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**PHILOSOPHICAL AND
THEORETICAL GROUND
OF
MATHEMATICS EDUCATION**

By

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LESSON STUDY TEAM

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I. General Overview

The main goal of this topic is to facilitate the participants to develop their vision about mathematics education and all of its aspects. Some references are used as the main sources for designing the topic e.g. “Mathematics, Education and Philosophy: An International Perspective” edited by Paul Ernest, and “Mathematics Education and Language: Interpreting Hermeneutics and Post-Structuralism” by Tony Brown. The first book addresses the central problem of the philosophy of mathematics education i.e. the impact of conceptions of mathematics and mathematics education on mathematics educational practices. The second book highlights contemporary thinking on philosophy and emphasizes the importance of language in understanding mathematics. This workshops let the participants to develop their discussion on: how mathematical invented or discovered by the students, what methodology is involved, and how does mathematical knowledge achieve its status as warranted knowledge, how the students develop their mathematical experiences, what is the value of mathematics, the genesis of student, the aim of mathematics education, the genesis of learning, the genesis of teaching, the genesis of evaluation, the genesis of students’ learn mathematics, the genesis of teaching learning resources, and the genesis of school mathematics.

The structures in a traditionally-organized classroom can be linked readily with the routine classroom activities of teacher-exposition and teacher-supervised desk work (Philips in Edwards 1987). If the teacher wants to introduce new ideas or skills s/he may feel it is appropriate to carry out teacher-led discussion. In this case the teacher may be faced with difficult styles of classroom interaction. Bain (1988), gave the description of this teacher-led discussion as : individual pupils have difficulty concentrating because they are not fully involved, shy pupils will fear exposure, the teacher is wholly occupied and the progress of the entire class can be interrupted by the misbehavior of a single pupil. On the other hand, if discussion takes place in a group, as he suggests, individual pupils have far more opportunity to speak, pupils are more likely to develop their answers, pupils are more

involved and therefore less likely to have problems with their concentration, shy pupils can speak with less fear of exposure, the teacher is freed to monitor/intervene/assess/talk to individuals, the teacher can deal with distractions and misbehavior without stopping the work of the entire class.

Hoyles in Grouws and Cooney (1988) concluded that mathematics teaching is about facilitating the learning process of pupils, and thus good teaching requires a combination of subject competency, a flexibility of teaching style and strategy, and a concern for the emotional and social as well as the cognitive need of pupils. Further, she suggested that this requires the use of a range of teaching styles and a focus on pupils' conceptions and ways of working as well as on mathematical content. This is actually in accordance with what the Cockcroft Report suggested that it is not possible to indicate a definitive style for teaching of mathematics (ibid, p.158). The report also suggested that approaches to the teaching of a particular piece of mathematics need to be related to the topic itself and the abilities and experience of both teachers and children; that methods which may be extremely successful with one teacher and one group of children will not necessarily be suitable for use by another teacher or with another group of children (ibid, p.158).

In-depth study of philosophy of mathematics education may lead to the conclusion that different philosophical position has significantly different educational implications. Concepts for the teaching and learning of mathematics – more specifically: goals and objectives, syllabi, textbooks, curricula, teaching methodologies, didactical principles, learning theories, mathematics educational research, teachers' conceptions of mathematics and mathematics teaching as well as students' perception of mathematics – carry with them or even rest upon particular philosophical and epistemological views of mathematics (Steiner, 1987 in Ernest, 1994). Teaching mathematics is difficult, because students find learning mathematics difficult (Jaworski, 1994). Teachers generally find it easier not to change their styles of teaching, which they have probably developed over a period of increasingly successful years in a school (Dean, 1982). An Individual teacher may hold very firm views on a particular issue in mathematical education, but must at the same time accept that very different, even completely contrary, views may be held by a colleague in the same school (Orton, 1987). Further, he claimed that some teachers believe that mathematics should be a silent activity with each of the children always producing their own

work, but others teacher value discussion between pupils. Above all indicate the importance of the study of philosophy and theoretical ground of mathematics education.

II. The Strategy of the Workshop

The activities in the workshop will focus on sharing ideas and discussion, in which the participants, starting from their own context and experiences, will extend their understanding of the comprehensive perspective of mathematics education. The workshop will also let the participants produce their own conclusions and communicate them to other participants in order to validate their knowledge.

III. The Content of the Workshop

1. Philosophy of Mathematics Education

Philosophy of mathematics education covers the review of some central problems of mathematics education: its ideology, its foundation and its aim. It also serves a more insight into the nature of its aspects: the nature of mathematics, the value of mathematics, the nature of student, the nature of learning, the nature of teaching of mathematics, the nature of teaching learning resources, the nature of assessment, the nature of school mathematics, the nature of students' learn mathematics. In order to have a clear picture of the role of the study of philosophy of mathematics and its relationship to workshop activities, it may be discussed about the nature of human resources development and the nature of lesson study in mathematics education.

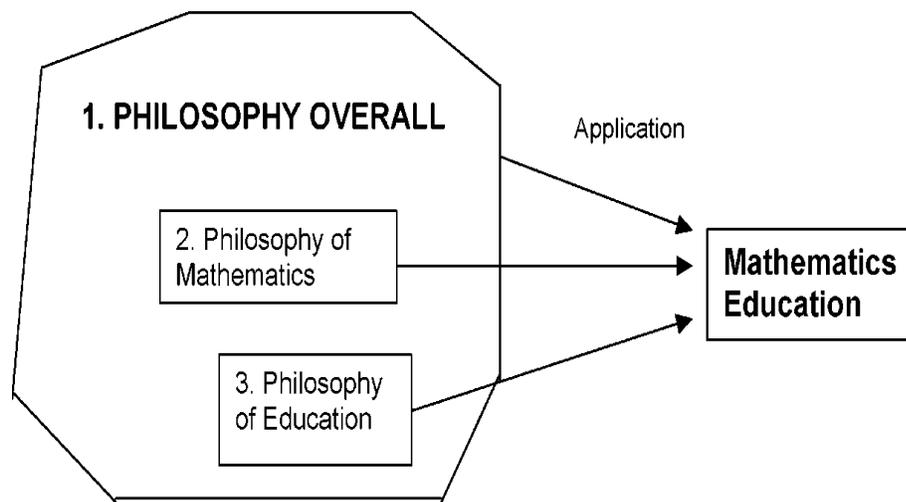


Figure: Applications of philosophy to mathematics education (Paul Ernest, 1994)

According to Paul Ernest (1994), the study of philosophy of mathematics education implies to the practice of mathematics teaching through the issues reflected on the following questions:

“What theories and epistemologies underlie the teaching of mathematics? What assumptions, possibly implicit, do mathematics teaching approaches rest on? Are these assumptions valid? What means are adopted to achieve the aims of mathematics education? Are the ends and means consistent? What methods, resources and techniques are, have been, and might be, used in the teaching of mathematics? What theories underpin the use of different information and communication technologies in teaching mathematics? What sets of values do these technologies bring with them, both intended and unintended? What is it to know mathematics in satisfaction of the aims of teaching mathematics? How can the teaching and learning of mathematics be evaluated and assessed? What is the role of the teacher? What range of roles is possible in the intermediary relation of the teacher between mathematics and the learner? What are the ethical, social and epistemological boundaries to the actions of the teacher? What mathematical knowledge does the teacher need? What impact do the teacher’s beliefs, attitudes and personal philosophies of mathematics have on practice? How should mathematics teachers be educated? What is the difference between educating, training and developing mathematics teachers?”

In a more general perspective, it can be said that the *philosophy of mathematics education* has aims to clarify and answer the questions about the *status* and the *foundation* of mathematics education *objects* and *methods*, that is, ontologically clarify the nature of each component of mathematics education, and epistemologically clarify whether all meaningful statements of mathematics education have objective and determine the truth. Perceiving that the *laws of nature*, the *laws of mathematics*, the *laws of education* have a similar *status*, the very real world of the form of the objects of mathematics education forms the foundation of mathematics education.

2. The Ideology of Mathematics Education

Ideologies of mathematics education cover the belief systems to which the way mathematics education is implemented. They cover radical, conservative, liberal, and democracy. The differences of the ideology of mathematics education may lead the differences on how to develop and manage the knowledge, teaching, learning, and schooling. In most learning situation we are concerned with activity taking place over periods of time comprising personal reflection making sense of engagement in this activity; a government representative might understand mathematics in term of how it might partitioned for the purpose of testing (Brown, T, 1994).

Comparison among countries certainly reveals both the similarities and the differences in the policy process. The ideologies described by Cochran-Smith and Fries (2001) in Furlong (2002) as underpinning the reform process are indeed very similar. Yet at the same time, a study of how those ideologies have been appropriated, by whom, and how they have been advanced reveals important differences. He further claimed that what that demonstrates, is the complexity of the process of globalization. Furlong quoted eatherstone (1993), “One paradoxical consequence of the process of globalisation, the awareness of the finitude and boundedness of the plane of humanity, is not to produce homogeneity, but to familiarize us with greater diversity, the extensive range of local cultures”.

Ernest, P (2007) explored some of the ways in which the globalization and the global knowledge impacts on mathematics education. He have identified four

components of the ideological effect to mathematics education. First, there is the reconceptualization of knowledge and the impact of the ethos of managerialism in the commodification and fetishization of knowledge. Second, there is the ideology of progressivism with its fetishization of the idea of progress. Third, there is the further component of individualism which in addition to promoting the cult of the individual at the expense of the community, also helps to sustain the ideology of consumerism. Fourth is the myth of the universal standards in mathematics education research, which can delegitimize research strategies that foreground ethics or community action more than is considered 'seemly' in traditional research terms.

3. Foundation of Mathematics Education

The foundation of mathematics searches the status and the basis of mathematics education. Paul Ernest (1994) delivered various questions related to the foundation of mathematics as follows:

“What is the basis of mathematics education as a field of knowledge? Is mathematics education a discipline, a field of enquiry, an interdisciplinary area, a domain of extra-disciplinary applications, or what? What is its relationship with other disciplines such as philosophy, sociology, psychology, linguistics, etc.? How do we come to know in mathematics education? What is the basis for knowledge claims in research in mathematics education? What research methods and methodologies are employed and what is their philosophical basis and status? How does the mathematics education research community judge knowledge claims? What standards are applied? What is the role and function of the researcher in mathematics education? What is the status of theories in mathematics education? Do we appropriate theories and concepts from other disciplines or ‘grow our own’? How have modern developments in philosophy (post-structuralism, post-modernism, Hermeneutics, semiotics, etc.) impacted on mathematics education? What is the impact of research in mathematics education on other disciplines? Can the philosophy of mathematics education have any impact on the practices of teaching and learning of mathematics, on research in mathematics education, or on other disciplines?”

It may emerge the notions that the foundation of mathematics education serves justification of getting the status and the basis for mathematics education in the case of its ontology, epistemology and axiology. Hence we will have the study of ontological foundation of mathematics education, epistemological foundation of mathematics

education and axiological foundation of mathematics education; or the combination between the two or among the three.

4. The Nature of Mathematics and School Mathematics

Mathematics ideas comprise thinking framed by markers in both time and space. However, any two individuals construct time and space differently, which present difficulties for people sharing how they see things. Further, mathematical thinking is continuous and evolutionary, whereas conventional mathematics ideas are often treated as though they have certain static qualities. The task for both teacher and students is to weave these together. We are again face with the problem of oscillating between seeing mathematics extra-discursively and seeing it as a product of human activity (Brown, T, 1994).

Paul Ernest (1994) provokes the nature of mathematics through the following questions:

“What is mathematics, and how can its unique characteristics be accommodated in a philosophy? Can mathematics be accounted for both as a body of knowledge and a social domain of enquiry? Does this lead to tensions? What philosophies of mathematics have been developed? What features of mathematics do they pick out as significant? What is their impact on the teaching and learning of mathematics? What is the rationale for picking out certain elements of mathematics for schooling? How can (and should) mathematics be conceptualized and transformed for educational purposes? What values and goals are involved? Is mathematics value-laden or value-free? How do mathematicians work and create new mathematical knowledge? What are the methods, aesthetics and values of mathematicians? How does history of mathematics relate to the philosophy of mathematics? Is mathematics changing as new methods and information and communication technologies emerge?”

In order to promote innovation in mathematics education, the teachers need to change their paradigm of what kinds of mathematics to be taught at school. Ebbutt, S. and Straker, A. (1995) proposed the **school mathematics to be defined** and its implications to teaching as the following:

a. Mathematics is a search for patterns and relationship

As a search for pattern and relationship, mathematics can be perceived as a network of interrelated ideas. Mathematics activities help the students to form the connections in this network. It implies that the teacher can help students learn mathematics by

giving them opportunities to discover and investigate patterns, and to describe and record the relationships they find; encouraging exploration and experiment by trying things out in as many different ways as possible; urging the students to look for consistencies or inconsistencies, similarities or differences, for ways of ordering or arranging, for ways of combining or separating; helping the students to generalize from their discoveries; and helping them to understand and see connections between mathematics ideas. (ibid, p.8)

b. Mathematics is a creative activity, involving imagination, intuition and discovery

Creativity in mathematics lies in producing a geometric design, in making up computer programs, in pursuing investigations, in considering infinity, and in many other activities. The variety and individuality of children mathematical activity needs to be catered for in the classroom. The teacher may help the students by fostering initiative, originality and divergent thinking; stimulating curiosity, encouraging questions, conjecture and predictions; valuing and allowing time for trial-and-adjustment approaches; viewing unexpected results as a source for further inquiry; rather than as mistakes; encouraging the students to create mathematical structure and designs; and helping children to examine others' results (ibid. p. 8-9)

c. Mathematics is a way of solving problems

Mathematics can provide an important set of tools for problems- in the main, on paper and in real situations. Students of all ages can develop the skills and processes of problem solving and can initiate their own mathematical problems. Hence, the teacher may help the students learn mathematics by: providing an interesting and stimulating environment in which mathematical problems are likely to occur; suggesting problems themselves and helping students discover and invent their own; helping students to identify what information they need to solve a problem and how to obtain it; encouraging the students to reason logically, to be consistent, to work systematically and to develop recording system; making sure that the students develop and can use mathematical skills and knowledge necessary for solving problems; helping them to know how and when to use different mathematical tools (ibid. p.9)

d. Mathematics is a means of communicating information or ideas

Language and graphical communication are important aspects of mathematics learning. By talking, recording, and drawing graphs and diagrams, children can come to see that mathematics can be used to communicate ideas and information and can gain confidence in using it in this way. Hence, the teacher may help the students learn mathematics by: creating opportunities for describing properties; making time for both informal conversation and more formal discussion about mathematical ideas; encouraging students to read and write about mathematics; and valuing and supporting the diverse cultural and linguistic backgrounds of all students (ibid. p.10)

5. The Value of Mathematics

In the contemporary times, the mathematical backbone of its value has been extensively investigated and proven over the past ten years. According to Dr. Robert S. Hartman's, value is a phenomena or concept, and the value of anything is determined by the extent to which it meets the intent of its meaning. Hartman (1945) indicated that the value of mathematics has four dimensions: *the value of its meaning*, *the value of its uniqueness*, *the value of its purpose*, and *the value of its function*. Further, he suggested that these four "Dimensions of Value" are always referred to as the following concepts: *intrinsic value*, *extrinsic value*, and *systemic value*. The bare intrinsic and inherent essence of mathematical object is a greater, developed intensity of immediacy. Mathematical object is genuinely independent either of consciousness or of other things; something for itself. In and for itself belongs to the Absolute alone, mathematical object can be perceived as the developed result of its nature and as a system of internal relations in which it is independent of external relations.

6. The Nature of Students

Understanding the nature and characteristics of young adolescent development can focus effort in meeting the needs of these students. The National Middle School Association (USA, 1995) identified the nature of students in term of their intellectual, social, physical, emotional and psychological, and moral. Young adolescent learners¹ are curious, motivated to achieve when challenged and capable of problem-solving and complex thinking. There is an intense need to belong and be accepted by their peers while finding their own place in the world. They are engaged in forming and questioning their own identities on many levels. The students may mature at different rates and experience rapid and irregular growth, with bodily changes causing awkward and uncoordinated movements. In term of emotional and psychological aspect, they are vulnerable and self-

conscious, and often experience unpredictable mood swings. While in the case of moral, they are idealistic and want to have an impact on making the world a better place.

Most of the teachers always pay much attention to the nature of student's ability. We also need to have an answer how to facilitate poor and low-ability children in understanding, learning and schooling. Intellectual is really important to realize mental ability; while, their work depend on motivation. It seems that motivation is the crucial factor for the students to perform their ability. In general, some teachers are also aware that the character of teaching learning process is a strong factor influencing student's ability. We need to regard the pupils as central to our concerns if our provision for all the pupils is to be appropriate and effective; some aspects of teaching for appropriateness for students might be: matching their state of knowledge, identifying and responding to their particular difficulties, extending them to develop their potential in mathematics, providing some continuity of teaching with a demonstrated interest in progress, developing an awareness of themselves as learners using the teacher as a resource, and providing regular feedback on progress (Ashley, 1988). Those who teach mathematics must take into account the great variations which exist between pupils both in their rate of learning and also in their level of attainment at any given age (Cockroft Report, 1982, para. 801).

7. The Aim of Mathematics Education

Philosophically, the aims of mathematics education stretch from the movement of back to basic of arithmetics teaching, certification, transfer of knowledge, creativity, up to develop students understanding. Once upon a time, a mathematics teacher delivered his notion that the objective of his mathematical lesson was to use better mathematical, more advance terminology and to grasp a certain concept of mathematics. Other teacher claimed that the objective of his mathematical lesson was to achieve notions stated in the syllabi. While others may state that his aim was to get true knowledge of mathematics. So the purpose of mathematics education should be enable students to realize, understand, judge, utilize and sometimes also perform the application of mathematics in society, in particular to situations which are of significance to their private, social and professional lives (Niss, 1983, in Ernest, 1991). Accordingly, the curriculum should be based on project to help the pupil's self-development and self-reliance; the life situation of the learner is the

starting point of educational planning; knowledge acquisition is part of the projects; and social change is the ultimate aim of the curriculum (Ernest, 1991).

8. The Nature of Teaching Learning of Mathematics

Some students learn best when they see what is being taught, while others process information best auditorily. Many will prefer movement or touching to make the learning process complete. The best approach to learning styles is a multisensory approach. This type of environment allows for children, who are primarily kinesthetic or motor learners, to be able to learn through touch and movement; it allows the visual learner to see the concept being taught, and the auditory learner to hear and verbalize what is being taught. Ideally, the best learning takes place when the different types of processing abilities can be utilized. Constructivists have focused more on the individual learner's understanding of mathematical tasks which they face (von Glasersfeld, 1995 in Brown, 1997).

Educationists use the terms 'traditional' and 'progressive' as a shorthand way of characterizing educational practices. The first is often associated with the terms 'classical/whole class', 'direct', 'transmission', 'teacher-centred/subject-centred', 'conventional', or 'formal'; and the second is sometimes associated with the terms 'individual', 'autonomy', 'constructive', 'child-centred', 'modern', 'informal', and/or 'active learning'. The lack of any clear definition of what the terms mean is one of the sources of misleading rhetoric of the practices. Bennett (1976) found evidence that the loose terms 'traditional' and 'progressive' are symbolic of deep conflicts about some of the aims of education. The main sociological point is that the terms 'progressive' and 'traditional' are emotionally loaded but lack any consensual meaning among practitioners or researchers (Delamont, 1987). He found that, in the UK, ever since 1948 there has been a division between those exposing traditional and progressive ideals, and that feelings about these ideals are bitter and vehemently held. Then, since 1970, there have been some investigations on how the teachers' behaviors attributed by the term of 'traditional' or 'progressive'. The most persuasive prescriptive theory of teaching was that reflected in the Plowden Report (1967) which, influenced by the educational ideas of such theorists as Dewey and Froebel, posited a theory of teaching which distinguished between progressive and traditional teachers.

Specifically, Paul Ernest (1994) elaborated issues of mathematics education as follows:

- a. *Mathematical pedagogy - problem solving and investigational approaches to mathematics versus traditional, routine or expository approaches? Such oppositions go back, at least, to the controversies surrounding discovery methods in the 1960s.*
- b. *Technology in mathematics teaching – should electronic calculators be permitted or do they interfere with the learning of number and the rules of computation? Should computers be used as electronic skills tutors or as the basis of open learning? Can computers replace teachers, as Seymour Papert has suggested?*
- c. *Mathematics and symbolization – should mathematics be taught as a formal symbolic system or should emphasis be put on oral, mental and intuitive mathematics including child methods?*
- d. *Mathematics and culture – should traditional mathematics with its formal tasks and problems be the basis of the curriculum, or should it be presented in realistic, authentic, or ethnomathematical contexts?”*

9. The Nature of Teaching Learning Resources

John Munchak (2004) indicated that in order to provide lessons that are both engaging and challenging to each individual, it is necessary to know the students as people. Each individual will come to my class with their own set of abilities, motivations, attitudes, goals, and cultural background. Further he stated the following:

“Getting to know these various facets of my students will allow me to excel as a teacher because I can tap into their talents, resources, and knowledge to make the classroom more interesting, dynamic, and personal. Establishing a familiar bond and some trust between me and the students, as well as among the students themselves, contributes to a safe and caring learning environment. Learning their interests, the activities they enjoy, their academic strengths and weaknesses, their future plans and motivations informs how I will teach each individual. This personal information is important in order to differentiate learning in a classroom with students of various levels of motivation, career goals, and academic abilities. Caring for my students means I will "honor their humanity, hold them in high esteem, expect high performance from them, and use strategies to fulfill their expectations"”

Related to the resources of teaching, Ernest (1991) suggested that due to the learning should be active, varied, socially engaged and self-regulating, the theory of resources has three main components :

- (1) the provision of a wide variety of practical resources to facilitate the varied and active teaching approaches;

- (2) the provision of authentic material, such as newspaper, official statistics, and so on for socially relevant and socially engaged study and investigation; and
- (3) the facilitation of student self-regulated control and access to learning resources.

10. The Nature of Assessment

Traditionally, assessments have been concerned with assessing the student's production of "correct" mathematical statements as evidence of a broader mathematical understanding. An alternative of this places emphasizes on the "story" told about the event of a mathematical activity (Mason, 1989, in Brown, 1997). In assessing mathematics we seem at first to be caught between on the hand, working with a style of mathematics where we assert a field of mathematics as if devoid of human and, on the other hand, speaking of mathematics as a depth interpretation of a certain style of human activity; this is not a satisfactory dichotomy, if only because we never have a choice of one over-arching symbolic framework (ibid.).

11. The relationship between mathematics education and society

Nobody argues that mathematics education is closely related to society. However, we may to learn the extent of its relationship. Paul Ernest (1994) delivered some questions:

"Are the aims of mathematics education valid and valued for their society? What the aims? To whom that mathematics is taught? Who will participate in the practice of mathematics teaching? Who supports, who takes the benefits, who decides, who dominates, who gains and who loses? To what extent the social, cultural and historical contexts relate to mathematics education? Further he exposed about what values underpin different sets of aims? How does mathematics contribute to the overall goals of society and education? What is the role of the teaching and learning of mathematics in promoting or hindering social justice conceived in terms of gender, race, class, ability and critical citizenship? Is anti-racist mathematics education possible and what does it mean? He also highlighted on how is mathematics viewed and perceived in society? What impact does this have on education? What is the relationship between mathematics and society? What

functions does it perform? Which of these functions are intended and visible? Which functions are unintended or invisible? To what extent do mathematical metaphors permeate social thinking? What is their philosophical significance? To whom is mathematics accountable?

12. Philosophical Ground of Human Resources Development: *Its implication to Educational Change*

a. Human Resources Development

According to Swanson, R.A. and Holton III, E.F. (2009) the philosophical ground of human resources development covers (1) a shift to the human resources school of thought, (2) the growth of laboratory training, (3) the use of survey research and feedback, (4) an increased use of action research (problem-solving) techniques, (5) an acknowledgment of socio-technical systems and quality of work life, and (6) a new emphasis on strategic change. Further, they suggested that developed mostly in response to serious concerns about the viability of traditional and bureaucratic organizations, the human relations model attempted to move away from these classical assumptions and focused more heavily on individual identities, their needs, and how to facilitate stronger interpersonal communication and relationships.

Accordingly, much of the concepts of human resources development are currently focusing on the increase of the effectiveness of strategic change. The use of open-systems planning was one of the first applications of strategic change methods. An educational institutions' demand and response systems could be described and analyzed, the gaps reduced, and performance improved. In the case of education, this work represents a shift in teachers' professional development away from a sole focus on the individual, and the supporting assumption that it is completely mediated through individuals, to a more holistic and open systems view of educational institution. This shift continues to this day and is evidenced in key revelations stemming from strategic change work including the importance of educational leadership support, multilevel involvement, and the criticality of alignment between organizational strategy, structure, culture, and systems (ibid)

b. Managing Educational Change

Fullan (1982, 1991) proposed that there are four broad phases in the educational change process: initiation, implementation, continuation, and outcome.



1) **Initiation**

The factors that affecting the initiation phases include: *existence and quality of innovations, access to innovations, advocacy from central administration , teacher advocacy, and external change agents*

2) **Implementation**

Three areas of the major factors affecting implementation: *characteristics of change, local characteristics and external factors (government and other agencies)*. They identified different stakeholders in local, and federal and governmental levels. They also identified characterizations of change to each stakeholder and the issues that each stakeholder should consider before committing a change effort or rejecting it.

3) **Characteristics of Change Local Factors External Factors**

Fullan (1999) characterized educational changes and their factors at different levels as follows:

Characteristics of Change	Local Factors	External Factors
<ul style="list-style-type: none"> • Need of change • Clarity about goals and needs • Complexity: the extent of change required to those responsible for implementation • Quality and practicality of the program 	<ul style="list-style-type: none"> • The school district • Board of community • Principal • Teacher 	<ul style="list-style-type: none"> • Government and other agencies

4) **Continuation/ Sustainability**

According to Fullan (1999), continuation is a decision about institutionalization of

an innovation based on the reaction to the change, which may be negative or positive. Continuation depends on whether or not:

- a) *The change gets embedded/built into the structure (through policy/budget/timetable)*
- b) *The change has generated a critical mass of administrators or teachers who are skilled and committed to*
- c) *The change has established procedures for continuing assistance*

Fullan (1999) pointed out the importance of the recognition that the educational change process is complex. To deal with such complexity is not to control the change, but to guide it. He provides eight new lessons about guiding educational change:

- a) *Moral purpose is complex and problematic*
- b) *Theories of education and theories of change need each other*
- c) *Conflict and diversity are our friends*
- d) *Understanding the meaning of operating on the edge of chaos*
- e) *Emotional intelligence is anxiety provoking and anxiety containing*
- f) *Collaborative cultures are anxiety provoking and anxiety containing*
- g) *Attack incoherence connectedness and knowledge creation are critical*
- h) *There is no single solution. Craft your own theories and actions by being a critical consumer.*

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Appendix

Worksheet

**PHILOSOPHICAL AND THEORETICAL
GROUND OF MATHEMATICS
EDUCATION**

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Activity 1: Ideology of Education

Objective : Understanding various ideology of education

Materials : Posed problems or questions, handout and supporting references

Method : Group Discussion

Question/Problem:

Followings are various ideologies of education:

<i>Radical</i>	<i>Conservative</i>	<i>Liberal</i>	<i>Humanist</i>	<i>Progressive</i>	<i>Socialist</i>	<i>Democracy</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 2: Nature of Education

Objective : Understanding various nature of education

Materials : Posed problems or questions, handout and supporting references

Method : Group Discussion

Question/Problem:

Followings are various natures of education:

<i>Obligation</i>	<i>Preserving</i>	<i>Exploiting</i>	<i>Transforming</i>	<i>Liberating</i>	<i>Needs</i>	<i>Democracy</i>	<i>Others</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 3: The Nature of Mathematics

Objective : Understanding the nature of mathematics

Materials : Posed problems or questions, handout and supporting references

Method : Group Discussion

Question/Problem:

Followings are various natures of mathematics:

<i>Body of Knowledge</i>	<i>Science of truth</i>	<i>Structure of truth</i>	<i>Process of Thinking</i>	<i>Social Activities</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 4: The Nature of School Mathematics

Objective : Understanding the nature school of mathematics
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various *natures of school mathematics*:

<i>Search for pattern and relation</i>	<i>Problems Solving</i>	<i>Investigation/ Research</i>	<i>Communication</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 5: Moral of Mathematics Education

Objective : Understanding and implementing the moral value of math education
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various *moral of mathematics education*:

<i>Good vs Bad</i>	<i>Pragmatism</i>	<i>Hierarkhies Paternalistics</i>	<i>Humani-ty</i>	<i>Justice, Freedom</i>	<i>Others</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 6: Value Mathematics Education

Objective : Understanding and implementing the value of math education
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various *values of mathematics education*:

<i>Intrinsic</i>	<i>Extrinsic</i>	<i>Systemic</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 7: The Nature of Students

Objective : Understanding the nature of students
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various natures of students:

<i>Empty Vessel</i>	<i>Character Building</i>	<i>Creativity</i>	<i>Growing like a seed Constructing</i>	<i>Others</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 8: The Nature of Students' Ability

Objective : Understanding the nature of students' ability and its implication
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various natures of students' ability:

<i>Talent Given</i>	<i>Effort</i>	<i>Need</i>	<i>Competency</i>	<i>Culture</i>	<i>Contextual</i>	<i>Others</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 9: The Aim of Mathematics Education

Objective : Understanding the aim of mathematics education
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various aims of mathematics education:

<i>Back to Basic (Arithmetics)</i>	<i>Certi- fication</i>	<i>Transfer of knowledge</i>	<i>Creativity</i>	<i>To develop people comprehensively</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 10: Nature of Learning

Objective : Understanding theory of learning and its implication
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various *theories of learning*:

<i>Work Hard, Exercises, Drill, Memorize</i>	<i>Thinking And practice</i>	<i>Understanding and Application</i>	<i>Exploration</i>	<i>Discussion, Autonomy, Self</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 11: Nature of Teaching

Objective : Understanding the theory of teaching and its implication
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various *theories of teaching*:

<i>Transfer of knowledge</i>	<i>External Motivation</i>	<i>Internal Motivation</i>	<i>Constru ction</i>	<i>Discussi on</i>	<i>Investig ation</i>	<i>Develop ment</i>	<i>Facilitat ing</i>	<i>Expository</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 12: Theory of Teaching Mathematics

Objective : Understanding the theory of teaching mathematics and its implication
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various *theories of teaching mathematics*:

<i>Expository</i>	<i>Problem Solving</i>	<i>Memorize</i>	<i>Drill</i>	<i>Discussion</i>	<i>Practical Work</i>	<i>Development</i>	<i>Facilitating</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 13: The Nature of Teaching Learning Resources

Objective : Understanding the nature of teaching learning resources
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various natures of teaching learning resources:

<i>White Board, Chalk, Anti Calculator</i>	<i>Teaching Aid</i>	<i>Visual Teaching Aid for motivation</i>	<i>Various resources/ environment</i>	<i>Social Environment</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 14: The Nature of Assessment

Objective : Understanding the nature of assessment and its implication
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various natures of assessment:

<i>External Test</i>	<i>Portfolio</i>	<i>Social</i>	<i>Contextual</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 15: The Nature of Society

Objective : Understanding the nature of society and its implication
Materials : Posed problems or questions, handout and supporting references
Method : Group Discussion
Question/Problem:

Followings are various natures of society:

<i>Diversity</i>	<i>Monocul ture</i>	<i>Desentra lisation</i>	<i>Compete ncy</i>	<i>Multiple Solution</i>	<i>Heterogo nomous</i>	<i>Social Capital</i>	<i>Local Culture</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 16: The Nature Curriculum

Objective : Understanding the nature of curriculum and its implication
 Materials : Posed problems or questions, handout and supporting references
 Method : Group Discussion
Question/Problem:

Followings are various natures of curriculum:

<i>Instrument Curriculum</i>	<i>Subject-based Curriculum</i>	<i>Integrated Curriculum</i>	<i>Knowledge Based Curriculum</i>	<i>Competent-based Curriculum</i>	<i>Individual Curriculum</i>	<i>Interactive Curriculum</i>	<i>ICT Based Curriculum</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 17: The Nature Students' Learn Mathematics

Objective : Understanding the nature of students' learn mathematics
 Materials : Posed problems or questions, handout and supporting references
 Method : Group Discussion
Question/Problem:

Followings are various natures of students' learn mathematics:

<i>Individual</i>	<i>Competition</i>	<i>Motivation</i>	<i>Readiness</i>	<i>Scaffolding</i>	<i>Collaborative</i>	<i>Constructing</i>	<i>Contextual</i>	<i>Enculturing</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.

Activity 18: The Nature Mathematical Thinking

Objective : Understanding the nature of mathematical thinking
 Materials : Posed problems or questions, handout and supporting references
 Method : Group Discussion
Question/Problem:

Followings are various natures of mathematical thinking:

<i>Subjective</i>	<i>Obyective</i>	<i>Producing</i>	<i>Reflecting</i>	<i>Critizing</i>	<i>Constructing</i>	<i>Social Activity</i>	<i>Attitude</i>	<i>Content</i>	<i>Method</i>	<i>Conjecture</i>	<i>Embodiment</i>
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Discuss its implication to mathematics teaching practice? Which one of them is the most favorable for you and your teaching? Explain.