PROBLEM-BASED LEARNING AND MEDIATED LEARNING EXPERIENCE

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The purpose of this study is to investigate the extent to which Mediated Learning Experience (MLE) is present in Problem-Based Learning (PBL) within a secondary school curriculum. The study explores: (i) The presence of MLE parameters in the various stages of the PBL cycle as practiced in the school under study and (ii) The students' perception of the presence of MLE parameters in the abovementioned PBL environment. The study involved data collection from three instruments, namely the PBL vs MLE Matrix, Intensity Chart and Case Vignette. The findings of this study suggest the strong presence of the following parameters: Intentionality and Reciprocity (IR), Meaning (ME), Transcendence (T) and Feeling of Competence (FC). In addition, the instruments registered the moderate presence of these parameters, Interdependency and Sharing (IS), Individual Uniqueness and Esteem (IU), Search for Optimistic Alternatives (OA) and Challenge of Novelty and Complexity (NC). These findings highlight the important fact that different parameters are present in varying degrees throughout the PBL cycle. Different activities carried out during the different stages necessitated and brought forth mediation of different MLE parameters. The insights acquired from this study indicate possible refinements to current PBL practices, so as to make it a viable instructional method for education in the 21st century.

Introduction

Education in the 21st Century: Thinking Schools, Learning Nation

Three major developments are evident as we approach the close of the twentieth century – globalisation, an accelerating pace of technological development, and the "economic catching-up" by developing countries in Asia. The extent of their impact will be realised in the 21st century.

Our education system must take up the challenge of preparing our students for unpredictable changes in this knowledge-based economy. Therefore, the focus of education must shift from efficiency to diversity, from knowing to thinking, and from fitting people to specific jobs to equipping them for lifelong learning, in order that they may create their own opportunities. (source: report of the Junior College/Upper Secondary Education Review Committee – October 2002)

In preparation for the 21st century workplace, Singapore students must develop into technologically savvy, independent lifelong learners flexible in the face of changing job demands. The quality of lifelong learning is based on a strong foundation of knowledge and process skills. This calls for an inquiring yet disciplined spirit, aptitude for critical and creative thinking and confidence in problem-solving within a rapidly changing environment. A mind attuned to lifelong learning, complemented with skills in communication, team-building and networking, will enable our students

to adapt and adjust to a globalised, technologically driven, fast-changing knowledge society.

In summary, the 21st century demands that workers are:
- Open to multi-disciplinary perspectives
- Creative and innovative
- Good at managing and working with people
- Able to think laterally
- Able to work independently
- Effective in communication
- Passionate about life-long learning
- Team-oriented

MOE's vision of "Thinking Schools, Learning Nation" (TSLN) aims to gear our education system toward a comprehensive provision of these needs for the 21st century. The Desired Outcomes of Education (Secondary) delineate the attributes that the TSLN initiative aims to foster in our youth:

Desired Outcomes of Education
At the end of secondary school, students should
- have moral integrity
- have care and concern for others
- be able to work in teams and value the contribution of others
- be enterprising and innovative
- possess a broad-based foundation for further education
- believe in their ability
- have an appreciation for aesthetics
(source: **http://www1.moe.edu.sg/desired.htm**)

To achieve these outcomes, *school curriculum*, the medium through which values and knowledge are impressed on students, as well as *pedagogical methods*, the processes through which school curriculum is delivered, must focus on Holistic Education – an education that will develop students to their fullest potential, equip them with the skills, values and mindsets for lifelong learning, as well as the capacity to take calculated risks and make right decisions.

Problem-Based Learning in Singapore: An Evolving Practice

In line with the TSLN initiative is an instructional method widely known as Problem-Based Learning (PBL), an inquiring approach to learning that requires learners to be engaged with a real-world problem before they are presented with content information. Margetson (1996) noted that PBL is a form of open-minded, reflective, critical and active learning that can promote the development of lifelong learning skills. These characteristics of PBL hold much interest for secondary school educators in Singapore who see its potential within the TSLN framework.

The current practice in most secondary schools is to introduce students to project work that focus on the solutions of multi-faceted problems. However, these projects are not allocated curriculum time, and most teachers in these schools leave the students to cope with the problem-solving process on their own. Teachers need to be

more aware of the conditions under which PBL is optimised. One of these conditions would involve teachers as active facilitators.

Hence, if PBL is to be implemented as a viable aid to the TSLN cause, the teacher must be sufficiently coached as well, so that he or she will be equipped with the necessary facilitation skills. In effect, this means that the PBL cycle will involve the Singapore teacher in ways beyond traditional pedagogical models. The teacher will develop into a coach as much as a learner, participating in a process of mutual learning that Costa and Garmston (1994) describes in *Cognitive Coaching*:

> Few educational innovations achieve their full impact without a coaching component… Cognitive coaching enhances the intellectual capacities of teachers, which in turn produces greater intellectual achievement in students. (pp.6-7)

The PBL method in relation to MLE

My study is motivated by the belief in MLE and MLE-based educational approaches, in which the facilitator plays a central role. It is my belief that through the active mediation of the facilitator, the activities carried out during the various stages of the PBL cycle can bring forth the benefits of mediated learning for the students.

As mentioned, the teacher plays a critical role as the mediator of learning experiences in the PBL cycle. According to Reuven Feuerstein 's theory of MLE, the quality of interaction between an individual and the environment plays an important role in transforming and developing one's cognitive system. Therefore, the mediator who facilitates this interaction plays a crucial role in enhancing the individual's learning potential.

Feuerstein's theory of SCM defined the parameters of MLE in line with Vygotskian perspectives on cognitive development. My belief is that because of the facilitator's active mediation, these MLE parameters are inherent in the activities throughout the various stages of PBL.

Thus, I argue that PBL works in practice precisely because of two factors, namely,
1) MLE parameters coterminous with SCM are inherent in the various stages of PBL classroom activities,
2) its emphasis on the teacher as a mediating influence.

In other words, given the active mediation by the facilitator of the PBL cycle, the influences of MLE parameters promote the learning process and the development of cognitive potential.

My study suggests that in the context of the school classroom, the parameters which characterise MLE are embedded within a PBL environment that involves the teacher in the central role as facilitator. Without such mediation, students might feel that they are being thrown into the deep end of the pool. Many of them will sink with only some remaining not as swimmers, but rather non-sinkers!

Figure 1

Conceptual
Framework of
MLE Parameters
within the PBL
Cycle

Upper Limit

Assimilation

Discovery
and
Reporting

NC

Self-
Directed
Learning

GO

ME

CA

Analysis of
Problem

OA

T

RP

IR

Emergence
of Problem

FC

Vygotsky's Zone
of Proximal
Development

IS

Mediated
Learning
Experience

IU

Lower Limit

Legend:

PBL
Stage

Different
Stages in
PBL

IU, IS, FC, RP, OA, CA, NC, GO,

ME, T, IR

Acronyms
for MLE
Parameters
(Refer to
Appendix
A5)
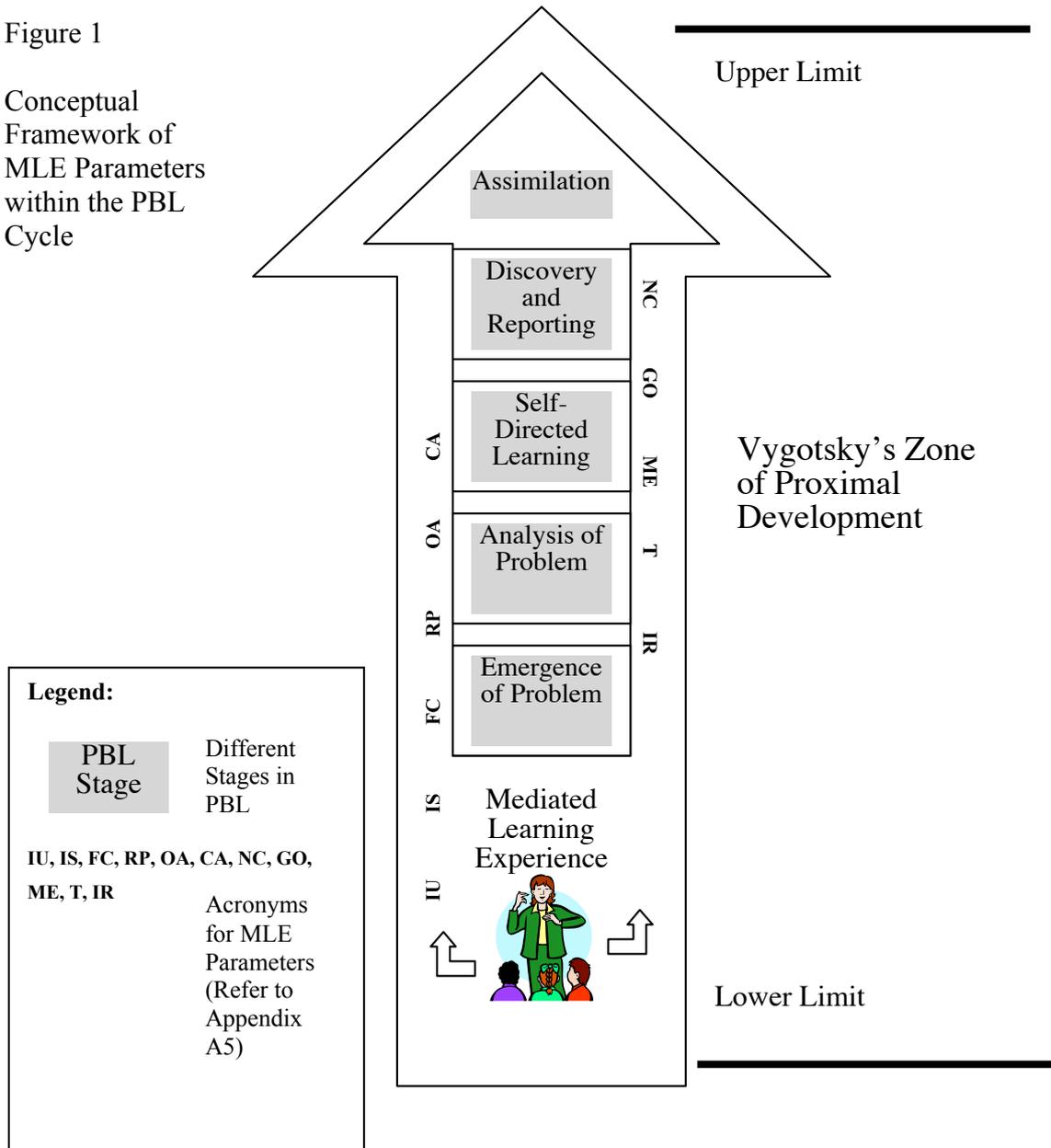
As depicted in Figure 1 above, this study is based on the premise that MLE parameters are inherent in the PBL cycle, where the facilitator plays a central role in the students' learning experience. As students progress through the problem-solving stages and experience mediated learning, their cognitive functioning is elevated from the lower limits to the upper limits of their respective zones of proximal development.

Statement of the Problem

The purpose of this study is to determine the extent to which MLE elements are inherent in the various stages of a PBL cycle, as practised in a typical Singapore

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classroom environment. The following research questions are designed to examine the link between PBL and MLE, with a further view to explore how the application of MLE theories to PBL practices can better inform and improve the learning process

Research Questions

1) What MLE parameters are present in the various stages of PBL as practised in the school under study?
2) Do students perceive the presence of MLE parameters in the abovementioned PBL environment?

Significance of the Study

If educators approach education from Feuerstein's perspective, which views human beings

> as having a unique propensity to change or be modified in the structure of their cognitive functioning, as they respond to changing demands of life situations. Changes occur in response to external stimuli and internal conditions. They are also a product of an active involvement in the process of learning, (Feuerstein & Falik, 1998)

they will come to the empowering conclusion that "anyone can be helped to become a more effective learner at any age, no matter what the cause of or degree of his or her retardation" (Burden, 1987a).

Therefore, educators have the potential capability to hone the underlying cognitive functions and intrinsic motivational drives of each and every student. The school has the capacity to provide environments that address not merely scholastic achievement, but the cognitive development of each and every student. This is in accordance with the beliefs of educators like Ledford (1996), who states that learning occurs most efficiently when strategies are designed to suit the learner's needs.

Thus far, there has been little research on Singapore secondary school students that focus on curriculum delivery and its effect on the development of students' cognitive processes. This study examines if and how the parameters of MLE operate within a teacher-mediated PBL environment.

Based on the assumption that MLE enhances the development of students' cognitive abilities and attitudes, the findings of this study will help in the identification of cognitive processes and mental parameters that students operate with, so as to refine the design of existing PBL practices. This will go towards making PBL a viable instructional method for education in the 21st century. The findings will encourage teachers in Singapore to adopt a wider repertoire of teaching and learning approaches that support the intent of educational initiatives such as TSLN. The Singapore education system will then be one step closer to the Renaissance Schools envisioned by Costa and Garmston (1994), in which teachers and students participate in "positive interpersonal relationships" (p.8) to reinforce mutual learning processes.

Methodology

The study was conducted in three phases:
Phase I – The planning and development phase
Phase II – The implementation phase
Phase III – The evaluation phase

Phase I – The planning and development phase

The 18-hours long study took place at a local neighbourhood, all-girls secondary school over a period of five-weeks.

Background
The Subject Head for Geography in the school has been teaching Geography for seven years, and was part of the team that piloted PBL in the school. After the three-day PBL workshop, this teacher revised curriculum and lesson plans to incorporate PBL into the first half of the two-year G.C.E Cambridge 'O' Level Geography syllabus for the Express stream.

The PBL Package
The PBL package was centred on the topic of "dams". The learning outcomes were further refined into learning issues that would bring about learning objectives as reflected in the curriculum matrix. With these in mind, the teacher crafted the problem scenario for her lessons. She then formulated the time-line for implementation, during which anticipated learning issues were divided over two facilitated discussions. Assessment guidelines were crafted so that these could be clearly communicated to the students.

Phase II - The implementation phase

The Participants
In the school over five weeks, Secondary 3 (Express) Geography lessons were conducted over five periods per week, with each period lasting 30 minutes. Besides these five periods, two extra periods were allocated every Wednesday for tutorials, starting from week four of term one. During the period of implementation, the tutorial slots were used to cover the PBL lessons.

The participants of the study were 15 year old Secondary Three students studying the first-year Geography syllabus of the two-year G.C.E Cambridge 'O' Level course in the Express stream. The class consists of 19 students, who were structured into five groups of three students and one group of four students. The subject teacher based the groupings on the students' secondary two streaming results to ensure that they were heterogeneously mixed in terms of ability.

The Conduct of the PBL Package

Before the PBL lessons, the participants were briefed on the aims, objectives and the implementation stages of the PBL package. The teacher also briefed the students on her role as a facilitator or coach in this learning process.

Before the lessons started, each group was given a work file. The group leader was assigned the responsibility of taking care of the group work file.

The PBL Lessons
The students were put through the stages of PBL as reflected in Figure 2.

Learning begins with meeting a messy unstructured real-world problem. The problem triggers students' learning by having them explore, analyse, create hypotheses and identify learning issues. Templates like the "Trigger words worksheet", "KWL worksheet" and work plans are given to the students to scaffold their learning and thus facilitate students' cognitive developments.

Students while trying to solve the problem will need to recall reason and tap on their prior knowledge, hence allowing them to appreciate what they have learnt. However, with their existing knowledge, the students would not be able to solve the problems. The students will need to identify what they do not know and need to know to solve the problem. They will prioritize their learning needs, set learning goals and objectives, and allocate resources so as to solve the problem within the given time frame. The students will then engage in self-directed study and preparation to research on the knowledge needed from resources such as books, magazines, journals, online information, reports and people with the appropriate fields of expertise.

The students in their groups will return to the problem scenario and apply the new knowledge acquired to solve the problem. If they still cannot solve the problem due to lack of information, the learning cycle is repeated by identifying further learning issues followed by self-directed learning to research and acquire new knowledge to solve the problem. The learning process will stop only when the problem is solved. After solving the problem, the students will relate the new knowledge acquired to their previous knowledge. They will build mental bridges that allow them to form relations between new and prior knowledge and hence view knowledge as integrated rather than fragmented and compartmentalized.

Throughout the whole process, students are asked to do reflections, self-and peer assessments. Through self-reflections, students are more aware about mental processes that help them learn

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        ┌─────────────────────────┐       ┌──────────────────────────┐
  ┌────▶│   Analysis of Problem    │◀─────▶│  Utilization of templates│
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  │                  │
  │                  ▼
  │     ┌─────────────────────────┐       ┌──────────────────────────┐
  │     │  Self-Directed Learning  │◀─────▶│  Research and Reasoning   │
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  │     ┌─────────────────────────┐       ┌──────────────────────────┐
  │     │ Discovery and Reporting  │◀─────▶│  Group Discussion and     │
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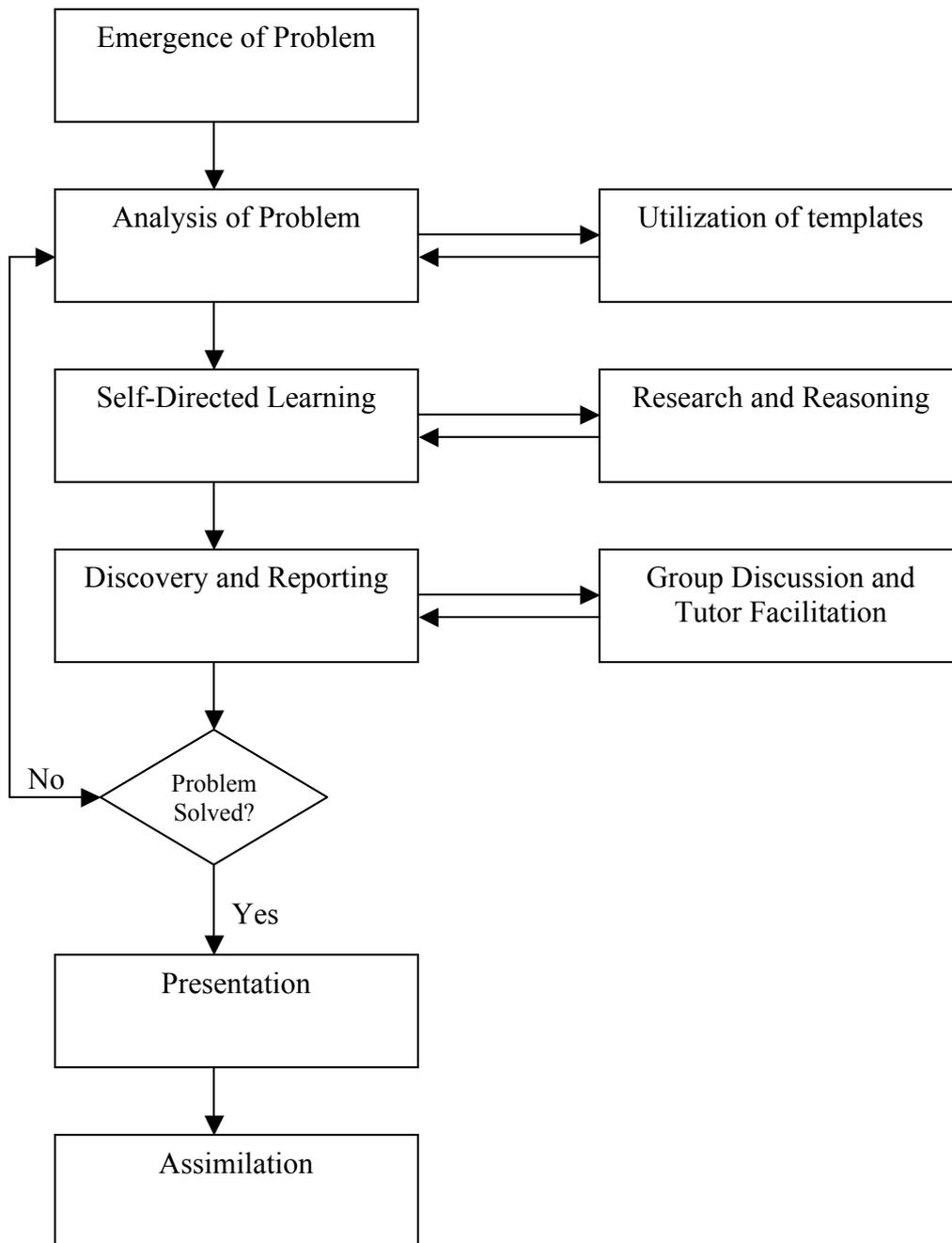
Figure 2: The Cycle for Problem-Based learning

Phase III - The evaluation phase

In this phase, interviews of student participants were conducted to gain insights on their perception of the PBL lessons. The questions were designed to isolate their experience of Mediated Learning Experience (MLE) parameters, if any, within the PBL environment.

The Sample

A Geography class consisting of 19 students and one teacher from a local neighbourhood, all-girls secondary school were involved in the implementation phase. The students were 15 year old Secondary Three girls studying the first-year Geography syllabus of the two-year G.C.E Cambridge 'O' Level course in the Express stream. From the 19, 5 students were selected on a random basis for interviews in the evaluation phase.

The Research Instruments

A Self-Designed MLE Rating Scale

This comprises a list of mediational activities that may occur in a classroom (Appendix A1). Using the scale, the researcher evaluates the quality of the teacher's mediation for each PBL stage. The evaluation was carried out using the following ratings:

Zero Occurrence---High Occurrence				
0	1	2	3	4
Not observed	Seldom	Sometimes	Often	Very often

Self-Designed PBL vs MLE Matrix

This mean rating (3.3) was then transferred to the PBL vs MLE Matrix where the mean rating $\overline{R}$ is interpreted as follows:

$0 \le \overline{R} < 2$ represents   • Weak Link

$2 \le \overline{R} < 3$ represents   Moderate Link

$3 \le \overline{R} \le 4$ represents   —— Strong Link

For each parameter, the link is charted. A line chart of the six stages of PBL against the 11 MLE parameters is drawn (Appendix A2). The matrix would then give an insight on the extent MLE parameters are present in the stages of PBL, as practised within the Geography class in study.

Finally, the average mean rating for each MLE parameter was calculated by totalling the mean ratings for each parameter during the various PBL stages, and then dividing this total by the number of stages present in the PBL cycle, which is 6 in this study. These average mean ratings were then used for direct comparison with the averages registered on the Intensity Chart *(further elaborated under Self-Designed Intensity Chart of MLE parameters)* to establish any possible correlations.

Interviews

In-depth personal interviews were also conducted as part of the study to collect verbal data from the students. The students' responses gave insights on their perceptions of the existence of MLE parameters in the PBL environment. This interview component provided another perspective to the results inferred from the PBL vs MLE Matrix.

The questions for the interviews were self-designed (Appendix A3) and were used to guide the interviewer in the conduct of the interview. However, any other relevant issue or question that the interviewer felt necessary and critical to the investigation were asked and clarified during the course of the interviews. For each parameter, there is a cluster of questions being asked. The intensity of mediation for each parameter as appreciated by the students is taken to be proportionate to the percentage of positive responses to the questions being asked within each parameter with the calculation as follows:

$$I = \frac{R_+}{R_t} \times 100\% \quad \text{where } I = \text{intensity in terms of percentage,}$$

R_+ = Number of positive responses

R_t = Total number of questions

We define a response as positive when the student uses an adjective or phrase that indicates a perception of the presence of MLE parameters. The intensity is interpreted as shown below:

High Intensity	$70 \leq I \leq 100$
Medium Intensity	$40 \leq I < 70$
Low Intensity	$0 \leq I < 40$

Self-Designed Intensity Chart of the MLE parameters

The intensity of mediation of the MLE parameters as perceived by the 5 students (student A to student E) are charted and represented by the Intensity Chart *(Appendix A4)*. The intensity chart will then give insights to students' perception of the presence of MLE parameters in the above mentioned PBL environment.

An average intensity for each parameter was calculated by totalling the intensity for each parameter for the 5 students, and then dividing this total by 5. This average intensity for each parameter is used for direct comparison with the average ratings plotted on the PBL vs MLE Matrix.

Case Vignettes

To gain further insights to students' perception, the interview transcripts are also recorded in the form of case vignettes, which form the basis of qualitative data.

Discussion, Conclusions and Implications

A collation of main findings from the three research instruments namely, the PBL vs MLE matrix, the Intensity Chart of the MLE parameters and the Case Vignettes form the basis of conclusions to determine the extent Mediated Learning Experience parameters were present in Problem-Based Learning within the secondary school classroom under study.

To qualify the conclusions, limitations associated with the research methodology and instruments will be discussed. The paper ends with the implications of this study and recommendations for future research.

Collation of Main Findings

The research in this study provided insight into MLE parameters that were operant within a PBL learning environment from two perspectives:
- the observer's, who sat in for the PBL lessons under study;
- the students', who had direct experience of PBL.

Their input was subjected to quantitative as well as qualitative analysis as detailed above.

To collate the main findings, average ratings and results were compiled for the whole PBL cycle. Whenever any discrepancy arose, cross-referencing was carried out between these averages obtained from the various research instruments, including the PBL vs MLE Matrix, the Intensity Chart of MLE parameters and the Case Vignettes.

MLE parameters	Average Mean Rating for the Parameter (Max=4) over the entire PBL cycle as observed by the investigator		Average Intensity (%) for the Parameter over the entire PBL cycle as perceived by the students as a group	
IR	3.8	Strong link	88	High Intensity
ME	3.8	Strong link	93.4	High Intensity
T	3.9	Strong link	100	High Intensity
FC	3.7	Strong link	100	High Intensity
RP	1.5	Weak link	55	Medium Intensity
IS	2.0	Moderate link	93.4	High Intensity
IU	2.2	Moderate link	95	High Intensity
GO	3.2	Strong link	64	Medium Intensity
OA	2.8	Moderate link	70	High Intensity

Table 3 Correspondences of the Average Mean Rating and the Average Intensities for the MLE Parameters

MLE parameters	Average Mean Rating for the Parameter (Max=4) over the entire PBL cycle as observed by the investigator		Average Intensity (%) for the Parameter over the entire PBL cycle as perceived by the students as a group	
NC	2.5	Moderate link	100	High Intensity
CA	0.9	Weak link	100	High Intensity

Table 3 Correspondences of the Average Mean Rating and the Average Intensities for the MLE Parameters

Table 3 displays the correspondence of the average mean ratings and the average intensities for the parameters over the entire PBL cycle, as observed by the investigator and perceived by the students as a group. This correspondence is cross-referenced with the Case Vignettes to establish the extent to which the MLE parameters were present in the PBL environment under study, as well as the nature of their presence.

Conclusions of Study

Research Question 1: What MLE parameters are present in the various stages of PBL as practised in the school under study?

Strong presence of IR, ME, T and FC Parameters

According to Feuerstein and Feuerstein (1991), the three parameters – namely IR, ME and T – are essential and sufficient conditions for a mediated interaction to take place. From our collation of main findings from the various research instruments, it is evident that these three parameters had a significant presence in the various PBL stages. There is strong positive correspondence between the results from the three research instruments.

The table also indicated the strong presence of the FC parameter. Guided exposure to challenging problems during the PBL process inspired the students with self-confidence. This will encourage them to take up difficult tasks in the future, important in an age when change is the only constant.

Moderate presence of IS, IU, OA, NC Parameters

On the whole, the investigator registered moderate ratings for the parameters of IS, IU, OA, NC in the PBL environment under study. These moderate links were averages complied from ratings recorded over the various stages of the PBL cycle.
These ratings were cross-referenced with the findings from the Intensity Chart and Case Vignettes. From the Intensity Chart, students' perceptions of these MLE parameters were strong. The findings from the Case Vignettes also registered positive mediation of the respective parameters. Therefore the results from the 3 research instruments highlighted the important fact that different parameters were present in varying degrees throughout the PBL cycle. Different activities carried out during the different PBL stages necessitated and brought forth mediation of different MLE parameters.

As there is no past research that suggests the extent to which MLE parameters are present in the various stages of the PBL cycle, the results established here can serve as a reference benchmark for future research in this area.

Weak presence of the RP and CA Parameters

The observer registered weak ratings for the RP and CA parameters. From the Intensity Chart, the students perceived a lower end medium intensity for the RP parameter. A detailed analysis of the Case Vignettes showed that while the students interviewed were conscious of the need to self-monitor and self-regulate their behaviour, learnt to refrain from acting on impulse, and demonstrated a more systematic approach to solving problems, they were not engaged in conscious self-regulation of their use of learning strategies.

The weak ratings reflected a lack of activities in the PBL learning environment under study which encourage deep seated cognitive shifts.

To self-regulate, the students must first be able to self-assess. The observer noted that there was little opportunity for students to think about their own thinking (metacognition) and to self-assess. However, the students were at least conscious of *the need* to self-monitor and self-regulate their thinking processes.

There is high students' perception of the CA parameter. A detailed analysis of the Case Vignettes indicated that the discrepancy could be due to the mismatch between observer and student criteria. While the students were concerned with *superficial behavioural changes*, the observer was looking for *deep cognitive shifts*. This will also be discussed as one of the limitations of the study.

The ability of the students to engage in self-assessment is also pivotal for effective mediation of the CA parameter. In the PBL learning environment under study, the "weak" mediation of the CA parameter as observed has still enabled the students to become more aware of their potential for change. To achieve more definite cognitive gains, this awareness can be further enhanced by introducing activities to allow students to appreciate the purpose behind self-assessment.

The observer noted that the teacher under study played a central role as a mediator in bringing across the mediation of the MLE parameters. The importance of the human mediator is in line with the thinking of theorists like Vygotsky, Costa and Feuerstein. As Feuerstein proposed, the quality of interaction between an individual and the environment plays an important role in transforming and developing one's cognitive system. The mediator who facilitates this interaction plays a crucial role in enhancing the individual's learning potential.

Research Question 2: Do students perceive the presence of MLE parameters in the abovementioned PBL environment?

High Intensities of Students' Perception of Most MLE Parameters

From table 3, the presence of all parameters except RP and GO were strongly perceived by the students.

From these results, we can conclude that the teacher under study was a competent mediator of MLE. As argued by Vygotsky (1978), an individual's immediate potential for cognitive growth occurs between two limits: the lower limit is determined by his or her independent efforts, while the upper limit is determined by his or her efforts in collaboration with a more knowledgeable other such as a peer, tutor, or teacher.

The teacher in this study was able to raise the students to the upper limits of their Zones of Proximal Development because she:

- Carefully planned and prepared the right content and activities;
- Clearly communicated the aims, intentions and instructions to the students;
- Was confidently equipped with facilitation skills and knew her role as a mediator;
- Used scaffolds to buttress the students' learning, in accordance to Vygotsky's belief in scaffolding.
- Allowed students' autonomy in their learning, in line with the beliefs of Yowell & Smylie (1999).

Hence, to understand why the parameters of RP and GO were perceived only moderately by the students, we have to examine the role of the teacher mediator in relation to the nature of cognitive shifts that these parameters entail.

To successfully mediate RP and GO, the teacher has to tap into the students' cognitive potential. This process deals with deep seated cognitive practices and requires continuous mediation and practice. For the students to better experience these parameters at work, they will need constant and sustained exposure to PBL activities of the same mould, not a one-off or brief encounter under the guidance of a mediator.

Thus, the results of my study confirm the students' perception of MLE parameters operating within a teacher-mediated PBL environment. The presence of the MLE parameters in the PBL enables a learning process that involves potential changes in metacognitive structures, as reflected in the students' responses.

Limitations of Study

Reliability of Research Instruments

This study attempted to collate theory with actual experiences current in the practice field. Information from the practice field was collected via three independent instruments that were self-designed. The reliability of these research instruments were not proven through rigorous statistical tests. This poses a significant limitation to the validity and applicability of the observation and feedback collected.

This limitation was partially resolved by the use of data collected from three different instruments, namely the MLE Matrix, Intensity Chart and Case Vignettes. The respective insights gained from each instrument yielded some inconsistencies, described in section 5.2. Where these inconsistencies could not be explained by reference to relevant theory, the findings concerned were further investigated to provide a rational account.

Thus, for the CA parameter, the case vignettes were examined to explain the divergence in observer input and student perception between the instruments. It was observed that student responses resided on the level of *superficial behavioural changes*, which led the students to conclude that PBL had brought about significant changes to their learning habits. However, the observer who investigated the PBL proceedings was more concerned with *deep cognitive shifts*. Therefore she concluded that the CA parameter was not brought across to the students. In this instance, the lack of correspondence between the criterion of measurement led to a divergence in the findings.

Lack of Representation in Students' Feedback

For the interview stage, only five students were selected. This limited the representativeness of the intensity chart.

Recommendations for Future Research

1. On hindsight, the duration of one PBL cycle seems too brief, and does not lead to the easy formulation of weighted conclusions. A more extensive study over a lengthier study, one that spans across multiple PBL cycles would offer more possibilities for trend-spotting and cross-reference.

2. The small group sampling size limited the validity and applicability of the study Future studies could focus on groups selected from different streams (Express or Normal Academic, etc) and different secondary school levels.

3. The study left out input from a central figure of the PBL cycle – the teacher. Future research should incorporate research instruments to relate the teachers' perceptions of their mediator role, to feedback from the observer/investigator and the students. In addition, the study can also look into the effects of introducing a cognitive coach into the PBL cycle, to assess its effects on the teacher's cognitive development and lesson delivery.

4. This study gave an indication of what parameters are essential, and for what stage of the PBL process. Future research can focus on specific parameters during specific stages of the PBL process for both observer and the students. This will allow for direct data comparison.

5. A qualitative study based on the interview of 5 students was carried out instead of a quantitative survey on students' appreciation of MLE parameters. In the future, to obtain results that are more reliable and valid, a survey on all students involved could be used make the research more robust.

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Mediated Learning Experience Rating Scale

The rating scale comprises a list of mediational activities that may occur in a classroom. The activities are grouped into the 11 sections according to the parameters of Mediated Learning Experience.

The rating scale offers the opportunity to rate the quality of mediation being exercised by a mediator, such as a teacher.

RATING
The evaluation should be carried out using the following ratings:

Zero Occurrence--High Occurrence				
0	1	2	3	4
Not observed	Seldom	Sometimes	Often	Very often

Description of MLE Activity

Intentionality and Reciprocity (IR)					
Intentionality (I)					
1. Teacher explains overall purpose and intention of PBL process.	0	1	2	3	4
2. Teacher demonstrates her planning and preparation for PBL.	0	1	2	3	4
3. Teacher creates a sense of anticipation.	0	1	2	3	4
4. Teacher is willing to re-explain when work is not understood.	0	1	2	3	4
Reciprocity (R)					
5. Students' interest and motivation are aroused.	0	1	2	3	4
6. Students ask questions relevant to the subject matter.	0	1	2	3	4
7. Students participate in learning activities.	0	1	2	3	4

Meaning (ME)					
1. The teacher explains the importance or value of the topic/problem.	0	1	2	3	4
2. The teacher explains the reason for focusing on the topic/problem.	0	1	2	3	4
3. The teacher uses the problem to facilitate	0	1	2	3	4

meaningful inquiry.					
4. The teacher gives positive or negative feedback to student responses.	0	1	2	3	4

Appendix A1

Transcendence (T)					
1. The teacher facilitates the solving of current problem.	0	1	2	3	4
2. The teacher facilitates learning of a concept or principle beyond the scope of the immediate subject matter.	0	1	2	3	4
3. The teacher relates the problem to prior learning.	0	1	2	3	4
4. The teacher links the problem to other disciplines.	0	1	2	3	4
5. The teacher explains how the underlying process of solving a problem (by posing the appropriate questions) can be applied to a variety of situations.	0	1	2	3	4
6. The teacher promotes the use of work habits that are necessary for life-wide learning.	0	1	2	3	4

Competence (FC)					
1. The problem scenario presented is appropriate to the students' levels of development.	0	1	2	3	4
2. The teacher phrases questions according to the students' levels of competence.	0	1	2	3	4
3. The teacher encourages students to be aware of their progress relative to their own standards.	0	1	2	3	4
4. The teacher scaffolds the information gathering process.	0	1	2	3	4
5. The teacher scaffolds the thinking process.	0	1	2	3	4
6. The teacher praises successful steps toward completing a task.	0	1	2	3	4

Reflective Practice (RP)					
1. Self-reflection is encouraged.	0	1	2	3	4
2. Students think about their own thinking (metacognition).	0	1	2	3	4
3. Self-assessment is encouraged.	0	1	2	3	4
4. Peer assessment is encouraged.	0	1	2	3	4

Interdependency and Sharing (IS)					
1. There is mediation of group dynamics (through group interaction).	0	1	2	3	4
2. Students share with each other.	0	1	2	3	4
3. Students listen to each other.	0	1	2	3	4
4. Students empathise with the feelings of others.	0	1	2	3	4

5. Students are collaborative in inquiry.	0	1	2	3	4

Appendix A1

Individual Uniqueness and Esteem (IU)					
1. PBL activities recognise the strength of each individual.	0	1	2	3	4
2. PBL activities enhance positive self-concepts	0	1	2	3	4
3. PBL activities foster an attitude of confidence for students to state their perspectives.	0	1	2	3	4
4. Students choose part of their classroom activities and encourage diversity in the use of free time.	0	1	2	3	4
5. The teacher supports the right of the student to be different.	0	1	2	3	4
6. Students learn to assign roles to another.	0	1	2	3	4
7. Students learn to assign tasks to another.	0	1	2	3	4

Goal Seeking, Setting and Achieving (GO)					
1. The problem that was designed created goal-setting behaviour.	0	1	2	3	4
2. The teacher encourages students to organise work and plan according to priority.	0	1	2	3	4
3. There is perseverance and patience in the pursuit of goals.	0	1	2	3	4
4. The teacher explains to students the strategy underlying goal planning.	0	1	2	3	4
5. Students review their goals according to changing needs and circumstances.	0	1	2	3	4
6. The teacher models goal-directed behaviour by monitoring of goals set (learning issues) and achievement.	0	1	2	3	4

Search for Optimistic Alternatives (OA)					
1. Divergent approaches to problem solving are encouraged.	0	1	2	3	4
2. Students are able to suggest alternative solutions to a problem.	0	1	2	3	4
3. The students design her lesson such that there are opportunities for students to learn to see other's perspectives.	0	1	2	3	4
4. The teacher designs her lesson such that there are opportunities for students to come up with more than one solution.	0	1	2	3	4

Novelty and Complexity (NC)					
1. The teacher encourages intellectual curiosity.	0	1	2	3	4
2. The teacher encourages originality and creativity.	0	1	2	3	4
3. Students find the problem challenging, novel and complex.	0	1	2	3	4
4. Students are encouraged to pose new ideas.	0	1	2	3	4
5. The teacher helps the students anticipate the satisfaction of completing a task.	0	1	2	3	4
6. Students are encouraged to preserve with difficult tasks.	0	1	2	3	4

Change Awareness (CA)					
1. The teacher promotes self-evaluation of individual progress.	0	1	2	3	4
2. The teacher generates an awareness of change within oneself, and in relationships with others and the environment.	0	1	2	3	4
3. The teacher models self-change by sharing his or her growth and learning experiences.	0	1	2	3	4
4. The teacher helps the students to become independent learners through self-evaluation.	0	1	2	3	4

Appendix A2

Matrix : PBL cycle vs MLE

PBL Stages	IR	ME	T	FC	RP	IS	IU	GO	OA
Assimilation	π	g	g	g	π	n	n	g	n
Presentation	g	g	g	g	n	π	g	g	g
Discovery & Reporting	g	g	g	g	n	g	g	g	g
Self-directed Learning	g	g	g	g	n	g	g	g	g
Analysis of Problem	g	g	g	g	π	π	n	g	g
Emergence of Problem	g	g	g	g	n	n	n	n	n

MLE parameters   g strong   n weak π moderate

Problem-Based Learning
Students' Interview

Intentionality and Reciprocity (IR)
Intentionality (I)
8.   What do you think was the purpose of the 'problem scenario'?
9.   How did the problem scenario capture your interest?
10. Did the teacher help you get engaged and interested?
Reciprocity (R)
11. From the problem scenario, what was it that interest and engage you?
12. From the presentation of the problem scenario, were you motivated to want to learn?

Meaning (ME)
5.   What is the value of solving the problem?
6.   What is the value of Problem-Based Learning activities?
7.   Was the whole process meaningful to you?

Transcendence (T)
7.   Did you learn something that you would apply in the learning of Geography? If yes, what is it?
8.   Did you learn something that would help you learn how to learn? If yes, what is it?
9.   Did you learn something on the attitude one should adopt when solving problem?
10. Did you learn about values when solving the problem presented?

Competence (FC)
7.   Did you feel competent in the initial stage of Problem-Based Learning?
8.   How did the scaffolding (templates) help? List some examples?
9.   How did the questions raised by the teacher help?
10. What happened when you feel like giving up?
11. How did you get the sense of success that you can do it?

Reflective Practice (RP)

5. How did self-reflection, journaling help you?
6. What did you learn about your own thinking?
7. How did self-assessment help you?
8. What did you learn from the feedback of others?

Interdependency and Sharing (IS)

6. Do you enjoy group work?
7. What is it that is valuable about working in groups?
8. How does sharing and collaborating help in learning and solving problem?

Individual Uniqueness and Esteem (IU)

8. What did you learn about the unique strength of others?
9. What did you learn about the unique strength of yourself?
10. How did Problem-Based Learning activities develop your confidence in voicing out your opinions?
11. How did you exercise your autonomy when engaging in Problem-Based Learning activities?

Goal Seeking, Setting and Achieving (GO)

| |
|---|
| 7. How did Problem-Based Learning activities help you learn about goal setting? |
| 8. How did Problem-Based Learning activities help you learn about organising work? |
| 9. Did you persevere in reaching the goals you set? |
| 10. What are some specific goals you set in getting information? |
| 11. What are some specific goals you set in learning something new? |

Search for Optimistic Alternatives (OA)

5. What did you learn about the different possibilities of a solution?
6. How did you arrive at the final solution?

Novelty and Complexity (NC)
7. How did your teacher stimulate your thinking?
8. How did your teacher encourage originality and creativity?
9. How was the problem challenging, novel and complex?
10. How did your teacher help you in completing a difficult task?

Change Awareness (CA)
5. How did your teacher promote self-evaluation of individual progress?
6. Are you aware of any change in you after engaging in Problem-Based Learning activities?
7. Are you more independent as a learner?   If yes, how?

Intensity Chart of MLE Parameters

Intensity Chart

	IR	ME	T	FC	RP	IS	IU	GO	OA	NC	CA
☐ Student A	80	67	100	100	75	100	100	80	50	100	100
☐ Student B	80	100	100	100	50	67	100	20	50	100	100
☐ Student C	100	100	100	100	100	100	100	80	50	100	100
☐ Student D	80	100	100	100	50	100	100	80	100	100	100
☐ Student E	80	100	100	100	50	100	75	60	100	100	100
☐ Average	88	93.4	100	100	55	93.4	95	64	70	100	100

MLE Parameters

50
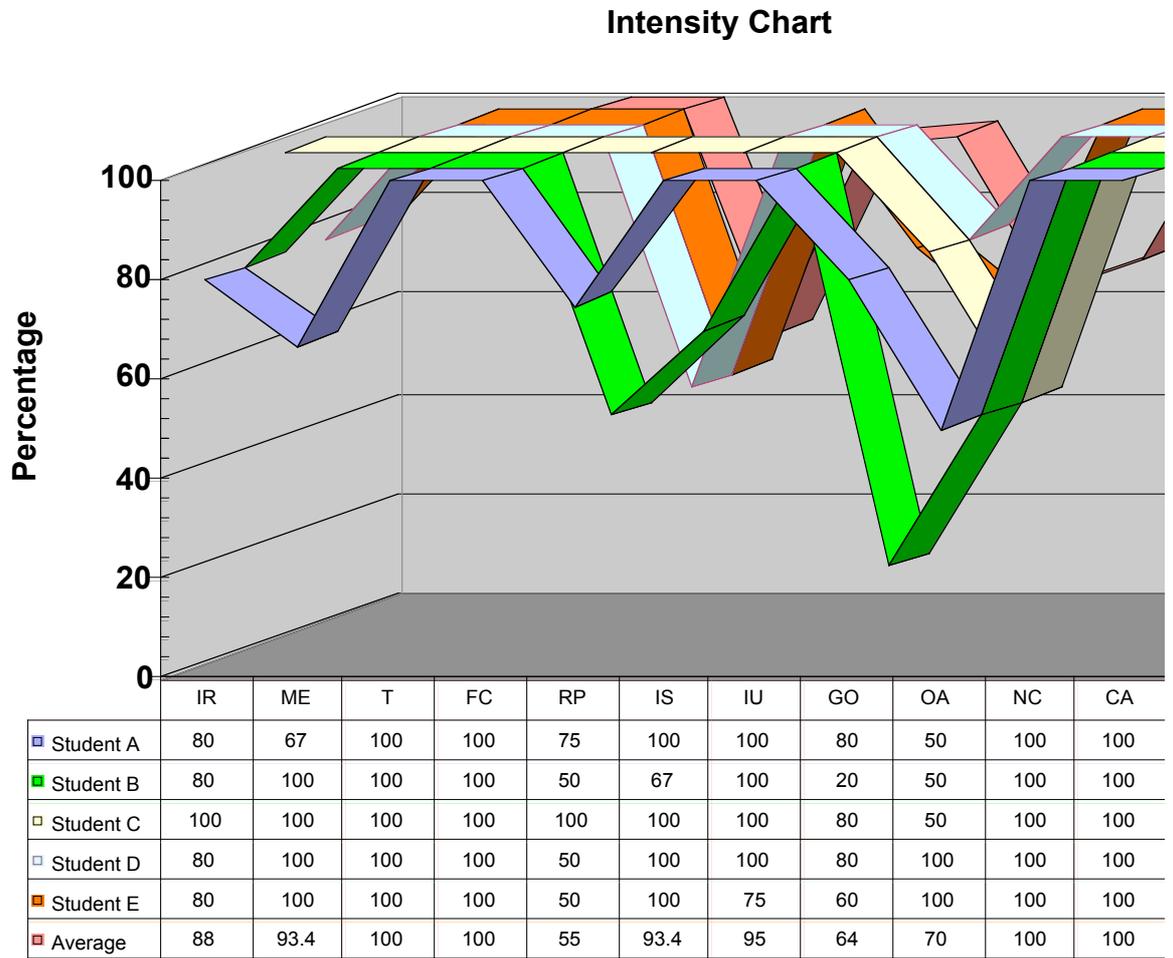
MLE Parameters

Tan (2000) reviewed the 12 parameters of Feuerstein and Feuerstein (1991) in terms of their relevance to students within a polytechnic setting in Singapore. His revised descriptions are summarised in Table below.

Parameter	Description
Intentionality and reciprocity (IR)	The mediator has a clear intention to mediate the stimuli and also demonstrates and shares his/her intention to the mediatee. Reciprocity calls for the mediatee's response to turn implicit intention into an explicit and purposeful outcome. *IR* creates like-minded attitudes expressed, in its nature, its goals, and its content.
Mediation of meaning (ME)	This refers to a continuous and intensive search for meaning. The awareness of meaning constitutes a major component of the motivation system. Meaning relates to the individual's cultural background, values system, aspirations and needs. The mediator makes known to the mediatee the meaning of the interaction, its significance, its "why" and its "what for".
Transcendence (T)	This involves moving beyond the "here and now" of the learning situation and beyond the primary goals of the interaction by connecting the situation to more remote and global ones. This is particularly important when addressing the individual's capacity to adapt and cope with new and changing environments.
Mediation of feeling of competence (FC)	Competence does not necessarily imply a feeling of competence. FC involves the mediator guiding the mediatee toward an awareness, feeling and consciousness of competence. FC involves removal of the unwanted fear of failure. FC addresses the fear of making mistakes that may result in the lack of motivation to try again. There is also the need to provide sufficient opportunities for the mediatee to confront certain situations which he or she has to master.
Mediation of reflective practice (RP)	RP is about the regulation of behaviour, self-evaluation, reflective thinking and metacognition. Such mediation creates the propensity for a reasoned way of behaving adaptively. RP involves two components. First, the cognitive functions leading to a decision. Second, metacognition that comprises: i) the combined evaluation of gathered data and the self-evaluated competence of the individual ii) the assessment of the meaning of the particular event which results in a systems or helicopter perspective of things.
Mediation of the search for an optimistic alternative (OA)	OA impacts on cognitive structure and affective motivational components. People are often confronted with a choice between optimistic and pessimistic alternatives in judging their own behaviours or the events they encounter. A pessimistic perception inhibits cognitive activities while an optimistic perception tends to lead to sharp, perceptive and systematic endeavour resulting in greater efficiency in unravelling otherwise neglected dimensions of the perceived

	ability. An optimistic turn of mind informs a lifestyle which affects one's readiness to resolve environmental factors threatening the emotional, mental and physical equilibrium of the individual.
Mediation of change awareness (CA)	CA deals with self-awareness of individual change. This can help the mediatee adjust to extreme changes in all possible directions involving competence, skills, moral judgements, emotions, and affect. CA indicates a need to address the underpinning belief systems of both the mediator and the mediatee in any intervention.
Mediation of challenge: the search for novelty and complexity (NC)	NC involves preparing the individual for adaptation to the novelty and complexity of the world. The propensity to confront a challenging novelty and complexity rather than giving up is vital for successful adaptation. NC is best carried out by allowing the individual to confront the novel situation in a gratifying way. Successful orientation toward mastery of the "new" as a source of intrinsic gratification encourages risk- taking initiative in the learner.
Mediation of goal seeking, goal setting, and goal achieving behaviour (GO)	Goal seeking, setting and achievement require one to enter a world beyond immediate perceived realities. They require abstinence from immediate gratification and impulsive behaviour. GO is about "having the end in mind", the prioritisation of goals and aspirations remote from immediate experience.
Mediation of individual uniqueness and esteem (IU)	IU relates to the recognition of the uniqueness and esteem of the individual, with emphasis on the development of a sense of independence and self-confidence. It is an acknowledgement of individual differences in terms of personalities and cognitive styles.
Mediation of interdependency and sharing (IS)	IS relates to the individual's sharing behaviour and sense of belonging. Knowledge sharing, teamwork and interdependence are important especially in certain cultures. Sharing behaviour reflects the individual's need to go beyond his or her own needs to participate in group activities.