability.

Generally Ghanaian students are more likely to attribute success in mathematics problem solving to ability rather than effort. East Asian children, on the other hand, perceive success as a function of effort, not ability. It is important for teachers to model perseverance in the face of challenging problems, and to convey those mistakes and misconceptions are inevitable and provide necessary opportunities for learning. In addition, both students and teachers must believe that all students are endowed with the capabilities to learn mathematics.

Classroom Implications

The practices, culture and norms of classrooms strongly influence student attitudes, particularly during elementary school years, when students' attitudes toward school and academics are forming. Among high poverty students, it was found that an emphasis on conformity, competition, and mathematics as rules produced decreased motivation and achievement compared to a more exploratory curriculum. Students are less likely to think flexibly and critically when their schools emphasize conformity, order, obedience, an acceptance of school and mathematical rules, and a dependence upon the structures provided by these rules. While an organized learning environment is important, promoting students' comfortable exploration of mathematics through challenging open-ended problems should replace classroom norms that emphasize procedures, rules, competition, and speed. However, while fostering students' positive attitudes toward mathematics, teachers need to be careful not to simplify a challenging curriculum or alleviate all of students' frustrations during problem solving.

Successful teachers communicate explicit expectations that students will provide adequate justifications for their answers, persist at problem solving when faced with frustration, and solve problems independently. Students of these teachers show satisfaction and enthusiasm for problem solving and demonstrate an autonomous view of themselves as learners.

Effective mathematics teachers establish good relationships with students by being friendly rather than formal, sharing personal anecdotes that illustrate their own problem solving strengths and weaknesses, and establishing systems that hold students accountable for their performance. Most of these teachers emphasize aspects of student performance other than obtaining correct answers. These teachers also tend to use cooperative groups to promote independence and to reduce feelings of frustration in students. Fostering these desirable classroom norms with low-achieving students can be particularly challenging for teachers, because these students have more difficulty than others at extracting important mathematical ideas from open-ended problems. Nonetheless, teachers have had success at implementing these norms. The teacher practices described above appear to be necessary for successful teaching of ambitious learning goals such as those specified by the NCTM Principles and Standards for School Mathematics.

Try the following activities.

Activity 1.1

Explain teachers' attitudes in teaching mathematics.

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Activity 1.2

Identify and explain the impact of attitudes on communication.

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Summary

- Positive attitudes of communicators towards themselves help them communicate successfully with others.
- Students' attitudes toward mathematics have a great effect on student achievement.
- Attitudes are stable dispositions, affective responses, or beliefs individuals have that develop largely through experience.
- A student with a productive attitude finds sense in mathematics, perceives it as both useful and worthwhile, believes that steady effort in learning mathematics pays off, and views him or herself as an effective learner and doer of mathematics.
- The practices, culture and norms of classrooms strongly influence student attitudes, particularly during elementary school years, when students' attitudes toward school and academics are forming.

SECTION 5: PRINCIPLES OF EFFECTIVE MATHEMATICS TEACHING PRACTICES

You are welcome to section 5. You will learn about some effective mathematics teaching practices. Congratulations! From time to time go back to the previous sections and revise the main points. In this way, you will not forget what you have learned.

By the end of this section, you should be able to:

- Identify and explain the principles of effective mathematics teaching.
- Identify and explain the guiding principles for action and mathematics practices.

Principles of Effective Mathematics Teaching Practices

Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.

Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.

Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving. Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.

Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.

Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.

Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Guiding Principles and Actions for Mathematics Teaching Practices

An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically.

The teaching of mathematics is complex. It requires teachers to have a deep understanding of the mathematical content that they are expected to teach and a clear view of how student learning of that mathematics develops and progresses across grades. It also calls for teachers to be skilled at using instructional practices that are effective in developing mathematics learning for all students. The eight mathematics teaching practices describe the essential teaching skills derived from the research-based learning principles, as well as other knowledge of mathematics teaching that has emerged over the last two decades.

Access and Equity. An excellent mathematics program requires that all students have access to a high-quality mathematics curriculum, effective teaching and learning, high expectations, and the support and resources needed to maximize their learning potential. Equitable access means high expectations, adequate time, consistent opportunities to learn, and strong support that enable students to be mathematically successful. Instead of one-size-fits-all practices and the differential expectations for students who are placed in different academic tracks, equitable access means accommodating differences to meet a common goal of high levels of learning by all students.

Curriculum. An excellent mathematics program includes a curriculum that develops important mathematics along coherent learning progressions and develops connections among areas of mathematical study and between mathematics and the real world. A robust curriculum is more than a collection of activities; instead, it is a coherent sequencing of core mathematical ideas that are well articulated across the grades. Such an effective curriculum incorporates problems in contexts from everyday life and other subjects whenever possible. These tasks engage students and generate interest and curiosity in the topics under investigation.

Tools and Technology. An excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking. Available tools and technology help teachers and students visualize and concretize mathematics abstractions, and when these resources are used appropriately, they support e ective teaching and meaningful learning.

Assessment. An excellent mathematics program ensures that assessment is an integral part of instruction, provides evidence of proficiency with important mathematics content and practices, includes a variety of strategies and data sources, and informs feedback to students, instructional decisions, and program improvement. Effective assessment supports and enhances the learning of important mathematics by furnishing useful formative and summative information to both teachers and students. Productive mathematics assessment is a process that is coherently aligned with learning goals and makes deliberate use of the data gathered as evidence of learning and provides guidance for next instructional steps and programmatic decision making. Students learn to assess and recognize high quality in their own work.

Professionalism. In an excellent mathematics program, educators hold themselves and their colleagues accountable for the mathematical success of every student and for personal and collective professional growth toward effective teaching and learning of mathematics. Effective schools communicate a tangible sense of the professional imperative to grow personally and collectively and to hold one another accountable for this growth. Professionals who are responsible for students' mathematics learning are never satisfied with their accomplishments and are always working to increase the impact that they have on their students' mathematics learning. Moreover, they cultivate and support a culture of professional collaboration and continual improvement that is driven by an abiding sense of interdependence and collective responsibility.

Actions

Although principles provide guidance and structure, actions determine impact. Principles to Actions argues that ensuring mathematical success for all will take teachers who, among other actions:

1. plan and implement effective instruction as described by the mathematics teaching practices
2. develop socially, emotionally, and academically safe environments for mathematics teaching and learning environments in which students feel secure and con dent in engaging with one another and with teachers;
3. evaluate curricular materials and resources to determine the extent to which these materials align with the standards, ensure coherent development of topics within and across grades, promote the mathematical practices, and support effective instruction that implements the mathematics teaching practices.
4. incorporate mathematical tools and technology as an everyday part of the mathematics classroom, recognizing that students should experience "mathematical action technologies" and physical or virtual manipulatives to explore important mathematics.
5. provide students with descriptive, accurate, and timely feedback on assessments, including strengths, weaknesses, and next steps for progress toward the learning targets.
6. work collaboratively with colleagues to plan instruction, solve common challenges, and provide mutual support as they take collective responsibility for student learning.

Principles to actions argues that ensuring mathematical success for all will take principals, coaches, specialists, and other school leaders who, among other actions:

1. make the eight Mathematics Teaching Practices a schoolwide focus that is expected for all teachers to strengthen learning and teaching for all students, and provide professional development, training, and coaching to make the implementation of these practices a priority.
2. maintain a schoolwide culture with high expectations and a growth mindset
3. allocate time for teachers to collaborate in professional learning communities
4. support improvement with multifaceted assessments used to monitor progress and inform changes to instruction.
5. make the mathematical success of every student a nonnegotiable priority.

Principles to Actions argues that ensuring mathematical success for all will take leaders and policymakers in districts,

states or provinces, including commissioners, superintendents and other central administrators, who, among other actions:

1. make ongoing professional development that supports the implementation of the eight mathematics teaching practices as a priority.
2. allocate resources to ensure that all students are provided with an appropriate amount of instructional time to maximize their learning potential
3. eliminate the tracking of low-achieving students and instead structure interventions that provide high-quality instruction and other classroom support, such as math coaches and specialists
4. understand the devastating impact of professional isolation and create collaborative structures to maximize professional growth.
5. Support risk taking and encourage new approaches that advance student learning.

Only when these words become actions and the actions lead to more productive beliefs, new norms of instructional practice, and implementation of the essential supporting elements will we overcome the obstacles that currently prevent school mathematics from ensuring success for all students.

Try the following activities

Activity 1.1

Identify and explain the principles of effective mathematics teaching.

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Activity 1.2

Identify and explain the guiding principles for action and mathematics practices.

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Summary

Some principles of effective mathematics teaching discussed are:

- Establish mathematics goals to focus learning.
- Implement tasks that promote reasoning and problem solving.
- Use and connect mathematical representations.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning mathematics.
- Elicit and use evidence of student thinking.

Some guiding principles and actions for mathematics teaching practices

- The teaching of mathematics is complex.
- Access and Equity.
- Curriculum.
- Tools and Technology.
- Assessment.
- Professionalism.

SECTION 6: MAKING CONNECTIONS BETWEEN TEACHERS' BELIEFS, PRACTICE AND DEVELOPING MATHEMATICAL TASK.

Welcome to the last section of unit 2. In section five, you learnt about effective mathematics teaching. You need the knowledge in section 5 to teach mathematics effectively. Well done!

In this section, we will discuss connections between teachers' belief, practices and the development of mathematical task.

By the end of the section, you should be able to:

- Identify the importance of teachers' beliefs on their teaching practice.
- Identify the various dimensions of belief systems.
- Identify and explain the connections between teachers' belief, practices and the development of mathematical task.

Connections Between Teachers' Beliefs, Practice and Mathematical Task

Mathematics beliefs is relevant with teachers' teaching practices (Watson & DeGeest, 2005). The teachers' abilities in creating meaningful classroom activities can be traced back to the three dimension of mathematics beliefs that include beliefs in the nature of mathematics, beliefs in teaching mathematics and beliefs in learning mathematics (Evans, 2003). Teachers' beliefs are critical in the implementation of their teaching and learning process in classroom. Life experience is a major contributor in shaping teachers' beliefs. Their teaching experience was a practical indicator about how teachers facilitated the changes that worked for their future development (Leder, 2003). Frykholm (1999) commented that previous experiences had become one of the factors involved in the fundamental process of teachers' learning and the beliefs system. Stipek et al. (2001) reported that most researchers conducted the study on the connection of beliefs and practices are qualitative based. The connection between teachers' beliefs and their teaching practices in mathematics classroom was rather complex yet powerful.

In addition, mathematics beliefs played an important role in filtering teachers' decisions during their instructional practice without relying on curriculum guidelines (Wittrock, 1986). How teachers used instructional strategies would give them an idea of what they could do when

they became teachers. This process was continued when they were admitted to the teachers training program. During the process of learning to teach, the beliefs would be embedded in these pre-service teachers and they would also be affected by the social factors in the educational institutions. Stipek et al. (2001) commented that teachers held their beliefs coherently, which in turn shaped their teaching practices. Much research has been done on the relationship between beliefs and teaching practices (Grouws, 2006); however, it is still relevant especially among the in-service teachers in Ghana.

It is widely acknowledged that what teachers believe influences their teaching, yet the focus of much professional learning remains on influencing the specific practices and tools that teachers employ in their classrooms. In this article it is argued that a greater and more explicit focus on teachers' beliefs would be beneficial. To this end an overview of aspects of our understandings of the nature of beliefs is presented followed by findings from a recent study that examined mathematics teachers' beliefs and their impact on classroom practice. Finally, implications for mathematics teachers and those involved in designing and implementing professional learning for both teachers and pre-service teachers are suggested.

Dimensions of Beliefs Systems.

The idea of belief systems recognises that beliefs are not held in isolation from one another but are in fact inter-related in complex ways. Green (1971) provided a description of belief systems that is still very useful. He described several dimensions of beliefs systems, three of which are of relevance here.

The first is the idea of centrality. The centrality of a belief is a function of the strength and number of its connections with other beliefs. Other beliefs may be held because they are consequences of a central belief and any change in a central belief would have important ramifications for the individual's belief system and could be experienced as quite unsettling. Centrally-held beliefs are thus relatively difficult to change.

A second aspect of Green's description of belief systems is the phenomenon of clustering. This means that beliefs with a system can be held in groups that are isolated from other beliefs. A consequence of this is that a person may hold beliefs that contradict one another without being aware of the contradiction. According to Green (1971) such clusters are likely to develop when

beliefs are formed in disparate contexts. An example might be a student's belief that he is a poor mathematics student, formed perhaps on the basis of negative experiences of school mathematics, held at the same time as a belief in himself as mathematically competent formed as a result of experiences of part time work in a retail context. The student may not be consciously aware of one or other or both of these beliefs and may continue to believe both in the absence of any experience that makes them explicit and stimulates reflection on their contradictory elements.

The third aspect of beliefs relates to the basis on which they held. The basis of a belief may be evidence, in which case the belief is said to be evidentially held, or it may be held for other reasons such as the perceived authority of its source, or because it is regarded as a consequence of another belief which may or may not be evidentially held. Evidentially held beliefs are by definition susceptible to change on the basis of evidence to the contrary, while non-evidentially held beliefs are impervious to evidence and hence very resistant to change. Implicit in both the centrality and clustering of beliefs is the importance of context. The relative centrality of beliefs varies according to the context.

The importance of mathematics teachers' beliefs teacher might express a belief in the importance of providing students with ready access to manipulatives as they engage with mathematics. The result might be that manipulatives are nowhere to be seen in that classroom. It is important to recognize that this would in no way mean that there was any lack of sincerity associated with the teacher's statement during the professional learning session. The notion of clustering provides an alternative explanation for apparent contradictions between stated beliefs and practices like that described above. It allows the possibility that a teacher might simultaneously hold contradictory beliefs that have developed in different contexts.

Try the following activities

Activity 1.1

How important is teachers' belief on teaching practice?

Activity 1.2

Identify and explain the aspects and dimensions of belief systems.

Activity 1.3

Explain the connections between teachers' beliefs, practice and the development of mathematical task.

Summary

You have learnt in this section that:

- Mathematics beliefs is relevant with teachers' teaching practices.
- The importance of mathematics teachers' beliefs teacher might express a belief in the importance of providing students with ready access to manipulatives as they engage with mathematics.
- The teachers' abilities in creating meaningful classroom activities can be traced back to the three dimension of mathematics beliefs that include beliefs in the nature of mathematics, beliefs in teaching mathematics and beliefs in learning mathematics.

- Teachers' beliefs are critical in the implementation of their teaching and learning process in classroom
- The aspects of belief systems are; the idea of centrality, the phenomenon of clustering and the basis on which they held.

Unit 2

Section 1

INTRODUCTION

Dear student teacher, you are warmly welcome to the first section of unit two of major theories of learning in upper primary mathematics in inclusive classrooms. This section will focus on developing your understanding of socio-cultural perspectives of learning mathematics in the upper primary classrooms. Take your time to go through this section and make effort to work on all the various activities, I assure you, it is going to be interesting and you will enjoy the section.

OBJECTIVES

By the end of this section, you will be able to:

- Demonstrate knowledge and understanding of the Socio-cultural Perspectives of learning mathematics
- Apply it in teaching mathematics in upper primary classroom

Socio-cultural Perspectives of learning

Dear learners, modern social learning theories stem from the work of Russian psychologist Vygotsky. His ideas are most recognized for identifying the role social interactions and culture play in the development of higher-order thinking skills and it is especially valuable for the insights it provides about the dynamic interdependence between individual and social processes in the construction of knowledge. The Socio-cultural Learning Theory is based upon the idea that a learner's environment plays a pivotal role in his or her learning development. Socio-cultural theory and related ideas provide a valuable contribution to a focus on the learner within their social, cultural, and historical context and also offer sound pedagogical solutions and strategies that facilitate development of critical thinking and lifelong learning. Socio-cultural perspective views learning taking place through interaction, negotiation and collaboration in solving authentic problems while emphasizing learning from experience and discourse, which is more than cooperative learning.

In socio-cultural approach in learning, cultural factors such as language, art, social norms and social structures play a significant role in the development of our cognitive abilities.

Dear learner, having been introduced to socio-cultural perspective of learning can you think about any advantages and disadvantages related to this perspective. Are your thoughts similar to the ones mention in this section?

SOME ADVANTAGES OF SOCIO-CULTURAL PERSPECTIVES OF LEARNING

1. **You can leverage multiple experts' knowledge:** One of the favorite aspects of socio-cultural theory is that learners learn from more than just the teacher. If we believe that learning through social interactions is ideal, then we would value bringing experts and practitioners into the classroom. You might bring in a firefighter to teach about fire safety or a soldier to speak on the importance of Remembrance Day and the likes.
2. **It can be inclusive of multiple cultural perspectives:** Socio-cultural theorists understand people of different cultures learn in different ways. A teacher would want to learn what your learners' cultural perspectives are and include them in your teaching. If a learner comes from a storytelling culture, you might want to bring their stories into learning scenarios. This not only helps people of minority cultures in your classroom; but it helps all children learn to respect cultural difference.
3. **Differentiation is embedded into the theory:** Differentiation is a learner-centered pedagogical concept that highlights the importance of changing up teaching for each student. Some students need easier tasks, some students need harder tasks. By contrast, socio-cultural theory is very strong on differentiation.

SOME DISADVANTAGES OF SOCIO-CULTURAL PERSPECTIVES OF LEARNING

1. **It doesn't take into account children's emotions:** The theory of humanism does a much better job of taking into account children's emotions than socio-cultural theory. In fact, the socio-culturalist is almost completely silent on the idea that children's emotions impact their learning which is a big oversight.
2. **Socio-cultural classrooms can be extremely noisy:** This is one of the biggest quarrels with social learning environments. Your classroom becomes so noisy and hard to manage

that you need to be a very effective educator. You need to teach your students self-regulation and ensure students both stay on task and keep their voices down so they don't distract others.

3. **Shy, timid or introverted students may struggle:** Students who are shy or prefer learning in isolation have a lot of trouble in social learning environments. An introvert person gets very exhausted in these environments and feel could have learnt much more effectively in silence and solitude.
4. **Students with sensory challenges find it hard to cope:** Many students may struggle with the high-energy, noisy and active environment of a socio-cultural classroom. Students particularly concerned about are students with autism who can really be set off by these challenging environments.

IMPLICATION FOR TEACHING

Dear learner, it is important to note that in applying Socio-cultural perspective of learning in the upper primary classroom, knowledge is co-constructed. As a result of this, the use of group work in the classroom as well as cooperative learning strategies is needed. Engaging learners in this way will enable them share ideas together and come up with an agreed 'truth' or set of facts that they can be proud of.

ACTIVITY 1.1

Choose a named topic in mathematics from the upper primary syllabus and describe how you would teach such topics employing the socio-cultural perspective of learning.

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SUMMARY

- The socio-cultural approach looks at how a person's experiences, influences and culture help shape why they act the way they do.
- It acknowledges both differences in individuals within a culture and differences in individuals across cultures
- It emphasizes the broader social, cultural, and historical context of any human activity
- Socio-cultural theory is sensitive to individual and cross-cultural diversity

Unit 2

Section 2

INTRODUCTION

Dear student teacher, you are welcome to section two of unit two of this course book. The section is titled "Activity theory perspectives of learning". In the previous section we learnt about Socio-cultural Perspectives of learning theories. We hope you have learnt some basic ideas about this perspective of learning. This section also focuses on another dimension of learning theory which would provide you with appropriate knowledge and competencies for handling children in upper primary classrooms.

OBJECTIVES

By the end of this section, you will be able to:

- Demonstrate knowledge and understanding of the Activity theory perspectives of learning mathematics in upper primary
- Implication for teaching and Learning

Dear learner, Activity theory is a development of aspects of Vygotsky's and Leont'ev work which later was expanded upon by Engeström. Modern developments of activity theory are known as cultural-historical activity theory (CHAT) and these are characterised as a framework rather than as a theory with a set of neat propositions. Activity theory has been influential, particularly in relation to language learning and literacy but its implications for mathematics learning are only now being articulated. The framework centers on culture, diversity, multiple voices, communities and identity. It focuses on the joint activity in the learning situation rather than on individual learners. In such activities, learners develop their skills, personalities and consciousness. Through activities, they are also able to transform their social conditions, resolve contradictions, generate new cultural artifacts, and create new forms of life. In simple terms, Activity Theory is all about 'who is doing what, why and how'. It provides a lens with which to tease out and to better understand human activity.

An activity theory approach offers a systematic way of describing and understanding pupils learning mathematics. From an activity theory perspective, mathematics learning takes place in and out of the classroom, regardless. The enterprise of mathematics teaching and learning is seen to take place in a social setting and its object is mediated by various means.

There are six components in the Activity theory framework. These are: subject, objects, tools, rules, community and division of labour. “Subjects” are participants of a social system or program. “Objects” represent goals that subjects pursue. “Tools” include tangible or intangible technologies, such as work processes or authority that subjects use in order to achieve the goals. “Rules” includes guidance regarding what is allowed, who, when, where, and how. “Community” is a group of key actors in the social system. “The division of labor” is the way of distributing tasks among community members. The interactions between the components can create contractions.

Teachers should be aware that everything in the classroom has a cultural and social meaning. The way children interact with each other and with the teacher will be influenced by objects such as the whiteboard, furniture, technology and configuration of the classroom. This also includes its ambient characteristics such as lighting and noise levels. Learning occurs within these contexts and usually through specific activities. Teachers should ensure that those activities are relevant and iterative, providing learners with incremental challenges that they can engage with at a social level, so that the entire community of learners extends its collective knowledge through the construction of meaning. Teachers should also be aware that tools can limit as well as enable social interaction, so must be applied wisely and appropriately to promote the most effective learning.

Activity 1.2

Describe how you will develop a particular mathematical concept at the upper primary using the activity theory approach.

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Summary

- Activity theory focuses on the joint activity in the learning situation rather than on individual learners.
- The six components in the Activity theory framework are: subject, objects, tools, rules, community and division of labour.
- The interactions between the components can create contractions.
- Learning occurs within these contexts and usually through specific activities.

Unit 2

Section 3

INTRODUCTION

Dear learner, you are welcome to section 3 of unit two. This section gives you the opportunity to learn about situated cognition perspective. In the previous sections we learnt about socio-cultural and activity perspectives of learning theories. We hope you are progressing steadily. Take your time to go through this lesson, and make effort to work on all the various activities.

OBJECTIVES

By the end of this section, you will be able to:

- Demonstrate knowledge and understanding of the situated cognition perspectives of learning mathematics in upper primary
- Describe its implication for teaching and learning in the classroom

Dear learner, situated learning is an instructional approach developed by Jean Lave and Etienne Wenger in the early 1990s and follows the work of Dewey, Vygotsky, and others who were of the view that students are more inclined to learn by actively participating in the learning experience. Situated learning essentially is a matter of creating meaning from the real activities of daily living where learning occurs relative to the teaching environment. From an educational point of view, the core idea behind the different uses of this term is to create a situational context for learning that strongly resembles possible application situations in order to assure that the learning experiences foster ‘real-life’ problem solving. Against this background, traditional school learning is criticized because it creates contexts for learning that strongly differ from ‘real-life’ application contexts.

Traditional learning occurs from abstract, out of context experiences such as lectures and books. Situated learning on the other hand, suggests that learning takes place through the relationships between people and connecting prior knowledge with authentic, informal, and often unintended contextual learning. In this situation, a student's role changes from being a beginner to an expert as they become more active and immersed in the social community where learning often is unintentional rather than deliberate. The following are examples of situated learning activities: Field trips, Cooperative education and internship experiences, Music and sports practice.

IMPLICATION FOR TEACHING

Dear learners having understood what a situated cognition perspective of learning is, we need to consider how we can apply this in our classroom. The under listed points are some of the ways in which the situated cognition perspective can be applied to teaching and learning at the upper primary.

- Provide differentiated learning strategies based on the cognitive skill levels of the learners in the classroom.
- Ask learners to reflect on their experience
- Help learners find new solutions to problems
- Encourage discussions about what is being taught
- Help learners explore and understand how ideas are connected
- Ask learners to justify and explain their thinking
- Using visualizations to improve learners' understanding and recall

ACTIVITY 1.3

Describe two teaching strategies that you will employ to teach pupils at the upper primary under situated cognitive perspective.

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SUMMARY

- Learning is grounded in the actions of everyday situations.
- Knowledge is acquired situationally and transferred only to similar situations.
- Learning is the result of a social process encompassing ways of thinking, perceiving, problem solving, and interacting in addition to declarative and procedural knowledge.
- Learning is not separated from the world of action but exists in robust, complex, social environments made up of actors, actions and situations.
- Acquire additional skills, less support will be needed.

Unit 2

Section 4

INTRODUCTION

Dear student teacher, you are welcome to section four of unit two of this course book. In the previous section we learnt about situation perspectives of learning theories. We hope you have learnt some basic ideas about this perspective of learning. This section will focus on another dimension of learning theory which would provide you with appropriate knowledge and competencies for handling children in upper primary classrooms.

OBJECTIVES

By the end of this section, you will be able to:

- Demonstrate knowledge and understanding of cognitive perspective of learning.
- Implication to the classroom teacher

Dear learner to understand the cognitive learning theory, it's important to learn the term "meta-cognition." Meta-cognition is the awareness of your brain's thoughts and thought processes. This concept of knowing how you think is the basis for cognitive learning theory. Cognitive learning perspective looks at the way people think. Mental processes are an essential part in understanding how we learn. The cognitive theory recognizes that learners can be influenced by both internal and external factors. Plato and Descartes are two of the first philosophers that focused on cognition and how we as human beings think. Many other researchers looked deeper into the idea of how we think, spurring more research. Jean Piaget is a highly important figure in the field of cognitive psychology, and his work focuses on environments and internal structures and how they impact learning. The cognitive theory has developed over time, breaking off into sub-theories that focus on unique elements of learning and understanding. At the most basic level, the cognitive theory suggests that internal thoughts and external forces are both an important part of the cognitive process. As students understand how their thinking impacts their learning and behaviour, they are able to have more control over it. Cognitive learning strategies

emphasize comprehension. You need to understand the reason for learning the subject in the first place and the role your knowledge plays in your work.

It discourages rote learning where you cram materials for memorization. In cognitive learning, the goal is to understand the subject at a deeper level. This creates an immersive effect that helps recall and improves your ability to relate new knowledge to past information. Cognitive learning strategies encourage you to reflect on the material and how to apply it to current and future situations. With this, you develop improved problem-solving skills, critical thinking skills and visionary leadership traits that can help you see things others cannot see in a clear form. Benefits of cognitive learning are enhanced comprehension, improve problem-solving skills, boost confidence, Encourages continuous learning.

Cognitive learning can be broken down into social cognitive theory and cognitive behavioral theory. Social cognitive theory is the idea that learning happens in a social concept and is impacted by the person, environment, and behaviour. Behavioral cognitive theory is the idea that how we think, how we feel, and how we behave are all directly connected together. Simply put, this means that our thoughts determine our feelings and behaviour.

Implication to teaching and learning

- The teacher is expected to provide a rich classroom environment that fosters the learners spontaneous exploration
- Instructional materials should include demonstrations, illustrative examples, and constructive feedback so that students can have mental models to exemplify
- Create learning environments that allow and encourage students to make connections with previously learned material (recall of prerequisite skills ;use of relevant examples, analogies)
- Provide for systematic problem-space exploration instead of conventional repeated practice.

Activity 1.4

Outline some similarities and differences among the socio-cultural, activity and situated cognition perspective theories.

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Summary

- Cognitive learning perspective looks at the way people think.
- Learners can be influenced by both internal and external factors.
- It discourages rote learning where you cram materials for memorization
- Cognitive learning can be broken down into social and behavioral cognitive

Unit 2

Section 5

INTRODUCTION

Dear student teacher, you are welcome to section five of unit two of this course book. The section is titled “constructivist perspectives of learning”. In the previous section we learnt about cognitive Perspectives of learning theories. This section will look at a learning theory which would provide you with some competencies for handling children in upper primary classrooms.

OBJECTIVES

By the end of this section, you will be able to:

- Demonstrate knowledge and understanding of the constructivist perspectives of learning mathematics in upper primary
- Implication to teaching and learning

Dear learner, constructivism is an important learning theory that educators use to help their students learn. Constructivism is based on the idea that people actively construct or make their own knowledge and that reality is determined by your experiences as a learner. Basically, learners use their previous knowledge as a foundation and build on it with new things that they learn. Constructivist learning theory underpins a variety of student-centered teaching methods and techniques which contrast with traditional education, whereby knowledge is simply passively transmitted by teachers to students. Constructivism is divided into three broad categories: Cognitive constructivism, Social constructivism and Radical constructivism. In cognitive constructivism knowledge is something that is actively constructed by learners based on their existing cognitive structures. Therefore, learning is relative to their stage of cognitive development. Social constructivism on the other hand sees learning as collaborative process, and knowledge develops from individuals' interactions with their culture and society. The notion of radical constructivism states that all knowledge is constructed rather than perceived through senses. Learners construct new knowledge on the foundations of their existing knowledge. However, radical constructivism states that the knowledge individuals create tells us nothing

about reality and only helps us to function in your environment. Thus, knowledge is invented not discovered.

Implications for Teaching and Learning

Dear learners, there are several main components to include if you plan on adhering to constructivist principles in your classroom and these include:

Elicit prior knowledge: New knowledge is created in relation to learner's pre-existing knowledge. Lessons, therefore, require eliciting relevant prior knowledge. Activities include; pre-tests, informal interviews and small group warm-up activities that require recall of prior knowledge.

Create cognitive dissonance: Assign problems and activities that will challenge students. Knowledge is built as learners encounter novel problems and revise existing schemas as they work through the challenging problem.

Apply knowledge with feedback: Encourage students to evaluate new information and modify existing knowledge. Activities should allow for students to compare pre-existing schema to the novel situation. Activities might include presentations, small group or class discussions and quizzes.

Reflect on learning: Provide students with an opportunity to show you what they have learned. Activities might include: presentations, reflexive papers or creating a step-by-step tutorial for another student.

Activity

5.1 Identify and describe two ways of using the constructivist approach in your classroom teaching.

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5.2 Compare and contrast the traditional classroom with that of constructivist classroom

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Summary

- Students learn best when engaged in learning experiences rather passively receiving information (Knowledge is constructed).

- Learning is inherently a social process because it is embedded within a social context as students and teachers work together to build knowledge.
- Because knowledge cannot be directly imparted to students, the goal of teaching is to provide experiences that facilitate the construction of knowledge.
- Knowledge is seen as dynamic, ever changing with our experiences.

Unit 2

Section 6

INTRODUCTION

Dear student teacher, you are welcome to section six of unit two of this course book. The section is titled “Behaviourism theory perspectives of learning”. In the previous section we learnt about constructivist Perspectives of learning theories. We hope you now understand what constructivist perspective of learning means. This section also focuses on behaviourism.

OBJECTIVES

By the end of this section, you will be able to:

- Demonstrate knowledge and understanding of the Behaviourism theory perspectives of learning mathematics in upper primary
- Implication to teaching and learning

Dear learners, behaviourism is a learning theory that studies observable and measurable behavioural changes which result from stimulus-response associations made by the learner. This theory stems from the work of Pavlov who studied animal behaviour and was able to condition a dog to associate the ringing of a bell with food. A group of dogs would hear a bell ring and then they would be given food. After enough time, when the bell would ring the dogs would salivate, expecting the food before they even saw it. This is exactly what behaviourism argues that the things we experience and our environment are the drivers of how we act. This Pavlovian conditioning is known as classical conditioning.

The classical conditioning process works by developing an association between an environmental stimulus and a naturally occurring stimulus. During the first part of the classical conditioning process, known as acquisition, a response is established and strengthened. Factors such as the prominence of the stimuli and the timing of presentation can play an important role in how quickly an association is formed. When an association disappears, this is known as extinction, causing the behaviour to weaken gradually or vanish. Factors such as the strength of

the original response can play a role in how quickly extinction occurs. The longer a response has been conditioned, for example, the longer it may take for it to become extinct.

Pavlov's premise was later developed by Thorndike, Watson and Skinner. Skinner introduced the theory of operant conditioning. Operant conditioning sometimes referred to as instrumental conditioning is a method of learning that occurs through reinforcements and punishments. Through operant conditioning, an association is made between behaviour and a consequence for that behaviour. When a desirable result follows an action, the behaviour becomes more likely to occur again in the future. Responses followed by adverse outcomes on the other hand, become less likely to happen again in the future.

Strict behaviourists believed that any person can potentially be trained to perform any task, regardless of genetic background, personality traits and internal thoughts within the limits of their physical capabilities. It only requires the right conditioning. Conditioning occurs through interaction with the environment. Behaviourists accept as true that our responses to environmental stimuli shape our actions.

Implication to Teaching and Learning

Dear learner, having been exposed to behaviourism theory perspectives of learning; we can implement behavioural learning strategy techniques in our classroom in many ways. These include the following:

- Teachers may practice skills using drill patterns to help students see the repetition and reinforcement that behavioural learning theory uses.
- Teachers can use a question as a stimulus and answer as a response, gradually getting harder with questions to help students.
- Teachers can be directly involved in helping students go through problems to give them the reinforcement and behaviour demonstration you want them to follow.
- Reviews are important to behavioural learning theory. Going back over material and giving positive reinforcement will help students retain information much better.

- Behaviourist classrooms utilize positive reinforcement regularly. This can be in the form of verbal reinforcement and praise, reward systems, added privileges, and more.

Activity 6.1

Compare and contrast Constructivism, Behaviourism, and Cognitivism as learning theories in class.

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Summary

- It studies observable and measurable behavioural changes which result from stimulus-response.
- Behaviourists believe that our responses to environmental stimuli shape our actions.
- Strict behaviourists believed that any person can potentially be trained to perform any task, regardless of genetic background, personality traits, and internal thoughts.
- There are two major types of conditioning, classical conditioning and operant conditioning.
- Learning can occur through reinforcement and punishment such as praise and reward.

Unit 3

Section 1

INTRODUCTION

Dear student teacher, you are warmly welcome to the first section of unit three of children's number readiness experiences. This lesson focuses on developing knowledge and understanding of what we know about how children in Upper primary think about mathematics and how their understanding of mathematics develops.

OBJECTIVES

By the end of this section, you will be able to:

- Give an exposition on theories that explain how children develop number readiness such size, shape and patterns
- Apply it in teaching mathematics in upper primary classroom

Pre Number Concept

Dear learner, infants cannot be given solids food to eat directly without introducing semi-solid foods to them. In the same manner, we cannot expect a child to do basic mathematics without understanding the pre-number concept. These pre number concepts in mathematics are very important for children to comprehend what mathematics is all about. They cannot do addition and subtraction in their early years of school if they do not even know the difference between small and big numbers. In order to let them do mathematics effectively, it is important to introduce them to the pre number concept.

Pre-number concept activities encompass all activities that pupils are taken through using concrete materials before they are introduced to formal normal work. They include sorting, classification, comparing, matching and ordering.

Sorting activities often begin in free play and in activities in the home. Children learn to classify on the foundation of qualities that involve sight, sound, touch, taste and smell. Being able to sort entails classifying which is a fundamental to mathematics. Some sorting activities that children can do include the following; picking pebbles out of raw beans or rice. Sorting bottle tops into their right brands or arranging different writing materials according to their colour, texture, size, weight or lengths.

Activities involving matching are fundamental steps in making comparisons and learning to count. This activity involves linking or associating one set of object to another set of object on one-to-one correspondence. The only way to compare sets is to match their members in a one-to-one correspondence when one is yet to be introduced to actual counting. Through matching activity, children learn terminologies such as; "more than", "less than", "as many as", "equivalent set" which are necessary pre-number concepts in learning to count. Other pre-number activities such as ordering and comparing are dependent on children ability to effectively carry out matching activities.

Dear learner, having studied what is meant by pre-number concept and some related activities, can you now think about the importance of this concept to the introduction of number to children. Is your thought similar to those mentioned below?

1. To explore the role of mathematics in day to day life without actually doing difficult mathematics
2. Developing a proper sense of numbers
3. To discriminate between objects that are either the same or different
4. To be able to categorize, group, or match the numbers or objects according to the given criteria
5. Classifying things according to their weight or height
6. To promote the development of the child's spatial awareness
7. To lay the foundation for understanding the essential concepts of mathematics

Activity 1.1

Describe two practical activities that can be used in primary level in the following pre-number activities:

Matching:……
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Odering……
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Comparing……
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Summary

- Pre-number activities are very fundamental to further number work
- Some pre-number activities include sorting, matching, comparing and ordering
- Through pre-number activity, children learn terminologies such as; “more than”, “less than”, “as many as”, “equivalent set

Unit 3

Section 2

INTRODUCTION

Dear student teacher, you are cordially welcome to the second section of unit three of children's ability to count verbally (first forward then backward). This lesson focuses on developing knowledge and understanding of how children can count and recognise numerals.

OBJECTIVES

By the end of this section, you will be able to identify the various procedures in helping children:

- Count verbally (first forward, then backward)
- Recognise numerals

Ability to Count Verbally

Dear student learner, one contribution of Piaget theory concerns the developmental stages of children's cognition. His work on children's quantitative development has provided mathematics educators with crucial insights into how children learn mathematical concepts and ideas. Evidence suggests that children at the sensori-motor stage have some understanding of the concepts of numbers and counting. Educators of children in this stage of development should lay a solid mathematical foundation by providing activities that incorporate counting and thus enhance children's conceptual development of number.

Young children enter school with many ideas about number. These ideas should be built upon as we work with them to develop new relationships. It takes time and a variety of experiences for children to develop a full understanding of number that will grow into more advanced number-related concepts. These foundational ideas can all be extended to larger numbers, operations, basic facts and computation.

Meaningful counting activities begin when children are 3 and 4 years of age, but by the end of kindergarten children should be able to count to 100. The counting process cannot be forced, so for children to have an understanding of counting, they must construct this idea. Only the

counting sequence of number words is a rote procedure. The meaning attached to counting is the key conceptual idea on which all other number concepts are developed.

Dear learner, counting is a complex task with typical developmental progressions. As a starting point, verbal counting has at least two separate skills. First, a child must be able to produce the standard list of counting words in order (Ordinal Sense of Number): "One, two, three, four". Second, a child must be able to connect this sequence in a one-to-one correspondence with the objects in the set being counted (Cardinal Sense of Number). As part of these skills, children should recognize that each counting number identifies a quantity that is one more than the previous number and that the new quantity is embedded in the previous quantity. This knowledge will be helpful later in breaking numbers apart. Experience and guidance are major factors in the development of these counting skills. Many children come to kindergarten able to count sets of 10 or beyond. At the same time, children with weak background knowledge may require additional practice.

Children learn early mathematics concepts by abstracting from concrete experiences. The child's ability to count will depends on their ability in abstracting the common property of the sets formed. For instance children are able to form the concept "one" if they are exposed to different set containing one element. This process of helping children build these number concepts are carried through gradually and sequentially with the other numbers. In so doing, children should be able to count first forward and backward using it number words. In consolidating children ability in counting, there the need to use a variety of nursery rhymes, games and songs to help children associate number sequence with situations that are already familiar to them.

Recognise numerals

Provide students with a variety of opportunities to recognize written numerals from one onwards. This can be accomplished with numeral cards, a deck of cards with both the numeral and a picture of the count of that many objects. As students recognize those numerals with ease, add more cards to the range of numbers. Focus on activities that connect the concept of a specific

quantity of objects and how they are represented by a number. Before pupils can recognise the numerals properly, there should be a gradual progression from word description of the numerals to the numeral itself.

Nevertheless, as pupils begin to recognize numerals, provide them with practice writing the numerals, using various modes including writing the numerals in the air as you model, writing numerals on large chart paper with a paint brush, writing in sand or shaving cream or tracing the numerals on paper. Student readiness will vary with the development of eye-hand coordination and small motor skills.

Activity 2.1

Describe any two theories that are needed to be at play to enable children acquire number readiness

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Summary

- Count depends on the child's ability in abstracting the common property of the sets formed
- Two aspect of number is the ordinal and cardinal sense of number
- Children first count using number words before learning to count using the numerals

- Children practice writing the numerals, using various modes including writing in the air, writing on large chart paper with a paint brush, writing in sand or shaving cream or tracing the numerals.

Unit 3

Section 3

INTRODUCTION

Dear student teacher, you are warmly welcome to the second section of unit three which is on concept of number quantity. This lesson focuses on developing your knowledge and understanding of various aspect of number quantity.

OBJECTIVES

By the end of this section, you will be able to:

- Identifying more and less of a quantity
- Understanding one-to-one correspondence

Identifying more and less than quantities

Dear learner, the concepts of "more," "less," and "same" are basic relationships contributing to the overall concept of number. Almost all pupils at the upper primary level can choose the set that is more if presented with two sets that are quite obviously different in number. Classroom activities should help children build on and refine this basic notion that links to their ability to count. Though the concept of less is logically related to the concept of more, the word less proves to be more difficult for children than more. A possible explanation is that children have many opportunities to use the word more but have limited exposure to the word less. To help children with the concept of less, frequently pair it with more and make a conscious effort to ask "Which is less?" questions as well as "Which is more?" questions. For example, suppose that your class correctly selected the set that has more from the two sets given. Immediately follow with "Which is less?" In this way, the concept can be connected with the better known idea and the term less can become familiar. For all three concepts (more/greater than, less/less than, and same/equal to), children should construct sets using counters as well as make comparisons or choices between two given sets. Activities in this regard should be conducted in a spirit of inquiry accompanied with requests for explanations. For example can you show me how you know these cards have fewer dots than the other? Observe children as they do these tasks. This is also a good opportunity for diagnostic interviews. However, it is worth noting that, some

children make comparisons of more or less without assigning numerical values. Children whose number ideas are tied to counting and nothing more will select cards at random and count each dot looking for the same amount. Others will estimate and begin by selecting a card that appears to be the same number of dots. This demonstrates a significantly higher level of understanding. A significant milestone occurs when children recognize small patterned sets without counting.

One –to-One Correspondence

Dear learners, it is important to note that, children come to school with varied experiences related to counting. Even if young children can recite the number sequence it cannot be assumed that they can apply this knowledge to counting small sets of objects. Knowing the one-to-one correspondence principle is essential for organised, meaningful counting. This leads to an eventual ability to perform higher-level calculations

One-to-one correspondence is often difficult for young children to comprehend. In mathematics recognizing the number forty and being able to count out forty items are two separate skills. Linking objects with numbers enables a child to count with understanding. However children without a well grounded knowledge in one-to-one correspondence make common errors when counting a set of items such as, skipping an item, assigning more than one number word to a single item or pointing to two or more items while saying one number word.

Activity 3.1

Design a practical activity that you will use to teach children to identify quantities that are more than, less than or equal to the other.

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Summary

- Classroom activities should help children build on and refine this basic notion that links to their ability to count.
- Activities involving identifying quantities that ore more or less should be conducted in a spirit of inquiry accompanied with requests for explanations.
- Knowledge in one-to-one correspondence principle is essential for organised, meaningful counting.
- Children without a well grounded knowledge in one-to-one correspondence make common errors when counting a set of items.

Unit 3

Section 4

INTRODUCTION

Dear student teacher, you are warmly welcome to the forth section of unit three which is on characteristics of children's developmental stages. This lesson focuses on identifying the various characteristics of children's developmental stages and its implication to the teacher.

OBJECTIVES

By the end of this section, you will be able to:

- Identify characteristics of children's developmental stages
- Implications to the teacher.

Dear learner, in stages of life enormous changes takes place. Human development is a lifelong process of physical, behavioral, cognitive, language acquisition, emotional growth and change. Throughout the process, each person develops attitudes and values that guide choices, relationships and understanding.

Each stage of development encompasses specific indicators. The following developmental guidelines apply to most children in the upper primary group. However, each child is an individual and may reach these stages of development earlier or later than other children of the same age. Let us now consider some characteristics regarding the various developmental milestones.

Cognitive Development

Intellectual development refers to the increased ability of people to understand and reason. In the upper primary child, intellectual development is not as visible as physical development, but it is just as severe. Typically, upper primary children are eager to learn about topics they find interesting and useful, that is ones that are personally relevant to them. They also favor active over passive learning experiences and prefer interactions with peers during educational activities.

The upper primary children develop the capacity for abstract thought processes though the transition to higher levels of cognitive function varies considerably across individuals. Upper primary children typically progress from concrete logical operations to acquiring the ability to develop and test hypotheses, analyze and synthesize data, grapple with complex concepts and think reflectively. Similarly, they are increasingly able to think through ideological topics, argue a position and challenge adult directives.

To make sense of the world around them, upper primary children as learners, build upon their individual experiences and prior knowledge. Experience plays a central role in developing the brain and induces learners to construct meaning based upon what they already believe and understand. During early upper primary, children are more interested in real life experiences and authentic learning opportunities. They are less interested in traditional academic subjects. Moreover, they have an enhanced ability to think about the future, anticipate their own needs, and develop personal goals.

Social and Emotional

Social-emotional development concerns a person's capacity for mature interactions with individuals and groups. In early upper primary, social-emotional maturity often lags behind physical and intellectual development. Upper primary children have a strong need to belong to a group with peer approval becoming more important and adult approval decreasing in importance. As upper primary children mature socially and emotionally, they may experience conflicting loyalties to peer group and family. They experience a variety of peer associations, positive and negative. Negative peer associations, particularly bullying, also become more prevalent in the middle school years.

Upper primary children tend to emulate their esteemed peers and non-parent adults. While they prefer to make their own choices, the family remains a critical factor in final decision-making. Children may be rebellious toward their parents and adults, yet tend to depend on them. They may overreact to social situations, ridicule others, and feel embarrassment. When experiencing adult rejection, they may seek the seemingly secure social environment of their peer group.

Physical Development

Most children in the upper primary exhibit most of these characteristics as describe subsequently. They experience a growth spurt with significant weight gain, muscle growth, and genital maturation (Growth spurt begins earlier for girls; lasts longer for boys).

Both females and males enter puberty, a time when hormones produced in the pituitary gland trigger production of testosterone in males, estrogen or progesterone in females. This usually begins earlier in girls than in boys. During puberty, Skin becomes oilier and may develop pimples. Sweating increases and youth may have body odor. Hair grows under arms, pubis, face and chest in males. Body proportions changes in areas such as hips widen in females, shoulders broaden in males. Joints may ache due to rapid growth. In males, genitals mature, scrotum darkens, voice deepens, sperm is produced and erections, ejaculation and wet dreams are more frequent. In females, genitals mature, breasts develop, vaginal lubrication increases, and ovulation and menstrual cycle begin.

Language and Speech

Good communication skills are integral to all aspects of a student's development not only in school but also in the workplace and the wider community. Upper primary children will have learnt skills such as extracting key information from what is said, ask or give clarification when there is a misunderstanding. Similarly the upper primary children will be able to able to infer meanings, reasons and predictions from what is being said. They can also use a range of words that are related to time and measurement and a wide range of verbs to demonstrate cause and effect or express their thoughts. Some of them can join in discussions with peers or adults about topics, programmes, an activity or visit using terminology related to the topic at hand.

Upper primary children will have a less literal understanding of language, idioms and basic sarcasm. In the later part of this stage, the upper primary child will attempt to use larger, complex or sophisticated words but would not always use them correctly. Again the upper primary child will be able to use complex conjunctions and recognise when a sentence is not

grammatically correct. They can as well tell extravagant and amusing stories and events that contain sub plots leading up to the main story line.

Implication to Teachers

Dear learner, as teachers there is the need to consider the importance of these characteristics for effective teaching and learning. Teachers need to provide an assortment of educational approaches and materials that are appropriate for their students' wide-ranging cognitive abilities to address intellectual developmental differences. For example, the concrete thinkers require more structured learning experiences, while the abstract thinkers need more challenging activities. Teachers need to plan curricula around real life concepts and supply authentic educative that is meaningful for the upper primary child. To foster intellectual development, these youth need to interact directly with their world through discourse and hands-on experience with peers and adults

Because of upper primary children need for affiliation and belonging, they must have opportunities to form affirming and healthy relationships with peers. Teachers must recognize the importance of peer relationships and friendship and provide occasions for positive peer interactions. Teachers can design cooperative learning activities and collaborative experiences for young adolescents to interact productively with peers. Young adolescents can also be afforded opportunities to examine their own choices and the consequences of these choices. Further, teachers can develop scenarios that prompt young adolescents to examine concepts of fairness, justice and equity.

Activity

Identify two challenges that may be associated with each stage of development in the teaching of mathematics and proffer solutions to them.

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Summary

- Human development is a lifelong process of physical, behavioral, cognitive, language acquisition, emotional growth and change.
- Intellectual development involves people's ability to understand and reason.
- They favor active over passive learning experiences and prefer interactions with peers during educational activities.
- Upper primary children are more interested in real life experiences and authentic learning opportunities.
- Social-emotional development concerns a person's capacity for mature interactions with individuals and groups
- Upper primary children have a strong need to belong to a group with peer approval becoming more important than adult disapproval
- They experience a growth spurt with significant weight gain, muscle growth, and genital maturation
- Upper primary children will have a less literal understanding of language, idioms and basic sarcasm

Unit 3

Section 5

INTRODUCTION

Dear student teacher, you are warmly welcome to the fifth section of unit three which is on child developmental stages. This lesson focuses on developing your knowledge on the contribution made by some psychologist in the field of mathematics. Additionally the knowledge in this section would enable you to effectively apply them in your teaching.

OBJECTIVES

By the end of this section, you will be able to identify the contributions of:

- Jerome Bruner
- Jean Piaget

Jerome Bruner

Dear learner, Jerome Bruner was an American educational cognitive psychologist. He was concerned with how knowledge was represented and organized through different modes of thinking or representation. In his research on the cognitive development of children, Jerome Bruner proposed three modes of representation; Enactive, Iconic and Symbolic representations. Bruner's constructivist theory suggested that it was effective when faced with new material to follow a progression from enactive to iconic to symbolic representation which held true even for adult learners. Bruner's work also submits that a learner even of a very young age was capable of learning any material so long as the instruction was organized appropriately. This was in sharp contrast to the beliefs of Piaget and other stage theorists. The modes of representation were the way in which information or knowledge are stored and encoded in memory. These modes of representation were integrated and only loosely sequential as they "translate" into each other.

The first mode which is the enactive mode is used within the first year of life. Thinking is based entirely on physical actions and infants learn by doing rather than by internal representation or

thinking. It involves encoding physical action based information and storing it in our memory. For example, in the form of movement as a muscle memory, a baby might remember the action of shaking a rattle. This mode continues later in many physical activities, such as learning to ride a bike and the likes.

In the iconic mode, information is stored as sensory images or icons usually visual ones, like pictures in the mind. For some, this is conscious and to others say they do not experience it. This may explain why when we are learning a new subject; it is often helpful to have diagrams or illustrations to accompany the verbal information. Thinking is also based on the use of other mental images (icons), such as hearing, smell or touch.

The last stage of Bruner's modes of representation is the symbolic mode. This is where information is stored in the form of a code or symbol, such as language. In the symbolic stage, knowledge is stored primarily as words, mathematical symbols, or in other symbol systems, such as music. Symbols are flexible in that they can be manipulated, ordered, classified so that the user is not constrained by actions or images which have a fixed relation to that which they represent.

One of the aims of education should be to create autonomous learners. However, in the view of Bruner, the purpose of education is not to impart knowledge, but instead to facilitate a child's thinking and problem-solving skills which can then be transferred to a range of situations. Specifically education should develop symbolic thinking in children. He argued that schools waste time trying to match the complexity of subject material to a child's cognitive stage of development. This meant that students are held back by teachers as certain topics are deemed too difficult to be understood and must be taught when the teacher believes the child has reached the appropriate stage of cognitive maturity. Bruner adopts a different view and believed that a child of any age is capable of understanding complex information. This involved information being structured so that complex ideas can be taught at a simplified level first and then re-visited at more complex levels later on.

Jean Piaget

Dear learner, Jean Piaget's work on children's cognitive development, specifically with quantitative concepts has garnered much attention within the field of education. His work on children's quantitative development has provided mathematics educators with crucial insights into how children learn mathematical concepts and ideas. Piaget believed that children develop steadily and gradually throughout the varying stages and that the experiences in one stage form the foundations for movement to the next. Piaget identified four primary stages of development; sensorimotor, preoperational, concrete operational, and formal operational.

In the sensorimotor stage, an infant's mental and cognitive attributes develop from birth until the appearance of language. This stage is characterized by the progressive acquisition of object permanence in which the child becomes able to find objects after they have been displaced, even if the objects have been taken out of his field of vision. An additional characteristic of children at this stage is their ability to link numbers to objects, example one dog, two cats, three pigs and the likes. Developing mathematical capability of a child in this stage might be enhanced if he is allowed ample opportunity to act on the environment in unrestricted but safe ways in order to start building concepts. Evidence suggests that children at the sensorimotor stage have some understanding of the concepts of numbers and counting. Educators of children in this stage of development must lay a solid mathematical foundation by providing activities that incorporate counting and thus enhance children's conceptual development of number.

The characteristics of Preoperational stage include an increase in language ability with over-generalizations, symbolic thought, egocentric perspective and limited logic. In this second stage, children must engage with problem-solving tasks that incorporate available materials such as blocks, sand and water. While the child is working with a problem, the teacher should elicit conversation from the child. The verbalization of the child, as well as his actions on the materials, gives a basis that permits the teacher to infer the mechanisms of the child's thought processes.

The third stage which is the concrete operational is characterized by remarkable cognitive growth, when children's development of language and acquisition of basic skills accelerate

dramatically. Children at this stage utilize their senses in order to know they can now consider two or three dimensions simultaneously instead of successively. Additionally, seriation and classification are the two logical operations that develop during this stage and both are essential for understanding number concepts. Hands-on experiences and multiple ways of representing a mathematical solution can be ways of fostering the development of their cognition.

The last stage of Piaget stages of development is the formal operation. The child at this stage is capable of forming hypotheses, deducing possible consequences and allowing the child to construct his own mathematics. Furthermore, the child typically begins to develop abstract thought patterns where reasoning is executed using pure symbols without the necessity of perceptive data. Reasoning skills within this stage refer to the mental process involved in the generalizing and evaluating of logical arguments and include clarification, inference, evaluation, and application.

Although it is not possible to teach cognitive development explicitly, research has demonstrated that it can be accelerated. All children in a class are not necessarily operating at the same level. Teachers could benefit from understanding the levels at which their children are functioning and should try to ascertain their children cognitive levels to adjust their teaching accordingly. In general, the knowledge of Piaget's stages helps the teacher understand the cognitive development of the child as the teacher plans stage-appropriate activities to keep children active

ACTIVITY

5.1 Describe how you will teach a named topic in mathematics at the upper primary involving the contributions of Piaget related to this level of learners.

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5.2 Explain how you will teach a named topic in mathematics at the upper primary linking the

contributions of Bruner related to this level of learners.

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SUMMARY

- Jerome Bruner proposed three modes of representation; Enactive, Iconic and Symbolic representations
- The modes of representation were the way in which information or knowledge are stored and encoded in memory.
- Bruner believed that a child of any age is capable of understanding complex information
- Piaget identified four primary stages of development; sensorimotor, preoperational, concrete operational, and formal operational.
- Piaget's stages of development aid teachers plan stage-appropriate activities to keep children active

Unit 3

Section 6

INTRODUCTION

Dear student teacher, you are warmly welcome to the sixth section of unit three which is on child developmental stages. This lesson focuses on developing your knowledge on the contribution made by some psychologist in the field of mathematics. Additionally the knowledge in this section would enable you to effectively apply them in your teaching.

OBJECTIVES

By the end of this section, you will be able to identify the contributions of:

- Maria Montessori
- Johann Heinrich Pestalozzi
- Friedrich Froebel

Maria Montessori

Dear learners, Maria Montessori was an Italian physician and anthropologist who devoted her life to understanding how children develop socially, intellectually, physically, and spiritually. Through carefully observing children all over the world, she discovered universal patterns of development which are found in all children regardless of their culture or the era in which they live.

Montessori type of education is based on self-directed activity, hands-on learning and collaborative play. Montessori classrooms are beautifully crafted environments designed to meet the needs of children in a specific age range. In Montessori classrooms children make creative choices in their learning, while the classroom and the highly trained teacher offer age-appropriate activities to guide the process. Children work in groups and individually to discover and explore knowledge of the world and to develop their maximum potential. Maria Montessori discovered that experiential learning in this type of classroom led to a deeper understanding of language, mathematics, science, music, social interactions and much more.

This approach to education can be integrated into the learning of mathematics at the upper primary by offering opportunities for collaborative intellectual exploration in which the child's interests are sustained and guided. Again children at this level can be supported to develop self-confidence, imagination, intellectual independence, and self-efficacy. Maria Montessori believed that children come to absorb mathematical concepts naturally. She recognised that there were specific sensitive periods in a child's development whereby the acquisition of mathematical concepts were eagerly explored through repetition of activities with concrete, scientifically developed, didactic materials.

Maria Montessori designed concrete mathematical materials to represent all levels of quantities and mathematical concepts after she observed that children who are interested in counting, like to move items as they enumerate them. In the Montessori learning environment, the children not only sees and learns the symbol for a number, they hold the quantity in their hand. For most children, the sensitive development period for learning mathematical concepts is between the age of four and six years. As children develop in the Montessori learning environment, they become ready to encounter more concrete mathematics materials that explore abstract thought, beginning with quantity.

Johann Heinrich Pestalozzi

Dear learner, Johann Heinrich Pestalozzi the father of modern pedagogy dedicated his life to the pursuit of truth for mankind. This quest considered the education and teaching of children as a whole, hence, his famous formula of "head, heart, and hands" was conceived not just as a slogan but, particularly, as a concept of comprehensive education. He was really the first educationalist to consider the child's own unique interests. He believed that the education of children should be in harmony with nature. In other words, children should be educated by responding to the child's own nature at each step in their development, which would demonstrate what the child really needed to learn. He also shared the view that all children should have an equal right to education and be able to recognize their innate capabilities. He tried to devise a system of teaching that was determined by the child's capacity at each stage of their individual development.

He placed much emphasis on the observation of objects in their known environment, which the children could relate to. This in effect would lead to verbalization, which would help make it easier for children to form concepts in a meaningful context. Pestalozzi advocated the principle that learning takes place best through self-activity. He therefore allowed children to observe and use resources, objects to learn and make sense of the real world. These important active sensory experiences which Pestalozzi saw as essential in the developmental process supported children's holistic development.

Pestalozzi believed that children worked best when being taught in groups that were mixed-age, much like a family group, where older siblings enjoy showing younger children what to do, by example. He emphasized that each child needs love, work and social interaction to underpin the right conditions for their holistic development and learning. Educators, he believed, should understand the child's social and emotional life because the security of relationships within the home directly influenced the child's holistic development. Children learn best in a loving and secure environment. He condemned rote-learning and the concept of cramming facts into the children. Pestalozzi promoted child-initiated learning, trusting the child's innate potential to be engaged in the appropriate activity necessary for their individual level of development.

Friedrich Froebel

Dear learner, Friedrich Froebel was a German educator who invented the kindergarten. He was one of the pioneers of early childhood educational reform. As an idealist, he believed that every child possessed at birth his full educational potential and that, an appropriate educational environment was necessary to encourage the child to grow and develop in an optimal manner. As an educator, Froebel believed that stimulating voluntary self-activity in the young child was the necessary form of pre-school education. Self-activity is the development of qualities and skills that make it possible to take an invisible idea and make it a reality. It involves formulating a purpose, planning out that purpose and then acting on that plan until the purpose is realized.

Froebel's significant contributions to early childhood education was his theory of introducing play as a means of engaging children in self-activity for the purpose of externalizing their inner

natures. His interpretation of play is characterized by free play which enlists all of the child's imaginative powers, thoughts and physical movements by embodying in a satisfying form his own images and educational interests. The teacher's role was not to drill or indoctrinate the children but rather to encourage their self-expression through play, both individually and in group activities.

In assisting children in their development of moving from one stage of educational growth to another, Froebel provided children with many stimulating activities to enhance their creative powers and abilities and designed a series of instructional materials that he called "gifts and occupations". A gift was an object provided for a child to play with, such as a sphere, cube, or cylinder which helped the child to understand and internalize the concepts of shape, dimension, size, and their relationships. Occupations were items such as paints and clay which the children could use to make what they wished. Through the occupations, children externalized the concepts existing within their creative minds. Therefore, through the child's own self-activity and creative imaginative play, the child would begin to understand both the inner and outer properties of things as he moves through the developmental stages of the educational process. Teachers need to place emphasis on what the children can do, rather than what they can't do. The tone and atmosphere should be encouraging and not judgmental.

ACTIVITY

6.1 Compare and contrast the educational contributions of the personalities discussed in this section.

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SUMMARY

- Montessori type of education is based on self-directed activity, hands-on learning and collaborative play.
- Children make creative choices in their learning, while the classroom and the highly trained teacher offer age-appropriate activities to guide the process.
- Children should have an equal right to education and be able to recognize their innate capabilities.
- Pestalozzi believed that children worked best when being taught in groups that were mixed-age, much like a family group.
- The teacher's role was not to drill or indoctrinate the children but rather to encourage their self-expression through play, both individually and in group activities.
- Froebel designed a series of instructional materials that he called "gifts and occupations".

UNIT 5

Multiple intelligences

SECTION 1 THE FOUNDATION OF MULTIPLE INTELLIGENCE

SECTION 2 CLASSROOM IMPLICATION OF MULTIPLE INTELLIGENCE

SECTION 3 MULTIPLE INTELLIGENCE THEORY AND PERSONAL DEVELOPMENT

SECTION 4 MULTIPLE INTELLIGENCE THEORY AS AGAINST LEARNING STYLES

SECTION 5 MULTIPLE INTELLIGENCE THEORY AND SPECIAL EDUCATION

UNIT 5 MULTIPLE INTELLIGENCES

INTRODUCTION

Dear learner, you are most welcome to Unit 5 of the course, Theories in the Learning of Numeracy. This unit discusses the foundation of multiple intelligence theory and the influence of this on personal development. The unit emphasizes the foundation of multiple intelligence theory, multiple intelligence theory and implications for teaching numeracy in Early Grade classrooms. It will also elucidate the principles of multiple intelligences, description of the dimensions of Howard Gardner's multiple intelligences and how it relates to learning styles. **(NTS 1b)**

OBJECTIVES

On successful completion of this unit, you will be able to:

- Demonstrate understanding of the meaning and principles of multiple intelligences.
- Demonstrate knowledge and understanding of the implication of multiple intelligences in the classroom. **(NTS 2e &f)**

LEARNING INDICATORS

- Outline and analyse principles of multiple intelligence
- Describe the dimensions of Howard Gardner's multiple intelligence
- Compare multiple intelligence with learning styles
- Reflect critically on their own learning experiences and how these relate to multiple intelligence
- Outline how the dimensions of Howard Gardner's multiple intelligence can be used in teaching early grade children.

SECTION 1

THE FOUNDATION OF MULTIPLE INTELLIGENCE

INTRODUCTION

Dear learner, you are welcome to the first section of unit five; the foundation of multiple intelligence. In this section, you will be allowed to share your conceptions about multiple intelligence. You will equally be taken through a brief history of multiple intelligences with a focus on Gardner's conception.

OBJECTIVES

On successful completion of this section, you will be able to:

- Demonstrate understanding of the meaning and principles of multiple intelligences. (**NTS 2e &f**)

LEARNING INDICATORS

- Outline and analyse principles of multiple intelligence.
- Describe the dimensions of Howard Gardner's multiple intelligences.
- Outline and discuss the critics of multiple intelligence.

What is Intelligence?

The concept of intelligence does not have a universally accepted definition. Several scholars and researchers alike define it to suit the purpose of their interest. Examples of these include;

Sternberg (1985), intelligence is a mental activity directed toward purposive adaptation to, selection and shaping of, real-world environments relevant to one's life. Subsequently, he conceived intelligence to be an individual's ability to think analytically, creatively, practically, and wisely to learn from experience and adapt to, shape, and select environments.

Richard Haier, intelligence is the opposite of stupidity.

Gardner's intelligence is a bio-psychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in the culture.

The previous definitions were limited to cognition or thought; one was intelligent to the extent that one could solve problems and adapt effectively to one's environment using thinking skills. Gardner, however, broadens the concept to include effective use of the body and thinking skills relevant to the social world. He also extends the functionality of intelligence to include the crafting of useful products, not just the solving of problems.

Multiple Intelligence

Historically, Edward Thorndike is believed to be the first scholar to have theorized three types of intelligence; social, mechanical and abstract. He defined; social intelligence as the ability to

understand and relate well with others, mechanical intelligence as the ability to control one's body and manipulate objects and abstract intelligence as the ability to think verbally and symbolically. Thorndike in his study placed much emphasis on behavior to that of consciousness. His study, however, serves as a bedrock of investigations related to social intelligence and multiple intelligence at large.

Subsequently, Raymond B. Cattell proposed two types of intelligence (Fluid intelligence and Crystallized intelligence) in the mid-20th century. Fluid intelligence (Gf) to him is an individual's ability to think logically and solve problems independent of previous experience or acquired knowledge. Similarly, Crystallized intelligence (Gc) is perceived as an individual's ability to use his/her skills, knowledge and experience. He posited that fluid intelligence increases till adolescence and then declines gradually, while crystallized intelligence increases gradually and remain relatively stable across adulthood but declines in late adulthood.

The proposition made by Edward Lee Thorndike open a new window of research into multiple intelligence. In 1983, Howard Gardner published a book on multiple intelligence in which he breaks intelligence down into eight different modalities: logical, linguistic, spatial, musical, kinesthetic, naturalist, interpersonal, and intrapersonal intelligence. Consequently, Robert Sternberg proposed the Triarchic Theory of Intelligence, which proposes three fundamental types of cognitive ability: analytic intelligence, creative intelligence, and practical intelligence.

Activity 1.1

1. In your own words explain the term intelligence.
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2. List the components of the Triachic theory of intelligence
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3. The statement, intelligence is the opposite of stupidity is to?
   a) Edward Gardner
   b) Thorndike
   c) Richard Haier
   d) Albert Bandura
4. Which of the following psychologist perceived intelligence to be "a bio-psychological potential"?
   a) Sternberg

b) Edward Thorndike
c) Edward Gardner
d) Lee Thorndike

5. The ability to control one's body and manipulate objects is termed?
   a) Psychological intelligence
   b) Abstract intelligence
   c) Mechanical intelligence
   d) Manipulative intelligence
6. Raymond B. Cattell proposed …… and Crystallized intelligence.

Gardner's multiple intelligence

It is a theory of human intelligence proposed by a psychologist named Howard Gardner in his book Frames of Mind (1983). This theory is anchored on individual differences and stresses the multiple ways individuals (learners) learn and acquire information. According to Gardner (2000, p.28) intelligence is a "biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture.

> *It is of the utmost importance that we recognize and nurture all of the varied human intelligence, and all of the combinations of intelligence. We are all so different largely because we all have different combinations of intelligence. If we recognize this, I think will have at least a better chance of dealing appropriately with the many problems that we face in the world.*
>
> *-Howard Gardner (1987)*

A brief history of multiple intelligence

Etymologically the principle of multiple intelligence is asserted to be a byproduct of a critic on the Intelligence Quotient (IQ) test.

The public instruction minister of Paris in the year 1904 asked a French psychologist named Alfred Binet and his colleagues to develop an appropriate means of ascertaining learners in the primary grade who were "at-risk" for failure to enable the government to provide remedial attention. The work of the group resulted in the first intelligence test which was accepted and given enormous recognition. The notion behind the usage of the IQ tests was that there is something called intelligence that could be objectively assessed and reduced to a single number.

In the early 80s, a Harvard psychologist named Howard Gardner contested the usage of the IQ test and proposed in his book titled Frames of Mind the existence of at least seven intelligence. Subsequently, he added an eighth intelligence and postulated the possibility of a ninth. According to Gardner, standardized (IQ) tests assess an aspect of the total abilities of an individual and do not mirror the totality of the individual.

Gardner in his theory sort to broaden the scope of human potential beyond the confines of the IQ score. He seriously contested the validity of determining intelligence through the practice of engaging individuals in an isolated task they had never done before and would never do if given a choice. He perceived intelligence to be an embodiment of (1) solving problems and (2)

fashioning products in a context-rich and naturalistic setting. He assumes that every individual has more than an intelligence but in each case, a particular intelligence is more apparent.

There is a need for educators and scholars alike to pay keen attention to the following criteria in the course of identifying the potentials of intelligence of an individual.

1. Potential isolation by brain damage
2. The existence of idiots, savants, prodigies and other exceptional individuals
3. An identifiable core operation or set of operations.
4. A distinctive developmental history
5. Evolutionary history and evolutionary plausibility.
6. Support from experimental psychological tasks.
7. Support from psychometric findings
8. Susceptibility to encoding in a symbol system.

The eight intelligence proposed by Gardner

Linguistic intelligence: this is explained simply to mean the capacity of an individual to effectively communicate orally or in writing. It also includes the ability to manipulate the syntax or structure of language, the phonology or sounds of language, the semantics or meaning of language. Examples of individuals with linguistic intelligence include Shakespeare, Oprah Winfrey, Kwame Nkrumah, Ama Ata Aidoo, Kofi Awoonor, Efua Sutherland, Akosua Busia, etc. this group of people analyze information and create products involving oral and written language such as speeches, books, and memos.

Strengths

- Writing and speaking (language)

Characteristics

- Enjoy reading and writing
- Good recall of written and spoken information
- Good in explanation and use of analogies

Proposed career occupations

- Teaching
- Journalist
- Lawyer
- Poet

- Musician
- Writer (books/journals).
- Radio/ Television presenter
- Linguist
- Editor

Logical-mathematical intelligence: this type of intelligence refers to an individual's capacity to use numbers effectively, analyze problems logically, carry out mathematical operations, and investigate issues scientifically. The kinds of processes used in the service of logical-mathematical intelligence include categorization, classification, inference, generalization, calculation and hypothesis testing. Examples of individuals with this intelligence include Pythagoras, Albert Einstein, Al-Khwarizmi, Carl Friedrich Gauss, Isaac Newton, Archimedes, Aryabhatta, Leonhard Euler, Hypathia, Angela Tabiri, and Francis Allotey. This group of people can develop equations and proofs, make calculations and solve abstract problems.

Strengths

- Logical reasoning, analyzing problems and mathematical operations

Characteristics

- Can solve complex computations
- Have excellent problem-solving skills
- Like conducting scientific experiments
- Enjoy thinking about abstract ideas

Proposed career occupations

- Mathematician
- Accountant
- Statistician
- Scientist
- Computer Programmer
- Logician
- Banker
- Insurance broker

- Trader

Spatial intelligence: this type of intelligence deals with an individual's ability to perceive and manipulate the visual-spatial world accurately and to perform transformations upon those perceptions. This intelligence involves sensitivity to color, line, shape, form, space, and the relationships that exist between these elements. It includes the capacity to visualize, graphically represent visual or spatial ideas, and orient oneself appropriately in a spatial matrix. Examples of individuals with spatial intelligence include

Strengths

- Spatial and visual judgment

Characteristics

- Read and write for enjoyment
- Good in interpreting pictures, graphs, and charts
- Recognize patterns easily
- Enjoy drawing and painting
- Good at solving puzzles

Proposed career occupations

- Hunting
- Interior decorator
- Architect
- Artist
- Carpenter
- Mason
- Town planner
- Photographer
- Cosmetics and beauty consultant
- engineer

Bodily-kinesthetic Intelligence: this intelligence deals with an individual's capability to use his body (part or whole) to express ideas and feelings. This encapsulates specific physical skills such as coordination, balance, dexterity, strength, flexibility and speed as well as tactile capacities. Examples of individuals with this kind of intelligence include Abedi Pelle, Michael Jordan, Michael Jackson and Kofi Kington.

Strengths

Physical movement and motor control

Characteristics

- Are skilled in dancing and sports
- Remember by doing rather than hearing or seeing
- Have good physical coordination of body parts.
- Enjoy creating things with their hands

Proposed career opportunities

- Dancer
- Mason
- Actor
- Footballer
- Athlete
- Soldier
- Diver

Musical Intelligence: individuals with this kind of intelligence can perceive, discriminate, transform and express musical forms. They have a strong appreciation for music and are often good at musical composition and performance. This intelligence includes sensitivity to the rhythm, pitch or melody and timbre or tone color of a musical piece. Examples of individuals with this type of intelligence include Joseph Hanson Kwabena Nketia, Gyedu-Blay Ambolley, Bernice Offei, Nana Acheampong, Akosua Agyapong, Wiyaala and Rocky Dawuni.

Strengths

Music and Rhythm

Characteristics

- A rich understanding of the musical structure, rhythm and notes
- Recognize musical patterns and tones easily
- Remember songs and melodies
- Enjoy singing and playing musical instruments

Proposed job opportunities

- Musician

- Conductor
- Music teacher
- Composer
- Singer

Interpersonal intelligence: individuals under this category are very good in relationships with others. They can make distinctions in the moods, intentions, motivations and feelings of other people. This can include sensitivity to facial expressions, voice, and gestures. Examples of individuals with this kind of intelligence include Kofi Anan, Alban Sumana Kingsford Bagbin and Otumfuo Osei Tutu II.

Strengths

Understanding and relating to other people

Characteristics

- Create positive relationships with others
- Resolve conflicts in group settings
- Good at verbal and nonverbal communication

Proposed job opportunities

- Psychologist
- Counselor
- Salesperson
- Politician
- Teacher
- Medical doctor

Intrapersonal intelligence: individuals with this kind of intelligence have a good awareness of their emotional states, motivations, feelings, intentions, temperaments and desires. In simple language, it can be explained to mean one's ability to act adaptively based on self-knowledge, self-understanding, self-discipline and self-esteem. Individuals who excel in this intelligence typically are introspective and can use this knowledge to solve personal problems. Examples of individuals with this kind of intelligence include Kwame Nkrumah, Virginia Woolf, Walt Whitman and Ayi Kwei Armah.

Strengths

- Introspection and self-reflection

Characteristics

- Enjoy analyzing theories and ideas
- Have excellent self-awareness
- Understand the basis of their motivation and feelings.

Proposed job opportunities

- Philosopher
- Writer
- Theorist
- Scientist

Naturalist intelligence: individuals with this intelligence are more in tune with nature and are often interested in nurturing, exploring the environment and learning about other species. These individuals are said to be highly aware of even subtle changes to their environment.

Strengths

- Finding relationships and patterns in nature.

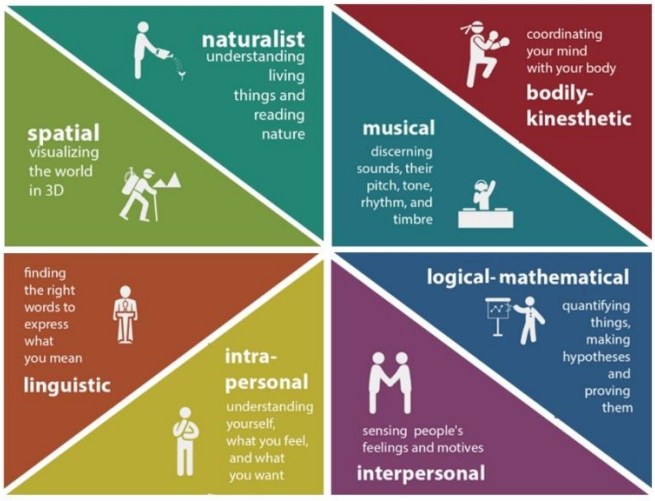
Characteristics

- Dislike learning unfamiliar topics that have no connection to nature
- Categorize and catalog information easily
- Enjoy camping, garden, hiking, and exploring the outdoors

Proposed occupational opportunities

- Biologist
- Conservationist
- Farmer
- Fisherman

The diagram below is a pictorial representation of the intelligence illustrated above.



Criticism

Notwithstanding the numerous benefits tiered to the practice and appreciation of multiple intelligence, it is, however, educative for us to note that it is being contested by scholars from the testing community, psychology and education. Some of the critics leveled against the MI theory are elucidated below.

Lucks empirical evidence

Critics of MI theory asserts that the theory was propounded out of subjective evaluations made by Gardner. Stemming from this backdrop, they affirm that MI theory has nothing to do with psychological data about individuals' abilities but rather how an individual (Gardner) perceives human intelligence. For this reason, there regard the theory as one that lacks evidence.

Represses the curriculum and makes learners believe they are smart.

Critics are also of the view that the appreciation and implementation of MI theory go a long way to stifle the capabilities of learners. Instead of learners exploring their capabilities, they stand a high chance of fixating their minds on their strongest intelligence. Similarly, critics suggest that MI theory promulgates an artificial "feel-good" attitude where every child is told that he or she is smart. In this light, MI theory is conceived as an outlandish idea.

Activity 1.2

1. Who authored the book "Frames of Mind"?

   a) Harry Gardner

   b) Merlin

   c) Howard Gardner

d) B. F. Skinner

2. List the intelligence proposed by Howard Gardner.

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3. How important is Gardner's multiple intelligence to early grade teachers?

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4. Individuals with the tendency to create friends are said to have ..... intelligence.

SUMMARY

We have discussed the foundation of multiple intelligence with focus on Howard Gardner's conception. We have learnt that:

- Intelligence was limited to activities of the human mind but was later extended to include the affective it is the effective use to the physical and psychological components of the body to add value to human life.
- Multiple intelligence is a byproduct of a criticism on intelligence quotient.

Similarly we equally discussed the intelligences proposed by Howard Gardner:

- Logical mathematical intelligence
- Linguistic intelligence
- Interpersonal intelligence
- Intrapersonal intelligence
- Natural intelligence
- Musical intelligence

- Spatial intelligence
- Bodily kinesthetic intelligence

SECTION 2

CLASSROOM IMPLICATION OF MULTIPLE INTELLIGENCE

INTRODUCTION

Dear learner, you are welcome to section two of unit five; classroom implication of multiple intelligence. In this section, you will be taking through multiple intelligence strategies teachers can apply to successfully teach and manage individual behaviors in an early grade classroom.

OBJECTIVES

On successful completion of this section, you will be able to:

- Demonstrate good knowledge of classroom implications of multiple intelligence. (**NTS 2e &f**)

LEARNING INDICATORS

- Outline and analyse teaching strategies for managing and keeping order in the learning environment that appeals to the varied intelligence of learners.

Definition of classroom

A classroom can simply be explained to mean a good design micro-society with the focus of educating learners who serve as a pinnacle of its creations. This society is governed by established rules, procedures, routines and regulations. Although MI is not a classroom management scheme, it, however, provides teachers new strategies for managing and keeping order in the learning environment. Below is some classroom implication of MI theory.

To gain learners attention

Multiple intelligence theory brings to light the varied intelligence of learners in our early grade classrooms. Stemming from this fact, teachers have to vary their instructions to be in consonants with learners' intelligence. For example, to gain the attention of learners in an overwhelmed situation teachers can resort to the following strategies:

- Linguistic - Write the words "Silence, please!" on the blackboard.
- Musical - Clap a short rhythmic phrase and have learners clap it back.
- Bodily-kinesthetic - Put your finger against your lips to suggest silence while holding your other arm up. Have learners imitate your gestures.
- Spatial - Put a blown-up photo of an attentive classroom on the board (perhaps a photo of the actual learners involved).114 Multiple Intelligences in the Classroom
- Logical-mathematical - Use a stopwatch to keep track of the time being wasted and write on the blackboard the number of seconds lost at 30-second intervals.
- Interpersonal - Whisper in the ear of a learner, "It's time to start-pass it on," and then wait while learners pass the message around the room.

- Intrapersonal - Start teaching the lesson and allow learners to take charge of their behavior.
- Naturalist - Play a recording of a shrill bird whistle, or (even better) bring a live animal into the classroom. Generally speaking, whenever there is an animal visitor in a classroom, that's where the attention will be!

Communicating class rules

School/ classroom rules can be communicated to learners via a multiple intelligence approach.

- Linguistic—Rules are written and posted in the classroom (this is the most conventional approach).
- Logical-mathematical—Rules are numbered and later referred to by number (e.g., "You're doing a great job of following rule #4").
- Spatial—Next to the written rules are graphic symbols of what to do and what not do to (e.g., "respect for others" might be symbolized by an image of two people holding hands).
- Bodily-kinesthetic—Each rule has a specific gesture; learners show they know the rules by going through the different gestures (e.g., "respect for others" might be symbolized by hugging oneself).
- Musical—The rules are set to a song, or each rule is associated with a relevant song (e.g., "respect for others" might be connected to Aretha Franklin's song "Respect")
- Interpersonal—Each rule is assigned to a small group of learners who then have responsibility for knowing its ins and outs, interpreting it, and even enforcing it.
- Intrapersonal—learners are responsible for creating the class rules at the beginning of the year and developing their unique ways of communicating them to others.
- Naturalist—An animal is assigned to each of the rules (e.g., "Respectful Rabbit"). Learners learn the rules by imitating the movements of the animals.

Note: putting learners at the center of creating classroom rules is an essential way of gaining their commitment. Likewise, they should be tasked to develop MI strategies of cues for classroom procedures.

Forming Groups

- Linguistic—"Think of a vowel sound in your first name. Now make that vowel sound out loud. Go around the room and find three or four people who are making the same vowel sound."
- Logical-mathematical—"When I give the signal, I want you to raise between one and five fingers. Go! Now keep those fingers raised and find three or four people whose raised fingers combined with yours total an odd number."
- Spatial—"Find three or four people who are wearing the same color clothes as you are wearing."
- Bodily-kinesthetic—"Start hopping on one foot. . . . Now find three or four people who are hopping on the same foot."

- Musical—"What are some songs that everybody knows?" The teacher writes on the board four or five of them (e.g., "Row, Row, Row Your Boat," "Happy Birthday to You," etc.). "Okay, I'd like you to file past me while I whisper in your ear one of these songs. Remember which one it is, and when I give the signal, I'd like you to sing your song and find all the others in the class who are singing the same song. . . . Go!"
- Naturalist—"Visualize a sheep, a pig, and a cow in a pasture. Suddenly, there is a loud noise and two of them run off. There is only one animal left. Start making the sound of that animal out loud, and then find three or four people who are making the same animal sound!"

Managing individual behavior

- Linguistic—Talk with the learner; provide books that refer to the problem and point to solutions; help the leaner use "self-talk" strategies for gaining control.
- Logical-mathematical— logical-consequences approach; have the child quantify and chart the occurrence of negative or positive behaviors.
- Spatial—Have the child draw or visualize appropriate behaviors; provide the child with a metaphor to use in working with the difficulty (e.g., "If people say bad things to you, see the bad things as arrows that you can dodge"); show the child videos that deal with the issue or that model the appropriate behaviors.
- Bodily-kinesthetic—Have the child role-play the inappropriate and appropriate behaviors and discuss the differences; teach the child to use physical cues to deal with stressful situations (e.g., taking a deep breath, tightening and relaxing muscles).
- Musical—Find musical selections that deal with the issue the child is facing; provide music that helps create the appropriate behavior (e.g., calming music for tantrums, stimulating music—"Musical Ritalin"—to help children labeled ADHD focus); teach the learner to "play" his favorite music in his mind whenever he feels out of control.
- Interpersonal—Provide peer group counseling; buddy up the learner with a role model; give the child other social outlets for her energies (e.g., leading a group).
- Intrapersonal—Teach the child to voluntarily go to a non-punitive "time-out" area to gain control (see Nelsen, 1999); provide one-to-one counseling; develop a behavior contract (that the child has input in creating); allow the learners to work on high-interest projects; provide self-esteem activities.
- Naturalist—Tell animal stories that teach about improper and proper behavior (e.g., "The Boy Who Cried Wolf" for a persistent fibber); use animal metaphors in working with difficult behavior (e.g., ask an aggressive learner what sort of animal he feels like and how he can learn to "tame" it); use "animal-assisted therapy" to help with social, emotional, and cognitive functioning.

Despite the numerous strategies outline by MI theorists for the management of the class and individual learners, it is, however, apparent for teachers to appreciate the varied needs, interests, backgrounds and learning styles of learners under their care.

Activity 2.1

Outline three multiple intelligence approaches teachers should implement to:

1. To gain learners attention

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2. Communicate class rules.

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3. Managing individual behavior

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SUMMARY

We have discussed the classroom implication of multiple intelligence zooming on how multiple intelligence strategies can be used to gain learners attention, communicate class rules, for group formation and to manage individual behavious in the early grade classroom. The table below is an excerpt of the strategies for the under listed activities.

ACTIVITY	**STRATEGIES**
To gain learners attention	• Linguistic - Write the words "Silence, please!" on the blackboard. • Musical - Clap a short rhythmic phrase and have learners clap it back. • Bodily-kinesthetic - Put your finger against your lips to suggest silence while holding your other arm up. Have learners imitate your gestures.
To manage individual behaviour	• Linguistic—Talk with the learner; provide books for the learner that refer to the problem and point to solutions; help the child use "self-talk" strategies for gaining control. • Logical-mathematical—Use Dreikurs's (1993) logical-consequences approach; have the child quantify and chart the occurrence of negative or positive behaviors. • Spatial—Have the learner draw or visualize appropriate behaviors; provide the learner with a metaphor to use in working with the difficulty (e.g., "If people say bad things to you, see the bad things as arrows that you can dodge"); show the learner videos that deal with the issue or that model the appropriate behaviors.
Communicating class rules	• Linguistic—Rules are written and posted in the classroom (this is the most conventional approach). • Logical-mathematical—Rules are numbered and later referred to by number (e.g., "You're doing a great job of following rule #4"). • Spatial—Next to the written rules are graphic symbols of what to do and what not do to (e.g., "respect for others" might be symbolized by an image of two people holding hands).

SECTION 3

MULTIPLE INTELLIGENCE THEORY AND PERSONAL DEVELOPMENT

INTRODUCTIONS

Dear learner, you are welcome to section three of unit five; multiple intelligence theory and personal development. In this section, you will be taken through the influences multiple intelligence has on the personal development of early grade learners and how teachers can assist learners to make the best out of multiple intelligence.

OBJECTIVES

On successful completion of this section, you will be able to:

- Demonstrate knowledge and understanding of multiple intelligence and personal development. (**NTS 2e &f**)

LEARNING INDICATOR(S)

- Reflect critically on their own learning experiences and how these relate to multiple intelligences.

The appropriate means of appreciating ones multiple intelligence is a realistic appraisal of ones performance in several activities that are in consonants to aspects of multiple intelligence. Contrary, you could equally do the same by reflecting over real-life experiences you have engaged the eight intelligence proposed by Gardner.

It is however educative for us to know that the results of the appraisal are not judgmental and do not represent the strong and weak intelligence of an individual but mirrors the varied intelligence and capabilities of the individual. Learners are hereby advised not to trap themselves under a particle intelligence because there performed well in it but should work acidulously to improve upon all the aspects of intelligence proposed by Gardner. This to say that all intelligence is in tandem with each other and to a large extend can't do without each other.

It is a known fact that no single individual can be good in all eight domains of intelligence. Stemming from this fact teachers are advised to tap resources in intelligence they shy from in the classroom. Below are some strategies teachers can fall on:

Learner-centered teaching

Teachers are to make learners active participants in the classroom for they stand the chance to demonstrate expertise in areas where the teacher's knowledge may be deficient. Examples of these include;

- A learner good in special intelligence sketch/ draw pictures and diagrams on board for colleagues to copy.
- A learner good in musical intelligence provides a musical background learning activities.

Use available technology

Technological tools are resources teachers can fall on to patch up their blind sports. Teachers are advised to tap and put to good use the technological resources of schools to provide information to learners they might to be able to provide in person. For example use;

- Tape recorder if not musical intelligent
- A calculator if not logical-mathematical intelligent

Sort expertise of colleague's

Teachers can/ should leverage the expertise of their colleagues to overcome their shortcomings. A teacher not good in any of the intelligence outline by Gardner can sort assistance from a colleague who is good in that area. For example;

- A teacher not good at music should consider getting help from the school's music teacher or musically inclined colleague.
- A teacher not good at drawing can sort support from a colleague who is good in spatial intelligence to help sketch/ draw diagrams (pictures) for learners to copy.

Development of multiple intelligence

Every individual has the capacity to develop his/her intelligence to an acceptable level of mastery. However, the development of this intelligence depends largely on three factors:

- Biological endowment – this includes inherent elements like genetic or hereditary factors.
- Cultural and historical background – this includes the environment and time in which an individual is born, raised and natured.
- Personal life history – this refers to an individual's experience with society.

The above-listed factors influence and plays an essential role in the makeup of any individual.

Activators and deactivators of intelligence

For an individual to effectively develop his/her intelligence there is the need for him/her to crystalize and/or paralyze some experiences. The crystallization and paralyzation of experiences serve a pinnacle in the development of intelligence. The crystallization of experience is a concept propounded by David Feldman (1980) and further developed by Gardner and his colleagues. This event does normally occur during the early stages of life despite the fact that it can occur at any time in one's life. Crystallization of experience is a process that gives rise to intelligence and nourishes its development. For example, when Albert Einstein was 4 years old, his father showed him a magnetic compass. Later, an adult, Einstein gave an account that the magnetic compass shown him ignited his desire to figure out the mysteries of the universe. This experience activated his genius and made him famous in 20^{th}-century thoughts.

Paralyzing experiences on the other hand refers to an experience that obstructs/shut down intelligence. Perhaps a teacher humiliated you in front of your classmates when you showed your solution to a mathematics problem, and that event marked the end of a good part of your mathematical intelligence. Similarly, your parent yelled at you to "stop sketching plane shapes" on the piano, and you never went near a musical instrument after that.

Below are some environmental factors that promote or hinders the development of intelligence:

- Access to resources or mentors—if your family was so poor that you couldn't afford a violin, piano, or other instruments, your musical intelligence might well have remained undeveloped.
- Historical-cultural factors—if you were a learner who demonstrated "appetites" in mathematics at a time when math and science programs were highly funded, your logical-mathematical intelligence would likely have developed.
- Geographic factors—if you grew up on a farm, you might well have had more opportunities to develop certain aspects of the naturalist intelligence than if you were raised in the Jubilee House of Ghana.
- Familial factors — if you wanted to be an artist but your parents wanted you to be a lawyer, their influence might well have promoted the development of your linguistic intelligence at the expense of your spatial intelligence.
- Situational factors — if you had to help take care of a large family while you were growing up, and you now have a large family yourself, you may have had little time to develop in areas of promise unless they were interpersonal in nature.

Multiple intelligence theory offers a model of personal development that provides an opportunity for educators to understand how their profile of intelligence influences their teaching approaches in the classroom. Further, it opens the gate to a broad range of activities that can help teachers develop neglected intelligence, activate underdeveloped or paralyzed intelligence, and bring well-developed intelligence to higher levels of proficiency.

Activity 3.1

1. In brief explain the concept 'crystallization of intelligence'.

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2. Outline three environmental factors that promote the development of intelligence.

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3. In brief describe how your learning experience relates to multiple intelligence.

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4. Discuss three strategies you will adopt to teach numeracy in an inclusive classroom.

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SUMMARY

It is a known fact that no single individual can be good in all eight domains of intelligence. Cognizance of this every individual has the capacity to develop his/her intelligence to an acceptable level of mastery. However, the development of this intelligence depends largely on three factors:

- Biological endowment – this includes inherent elements like genetic or hereditary factors.
- Cultural and historical background – this includes the environment and time in which an individual is born, raised and natured.
- Personal life history – this refers to an individual's experience with society.

Unit 5 section 4

MULTIPLE INTELLIGENCE THEORY AS AGAINST LEARNING STYLES

INTRODUCTION

Dear learner, you are welcome to section four of unit five; multiple intelligence theory as against learning styles. In this section, you will be given the opportunity to juxtapose your personal learning experiences against multiple intelligence and bring to bear their similarities and differences.

OBJECTIVES

On successful completion of this section, you will be able to:

- Demonstrate understanding of the meaning and principles of multiple intelligences. (**NTS 2e &f**)

LEARNING INDICATORS

- Outline and analyse the kinds of learning styles.
- Compare multiple intelligence with learning styles.

What are learning styles?

The concept of style, in psychology, was introduced by Allport in 1937 for the identification of personality and behavior types. The concept of learning styles is, however, asserted to be derived from the field of individual differences in information processing. It is however essential for us to note that it does not have a universally accepted definition. Below are some conceptions of learning styles by scholars.

Keefe (1979) conceives learning styles as cognitive, affective and physiological traits that are relatively stable indicators of how learners perceive, interact with and respond to the learning environment. He further argued that learning styles are anchored on neural organization and personality and shaped by human development and experience.

Similarly, Reid (1995) explained learning styles to mean an individual's natural, habitual, and preferred means of absorbing, processing, and retaining new information and skills.

Moreover, Dunn and Dunn (1999) perceived learning styles to be the way an individual begins to concentrate on, process, internalize and retain new and difficult academic information.

In light of the above exposition, learning styles can be explained to mean one's unique or preferred approach to learning. These approaches are being influenced by teaching methods and learning environment(s) a learner finds him/her self. It is of great importance for us to note that learning styles are generally classified in terms of three main components; physiological, cognitive and affective.

Kinds of learning styles

Several scholars have attempted breaking learning styles into several components. Notable amongst them include David Kolbs, Neil Flemming (VARK model) and Douglas H. Brown (2000) who advanced Flemming's model by adding two components (individual and group). Below is an elucidation of Brown's Model:

Visual learning

Visual learning style refers to preferring to learn through seeing, that is, visual channel. Oxford reports that "Visual learners need the visual stimulation of bulletin boards, videos and movies" (1995, p. 36). They like reading, computers, pictures and written instructions (Oxford, 2002). Learners whose dominant learning style preference is visual can visually recall what they have read or observed (Wooldridge, 1995).

Auditory learning

Auditory learners prefer to learn through "oral-aural learning channel" and to "engage in discussions, conversations, and group work" (Oxford, 1995, p. 36). The 54 "may need to hear written text material, ask for tapes or passages to be read out, prefer oral practice without books, and so on" (Erhman, 1996, p. 61).

Kinesthetic learning

Kinesthetic learners prefer to learn through "experiential learning, that is, total physical involvement with a learning situation" (Reid, 1987, p. 90). They need body movement to absorb and retain what is learned (Wooldridge, 1995). They prefer learning through activity and they cannot focus on challenging information passively (Dunn, 1999).

Tactile learning

Tactile learners prefer to learn through hands-on activities. They "need to touch and handle objects" (Oxford, 1995, p. 35). Those learners generally underline when they read and take notes while listening. They keep their hands busy (Wooldridge, 1995). They need to use manipulative and models (Dunn, 1999).

Individual Learning

Individual learning is one of the sociological styles. It refers to preferring to learn through working alone (Reid, 1995). Learners whose primary learning style is individuals learn more efficiently by themselves (Dunn, 1999). They want to pace themselves and become critical with the presence of an authority.

Group Learning

Group learning style is also one of the sociological styles. Group learners prefer learning through working with others and participating in group works (Reid, 1995). They like working in small groups, teams, or with a peer (Dunn, 1999).

Multiple intelligence and learning styles

There is a great deal of debate when it comes to contrasting between multiple intelligence and learning skills. It is, however, educative for us to note that majority of scholars in psychology and academia at large saw a great difference between multiple intelligence (intelligence) and learning styles. Intelligence conceived to be synonymous with ability is explained to mean an individual's capability of learning or performing certain cognitive tasks. Style, on the other hand, is perceived to be synonymous with preference and is explained to mean an individual's preferred mode of learning.

In light of the above several scholars advanced their arguments pointing out the differences between the constructs. Examples of these include;

Stenberg and Grigorenko (2001) emphasized a distinction between styles and abilities stressing that abilities and preferences may or may not correspond. They are of the view that styles can account for the variance in performance that cannot be accounted for by variance in ability tests. Gardner (1999) pointed out that:

> *The concept of style designates a general approach that an individual can apply equally to an indefinite range of content. In contrast, intelligence is a capacity, with its component computational processes, that is geared to a specific content in the world.*

To bring to bear the differences between the two constructs, he explained that when a person is said to be reflective, that person can be reflective with music or with mathematics or spatial thinking. He added that the relation between style and intelligence should be studied empirically on a style-by-style basis.

Similarly, Krechecsky and Seidel (2001) argued that learning styles are different approaches people apply to understand content whiles Intelligence is capacities related to neurological functions and structures that respond to content.

Contrary to the above assertions, Silver, Strong and Perini (2000) argued that learning styles and multiple intelligences complement each other by responding to each other's limitations. While MI theory is focused on the content of learning, it does not pay attention to the perception and process of information. On the other hand, learning style is centered on the process of learning while it is not directly concerned about the content of the learning.

The table below shows a connection between learning styles and multiple intelligence

Learning styles	Multiple intelligence
Visual learning	Logical-mathematical, Spatial-visual and Natural intelligence
Auditory learning	Linguistic and musical intelligence
Kinesthetic learning	Bodily-Kinesthetic intelligence
Individual learning	Intrapersonal intelligence

Tactile learning	Bodily-Kinesthetic intelligence
Group learning	Interpersonal intelligence

Note: intelligence stands the chance to influence more than a style and vice versa.

Activity 4.1

1. In brief explained the concept learning styles.

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2. How related or different are learning styles to multiple intelligence?

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3. Complete the table below with the following learning styles visual, auditory, kinesthetic, individual, tactile, individual and group.

	Learning styles	Multiple intelligence
1		Interpersonal intelligence.
2		Bodily-Kinesthetic intelligence
3		Bodily-Kinesthetic intelligence
4		Intrapersonal intelligence
5		Linguistic and musical intelligence.
6		Logical-mathematical, Spatial-visual and Natural intelligence

SUMMARY

In this section, we have discussed issues on the theme multiple intelligence theory as against learning styles. Some of the issues discussed are;

- Learning styles can be explained to mean one's unique or preferred approach to learning.
- Kinds of learning styles; visual, auditory, kinesthetic, tactile, individual and group learning styles.
- Learning styles and multiple intelligence are not same but are in tandem.

Unit 5 section 5

MULTIPLE INTELLIGENCE THEORY AND INCLUSIVE EDUCATION

INTRODUCTION

Dear learner, you are welcome to section five of unit five; multiple intelligence theory and inclusive education. In this section, you will be taken through multiple intelligence as a pedagogical tool in an inclusive classroom setting.

OBJECTIVES

On successful completion of this section, you will be able to:

- Demonstrate knowledge and understanding of multiple intelligence theory and its implication on inclusive education.

LEARNING INDICATORS

- Provide an accurate definition of inclusive education.
- Outline multiple intelligence strategies teachers can apply in inclusive classrooms.

Meaning of inclusive education

Etymologically, inclusive education is asserted to have originated from special education. The current curriculum for Ghanaian early grade schools placed much emphasis on inclusive education. Inclusive education in light of the curriculum can be explained to mean a process of addressing and responding to the varied needs of learners through the conscious effort of reducing exclusion within and from education, inclusive practices in learning, culture and communities (UNESCO, 2005).

Similarly, inclusive education can be explained to mean a system of education that emphasizes equity among learners and accommodates their varied needs, abilities and interest. For teachers to effectively implement inclusive education, there is the need for them to differentiate content, pedagogy and the curriculum at large to be in consonants with the varied needs of learners.

It is quite educative for us to note the implication of multiple intelligence theory on inclusive education. The theory of multiple intelligence has broad implications for special education. By focusing on a wide spectrum of abilities, MI theory places “disabilities” in a broader context. Using MI theory as a backdrop, educators can perceive learners with special needs as individuals possessing strengths in many intelligence areas. For example, a visually impaired learner may have or show competencies in areas such as linguistic, musical, bodily-kinesthetic, intrapersonal and/or interpersonal intelligence.

Implications of MI theory for special education

The influence that MI theory can have on special education goes far beyond the development of new remedial strategies and interventions. If MI theory is implemented on a large scale in both

the regular and special education programs in a school district, it is likely to have some of the following effects:

Fewer referrals to special education classes

When the regular curriculum includes the full spectrum of intelligence, referrals to special education classes will decline. Most teachers now focus on linguistic and mathematical intelligence, neglecting the needs of children who learn best through musical, spatial, bodily-kinesthetic, interpersonal, or intrapersonal intelligence. It is these learners who most often fail in regular classrooms and are placed in special settings (Armstrong, 1987a; Schirduan & Case, 2004). Once regular classrooms themselves become more sensitive to the needs of different kinds of learners through MI learning programs, the need for special placement, especially for learning disabilities and behavior problems, will diminish. This model thus supports the full inclusion movement in education (Kluth, 2003).

A changing role for the special education teacher

The special education teacher or learning specialist will begin to function less as a "pullout" or special class teacher and more as a special MI consultant to the regular classroom teacher. In this new role, MI consultants, perhaps operating like Gardner's student, can assist regular classroom teachers in some of the following tasks:

- Identifying learners strongest intelligences
- Focusing on the needs of specific learners
- Designing MI curricula
- Creating specific MI interventions
- Working with groups using MI activities

All or most of a special-needs/MI teacher's time can be spent in the regular classroom focusing on the individual needs of learners and the targeting of special MI activities to achieve educational outcomes.

A greater emphasis on identifying strengths

Teachers assessing special-needs learners will likely put more emphasis on identifying the strengths of learners. Qualitative and authentic measures (such as those described in Chapters 3 and 10) are likely to have a larger role in special education and may perhaps even begin to supplant standardized diagnostic measures as a means of developing appropriate educational programs.

Increased self-esteem

With more emphasis placed on the strengths and abilities of special-needs children, learners self-esteem and internal locus of control are likely to rise, thus helping to promote success among a broader community of learners.

Increased understanding and appreciation of learners

As learners use MI theory to make sense of their individual differences, their tolerance, understanding, and appreciation of those with special needs are likely to rise, making their full integration into the regular classroom more liable.

Eventually, the implementation of MI theory in education will inform a paradigm shift in special education which will facilitate a greater level of cooperation between special education and regular education. MI classrooms will then become the least restrictive environment for all special-needs learners except the most disruptive.

Models for special learners

To motivate and activate the interest of special needs individuals in education, there is the need for teachers, parents and stakeholders, in general, to inspire them with stories of special needs individuals who are successful in life. The stories should point at the varied disabilities such models struggled with and the primary intelligence(s) through which they expressed much of their genius.

Intelligence	**LI**	**CI**	**EI**	**PI**	**HI**	**SI**
Linguistic	Agatha Christie	Demosthenes	Edgar Allan Poe	Alexander Pope	Samuel Johnson	Rudyard Kipling
Logical mathematical	Albert Einstein	Michael Faraday	Charles Darwin	Stephen Hawking	Thomas Edison	Johannes Kepler
Spatial	Leonardo da Vinci	Marc Chagali	Vincent Van Gogh	Henri de Toulouse-Lautrec	Granville Redmond	Otto Litzel
Bodily Kinesthetic	Auguste Rodin	Admiral Preary	Vaslav Nijinsky	Jim Abbott	Marlee Matlin	Tom Sullivan
Musical	Sergei Rachmaninoff	Maurice Ravel	Robert Schumann	Itzhak Perlman	Ludwig van Beethoven	Joaquin Rodrigo
Intrapersonal	General George Patton	Aristotle	Friedrich Nietzsche	Joan of Arc	Helen Keller	Aldous Huxley
Interpersonal	Nelson Rockefeller	Winston Churchill	Harry Stack Sullivan	Franklin Roosevelt	King Jordan	Harry Truman
Naturalist	Linnaeus	Charles	Gregor	Jean Jacques	Johannes	E.O.

		Darwin	Mendel	Rousseau	Kepler	Wilson

Note: LD = learning impediments; CD = communication impediments; ED = emotional impediments; PD = physical impediments; HD = hearing impediments; SD = sight impediment

In our Ghanaian setting, we have several other models for our special learners. Notably among them is Honorable Henry Seidu Daanaa (born 1955) who served his motherland as a minister of Chieftaincy and Traditional Affairs in the erstwhile Mahama's administration. Notwithstanding his visual challenges, Daanaa displayed his intellectual ability in the field of law and had the honor of being crowned the first visually impaired legal practitioner in Ghana. Similarly, we have another visually impaired legal luminary in the person of Dr. Bashiru Koray. He is a disability rights advocate and honorary legal adviser to the Ghana Federation of Disability Organaisation. Last but not least is Ghanaian Highlife Legend, Mr. Nana Boakye Ofori Atta popularly known as Pozo Hayes in the Ghanaian music industry. He is a physically disable with musically intelligence who has made imprints in the lives of music lovers in Ghana. Educators who view disability against the background of the eight intelligence see that disability occurs in only part of a learner's life and not the totality of his being. Stemming from this teachers are encouraged to place much emphasis on the strengths of the special-needs learner as a pre-requisite to developing appropriate remedial strategies.

Activity 5.1

1. What is inclusive education?
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2. Outline three multiple intelligence strategies teachers can apply in an inclusive classroom.
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3. Outline three implications of Multiple Intelligence in the teaching and learning of mathematics.
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SUMMARY

We have discussed in this section that:

Inclusive education is a system of education that emphasizes equity among learners and accommodates their varied needs, abilities and interest

The implementation of inclusive education will lead to;

- Fewer referrals
- Change the role of a special education teacher to a special class teacher of consultant
- Increase self-esteem of special learners.
- Increase understanding and appreciation of special learners by their counterparts.

Bibliography

Armstrong, T. (2009). *Multiple intelligences in the Classroom* (3rd ed.). Virginia USA: ASCD.

Cherry, K. (2019, July 17). *Gardner's Theory of Multiple Intelligences*. Retrieved from Verywell Mind: https://www.verywellmind.com/gardners-theory-of-multiple-intelligences-2795161?print

Harvey , S., Richard, S., & Mathew, P. (1997, September). Integrating Learning Styles and Multiple Intelligence. *Teaching for Multiple Intelligence, 55*(1), 22-27.

Sabriye, Ş., & Ayten, Ç. (2018). An Investigation between Multiple Intelligences and Learning Styles. *Journal of Education and Training Studies, 6*(2), 125-132. Retrieved from http://jets.redfame.com

UNIT SIX

FACTORS THAT AFFECT TEACHING AND LEARNING OF NUMERACY IN EARLY GRADE

SECTION 1 PRINCIPLES OF TEACHING AND LEARNING EARLY GRADE MATHEMATICS

SECTION 2 TEACHERS KNOWLEDGE OF MAJOR FACTORS THAT AFFECT EARLY CHILDREN LEARNING OF MATHEMATICS

SECTION 3 TEACHERS KNOWLEDGE OF LEARNER TEACHER RATIO

SECTION 4 SOCIO-CULTURAL FACTORS IN PERSPECTIVE

SECTION 5 SOCIAL AND EMOTIONAL INTELLIGENCE AND CHILDREN LEARNING OF MATHEMATICS

SECTION 6 HELPING LEARNERS TO IDENTIFY AND EXPRESS THEIR EMOTIONS IN A BUSY CLASSROOM

UNIT 6 FACTORS THAT AFFECT TEACHING AND LEARNING OF NUMERACY

INTRODUCTION

Dear learner, you are most welcome to unit 6 of the course, theories in the learning of numeracy. This unit discusses principles of teaching and learning early grade numeracy, teachers knowledge of major factors that affect early grade children's learning of mathematics, factors that affect teaching and learning of mathematics in early grade mathematics classrooms and social and emotional intelligence and children learning of mathematics. **(NTS 1b,2c,e&f)**

OBJECTIVES

On successful completion of this Unit, you will be able to:

- Demonstrate clear understanding of the principles of teaching and learning early grade numeracy; factors that affect teaching and learning of early grade numeracy and their implications in classroom practice; and social and emotional intelligence **(NTECF P 4, 13, 18, NTS 3P)**.

Learning indicators

- Outline and analyse different broad composition of factors that affect learning and teaching of early grade numeracy.
- Describe conceptions about teacher-learner ratio as pre-requisites of Early Grade numeracy
- Discuss the conceptions about the principles of teaching and learning Early Grade numeracy
- Outline and analyse different roles that teachers play in developing children's emotional intelligence.

Wish you well in your studies.

SECTION 1 PRINCIPLES OF TEACHING AND LEARNING EARLY GRADE NUMERACY (MATHEMATICS)

INTRODUCTION

Dear learner, you are welcome to section 1 of unit 6; principles of teaching and learning early grade numeracy. In this section, we will discuss the concept of teaching and learning numeracy in early grade coupled with the principles of teaching and learning and their classroom implications.

OBJECTIVES

On successful completion of this unit, you will be able to:

- Demonstrate knowledge and understanding of the principles of teaching and learning numeracy in early grade classrooms. (**NTS 2e &f**)

LEARNING INDICATORS

- Discuss the conceptions about the principles of teaching and learning in early grade numeracy based on teacher-learner factors.
- Outline the principles of teaching and learning mathematics in the current early grade mathematics curriculum and analyse their effectiveness.

For effective comprehension of the topic under discussion there will be the need for us to grasp the individual concepts that are put together in the formation of the topic.

Activity 6.1.1

In brief, write down what comes to mind when you hear the following terms;

Learning

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Teaching

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Early grade

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Numeracy

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Compare your understanding with the explanations below.

PRINCIPLE

In simple language principle is explained to mean a guide for behavior. On the contrary, it is explained to mean rule(s) that are meant to be followed in law. It can also be explained to mean a fixed predetermine policy or mode of action. The varied definitions/ explanations of principle as presented above points at three basic constructs; a guide, policy and rule. This however, points to the fact that the concept principle has not got a universally accepted definition.

THE CONCEPT OF TEACHING

The concept teaching is not a novel term. Stemming from this fact, severally scholars and academicians alike turn to explain it to suet the purpose of their interest. In simple language, it is explained to mean what teachers do.

Schlechty (2004) defines teaching as an art of inducing learners to behave in ways that are assumed to lead to learning, including an attempt to induce learners to so behave. What Schlechty meant by teaching being 'an art' is that the teacher must create situations to facilitate learning and then motivate learners to have interest in what is being transmitted to them.

Melby (1994) also states that teaching is not merely dispensing subject or lesson-having, but an art which involves the learner in the teaching-learning process where the learner is given the chance to participate fully in the process – that the teacher accepts each pupil and has a favorable attitude towards individual differences. It is a relationship in which the teacher eschews sarcastic statements, ridicule and fault-finding.

Thring, (2001) says pouring out knowledge is not teaching. Hearing lessons is not teaching, teaching is getting at the heart and mind so that the learner values learning and to believe that learning is possible in his/her own case.

Smith (2004) sees teaching as the process of carrying out activities that experience has shown to be effective in getting learners to learn. He goes on to say that teaching is that which results in learning – learning is the responsibility of the teacher and that if learners do not learn, it is the fault of the teacher. He capped his statements on teaching by stating that teaching is undertaking certain ethical tasks or activities, the intention of which is to induce learning. Farrant (1980) simply defined teaching as a process that facilitates learning.

Frimpong (1990) defined teaching as the process whereby a teacher imparts knowledge, skills, attitudes and values to a learner or group of learners in a way that respects the intellectual integrity and capacity of the learners with the aim of changing the behavior of the learner(s)'. From this definition, one can say that teaching involves not only how information gets from the teacher to the learner but also how the learner (i) uses it, (ii) interacts with it, (iii) receives guidance (iv) receives feedback.

Confucius cited in Knott and Mutunga said "in his teaching, the wise man guides his learners but does not pull them along; he urges them to go forward and does not suppress them; he opens the way but does not take them to the place ….If his learners are encouraged to think for themselves, we may call the man a good teacher" (1993:158).

From the above definitions on teaching, one can surmise that there are two main types of institutionalized teaching – these are (a) formal teaching in which the teacher directs the teaching learning process with minimal learner participation and (b) informal teaching in which the teacher serves as a guide, facilitator, counselor or motivator and learner participation is very high.

THE CONCEPT OF LEARNING

The concept of learning just like teaching, is perceived differently by scholars and academicians. Below are some of the conceptions of learning by scholars.

Robert Gagne (1977), explain the concept of learning to mean a change in human disposition or capability that persists over a period of time and is not simply ascribed to processes of growth.

"Learning is the relatively permanent change in a person's knowledge or behavior due to experience. This definition has three components: 1) the duration of the change is long-term rather than short-term; 2) the locus of the change is the content and structure of knowledge in memory or the behavior of the learner; 3) the cause of the change is the learner's experience in the environment rather than fatigue, motivation, drugs, physical condition or physiologic intervention." *–From Learning in Encyclopedia of Educational Research, Richard E. Mayer*.

"Learning is a process of creating knowledge through the grasping and transformation of experience. (Kolb,

1984).

"Learning is a change in what you know caused by experience. Meaningful learning is a generative activity in which the learner actively seeks to make sense of the presented material (Fiorella & Mayer, 2015).

"Learning is defined as a process of Individual construction of knowledge 'from within' through assimilation and accommodation of ideas (Piaget, 2016).

"Learning is referred to as constructionist learning where learners construct mental models to understand the world around them. In this regard, learning is viewed as a reconstruction process rather than as a transmission of knowledge (Papert. S, 1982).

"Learning is a reflective activity which enables the learner to draw upon previous experience to understand and evaluate the present, so as to shape future action and formulate new knowledge (Moreno Bernal, 2004).

From the above definitions and explanations learning is asserted to be a byproduct of assimilation, experience, constructions of knowledge and understanding. In light of these learning can equally be perceived to be a continuous process of appreciating nature.

EARLY GRADE

As the name rightly suggest, early grade refers to the preliminary stages of education. In our Ghanaian setting it span from Kindergarten 1 to basic 3. It is also referred to as early childhood education and explain to mean a branch of educational theory that relates to the teaching of children (formally and informally) from birth up to the age of eight.

NUMERACY

Numeracy is perceived as a bridge between mathematics and the real world. Numeracy is an umbrella term that both expands the breadth of the mathematics that is considered and the contexts in which children use that mathematics. Numeracy is about making meaning of mathematics, at whatever level of mathematical skills, and mathematics is a tool to be used in variety of applications in both education and life. From the above exposition, principles of teaching and learning early grade numeracy can simple be explain to mean the rules governing teaching and learning of early grade numeracy. Below are some examples of principles for teaching and learning numeracy in early grade.

*Note: **numeracy** is used interchangeably with **mathematics** at the early stages of mathematics education.*

Principle 1 Children's beliefs or perceptions about intelligence and ability affect their cognitive functioning and learning.

Children develop beliefs about intelligence. Some children learn that intelligence is a fixed trait or an "entity." That is, people have a certain amount of intelligence, and this amount does not change. This perception of intelligence is labeled as a "fixed" or an "entity mindset." Other children believe that intelligence is malleable or changeable, a "growth" or "incremental mindset," and that with effort, practice, and better strategies they can become smarter. Children's mindsets may vary by situation or context and may be affected by cultural differences.

There are educational implications for each of these mindsets. Children who have a fixed mindset tend to focus on their performance, thinking that those who can do tasks quickly are more intelligent than those who take their time. These children may want to demonstrate and prove their intelligence, and to look smart in others' eyes. These children are subsequently more

reluctant to take on challenges and are more resistant to constructive feedback. In contrast, children with a growth mindset are generally more willing to engage in challenging tasks that test and expand their intelligence. Hence, they rebound more easily from negative feedback and failure and may even see these setbacks as opportunities for learning.

Educational implications

- Teachers can recognize children's improvement in their performance over time. In early childhood settings, a teacher can reframe a challenge to help children see their progress rather than their immediate ability to meet a performance benchmark. For example, if children are expected to identify all letters of the alphabet, instead of testing children on letters in isolation and indicating whether they are correct or incorrect, the teacher could keep records of children's letter naming in natural classroom contexts over time.

- Teachers should be careful not to give indirect and subtle cues about low ability (see principle 11). They can unintentionally communicate a child's low ability when they attempt to protect the self-esteem of children who are less secure about their ability.

- Teachers should monitor situations in which children expend minimal, modest, or incomplete effort when presenting children with challenging materials and tasks. This self-handicapping may reflect a child's fear of embarrassment or failure ("If I don't even try, people will not think I'm dumb if I fail").

PRINCIPLE 2 what children already know affects their learning.

Children bring their previous knowledge and experiences into their early childhood classrooms. Previous knowledge is a result of children's everyday experiences at home, in childcare settings, in their community, or from social interactions with their family or friends. Prior knowledge influences how young children incorporate new knowledge and what they learn from new experiences. Accordingly, learning consists of either adding to existing knowledge, which is known as conceptual growth; or transforming or revising knowledge, known as conceptual change. Conceptual growth occurs when children's previous knowledge is consistent with new knowledge.

Classroom application

- Teachers should assess children's current level of knowledge and previous experience (i.e., conduct "formative assessment" (see Principle 18) before they begin teaching a topic.

- When young children do not have sufficient first-hand or background knowledge about a topic, teachers should provide activities that present background information before they teach new information.

- Teachers can have children play an active role in predicting outcomes or solutions and then show the actual results. This is especially important if the children's predictions are faulty.

- Teachers can present children with credible information or data that run counter to their misconceptions.

PRINCIPLE 3 Children's cognitive development and learning are not limited by general stages of development.

Children's reasoning is not limited or determined by underlying stages of cognitive development. That is, stages of development are not linked to a particular age or grade level. Historically, many people have identified development as progressing through a number of fixed stages and at fixed ages. For example, theories have proposed that preschool children have difficulty taking the perspective of others while elementary aged children do not have this difficulty. However, researchers generally find that these developmental stages are more descriptive about the ability to demonstrate these skills rather than how the skills themselves transform through stages.

Classroom application

In sum, children are capable of higher-level thinking and behavior when:

- There is some biological base (early competency) for knowledge in the domain,
- They already have some familiarity or expertise with a knowledge domain,
- They interact with more capable others or with challenging materials, and
- They are in sociocultural contexts from which they become familiar with that topic through experience.

Conversely, when children are not familiar with particular knowledge in a domain, are not challenged by the interpersonal context or learning materials, or are in a context for learning that is too unfamiliar to them, their reasoning may be less sophisticated

Classroom implication

- Ask children to make connections between what they learn at school and their lives at home.
- Help children see the application of their knowledge to the real world (e.g., using addition and subtraction to understand the cost of purchases in stores) or assist them in transferring real-world knowledge when trying to understand academic principles.
- Identify and build on strengths and experiences that children bring to a learning situation.

PRINCIPLE 4 Learning is based on context, so generalizing learning to new contexts is not spontaneous but instead needs to be facilitated.

Learning occurs within multiple contexts. These contexts can focus on one of several domains of learning such as cognitive domains (e.g., mathematics development and scientific reasoning), visual-spatial domains (e.g., pattern recognition, eye-hand coordination), or social domains, including relationships with adults and other children (e.g., caretaking routines between a parent

and child, interactions between children during free play). Children do not automatically transfer or generalize their knowledge from one context or situation to new contexts or situations. In fact, the more dissimilar the new context is from the original learning context, the more difficulty children will experience.

Classroom application

- Ask children to make connections between what they learn at school and their lives at home. "When your family buys food, how do you use numbers?" "Where have you seen numbers on your way to school?"
- Help children to see the application of their classroom knowledge to the real world (e.g., using addition and subtraction to understand the cost of purchases in stores) or assisting them in transferring real-world knowledge when trying to understand academic principles.

PRINCIPLE 5 Acquiring long term knowledge and skill is largely dependent on practice.

To be retained more permanently, information must be transferred into long-term memory, which, by definition, is of relatively long duration (e.g., decades), has very large capacity, and is highly organized (e.g., categorized). The transfer of information from short-term to long-term memory occurs when children use different strategies, and practice is key to this transfer process.

Classroom application

- Teachers could use music and movement activities to help children acquire long-term knowledge through songs, which physically engage children.
- Rote learning experiences can be incorporated into everyday activities such as transitions.

In addition to the above under listed principles include the following. Early grade teachers must;

- Time the various stages of a lesson so that each stage receives the desired attention without exceeding the time limit of the lesson.
- Detect when his/her pupils are getting bored or restless so that s/he can vary his/her approach or the stimulus.
- Use the experiences of his/her pupils to initiate as well as generate further learning.
- Make judicious use of available resources in the teaching-learning process.
- Present what s/he teaches in an interesting way.
- Write orderly layout of summaries on the chalk/whiteboard.
- Express him/herself and illustrate his/her points clearly in the lesson particularly in his/her explanation of content.

- Design suitable and adequate quantity of exercises and assignments for his/her pupils, and insist on prompt tackling and submission.
- Use good or correct language in the teaching process.
- Correct and direct his/her pupils without making them feel embarrassed or frustrated.
- Learning situations that will serve as challenges to his/her pupils.
- Select appropriate learning experiences of his/her pupils.
- Employ a variety of teaching methods and techniques within a lesson.
- Generate divergent thinking and creativity in his/her pupils.
- Be able to achieve the objectives of his/her lessons.
- Use praise to urge his/her pupils to become eager to participate more in a lesson.
- Study and become aware of the need of the individual pupils in his/her class.
- Be able to assist his pupils/learners to able to assess their own performances.
- Maintain a reasonable balance between pupil-activity and teacher-activity as dictated by the nature of the lesson.

Activity 6.1.2

1. Outline three principles of teaching early grade mathematics coupled with their respective classroom implications.

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II. ……
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SUMMARY

In this section, we discussed the principles of teaching and learning numeracy in early grade classrooms and their classroom implication. Below is an excerpt of what we have learnt;

nciple	assroom implication(s)
arning occurs within multiple contexts.	• Ask children to make connections between what they learn at school and their lives at home. • Help children to see and realize the application of their classroom knowledge to real world situations.
Children's cognitive development and learning are not limited by general stages of development.	Children are capable of higher-level thinking and behavior when: • There is some biological base (early competency) for knowledge in the domain. • They already have some familiarity or expertise with a knowledge domain. It behooves on early grade teachers to provide enabling environment for the above.
Acquiring long term knowledge and skill is largely dependent on practice.	• Teachers could use music and movement activities to help children acquire long-term knowledge through songs, which physically engage children. • Rote learning experiences can be incorporated into everyday activities such as transitions.
What children already know affects their learning.	• Teachers can have children play an active role in predicting outcomes or solutions and then show the actual results. This is especially important if the children's predictions are faulty. • Teachers can present children with credible information or data that run counter to their misconceptions.

SECTION 2 TEACHERS KNOWLEDGE OF MAJOR FACTORS THAT AFFECT EARLY CHILDREN LEARNING OF MATHEMATICS

INTRODUCTION

Dear learner, you are welcome to section 2 of unit 6; teachers' knowledge of major factors that affect children learning of mathematics in the early grade classroom. In this section, we will discuss the factors that affect the teaching and learning of numeracy in early grade classrooms.

OBJECTIVE

- Demonstrate understanding of factors that affect the teaching and learning of mathematics in early grade classrooms. **(NTS 2e &f)**

INDICATORS

- Outline and analyse different broad composition of factors that affect learning and teaching of early grade numeracy.
- Discuss the impact teachers' knowledge of some factors affecting children learning on their classroom practice. Of teaching and learning of early grade numeracy.

The National Council of Teachers of Mathematics (NCTM) and the National Association for the Education of Young Children (NAEYC) affirm that high-quality, challenging, and accessible mathematics education for 3- to 6-year-old children is a vital foundation for future mathematics learning. In every early childhood setting, children should experience effective, research-based curriculum and teaching practices. Such high-quality classroom practice requires policies, organizational supports, and adequate resources that enable teachers to do this challenging and important work (NAEYC & NCTM, 2002). It is however quite educative for us to note that the above under listed activities would not be fruitful if teachers luck the appropriate mathematical knowledge.

Teacher's knowledge in teaching early grade mathematics is broader in scope. For as to effectively comprehend the topic under discussion, there is the need for us to understand what a factor is and the components of mathematical knowledge.

FACTOR

A factor can simply be explained to mean causative agents or elements that give rise to a situation.

MATHEMATICAL KNOWLEDGE FOR TEACHING EARLY GRADE MATHEMATICS

According to Ball (2002) mathematics knowledge is the knowledge teachers need to carry out their work as teachers of mathematics. Mathematical Knowledge for Teaching (MKT) encompasses abilities such as analyzing the learner thinking that led to an incorrect answer,

identifying the mathematical understanding a learner does not yet have, and deciding how to best represent a mathematical idea so that it can be understood by learners. A cursory look at the definition brings to bear three components of knowledge early grade teachers need to be abreast with in other to effectively present curricular content to learners. These include pedagogical knowledge, content knowledge and knowledge of early grade learners.

FACTORS THAT AFFECT TEACHING AND LEARNING OF MATHEMATICS IN EARLY GRADE.

They are countless number of factors that affect teaching and learning of mathematics in early grade classrooms. Certain factors are innate or personal to the individual engaged in the process of learning that are specifically unique to him/ her. These factors include intelligence, motivation, emotions, interests, attitudes, beliefs, values, learning styles etc. There are certain other factors which belong to the environment or the surroundings with which the individual continuously interacts. Such factors include family, peer-group, neighborhood, community, school-related factors etc. All these personal and environmental factors play a crucial role in influencing learner learning.

Personal factors (psychological factors) are the intra or within individual factors like intelligence, motivation, interests, attitudes, etc. which predispose an individual towards learning. Environmental factors, on the other hand, are those contextual factors, which highlight the role of the environment in learning, such as the socio-emotional, societal, cultural and other school-related factors. Although these factors represent two different categories, they operate in a common system. The learner and the learning process can only be completely understood with reference to the interaction of both personal and environmental factors.

Personal (Psychological) Factors Influencing Learning of Numeracy

Psychological factors are unique or specific to the individuals engaged in the process of learning. A thorough knowledge and understanding of these factors is very essential for the teachers and parents in providing and guiding learning among the children. A detailed discussion of the sub-factors falling in the domain of psychological factors that influence learning is provided here:

Intelligence

Research studies revealed that intelligence is positively related to learning ability of the children. You must have seen wide variations across individuals and cultures as to what actually constitutes intelligence. Let us take a closer look at what this statement means by engaging in the following analytical task:

- Tuohisung always comes first in class.
- Sungnuma has the ability to memorize dates and years of historical events in a chronological order.
- Mavis is very good in dancing.
- Samuel can produce sound of any bird or animal.

- Amah is a good table-tennis player.

Looking at the above profiles of five learners, could you identify who is the most intelligent learner? Perhaps, you cannot. This is because each of the five learners has their distinctive talent in their own area or field. This is indicative of the fact that you cannot define 'intelligence' with a single context. Probably, there are as many definitions of intelligence as there are experts who study it. Broadly, we can define intelligence as the ability to learn about, learn from, understand, and interact with one's environment. This general ability consists of a number of specific abilities, which include:

- adaptability to a new environment or to changes in the current environment;
- capacity for knowledge and the ability to acquire it;
- capacity for reason and abstract thought and to comprehend relationships;
- ability to evaluate and judge; and Factors Affecting Learning
- capacity for original and productive thought.

Besides this, intelligence as a concept has been understood in different ways by different psychologists and has, therefore, a wide variety of definitions (**Refer to unit 5**).

Motivation

Motivation may be regarded as something which prompts, compels and energizes an individual to act or behave in a particular manner, at a particular time for attaining some specific goals or purposes. Motivation may also be formally defined as an internal state that arouses, directs and maintains behavior. In light of the above explanations motivation can simply be explained to mean an internal energy or mental force that drives a person to achieve a goal.

Motivation plays a pivotal role in learning and it is an academic reality. In fact it serves to activate, guide and maintain learning. In a sense, motivation is an index of the eagerness of an individual to learn. Adequate motivation not only sets the activities in motion which results in learning, but also sustains and directs these activities. It is, thus, an indispensable factor in promoting learning, as it energizes and accelerates the process and evokes a very positive response from the learner. You would have observed that some learners learn the same task or subject matter more efficiently than others, because they find it more rewarding and interesting.

Maturation for Readiness to Learn

A learner's readiness and will power to learn is a great deciding factor of his/her results in learning. It is presumed that if an individual has will to learn, then automatically he/she will find ways for effective learning. In other words, the learner should be mature enough to learn a particular skill or task. This means that there is an optimal or most appropriate time for each individual to learn a specific skill or a concept with ease and efficiency. This indicates that an attempt to teach things before learners attain adequate level of readiness is futile. This also serves

to explain why non-performance on the part of learners or their inability to grasp a concept can be attributed to lack of adequate maturation and readiness to learn.

Emotions

Emotions can simply be explained to mean an agitated or excited state of our mind and body. The connections between emotions and learning are bi-directional and complex. When we think about a happy incident, our mood improves. When we think about an angry incident, we are likely to feel angry. Also, being in a happy mood makes us think about happy thoughts; being in a sad mood brings sad and negative memories and images to mind. Hence, we may say that emotions can affect learning, in both positive and negative ways.

Learning styles

Individual show preference for different learning conditions. These are called learning styles, or learning preferences. The learning style theories recognize that individuals learn in different ways and that each individual has a unique style of learning. You must have noticed that some learners learn well in the morning while some others prefer to study at night. Some learners like to sit in quiet places, while some others like to have music accompanying their learning.

Self-concept

In the context of learning, the 'self-concept' of an individual assumes considerable importance since it represents what an individual feels about himself/herself and his abilities to perform and achieve. Self-concept is a broader term which includes the sub-categories of self-image, self-esteem and self-efficacy. Let us try to understand all the three since these have a bearing on learning. Self-image refers to one's own perceptions about oneself – what are one's strengths and capabilities and what are one's weaknesses or limitations. It is usually based on the self-analysis or energies in the course of one's real life experiences. You must have heard many learners say "I'm good at mathematics or art or english and simply awful at geography or science". This is a judgment they make about themselves after engaging with these subjects over a period of time. It assumes importance as the learner who feels that, she/he is good at mathematics or english will learn these subjects with great interest, energy and enthusiasm, unlike subjects which she/he finds him/her weak. This holds true for all other activities as well. Those learners who feel that they are weak at sports or art or creative work, will try to avoid these activities and will take much more time and effort to learn them. Thus self-image influences the direction and intensity of our learning. Very closely related to the concept of self-image, is self-esteem. Self-esteem refers to the value a person places on himself or herself. It is the ideas one has about his/her attributes and abilities. These ideas are not only based on personal experience and self-analysis but are located within the domain of how one perceives one's acceptance and recognition by others. Self-esteem is thus a measured component of self-concept. It is almost like an evaluation of oneself.

Attitude

Attitude can simply be explained to mean preconceived ideas and notions which exist in our psyche. Attitudes may be positive, negative or natural. The direction of children attitude is

important for it influences what they learn willingly and what they will be unwilling to lean or do. Thus the positive or negative predisposition within a person has important motivational components. When learners have a positive attitude towards the school, not only does it imply that they will like school, but they are likely to endeavor to do well, to be liked by the teachers and will conform to the culture, goals and expectations of the school.

Interest

Interests are actually deep rooted constructs and are determined by the need structure of an individual. An individual with strong social needs such as belongingness, affiliation and recognition will direct all his/ her energies into activities which enable him/her to fulfill these needs such as meeting people, going to clubs, associations, parties, meetings, etc. In theoretical terms, an interest may be defined as a learnt or acquired motive stemming from some inherent needs of the individual which drive him/her to act in a way that will sustain or satisfy his/her inner need structure.

Individual differ a great deal in their patterns of interests because their need structures vary. For some persons, social and emotional needs become the guiding forces, for others, aesthetic or higher cognitive needs may be the preponderant factors. Age variations are also visible. Young children have a need for activity, play, adventure etc. and thus they learn much better through a play way approach. This arouses their interest in studies and helps to sustain their involvement in work.

Socio-Cultural (Environmental) Factors Influencing Learning

The socio-cultural environment, within which a child grows, has a significant impact on his/her learning of numeracy. This encompasses;

- Family
- Neighborhood and community
- Socio-cultural diversities like, caste, class, ethnicity, religion, etc.

In fact, all learning occurs with special reference to the cultural context of an individual. The social constructivist view of psychology holds that all learning is culturally oriented and guided.

School Related Factors Influencing Learning

Learning is also assumed to be greatly influenced by the school and the school environment in which learners are imparted with different types of learning experiences. The term ‘school environment’ encompasses the terms ‘school culture’ and ‘school climate’ that affect the behavior of teachers and learners. School culture is the shared beliefs and attitudes that characterize the districtwide organization and establish boundaries for its constituent units. School climate characterizes the organization at the school building and classroom level.

The school related factors encompasses the following the aspects of the school climate:

- A physical environment that is welcoming and conducive to learning;

- A social environment that promotes communication and interaction;
- An affective environment that promotes a sense of belonging and self-esteem;
- An academic environment that promotes learning and self-fulfillment

It is however educative for us to note that none of the aspects outline above is mutually exclusive but rather influence each other.

Teaching-Learning Process Related Factors Influencing Learning

Effective learning promotes good memory of the corresponding material. The quality of learning depends on the abilities of a teacher and a learner to link the present new learning with the past experiences of the learner which helps the learner to assimilate and understand new learning. In the same way, one can expect good results in learning, if learning experiences are given in view of seeking correlation among different subjects or areas and with real life happenings and situations.

Socio-economic background of learners (parents)

Socio-economic factors such as income, education, employment and safety significantly influence the teaching and learning of early grade numeracy. For learners to effectively concentrate in class, they should have a sense of security and protection from their respective homes. Families have to provide basic necessities such as food, shelter, uniform and learning materials. The ability of parents to provide this necessities is closely related to their socio-economic background.

Appropriate training

Having the appropriate training to teach a specific subject is an important factor in being able to teach that class effectively. For teaching in the early grade system, teachers should have taken courses in the subjects they wish to teach. In Ghana early grade teachers are class teacher and not subject masters for that matter should be equipped with the requisite knowledge to teach early grade numeracy and other related subjects.

Environmental factors

One of the factors that affect the efficiency of teaching and learning is the condition in which learning takes place. This includes classrooms, textbooks and other instructional materials. The conditions for learning must be favorable and adequate if teaching of numeracy is to provide the desired results. It is an obvious fact that the type and quality of instructional materials and equipment play an important part in the instructional efficiency of the school.

Emotional and social factors

Personal factors, such as instincts and emotions, and social factors, such as cooperation and rivalry, are directly related to a complex psychology of motivation. It is a recognized fact that the various responses of the individual to various kinds of stimuli are determined by a wide variety of tendencies.

Some of these innate tendencies are constructive and others are harmful. For some reason a pupil may have developed a dislike for some subject because he may fail to see its value, or may lack foundation. This dislike results in a bad emotional state.

Some pupils are in a continuing state of unhappiness because of their fear of being victims of the disapproval of their teachers and classmates. This is an unwholesome attitude and affects the learning process to a considerable degree. This is oftentimes the result of bad training.

Social discontent springs from the knowledge or delusion that one is below others in welfare.

Teacher's Personality

The supreme value of a teacher is not in the regular performance of routine duties, but in his power to lead and to inspire his pupils through the influence of his moral personality and example. Strictly speaking, personality is made up of all the factors that make the individual what he is, the complex pattern of characteristics that distinguishes him from the others of his kind. Personality is the product of many integrating forces.

The teacher as an individual personality is an important element in the learning environment or in the failures and success of the learner. The way in which his personality interacts with the personalities of the pupils being taught helps to determine the kind of behavior which emerges from the learning situation.

TEACHERS MATHEMATICAL KNOWLEDGE FOR TEACHING

Teachers mathematical knowledge for teaching is an umbrella term which incorporates; knowledge of content; knowledge of curriculum; pedagogical content knowledge; knowledge of pedagogy; knowledge of learners and learning; knowledge of contexts of schooling; and knowledge of educational philosophies, goals, and objectives (Shulman, 1987). It entails all that a teacher needs to effectively and efficiently present mathematical contents to learners. Below is an explanation of some of the required knowledge bases.

Knowledge of content (content knowledge/subject matter knowledge)

The term content knowledge refers to the body of knowledge and information that teachers teach and that learners are expected to learn in a given subject or content area, such as English language arts, mathematics, science, or social studies. Content knowledge generally refers to the facts, concepts, theories, and principles that are taught and learned in specific academic courses, rather than to related skills—such as reading, writing, or researching—that learners also learn in school.

Pedagogical knowledge

The term pedagogical knowledge refers to a specials knowledge of teaching and learning that encompasses teachers' knowledge of creating effective teaching and learning environment for all learners. It comprises the understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that learners of different ages and backgrounds

bring with them to the learning of those most frequently taught topics and lessons. In simple language it is explained to mean “how to teach for understanding”.

Knowledge of learners

Knowledge of learners is an important component of teachers’ knowledge of teaching elementary mathematics. It is explained to mean teachers knowledge in learners’ misconception, preconceptions, and conceptions. This category of teachers’ knowledge requires teachers to present content to meet the varied needs of learners’ needs and backgrounds.

Pedagogical content knowledge

Pedagogical content knowledge is a type of knowledge that is unique to teachers, and is based on the manner in which teachers relate their pedagogical knowledge (what they know about teaching) to their subject matter knowledge (what they know about what they teach).

Activity 6.2.1

1. List and explain three factors that influence the teaching and learning process.

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2. Explain the following concepts;

   Content knowledge

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   Pedagogical knowledge

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   Pedagogical content knowledge

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SUMMARY

In this section, we discussed and comprehended some of the factors the affect teaching and learning of numeracy in early grade classrooms coupled with some components of teachers' mathematical knowledge.

Note withstanding the numerous factors that affect the teaching and learning of numeracy in early grade, the current section brings to light the key factors:

- Personal/psychological factors; these includes interest, attitude, learning styles, self-concept, intelligence, readiness to learn and motivation
- Socio-cultural factors; these includes family, community and Socio-cultural diversities like, caste, class, ethnicity, religion, etc.
- Teaching-Learning Process Related Factors; these include teacher's personality and qualification, socio-economic background of learners and lesson environment.

With regards to the components of mathematical knowledge for teaching early grade we leant that: **Pedagogical knowledge** is knowing 'how to teach for understanding'; **Content knowledge** is knowing what to teach; knowledge of learners is having knowledge of learner conceptions (preconceptions and misconceptions) of mathematical concepts and **Pedagogical Content Knowledge** (**PCK**) as teachers knowledge of what to teach, how to teach it for learners to understanding.

SECTION 3TEACHERS KNOWLEDGE OF LEARNER TEACHER RATIO

INTRODUCTION

Dear learner, you are welcome to section 3 of unit 6; teachers knowledge of learner teacher ratio. In this section, we will discuss the impact of teachers' knowledge of learner teacher ratio on their classroom practices.

OBJECTIVES

- Demonstrate clear understanding of learner teacher ratio.

INDICATORS

- Discuss the impact learner teacher ratio on their classroom practice.

Learner teacher ratio can simply be explained to mean the number of pupil enrolled per teacher in an educational institution. It is obtained by dividing total number of learner enrolment by the number of teachers in a given educational institution. It is one of the factors that stand a chance to pose serious threat in the teaching learning environment if not checked.

Class size is an important factor in relation to academic performance of learners. There is a consensus among various researchers and educationists that, the lower the class size or teacher-learners ratio, the better learners perform. Classrooms with sizable or less learner population pose few or no challenges to learners and makes it easy for teachers to effectively evaluate and get positive feedback from learners.

Classification of Pupil Teacher Ratio

The required ratio for pupil to teachers for Ghanaian early grade classroom is 30: 1. Notwithstanding the generally accepted ratio, learner teacher ratio is however categorized under three sub headings; acute surplus, mild surplus, acute shortage and mild shortage. The categorization is based on the availability and allocation of teachers as compared to number of learners enrolled. Below is an elucidation of the various categories.

- **Acute surplus**: It is simply a situation where learner teacher ratio below 15:1, thus 15 pupils to a teacher.
- **Mild surplus:** It is a situation where learner teacher ratio is between 24:1 and 15:1, thus 15-24 pupils to a teacher.
- **Acute shortage**: it is explained simply to mean learner teacher ratio higher than 45:1, thus more than 45 learners to a teacher.
- **Mild shortage**: In contrast to acute shortage, mild shortage is a learner teacher ratio between 36:1 to 45:1. Thus about 36-45 learners to a teacher.

Classroom Implication of learner Teacher Ratio

To comprehend and appreciate the implication of learner teacher ratio in the teaching and learning of early grade mathematics, there is the need for as to understand the teaching strategies

for early grade mathematics. It is however, quite educative for as to understand that learners manifest varied interest and needs at early stages of learning. Teachers at this stage of education have to employ varied strategies that appeal to the needs of heterogeneous group of learners under their care. Blow are some of the effective teaching strategies that can help learners to efficiently improve their learning abilities:

Visualization of information

Visualization is a great method to summarize or process information that has been taught in class. When learners consume information through visual means, it helps them retain what they have learned for a longer time. This strategy also helps slow learners in class to visualize the ongoing lesson in a clear, simple and systematic way.

Learner-led Classrooms

Learner-led classrooms have become a creative way for teachers and learners to interact and carry out discussions in the class. Encouraging learners to switch roles and become teachers for the day not only helps them in gaining confidence but also brings in a new perspective to the class.

Differentiated instruction

It is a popular and effective teaching strategy that involves reacting to the diverse learning styles in every classroom with adjusted content and processes. As an approach to teaching differentiation should cut across all facets of education. Thus the curriculum, lesson planning, lesson delivery, and assessment all should be carried out with learners needs and interest in mind.

Gamification

It is a process of learning that appeals to the interest of learners and surge up fun and energy levels of learners. This strategy of teaching is stress free and make learners active participants in the teaching and learning process. Research had it that children at the early stages are found of playing and for them to be hooked on to lessons the classroom environment should be structured to resemble their playground.

Scaffolding

Scaffolding simply is a systematic process of presenting lessons in bits or from known to unknown so as to captivate and sustained the interest of learners. Similarly, scaffolding is perceived as legend or key that shows children the way to acquire knowledge. With this approach in mind mathematics teachers are required to practice acculturation and enculturation of mathematics. Thus creating a link between the child's environment and mathematics and effectively imbibing in the child the culture of mathematics.

Notwithstanding the numerous benefits tied with the teaching strategies elucidated above, it will however be educative for us to note that learner teacher ration pose a great challenge to teachers and learners when carrying out this strategies.

Activity 6.3.1

1. Explain the following terms;
    I. Acute surplus

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    II. Mild shortage

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    III. Acute shortage

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2. Which of the following is not a category of learner teacher ratio?
    a. Acute surplus
    b. Mild surplus
    c. Mild shortage
    d. Acute moderate
3. A systematic process of presenting lessons in bits to captivate and sustain the interest of learners is termed as …….
4. A learner teacher ratio of 15-24 learners to teacher is termed as ……..

SUMMARY

In this section we discussed learner teacher ratio as a factor that affect the teaching and learning of numeracy coupled with it classroom implication.

Learner teacher ratio is explain to mean number of pupil enrolled per teacher in an educational institution. Below are the sub-categories of learner teacher ratio.

- **Acute shortage** is a learner teacher ratio higher than 45:1.
- **Acute surplus** is learner teacher ratio of 15:1
- **Mild shortage** is a learner teacher ratio between 36:1 to 45:1.
- **Mild surplus** is a situation where learner teacher ratio is between 24:1 and 15:1, thus 15-24 pupils to a teacher.

Note: the appropriate learner teacher ratio for Ghanaian early grade schools is 30:1.

SECTION 4 SOCIO-CULTURAL FACTORS IN PERSPECTIVE

INTRODUCTION

Dear learner, you are welcome to section 4 of unit 6; socio-cultural factors in perspective. In this section we will discuss the socio-cultural factors that affect teaching and learning on numeracy in early grade classrooms.

OBJECTIVE

- Demonstrate knowledge and understanding of the social cultural factors that affect teaching and learning of numeracy in early grade classrooms. (**NTS 2e &f**)

LEARNING INDICATORS

- Outline and explain at least three socio-cultural factors that affect teaching and learning of numeracy in early grade classrooms.

The socio-cultural environment, within which a child grows, has a significant impact on his/her learning. In fact, all learning occurs with special reference to the cultural context of an individual. The social constructivist view of psychology holds that all learning is culturally oriented and guided. For our own understanding, we can sub-divide socio-cultural factors into:

a) Family,

b) Community; and

c) Socio-cultural diversities like, caste, class, ethnicity, religion, etc.

Family

The family serves as the bedrock that models and nourish the learning abilities of children. It plays a fundamental role in the socialization process of an individual. It is within the structure of the family that a child learns the behavior patterns for survival, attitudes, social skill, interpersonal skills, social norms, the do's and don'ts of his/her culture and community, acquires a sense of right and wrong, a value orientation etc. In light of these, the family is perceived as the site of all learning. In a family, the relationships with the parents play a vital role in the learning process of the learners. If the child-parents relationship is based on mutual respect and faith, it can provide the child a congenial atmosphere which in turn can facilitate his/her learning. A distorted and unhealthy environment, on the other hand, adversely affects the learning of the learner. The upward mobility brings resistance on the part of the learner to learn. Learners in such families find themselves unable to cope up.

Community

The neighborhood and community in which a child lives also have a potent impact on what he/she learns and acquires. Many attitudes, habits, beliefs, perceptions, stereotypes and social roles and responsibilities are shaped directly or indirectly by child's experiences with the persons in his/her neighborhood. These persons include his/her peers and age-mates and all the elders

around his/ her. Through conditioning, social learning, direct instruction and modeling a child learns a number of things from them.

Peers

A healthy peer relationship also plays an important role in learning. Learner relationship in the classroom, school, society, etc. creates a particular type of emotional climate. A sound peer relationship provides a tension free environment to the learner to learn more and to compete in the class. If the relationship among peers in not good, it adversely affects their learning. Therefore, it is recommended that in order to improve classroom learning climate, free discussions should be organized during teaching-learning process. The learner should be encouraged to meet each other and their teachers freely. If any misunderstanding is created or developed, it should be immediately clarified so as to maintain the healthy climate and cordial relationship among peers.

Casts, Class and Religion

In our country, casts, class and religion also play a predominant role in shaping our identity, self-concept, attitudes, value orientation, goals and achievement patterns. For example, the socio-economic status of the group to which we belong can be directly linked with the degree of stimulation or enrichment available to us in our learning environment. It has been seen that an adequately enriching and stimulating environment provides the learner with more learning opportunities, and greater control over the environment than an impoverished or needy environment.

Learning is also seen to vary across religious and ethnic groups, owing to the distinction in their beliefs, values, attitudes and practices. In the Pan Indian culture, we are encouraged to develop a sense of autonomy, independence and control over our own lives. In many orthodox communities, the social learning of girls is fraught with biases and injunctions which are justified in the name of religious beliefs. The kinds of experiences which a learner is exposed to, differ across regions and geographical locations as well.

Hence, it may be concluded that the socio-cultural environment provides us with a learning framework. Learning is a process of constructing meaning of our experiences and in this process of ‘meaning making’ the socio-cultural dispositions and training we have received are likely to exert their influence.

Culture of the society

The culture of a society is relative; behaviors that are abhorred by a culture may be upheld and encouraged in another culture. For example, to in steal toughness, smartness and bravery among children, Ancient Greeks do send their children out to steal from their neighbors. If a child is caught, s/he was punished severely for not being smart to escape and not for committing the act. Similarly some cultures regard aggressiveness as an act of self-defense and train their children to be tough and aggressive. In contrast to the above some cultures despise the acts elucidated above and trained the children to desist from their practice.

Activity 6.4.1

1. Outline and explained three socio-cultural factors that affect teaching and learning of numeracy in early grade classrooms.
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   III. ……
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SUMMARY

Scio-cultural factors are social and emotional elements that stand the chance to positively or negatively influence the teaching and learning of numeracy in early grade classrooms. Examples of these include:

- Family-It is within the structure of the family that a child learns the behavior patterns for survival, attitudes, social skill, interpersonal skills, social norms and the do's and don'ts of his/her culture and community.
- Community- next to the family is community. It equally provides learners a window to learn societal norms and improves upon their interpersonal skills.
- Peers – it is one important element teachers and other stake holders have to pay attention to. Learners fill free to share with their peers their feelings and situations in which they find themselves and how they manage to address those challenges. This narratives stand a greater chance to positively or negatively influence the behavior of learners.

INTRODUCTION

Dear learner, you are welcome to section 5 of unit 6; social and emotional intelligence and children learning of mathematics. In in this lesson you will be taken through the concepts social and emotional intelligence coupled with the features of a socially and emotionally intelligent learner in an early grade mathematics classroom.

OBJECTIVES

- Demonstrate understanding of social and emotional intelligence and how this influence early grade children's learning of mathematics.

LEARNING INDICATORS

- Outline and analyse different roles that teachers play in developing children's emotional intelligence.
- Discuss the basic ingredients of emotional and social intelligences (self-awareness, self-control, empathy, personal motivation and relationships skills)

Education is a major determinant of progress and development in any given human society (country). The educational system of any given country seeks to produce learners who are sufficiently trained to contribute meaningfully to the development of the system and the society at large. Research had it that the effectiveness of any educational system is measured by the extent to which the learners involved in the system achieved with their cognitive, affective and psychomotor domains. Historically the measure of learner achievement has being tied to cognitive process and personal factors.

Recently, the system of education have witnessed new psychological measures. New theories of intelligence have been introduced and are gradually replacing the traditional theory. The total make of learners have no become the center of concern not only his cognitive capabilities, but also his creativity, emotions and interpersonal skills. Emotional intelligence is however, an elucidation of the affective domain and it impact on learning.

Emotional intelligence (EI)

Emotional intelligence also termed intrapersonal intelligence can simply be explained to mean the ability to empathize, persevere, control impulses, communicate clearly, make thoughtful decisions, solve problems, and work with others in a way that earns friends and success. The under listed abilities allow an individual to recognize and regulate emotion, develop self-control, set goals, develop empathy, resolve conflicts, and develop skills needed for leadership and effective group participation.

Social intelligence (SI)

Social intelligence also termed interpersonal intelligence is the human ability of decoding the happenings of the world and responding to it likewise. This ability is exclusive to humans and

distinguishes us from the rest of beings in the animal kingdom. Social Intelligence is also the capability to act wisely while maintaining human relations. It is markedly different from just intelligence, unlike what people used to think earlier. Over the years, it has been observed that many exceptionally intelligent people struggle a lot while maintaining a social life.

Social Intelligence is also known as interpersonal intelligence because it is also the study of an individual's ability to notice the distinctions between him and other people. As per this concept, a person's own unique personality is a product of the person's difference in knowledge on different areas as well as the level of social interactions he has with the people in his surroundings.

Albeit the fact that the intelligences explained above are different psychological constructs, it is however educative for us to note that they play a major role in children learning of mathematics. In light of these, teachers have to plan and deliver their lessons with the interpersonal and intrapersonal intelligence of learners in mind.

Below are some of the features of a socially and emotionally intelligent learner in a mathematics classroom.

- **Self-Awareness and Self-Management**. All education is based on the implicit assumption that learners will have the self-awareness and self-management skills necessary to recognize their feelings, calm themselves, and focus their attention sufficiently so they can effectively participate in learning, including Mathematics. Further, all learning, including Mathematics, assumes that learners will have basic goal-setting skills to complete academic assignments.
- **Social Awareness**. Effective participation in all educational activities, including Mathematics, depends on learners' ability to understand and observe important social norms of the class, recognize there are diverse approaches to problem solving, and understand that the approaches of others can help us identify new and improved strategies ourselves. Further, empathy and perspective-taking are critical skills when applying mathematical reasoning to real world problems.
- **Relationship Skills**. Success in Mathematics and other academic subjects depends on effective communication skills, including how to listen well and how to ask questions, as well as broader social skills such as how to effectively seek help when one doesn't understand academic content. Cooperative learning and group problem-solving are anchored in relationship skills.
- **Responsible Decision-Making**. Mathematics assumes that learners will have the basic ability to evaluate options and make effective decisions to complete assignments.

Mathematics can be enhanced when instruction and teaching practices are explicitly designed to promote all five core competencies of social and emotional intelligence. Rigorous research revealed that curriculum and instruction that are intentional about giving learners the chance to develop core social and emotional competencies of self-awareness, self-management, social awareness, relationship skills, and responsible decision-making significantly increase academic

achievement, improve attitudes and behaviors, decrease negative behaviors and discipline problems, and reduce emotional distress. Effective Mathematics instruction builds upon these competencies to drive learner learning and engagement.

For example, Mathematics educators can support leaners to:

- See connections between current tasks and their personal interests (*self-awareness*).
- Develop skills for focusing attention, managing stress and anxiety, and accomplishing goals in order to effectively participate in learning (*self-management*).
- Develop awareness of positive classroom norms and an understanding of how learners contribute to a positive classroom experience, respect for peers and teachers, and empathy and perspective taking in order to apply mathematical reasoning to real-world problems and reviewing the reasoning of others (*social awareness*).
- Develop speaking and listening skills (e.g., how to ask questions, how to listen well, and how to effectively seek help when one doesn't understand academic content) and the ability to collaborate to solve problems (*relationship skills*).
- Use reasoning strategies to reflect on choices and goals as a way of developing strong decision making skills (*responsible decision-making*).

Emotional Quotient (EQ) and Intelligence Quotient (IQ)

We all can give an account of colleague whom we know as a really talented and hardworking learner who will never be considered for learner leadership opportunities. Much as their intelligence is obvious for all to see their poor interpersonal and intra personal intelligences also become obvious. The qualities that such learners luck are termed as social skills. These are the skills or traits that have nothing to do with an individual's intelligence but everything to do with their success in life.

Educational psychologist have termed such qualities as Emotional Quotient (EQ) and frequently compares its roles in the improvement of human beings, with respect to Intelligence Quotient (IQ). It is quite obvious from the exposition above that a person's IQ manifest his levels of intelligence and information-processing speed, whiles the EQ puts him/her in control of his feelings and teaches him/her to handle complex situations.

Activity 6.5.1

1. What is emotional intelligence?
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2. Interpersonal intelligence is also termed as …….
3. Outline and explain three feature of a socio-emotional leaner.

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II. ……
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III. ……
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SUMMARY

Emotional intelligence also termed as intrapersonal intelligence is the ability of an individual to develop self-control, empathy and skills needed for effective leadership.

Social intelligence also termed as interpersonal intelligence is the ability of an individual to decode the happenings of the world and respond appropriately.

Some of the features of an emotional and socially stable learner includes:

- Self-awareness and self-management.
- Social awareness
- Good relationship skills
- Good in decision making

SECTION 6 HELPING LEARNERS IDENTIFY AND EXPRESS THEIR EMOTIONS IN A BUSY CLASSROOM

INTRODUCTION

Dear learner, you are welcome to section 6 of unit 6; helping early grade learners identify and express their emotions in a busy mathematics classroom. In this lesson we will discuss strategies early grade teachers should employ to provide room for learners to identify and express their emotions within and outside the classroom.

OBJECTIVE

- Demonstrate knowledge and understanding of how to validate the emotions of learners in a busy classroom.

INDICATORS

- Develop a short personal strategies for identifying interpersonal and intrapersonal intelligences and to discuss how these influence classroom practice.
- Reflect critically on how early grade children feel about learning of mathematics
- Outline and analyse how social and emotional intelligence influences the promotion of equity and inclusivity in the mathematics classroom.

Early grade teachers do face a battle in finding ways to handle learners who throw a tantrum and explode with emotions without losing their patients. The early grade classroom is a heterogeneous setting that contains learners from diverse backgrounds with varied interest and needs. It however, behooves on the early grade teacher to help learners understand their emotions and how they can appropriately express them. Teaching and helping learners develop emotional and social intelligences is not only to help them minimize tantrum, but serves as a lifelong skill that will provide them with opportunities such as leadership and managerial positions and friendship.

Similarly, children who learn self-regulation and how to control their emotions are shown to have longer attention spans, understand appropriate dynamics of interacting with others, are less impulsive, more self-aware and better communicators.

Helping learners to identify and appropriately express their emotions

They are countless number of strategies teachers can apply to help learners identify and express their emotions. Examples of these include:

Model Reactions and Emotional Behavior

Aside parents, children look up to teachers as models worth to emulate. They perceive teachers to be ‘saint’ and will try all they can to live their lives like their teachers. They found of mimicking the behavior and mannerisms they are surrounded with, be it good or bad. Cognizance of these, teachers are encouraged to practice what they preach and also try as much as they can to control their emotions in the midst of learners.

Talk About Emotions and Feelings with Kids

Children often feel overwhelmed by what they feeling because they don't know what it is. In light of this, early grade teachers have to consciously teach learners to understand the varied emotions they are likely to experience in the learning process. To help children understand and appropriately express their emotions, teachers should consciously help learners find solutions to the following questions.

- What are emotions?
- What are feelings?
- What does this feeling I have mean?
- What is the emotion that matches this feeling?
- Why am I acting this way?

Identify and label learners emotions with respect to their behavior.

- Crying = sad
- Throwing a toy = anger
- Laughing = joy

Teachers can help learners identify the meaning of facial expression with the help of mirror. With a mirror mimic varied emotions and record their facial expressions in mind. These will help learners to recognize and understand facial expressions shown by teacher in the learning environment and the desired responds for each expressions.

Teachers are also encouraged to regularly engage learners in talks about feelings and use emotion picture cards to help learners identify what they are feeling.

Praise Behavior You Want to See Repeated

Praises serves as motivation to learners to repeat behaviors. At the early stages children crave appreciations and praise for it make them feel accepted by the community in which they found themselves. To improve upon the emotional intelligence of learners teachers have to positively reinforce learners' behaviors and openly give appreciations for good behaviors.

Be the safe spot for learners before and after unpleasant emotions

Learners are always in need of a shoulder to rest on in unpleasant situations. If a learner does not want affection or your presence during this time, but your presence will give them sense of safety. Teachers have to establish trust with learners', empathies and sympathies with them in times of trouble (unpleasant emotions).

Cognizance of environmental factors that influence emotions.

A lot of environmental factors influence emotional experiences of learners in the learning environment. Early grade teachers need to have good knowledge of these factors so as to appropriately respond to the emotions of learners in a busy classroom. Notable among this environmental factors are:

- Sleep
- Hunger
- Stress
- Overstimulated

Most often, poor behavior and misbehavior in early grade classrooms are the result of learners being tired, hungry or overstimulated.

Get into the habit of labeling the feelings you believe your child is experiencing.

For example, if your child runs up to you and hugs you as you walk through the door, you can say something like "someone is excited to see me" or "someone is happy I'm home." Labeling your child's feelings as they happen helps them to build their feelings vocabulary.

Use games and activities to teach children about feelings

Children like learning through playing and having fun. A fun game to help kids learn about feelings is Feelings Charades.

For this game you will need to make a 'feelings dice'. Paste pictures of feeling faces on a box. Have kids roll the box and whatever feeling face it lands on they have to act out.

Activity 6.6.1

1. Outline three strategies you would employ to identify learners with interpersonal intelligence.

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2. What is intrapersonal intelligence?

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3. In brief explained the term emotion.

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4. What is the appropriate label for a child who throws a toy away?
   a) Hanger
   b) Joy
   c) Sad
   d) Anger

5. Describe an activity you will take learners through to help them understand feelings.

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SUMMARY

Emotion can simply be explained to mean an individual's state of being coupled with their involuntary physiological response to an object or situation, based on a physical state and or sensory data. They are numerous strategies early grade teachers can adopt to help early learner appropriately express their emotions. Examples include;

- Model reactions and emotional behavior
- Praise behaviors you want to see repeated
- Be a save spot for learners before and after unpleasant emotions.

Bibliography

(n.d.). Retrieved June 26, 2021, from 7 Ways to Help Kids Identify Feelings & Control Emotions: https://www.thepragmaticparent.com/help-kids-identify-control-emotions/

Ababio, B. T. (2013). Nature of Teaching: What Teachers Need to Know and Do. *International Journal for Innovation Education and Research, 1*(3), 37-48.

Adebayo, A. (2019). *Understanding Effective Learning.* University of Minho, Department of Curriculum Studies and Educational Technology. Portugal: Adebayo Adebiyi.

American Psychological Association. (2019). *Top 20 principles from psychology for early childhood teaching and.* Washington: Center for Psychology in Schools and Education. Retrieved from https://www.apa.org/ed/schools/teaching-learning/top-twenty-early-childhood.pdf

CASEL. (2015). *Examples of Social and Emotional Learning in Elementary Mathematics Instruction.* CASEL. Retrieved from casel.org

Deborah, M. N., & Eunice, A. Y. (2018). *Ghana Accountability for Learning Outcomes Project (P165557).* Washington, D.C.: World Bank. Retrieved from http://www.worldbank.org/projects

Guerriero, S. (n.d.). *Teachers' Pedagogical Knowledge and the Teaching Profession.* OECD. Retrieved from https://www.oecd.org/education/ceri/background_document_to_symposium_itel-final.pdf

NAEYC, & NCTM. (2002). *A joint position statement of the National Association for the Education of Young Children and National Council of Teachers of Mathematics.* NAEYC. Retrieved from https://www.naeyc.org/resources/position-statements.

Sharma, B. C., Pathak, A., & Sinha, A. (2017). *Teaching and Learning at Elementry Level Unit-3 Factors Affecting Learning.* enyankosh.ac.in. Retrieved June 17, 2021, from http://www.ewingdigital.com

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review, 57*(1), 1-23.

Tutorialspoint. (2015). *Social Intelligence.* Retrieved from Tutorials Point (I): https://www.tutorialspoint.com/social_intelligence/social_intelligence_tutorial.pdf