EARMARKING THE CREDENTIALS OF REFLECTIVE JOURNALING DESIGN THAT SPELLS PROGRESS IN MATHEMATICS LEARNING SPACE

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Abstract

When reflective Journaling has been identified as an important component of mathematics education, it provides learners with an opportunity to correct misconceptions and fill in gaps by helping them to think about what they are doing; how they are doing; and why they are doing it. This study attempts to earmark the credentials of the select reflective journaling design that spells progress in the mathematics learning space at secondary level. The findings and conclusions derived in this study illuminate the in depth influence of select reflective journaling design for igniting the learner's mathematical competencies and thereby up scaling academic performance.

In this age of cut throat competition and globalization,the nation entails intuitive as well as rational thinkers to prepare its growth perspectives at international levels.Mathematics education embraces attaining in these forms of thinking,reasoning and problemsolving that are simplistic in relation to the complexity of the physical world.The central importance of the practices in producing a mathematics learner is stressed in many literature as a subject who could invoke not only the certainty of absolute power over nature but an omnipotent fantasy at the heart of productive rational economic man.In this mileau, learning of mathematics extends beyond learning concepts, procedures and their applications. It also includes developing a disposition toward mathematics and seeing mathematics as a powerful way for looking at situations.Student's maths dispositions are manifested in the way they approach tasks,whether with confidence,willingness to explore alternatives, perseverance and interest and in their tendency to reflect on their own thinking. Hatano and Inagaki (1986) as reported by (Peterson et al., 2010) opined that students have to acquire in mathematics education is adaptive expertise- the ability to apply meaningfully learned procedures flexibly and creatively – as opposed to routine expertise- simply being able to complete school mathematics exercises quickly and accurately without understanding.

When reflective practice has been identified as an important component of mathematics education, it provides learners with an opportunity to correct misconceptions and fill in gaps by helping them to think about what they are doing; how they are doing; and why they are doing it. It refines their thinking, improves their thoughts, addresses the roots of their beliefs and assumptions and transforms their practice. Many researchers argue that reflective processes are essential to the quality of learning .Reflection is especially helpful in solving complex tasks, because it helps learners to identify facts, formulae, and theories that are relevant for the solution of an ill defined problem. (King & Kitchner, 1994). Regular and purposefull reflection may require a commitment to reflection, learning how to reflect,and supportive conditions in which to reflect.Bould et .al. 1985b as reported by Bell and Mladenovic (2013). The time and effort invested in reflection yield a harvest of greater student learning, higher teacher morale, enhanced feelings of efficacy and a more collaborative professional community. The National Council of Teachers of Mathematics, (NCTM, 2000) calls upon teachers and students to emphasize reflection as part of

the process of teaching and learning of mathematics.Thus the pedagogic domain in mathematics should be incarnated with innovative and progressive design tools and mechanisms embedded with reflective learning practices for increasing the cognitive involvement of all students with mathematics curriculum pursuing the transformation of the learners to be active thinkers and problem solvers.

Out fielding mathematics learning through reflective Journaling.

Reflective Journals are the corner stones of reflective practice work. Reflection on practice or learning by keeping a Journal is a fundamentally dynamic rewarding process (Benner,1984; Beveidge, 1997 and Schon, 1983). Journals are a collection of expressions of thinking and explorations. It reflects the personal reflective background of the learner in the context of the experience and understanding.The pedagogical potential of this technique includes student responsibility for learning,active engagement in reflective process,student centered approach and shaping the knowledge as learners see fit. Journaling is an interactive process which needs commitment, energy and open mindedness from the learner. Reflective writing need be pitched according to the purpose of writing it. While writing in a journal we not only record what happened or what was observed, but also develop new understanding, and insights and thereby new hypothesis and new perspectives of the phenomena.

Journal writing is a learning technique for encouraging reflection and active learning for positive change in learners. It enables the documentation of personal experiences, reflections, thoughts, activities, facilitations, goals and evolutions to situations that can then be implemented in praxis to explore and analyze ways to thinking and being in contexts. By documenting such information on a regular basis focusing on stipulated modes reduces the change of omission and encourage a regular cycle of action planning. Self reported artifacts consistently suggests that journal writing is a helpful device, both in encouraging reflective activity in students and in providing educators with a window to make critical judgment of their student's learning.Literature [Selfe et al. (1986), Langer, (2002)] suggests that reflective learning journals facilitate critical reflection; particularly it assists learners in conceptualizing and reconceptualizing abstractions through reconfigurating, reframing and relating it to practice. Besides, the learners developed better problem solving strategies through journaling which needs critical reflection.Knowing how we learn makes us a more effective learner. Thinking about our learning and writing things down help to clarify our thoughts and emotions in this regard. There is evidence that the use of learning journal facilitate metacognitive abilities which leads to self inquiry, self managing learning process and self esteem [Holly (1989), Norton, Ownes, and Clark (2004)].

Learning Design based on Reflective Journaling

Using a model as a framework is an excellent way of encouraging sound effort in reflection in journal entries. A framework provides a degree of structure that is often necessary to guide learners in their learning and it assists facilitators to make some headway in terms of clarifying the stages and levels of reflection.

The investigator reflected upon the varied theoretical versions of journal stages, the model proposed by Brown & Irby, (2001) is found to be the most suitable one for the present study as it touches deeper levels of reflection. This model reflective cycle of journaling comprising five stages of reflection namely, **select, describe, analyze appraise, and transform** was adopted.The investigator made learners to conceive of the evidence of learning to be documented through journaling by exposing them through this cycle of journal writing.

In formal reflective wiring where the learner's reflection work is being exposed and assessed, it is important to use a framework for the development of lesson. The investigator used Gibb's model of reflective cycle (Gibb, 1988) for developing the learning design. The phases of this model are, **Description,Feelings,Evaluate,Analysis,Conclusion,Action plan**

Architecting an artful and productive learning design with structural integrity that appropriately meet the needs of practitioners as well as the learners is the concern of professional learning scenario at all levels of mathematics education. Effective learning design is probably a formulaic process to manage the mammoth task of mathematics learning. It is a rich learning space of learners by creating environments, networks, access to resources, and increases the capacity of learners to function and forage for their own knowledge. In this study, the investigator developed the select reflective journaling design through a perfect wedding of the varied phases of Journaling strategy and Gibb's model of reflection cycle for lesson development. For making a concerted effort of the learning endeavor, each phase of the journaling cycle is synchronized with the collinear phases of Gibb's model of lesson development. At the outset, during the 'description' phase of the lesson the learners are expected to select and describe the resume of the evidences to be documented. They sketch out the main benchmarks of the documentation by discerning the circumstances and issues of the learning event. They are nourished with suitable motivational remarks to remold the mathematics task. In the 'evaluation' phase of the lesson deeper analysis of the artifact to be produced is done while conducting explorations for strategy formulation. In the next stage 'analysis' deeper reflection and explicit processing of the stipulated task have to be undergone for addressing the causatory factors of the evidence and the path through which the learners integrate theory with experience. The next phase of the lesson namely 'conclusion' the learning effects are reified and the learners become self-managers of the learning process. Here they interpret the evidence and evaluate its appropriateness, effectiveness and efficiency and impact by reflecting on the values, beliefs and assumptions. During 'action plan' phase of the lesson the learners are expected to use the insights gained from varied levels of reflection to formulate a plan of action of the future experience prophesying new perspectives of the learning goals. Journaling prompts along with suitable scaffoldings were amended throughout the design implementation for making learning student directed, developmentally elegant, active, challenging, productive and realistic. A schematic frame of the developed learning design is depicted as in Figure 1

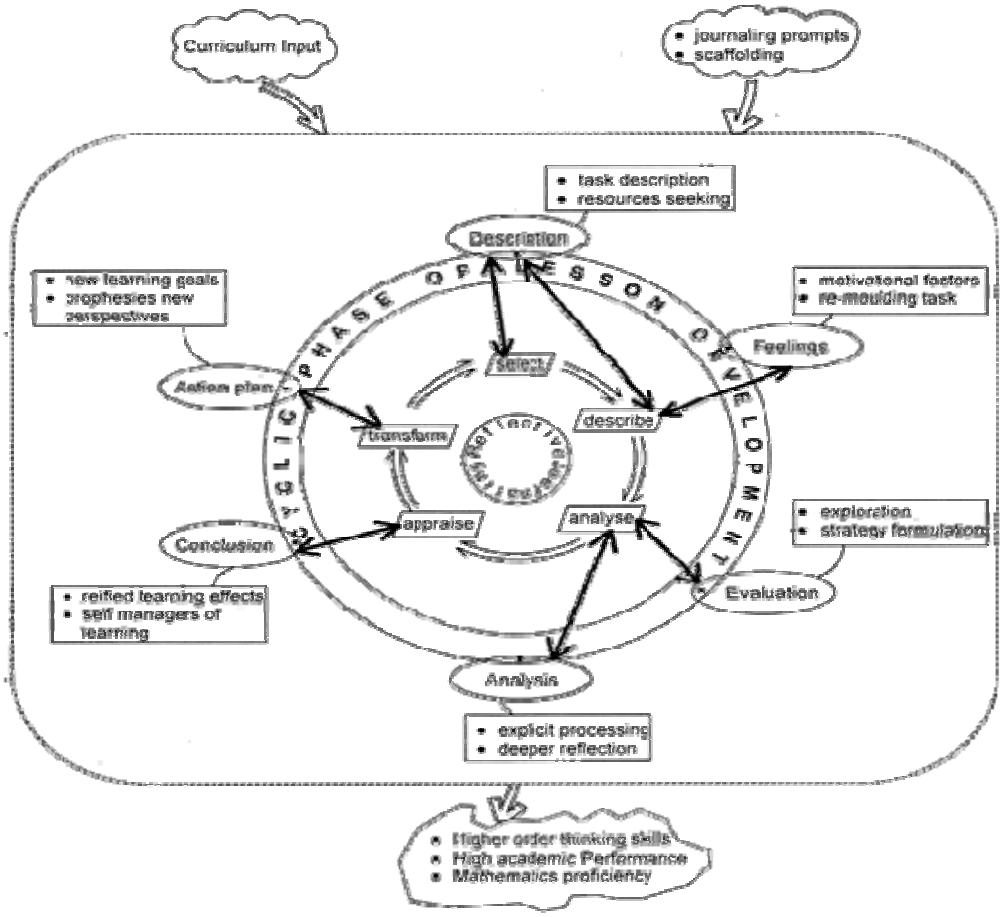

Figure 1. Schematic Expression of Reflective Journaling Design

The problem : This study was mainly meant to establish the effectiveness of Reflective Journaling design in upscaling mathematics learning space at secondary level

Objectives of the Study

1) To test the effectiveness of Reflective Journaling design in improving the academic performance in mathematics of pupils at secondary school level.

2) To analyse how the select Reflective Journaling design is effected to intensify the learning of mathematics in the experiential space among certain cohorts of pupils in an interactive set up at secondary school level.

Methodology in Brief

The present study attempted to empower the student folk at secondary school level with reflective dispositions pursuing heightened academic performance in mathematics by the Reflective Journaling design. For attaining the set objectives of the investigation both quantitative and qualitative methodology were adopted by the investigators for the study. The quasi-experimental design with pre test posttest non equivalent group design was employed for

the quantitative segment and focus group discussions was adopted for the qualitative segment of the present study.The participants of the study primarily consisted of144 pupils at secondary school level

Analytical supports and techniques of the study.

1) Achievement test in mathematics:

2) Lesson design based on Reflective Journaling :

3) Focus group ‘questioning route’: In this study the investigator has designed a questioning route to assist focus group members to relax, open up, think deeply, and consider alternatives The questions were used in a semi-structured way to ensure coverage of important issues yet allow for flexibility in responding to group initiated concerns

Analysis and interpretation

In order to find out the effectiveness of Reflective journaling design with respect to achievement in mathematics of pupils the investigator analyzed the post test scores of the control group and experimental group who were exposed to Reflective journaling design. To find out whether any significant difference exists between the experimental group and control group, the mean and standard deviation of the posttest scores of achievement were estimated. The critical ratios were found out based on the data presented in the Table 1.

Table 1. Test of Significance of the Mean Post test Scores of Achievement

Sl. No.	Sample	Control group			Experimental group			Critical Ratio	Level of significance %
		Mean	SD	No. of pupils	Mean	SD	No. of pupils		
1	Total	19.69	7.42	75	30.65	9.18	69	7.06	0.01
2	Urban	20.63	7.36	36	30.44	9.56	34	4.82	0.01
3	Rural	19.20	7.28	39	29.68	9.91	35	5.22	0.01
4	Male	19.6	6.8	37	30	10.12	33	4.97	0.01
5	Female	20.15	7.73	38	30.11	9.39	36	5.06	0.01

The obtained critical ratios for the total sample, locale wise and gender wise sub samples are significant as their levels of significance are 0.01%. This shows that significant difference exists between the mean scores of the

post achievement test of experimental group and control group.This result indicates that the performance of the experimental group and control group in the post achievement test are not similar. The table values show that the higher mean scores are associated with the experimental group . This means that experimental group shows better performance than the control group in their achievement for the total sample, locale wise and gender wise sub samples.

But it cannot be conclusively said that both groups differ significantly exclusively due to the experimental factor by simply comparing their post test scores as well as the pre and post scores of the two groups. So it became necessary that these scores be analyzed using the technique of Analysis of Covariance (ANCOVA) for comparison in which the prior abilities are statistically controlled.

Single factor ANCOVA with pre-experimental status in achievement as covariate was employed to investigate the effectiveness of Reflective journaling design in promoting reflective learning practices in mathematics over present activity oriented method. The details are given in Table 2.

Table 2. Summary of ANCOVA for Total Sample

Source	Type II sum of squares	df	Mean square	F- value	Significance level %
Model	54564.03 (a)	1	54564.033	262.238	0.01
Control post	54564.033	1	54564.033	262.238	0.01
Error	14143.967	68	208.000		
Total	**68708.000**	**69**			
A R squared = 0.815 Adjusted R squared = 0.805					

The obtained F- value (262.238) is significant as the level of significance 0.01%

It can be inferred from the covariance analysis that after a linear adjustment was made for the effect of variation due to difference in the pre experimental status in mathematics achievement as measured by the covariate there is statistically significant difference exists between the experimental group and control group in the post test scores for the total sample. This means that the experimental group performed better than the control group in their post achievement test.

Adjusted mean comparison

An additional analysis was employed in order to determine which one of the two groups based on Reflective journaling design cause difference from another in terms of the variation in the criterion mean. Adjusted means of achievement for the experimental group was calculated using regression equations for the total sample. The details are given in Table 3.

Table 3. Adjusted Mean of Post test Scores of Experimental Group forTotal sample.

Sl. No.	Sample	Mean of control group	Mean of experimental group	Adjusted mean of experimental group
1	Total	19.69	30.05	29.99

The criterion means were adjusted to avoid the effect of the covariate from the final result. The obtained adjusted means of the experimental group for total sample,is found greater than the corresponding means of control group. It can be inferred from the result that the experimental group is better than the control group with regard to the post achievement scores. This better performance is due to the effectiveness of Reflective journaling design, which was treated to experimental group in promoting reflective learning practices in mathematics. Thus it is evident from the analysis that Reflective journaling design enhances the achievement level in mathematics of secondary school pupils.

Focus group discussion

Some of the major hunches of the select reflective journaling design put forward by each of the focus groups were detailed in the following part. The pupils of focus group **A** were below average group of pupils from urban area and focus group **B** were above average group of pupils who were exposed to Reflective journaling design. Pupils hailed from rural sub sample generally remarked that they have seen journal writing as a means of encouraging reflections on their field experiences and make connections with and extensions to what they had read and heard in class. Students' recognition of freedom, that journal writing provides as a means of reflection is mainly highlighted by the urban sub sample. They are of the view that journaling provides more freedom in reflecting upon their own personal growth and development and in nurturing their natural observation skills drawn on a wide range type of intelligences. Both the groups registered their opinion that journals opened avenues for critically evaluating the learning experiences for instructors and themselves. Besides, they suggested that the exposure to the Reflective journaling design could enable them to:

- Induce self confidence and self respect among themselves that energize them in the better processing of mathematical tasks.

- To compare mathematical concepts and reconceptualizing the emergent problems
- Explore contradictions pursuing alternate strategies to maximize their learning
- Planning, coordinating, monitoring and assessing the solution processes
- Discover for themselves the creative ways to solve problems
- Communicate mathematical idea coherently and clearly to peers and others
- Promoting critical thinking, challenging assumptions, increasing personal growth and solidifying learning
- Illuminate self assessment and self reflection in journaling.
- Consolidate the thinking underpinned in the mathematical tasks.

These unique highlights of the select Reflective journaling design empowered them to hone their mathematical competencies and to engrave mathematically proficient learners

Major Findings

1) The reflective journaling design is effective to a great extent in improving the academic performance in mathematics of secondary school pupils.

2) It is found out from the focus group discussion that the select Reflective journaling design link mathematics theory and practice as well as integrate personal, intrapersonal, interpersonal, intellectual and professional aspects of pupils during all mathematical endeavors subsequently supports the movement of learners towards becoming reflective practitioners.

3) The discussion results entailed certain findings with regard to the constraints in practicing the select Reflective journaling design like the lack of availability of time and resources in the curriculum and institutions and the dearth of continuous monitoring of the journal entries by the respective mentors. The results of the discussion also point towards the significance of providing journaling prompts as it acts as a catalyst to initiate the reflection process and a device for structuring reflective writing.

The findings and conclusions derived in this study illuminate the indepth influence of select reflective journaling design for igniting the learner's mathematical competencies and thereby upscaling academic performance. The phased implementation of the reflective journaling design invited the pupils to reflect on which behaviors might be modified, strengthened or extinguished to produce better academic performance in mathematics. .

During the experimental intervention the learners are funneled into the sequential flow of the lesson design which provides plenty of exercises and activities entailing the development of discourse between the learner and the learning events involving deeper reflections.The first phase of the lesson design acknowledged the learners to actively interact with the learning environment with an initiation in the framing of issues and goals and in seeking the resources needed. The second stage in the sequential process injects the motivational factors; lift the level of self confidence to better processing and remolding the learning task driven by self analysis, self referring, self evaluating and self managing. The third phase in the syntax of the design enabled them to evaluate the cognitive as well as affective promoting factors and restraints that were involved in the harmonious synchronization of the stage by stage schemata for the formulation of the plan of action. The documents produced at this stage addressed the flexibility of procedure and proper use of logical relationship to frame self strategic mode of problem solutions. During the 'analysis' phase the learners could explicitly exhibit deeper shared reflections with peers wielding the nexus of higher learning out comes. The artifacts produced at this phase could integrate the experience with theory and the praxis demonstrated improved awareness and self development. The 'conclusion' phase demarcated the closure of the learning effects discerned from deeper reflection through the phased sequential programme of active intervention. Learners became equipped with the new insights and out looks about the learning process and outcomes and subsequently became self mangers of the learning episodes. The final phase of the reflection cycle invited the learners to make out original thoughts steered by their own perspectives about the new learning situation to generate knowledge. The bridging or transformation potential of the select Reflective journaling design may be the due cause of better academic performance of experimental group who were exposed to Reflective journaling design.

These trends are in accordance with the following observations. Moon (2004) reported that a learning journal is essentially a vehicle for reflection and is an accumulation of material that is mainly based on the writer's processes of reflection. As Hammond (2002) stated, journal keeping can improve students' writing, enhance visual literacy and provide them with an opportunity to think and express themselves graphically, poetically, metamorphicaly and informally. Given the many benefits of learning journals it is not surprising that they have been employed in a diverse array of disciplines to promote students capacity for reflection, critical thinking and ultimately their broader learning. (Ballantyne and packer 1995a, 1995b: Moon 1999; Bound, 2001; Henderson Napan and Monteiro, 2004).

Implications of the Study

1) The experiential space embedded with the pedagogical task grounded in reflective dispositions requires students to play the role of decision makers in being able to evaluate different perspectives and take multiple views into account so as to make an informal decision. In this stance of reflective culture cognitive patterns and networks of knowledge structures are incrementally constructed by drawing linkages between the fundamental base of prior knowledge and the body of new knowledge gathered from current learning activities. The practitioners should bear in mind that learner's prior mathematical content knowledge levels have to be assessed and adequate mediation need to be done to acquaint students with the foundation of expertise before plugging them into reflective endeavors.

2) Not only the enthusiastic benefits namely the untapped potential of journals were highlighted in the study but also it points towards the numerous constraints embedded within the dominant culture of educational system that limit the full potential of journal writing.The major impediments evolved through focus group discussions were lack of journaling prompts ,dearth of timely monitoring of journal entries and lack of availability of time and resources. The study underscores that curriculum framers and practitioners should find new dynamisms to steer clear of these challenges during every pedagogical endeavors.

3. When students reflect on their work, become more adept at describing the skills and strategies they use to solve complex problems and apply those same strategies in a variety of contexts consequently discover their metacognitive process for learning. They transform their roles as a learning community by joining as partners in the instructional process. These impressions of reflective designs under the present study affirm that practitioners in all disciplines should find new dynamisms and tools synchronized with reflective orientations to expand their repertoire of pedagogical mechanisms for a better learning community

REFERENCES

Ballantyne, R and Packer, J. (1995 b) Making connections: using student journals as a teaching/learning aid. HERDSA Gold Guide No. 2 Canberra; HERDSA.

Ballantyne, R. and Packer. J. (1995a). The role of student Journals in facilitating reflection at the doctoral level. Studies in Continuing Education, 17,(1-2):29-45.

Bell,A.&Mladenovic,R.(2013) How tutors understand and engage with reflective practices.Reflective Practice..14(1) , 1-11

Benner, P. (1984). From novice to expert: Excellence and power in clinical nursing practice. Menlo part: Addison Wesley.

Beveidge, I. (1997). Teaching your students to think reflectively: The case for reflective Journals. Teaching in Higher Education, 2(1), 33-43.

Boud, D. (2001). 'Knowledge at work issues of learning', in D Boud and N. Soloman (Eds.) Work based learning. Milton Keynes: SRHE/open university press, 34-43.

Brown, G. & Irby, B.J. (2001) .The principal portfolio (3rd Ed). Thousand Oaks, CA: corwin press.

Chambers, P. (2010). Teaching mathematics: Developing as a Reflective Secondary Teacher. Sage Publications India Pvt. Ltd. New Delhi.

Gibb, G. (1988). Learning by doing: A Guide to Teaching and Learning Methods. Oxford: Oxford Polytechnic FEU.

Henderson, K., Napan, K. and Monteiro. S. (2004). Encouraging reflective learning: An online challenge. Paper presented at beyond the comfort zone: Proceedings of the 21st ASCILITE Conference, 5-8 December, at Perth.

Holly, M.L. (1989). Writing to grow: Keeping a Personal-Professional Journal Portsmouth, NH: Heinemann.

King, P. & Kitchner, K. (1994). Developing reflective judgement. San Francisco: Jossey-Bass.

Langer, A.M. (2003). Reflecting on practice: using learning journals in higher and continuing education. Teaching in Higher Education, 7(3), 337-351. DOI: 10.1080/13562510220144824.

Moon, J.A. (2004). A handbook of reflective and experiential learning. London and New York. Routledge-Falmer.

Moon, J. (1999 b). Learning journals: A handbook for academics students and professional development. London: Kogan page.

Moon, J.(1999 a) .Reflection in learning and professional development. London: Kogan page.

NCTM, (2000). National council of teachers of mathematics, principles and standards for school mathematics. Reston, VA: Author.

Norton, L.S., Owens, T. and Clark, L. (2004). Analysing meta learning in first – year undergraduates through their reflective discussions and writing. Innovations in Education and Teaching International, 41(4), DOI 10. 1080/14703290 420002 77011.

Peterson, P., Baker, E.,and Mc Gaw, B. (Eds).(2010). International Encyclopedia of Education. Academic press.

Schon, D.A. (1983). The reflective practitioner: How professional think in action. New York: Basic Book.

Selfe,C. and Arbabi, F. (1986). Writing to learn engineering student's journals, in A. Young and T. Fulwiler (Eds) .Writing Across the Disciplines, Upper Montclair, NJ: Boynton /cook.

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ANALYTICAL PERCEPTION ON THE PEDAGOGICAL SPACE OF MATHEMATICS AT SECONDARY LEVEL FOCUSING ON THE PRACTICES, CHALLENGES AND EMPHATIC TRENDS IN NURTURING MATHEMATICS PROFICIENCY

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Abstract This investigation gives a fresh look at the present scenario of mathematics learning with special emphasis to the practices, challenges and affirmative dynamics to nurture mathematically proficient learners. It was found out through a semi structured interview with school practitioners in mathematics at secondary level, experts in the field of mathematics and teacher educators at B.Ed. and M.Ed.levels. The study reveals that reform efforts to the prevalent mode of curriculum transaction are to be activated by giving a more rounded portrayal of mathematics that children need to learn, how they learn it and how it might be taught to them effectively.

Mathematics has penetrated many parts of our life as it the universal mode of thought. The power of mathematics which is regarded as the grammar of all scientific discourses is capitalized in the way it has been processed and learned. The mission of researches in the field of mathematics learning is appraising and amplifying the pedagogical practices of mathematics at all levels. It is also aiming at a better understanding of the processes underlying the acquisition and development of mathematical knowledge, skills, beliefs, attitudes, dispositions and powerful environments for teaching and learning of the subject. Dymoke and Harrison (2008) reported that mathematics is fundamental to national prosperity in providing tools for understanding of science, engineering and technology and for participation in the knowledge economy. The basic level of mathematics proficiency needs to be raised substantially and the gaps in proficiency across societal groups need to be eliminated to participate fully and productively in society and the economy of the 21st century.

A careful attention to the pedagogical mechanisms in mathematics education is direly needed to minimize the disparities in the pragmatic implementation of the programme of study in this domain. This investigation gives a fresh look at the present scenario of mathematics learning with special emphasis to the practices, challenges and affirmative dynamics to nurture mathematically proficient learners.

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Statement of the problem

The present study is entitled as, ‘Analytical perception of the pedagogical space of mathematics at secondary level focusing on the practices, challenges and emphatic trends in nurturing mathematics proficiency.

Hypothesis of the Study

The predominant pedagogical functions for transacting mathematics curriculum at secondary school level are inadequate in upbringing mathematics proficiency.

Objective of the study

To analyse the predominant pedagogical functions for transacting mathematics curriculum at secondary school level with special emphasis to the practices, challenges and affirmative dynamics in upbringing mathematics proficiency

Methodology in brief

The expanse of the predominant pedagogical practices in mathematics at secondary level was found out through a semi structured interview with school practitioners in mathematics at secondary level, experts in the field of mathematics and teacher educators at B.Ed. and M.Ed.levels (N=81). For having a comprehensive judgment in this respect, a semi structured interview guide was developed and used to facilitate organization, consistency and coverage of questions to ensure that interviewees touched on relevant topics. The interview guide comprised of 14 items focused on the thrust areas namely,

a) the conceptualization of the componential dimension of mathematics proficiency,

b) the challenges, constraints and potentials if any, in the prevailing classroom practices of mathematics learning for developing mathematics proficiency among the studentscape at secondary level,

c) the nexus of affirmative dynamics credential to the development of mathematics proficiency.

The responses and ratings of teachers were collected and analyzed using percentage computation.

Analysis and Interpretation

a. Analysis of the conception of componential dimensions of mathematics proficiency at secondary level.

At the outset of the interview the investigator enquired about the commonly practiced strategies in mathematics classes for actualizing the componential aspects of mathematics proficiency. The reflections of the teachers indicated that most of the teachers (95%) are practicing activity oriented method and discussion method in their classrooms while very few teachers earmarked with high academic credentials opined that they are practicing certain innovative strategies like cooperative learning, brainstorming, problem solving and the like even though moderate number of teachers is aware of these innovative strategies. This may be due to the habitual inhibitions of the majority of practitioners to face the challenges in selecting cognitively demanding tasks exploring rich resources and designing lessons by elaborating the mathematical competencies that the students are to learn through those tasks and to outweigh the restrains from institutions which are in tune with the present activity oriented mode of curriculum transaction. Nevertheless, very few teachers with high academic merits and experiences may have the specific skills in integrating the competencies with contextual programs and the insightful trend and efficacy to face those challenges.

The adequacy of the prevailing classroom practices in actualizing the dynamics of mathematics competency is analyzed through the interview. While analysing the responses it is observed that majority (82%) of teachers rated it as not at all sufficient, 10% of them rated sufficient to some extent and only 2% of teachers were of the opinion as sufficient. None of them opined that the prevailing classroom practices are efficacious enough in actualizing the set elements of mathematics competency. The major reason behind these phenomena as claimed by the select sample of experts is the exclusion of an integrated and balanced treatment of all the strands of mathematics proficiency at every point in the predominant practices of learning and teaching of the subject. The investigator felt that the study of mathematics has to be seen as bringing the discipline of logical thinking to all the stakeholders and the mastery of its form of reasoning has to make a hallmark of mathematics learning. It is to be noted that the prevailing stance of instructional dynamisms struggle to describe and categorize mathematical

situations, analyse attributes of mathematical representations and design conceptual supports ensuing the empowerment of the learners to analyse mathematical modeling and strategies to increase their learning.

While analyzing the functional foci of mathematics learner it can be observed that majority of teachers suggested a multidimensional approach in this regard. In their opinions, the major foci of mathematics proficiency are explaining mathematical problems, applying principles, reasoning, communicating mathematical ideas, estimating results accurately, illustrating mathematical procedures and showing confidence in working with problems.

The details are provide in Table 1

Table 1. Details of Opinions of Teachers Regarding the Functional Dimensions of Mathematically Proficient Learner

Sl. No.	Functional dimensions of mathematically proficient learner	% of teachers opined
1	Explains mathematical problems	95
2	Integrates and functionalizes mathematics concepts	89
3	Uses multiple representation of mathematical tasks	91
4	Uses appropriate algorithms	90
5	Formulates plan of action for solving problem	85
6	Estimates results accurately	92
7	Selects and applies suitable principles to solve mathematical issues	87
8	Explains mathematical procedures	82
9	Communicate mathematical ideas effectively	85
10	Justifies conclusions	81
11	Use heuristic approaches	90
12	Shows confidence in working with problems	82

These activation dimensions enforced the learners to participate actively and to bring embracing changes in the processing and application of thinking in a structured pattern in all the mathematical endeavors and to add a mathematical punch in all the routine actions so

that they can become systematic and creative decision makers and problem solvers. This result is supported by Mubarak (2011) who found out a positive result about the consistency between teacher's perception and student performances of the select six aspects of mathematics thinking namely, searching for patterns, induction, deduction, symbolism, logical thinking and mathematical proof. The theoretical evidences (Studies and Reports published by National Research Council, 2001) emphatically support these observations.

While categorizing the levels of mathematical competencies possessed by their pupils at secondary level most of the teachers opined that a considerable percentage of pupils are at Novice level (67%); where as 17% of pupils are at Basic level, 10% of pupils are at Proficient level and 6% at Advanced level respectively. That is why a remarkable proportion of pupils at secondary level exhibit a dearth of positive disposition towards mathematics learning which affects the explicit processing and cognitive management of mathematical task at hand flexibly. It is clear that learners that are more proficient can form mental representations of problems detect mathematical relationships and device novel solution methods when needed. From the experiences of the investigator as a senior teacher educator, it is revealed that prevailing curriculum transaction modes are ineffective in nurturing the innate potentials of learners to attain the varied strands of mathematics proficiency namely, conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition. The results of the State level examinations at secondary schooling also support these observations.

The rationale behind this happening might be the deficit of instructional practices followed in mathematics learning to exercise originality of thinking and critical judgment of procedures and strategies in finding solutions offered by self and peer assessment techniques and reflective activities. Being a reflective learner, an individual can make sense of both formal and informal learning and to organize, evaluate and monitor it.

b. The challenges and constraints if any, experienced by the student scape at secondary level in the prevailing classroom practices as perceived by the practitioners.

In this segment of the interview, the investigator dealt with the impediments and challenges in the pedagogical transaction of mathematics for enriching and imparting explicit cognitive orientations of pupils as perceived by the practitioners. The details of responses are provided in table 2.

Table 2. Challenges and Impediments in Actualizing Mathematics Proficiency- Teacher's Responses.

Sl. No.	Teacher reflections with respect to challenges and impediments in actualizing mathematics proficiency
1	Negative attitude towards mathematics
2	Lack of motivation in inspiring confidence
3	Stereo type thinking of task analysis
4	Approaching new task with the aim of performance rather the hierarchical nature of mathematics
5	Absence of mindful and effortful involvement of learners
6	Lack of independent practice
7	Mechanical approach to task engagement
8	Mismanagement of discourse around the mathematical task
9	Ineffectual interaction among teacher, student and the task
10	Inability to link experience to abstractions
11	Lack of self assessment by learners
12	Incapacity to attend to the multiple approaches of problem solving

The results of Table 2 point towards the suggestions of select mathematics teachers with regard to the different domains of the challenges and constraints confronted by them in their mathematics classes. Almost all the practitioners selected were of the view that a considerable proportion of learners approach mathematics task management with pre- owned plan of actions. They often show reluctance to open mindedness and flexibility in experimenting solution pathways for effectively solving mathematical problems because of the absence of self-confidence and intellectual dispositions. This result is in consistent with Savas (2010) and

Wong, et al (2011) who found that mathematical proof which is needed to understand concepts and procedures and justification of each procedure which also require high ability in thinking was considered as an important area in mathematical education. The noticeable reasons for this phenomena may be the lacunae in the predominant practices in identifying the new goal of mathematics learning that represents a major shift towards mathematical reasoning; conjecturing, inventing and problem solving; logic and mathematical evidences as verifications and connecting mathematical ideas and applications and other proficiency orientations to other disciplinary bodies of knowledge.

C .Affirmative dynamics credential to development of mathematics proficiency.

While enquiring about the affirmative aspects for optimizing mathematical thinking among pupils most of the teachers responded very creatively. The details are given in Table 3

Table 3. Details of Suggestions for Optimizing Mathematical Thinking Scenario

Domain of aspects	Sl. No	Aspects
Environmental oriented	1	Networking and patterning of information
	2	Communicating with clarify and precision
	3	Organizational control of ideas
	4	Activating logistics in thinking domain
	5	Augmentative and logical organization of ideas
Learner oriented	1	Using prior contexts pragmatically
	2	Freedom to explore
	3	Learner controlled environments
	4	Collaborative learning arrangement
Teacher oriented	1	Reflective question prompts
	2	Scaffolding mechanisms
	3	Teacher wait time
	4	Teacher explanations
	5	Reflective level feed back

From the above table it is noted that majority of teachers who were undergone in service courses frequently affirmed forcefully some cognitive as well as reflective aspect of the learning process for unfolding the potential of the learner in the mathematics learning scenario. This is because the descriptors of reflective learning process are more consistent with the emergence of metaphor of learning focused on individual enrichment. Learners became more open-minded, whole hearted and receptive of conflicting views to further overcome the impediments of mathematics learning such as forming mental representations of problems emerge with several approaches to a problem, choose one among them flexibly to fit the requirement of the novel situation and the like.

The investigator put forward 10 designations of mathematics learning process like real life tasks, problem based learning activities ,visual transformations of learning, reflective writing, encouraging open mindedness to others ,fostering objections as a way to examine new thoughts, analyzing contradictions and inadequacies in their learning, timely reviewing and monitoring of the learning process, regulating and directing learning episodes and debriefing of actions leading of future modifications for giving momentum to the process. Above 80% of the select teachers advocated all the suggested elements as essential in inculcating mathematics competency. While responding to the open-ended item about the repertoire of strategies that could facilitate mathematics learning in the desired direction most of the teachers were of the opinion that innovative strategies including problem solving, concept mapping, reflective journaling, portfolio writing, inquiry method, graphic organizers, and problem based learning and the like attuned to reflective orientations are very essential in fortifying mathematics learning.

This may be due to the unique designations of the suggested strategies in enriching the range of connections and relationships between mathematical concepts and principles among different styles of absorbing, associating, applying information and increasing retention of concepts. As learners are enabled to crystallize their thought processes through these strategies they can functionalize the mathematical concepts fruitfully, strategize solution routes flexibly, do

mathematical procedures fluently, judge the solution procedures reasonably and can tackle challenging mathematical tasks confidently.

By analyzing the responses of item which enquired about the awareness about the facilitators and constraints in implementing these suggested strategies the following details were obtained. The prominent ones among these are detailed in Table 4.

Table 4. Details Regarding the Facilitators and Constraints in Practicing Reflective oriented strategies.

Strengths (Facilitators)	Constraints
▪ Pathways to think at higher levels.	▪ Dearth of timely availability of adequate resources and materials.
▪ Emanates competency to become lifelong learners.	▪ Deficiency in the availability of time.
▪ Transforms the role of learners as partners in the instructional processes.	▪ Inhibitions in practicing innovative trends.
▪ Sense of ownership in one's own learning process.	▪ Lack of initiative in exploiting the empowered environment at schools.
▪ Sequencing of mathematics concepts and processes.	▪ Deficit of institutional support for flexibility
▪ Contextualizing of learning task.	

While going through the details of Table 4 the investigator could identify some of the practical difficulties such as dearth of timely availability of adequate resources and materials, deficiency in the availability of time and the like in practicing these strategies.

While responding to the item concerning the best method or approach in transacting mathematics curriculum effectively the teachers responded with prominent suggestions. A reasonable number of practitioners in mathematics (around 60%) who were undergoing regular in-service courses and cluster meetings expressed their views in practicing reflective learning strategies as a way to add academic flexibility, critical awareness and creative expressions in accentuating mathematics learning process. The others (40%) who show genuine interest in charting new vistas in the pedagogical landscape of mathematics recommended innovative

approaches namely critical pedagogy, ICT oriented approach, e- learning kits, web based learning packages and the like for curriculum transaction in mathematics.

Thus, the select sample of mathematics teachers and experts argued that reform efforts to the prevalent mode of curriculum transaction are to be activated by giving a more rounded portrayal of mathematics that children need to learn, how they learn it and how it might be taught to them effectively. Instruction should be based on solely by attending relationship between problems and solutions, and to the nature of justifications and mathematical arguments thereby inventing mathematical conceptual frame on their own.

Major Conclusions

- ❖ The findings lead to the conclusion that the predominant space of pedagogical functions in actualizing mathematical scholarship among secondary schools pupils is insufficient and hence vibrant instructional mechanism for enriching the thinking processes are needed.
- ❖ The findings lead to the conclusion that the pupils at secondary level are experiencing certain constraints and challenges in the mathematical task engagement in the present activity oriented approach. It is also concluded from the findings that these branded pedagogical imputations are to be outweighed while discerning the benchmarks of new learning designs.
- ❖ The conclusion emanates from all these findings reveals that off beating instructional procedures embedded with reflective dispositions are essential in resurging mathematics learning scenario at secondary level of schooling.

Implications of the Study

The conclusions derived in the investigation evinced that a realignment of mathematics learning scenario is inevitable now in order to bridge the gap between what the learners acquire from the mathematics classroom environment and what knowledge and skills they are expected to have to meet the demands of 21st century communities. Educational institutions are struggling to keep pace with the astonishing rate of change in the learner's life outside the school due to the inception of innovative trends in social media technology. They have to spend their lives in a multitasking, multifaceted, technology driven, diverse, and vibrant and globalize world and they must arrive at equipped to do so. This situation demands the

symbiosis of multipronged pedagogical modes to fabricate a culture of higher order thinking in every mathematical task engagements. In the prevalent scenario of mathematics learning the learners experience certain barriers and hindrances in the effective processing of information and knowledge production. They are often constrained by mental habits, biases, presuppositions and preset standards of operations that tend to close off new ways of perceiving and interpreting their experiences. The results of public examinations of standard X and higher secondary in mathematics reveal that a large proportion of pupils are still struggling to deal with the subject fruitfully even though some potential improvements in the pedagogy of mathematics like activity oriented approach were introduced into the curriculum. A major reason behind this observable fact can be the dearth of innovative and reflective instructional designs which enforces the learners to think deliberatively, and articulate the rationale that underlies their learning decisions. The reflective mechanisms evolved from such reflective learning designs can make perpetual problem solvers who can synthesize experiences integrating information and feedback, uncover underlying reasons and discover new meaning. All the practitioners in mathematics education need to be made aware of and be disposed to constructive pedagogical instruments involving reflective journaling, portfolio writing, PBL, graphic organizers, inquiry approaches and the like to upgrade the landscape of mathematics learning. The curriculum framers, policy makers and teacher educators should allocate plethora of educational resources to bring about the needed critical changes in both in-service and pre-service course of teacher education.

BIBLIOGRAPHY

Apple, M.V. (2000). Mathematics reform through conservative modernization: Standards, markets and inequality in education. Reported by Boaler, J. (Ed). Multiple perspectives on mathematics teaching and learning. 243-259, West Port, CT: Ablex.

Burton, N., Brundrett, M., & Jones, M. (2008). Doing your educational research project. Thousand Oaks, CA: Corwin press.

Chambers, P. (2010). Teaching mathematics: Developing as a Reflective Secondary Teacher. Sage Publications India Pvt. Ltd. New Delhi.

Mubarak,M.M.(2011). Mathematical thinking: Teachers perceptions and student performance. Canadian social science.Vol.7 No.5 pp 176-181 doi 103968/J.CSS.1923669720110705.502

***NRC, (2001*).** National Research Council. Mathematics learning study: Center for Education, Division of Behavioural and Social Sciences and Education, Adding it up: Helping children learn mathematics. Edited by J. Kilpatrick et al., Washington, DC: National Academy Press.

Savas,B.(2010). First year Secondary School Mathematics Students' Conception of Mathematical proofs and proving. Educational Studies, 36(3).283-298.

Senk,S.(1985). How Well do Students Write Geometry proofs? Mathematics Teacher,78960.448-456.

Wong,W.,Yin,S.,Yang,H.&Chen,Y.(2011). Using computer assisted multiple representations in learning geometry proofs.Journal of Educational technology& society;14(30,43-54.

RESURGING MATHEMATICS LEARNING SPACE AT SECONDARY LEVEL BY ATTUNING REFLECTIVE DISPOSITIONS THROUGH PROBLEM BASED LEARNING.

PROF. (DR.) A. SUDHARMA & DR.O.S. ASHA

Mathematics rests on the premise that learning is an active process in which learning mathematics is something pupils do, not something that is done to them. PBL process engage learners actively in self directed learning processes with a concerted group effort.The main hub of the present study is to explore the effect of PBL strategy in resurging mathematics learning space at secondary level by attuning reflective dispositions. The study concluds that the select PBL strategy is effective in habituating reflectivity subsequently enriched proficiency in mathematics among secondary school pupils. Hence the pedagogical dynamisms encompassed with the radiance of reflective learning practices can potentially lead to the development of a strong mathematical identity by re-thinking, re-structuring and re-culturing the fundamental shifts in the landscape of mathematics education and can thereby expand the horizons of effective knowledge management.

The fifth generation of computing namely cloud computing enables the movement of information technology platforms to the clouds. This fastest growing part of IT in the 21st century is reforming the learning environments and education concepts, because children now live in a world of almost unlimited streams of trivial and profound information getting them out in to the world with virtual outreach and excursion in to the physical world. Infusing dynamic, real world contexts into classroom learning will invigorate teacher and student engagement and accelerate the movement of the conception of learning as a set of individual decontextualised cognitive process to a socially organized activity that is inseparable from its socio cultural locus in time and space. This in itself requires a paradigm shift in our concept of education from one of providing instruction to promoting effective learners who could strategically confront and creatively resolve the ambiguous paradoxical and dichotomous problems and conflicts they will encounter in the increasingly more complex society. A consequence of this shift is the need to capacitate the students to develop a sense of ownership over their individual learning processes and opportunities for self assessment and reflection on their achievement such that they as learners can develop a sense of their own personal and intellectual development.

Individuals who are not proficient in mathematics are cut off from the whole realm of human endeavor, as it is the universal mode of thought and indispensible segment of all scientific efforts in the universe . The research in cognitive psychology and mathematics education has led us to adopt a composite comprehensive view of successful mathematics learning. National research council (2001) has chosen mathematics proficiency to capture completely all aspects of expertise, competence, knowledge and facility in learning mathematics successfully. Learners with mathematical proficiency understand basic concepts, are fluent in performing basic operations, exercise a repertoire of strategic knowledge, reason clearly and flexibly and maintain a positive outlook towards mathematics.

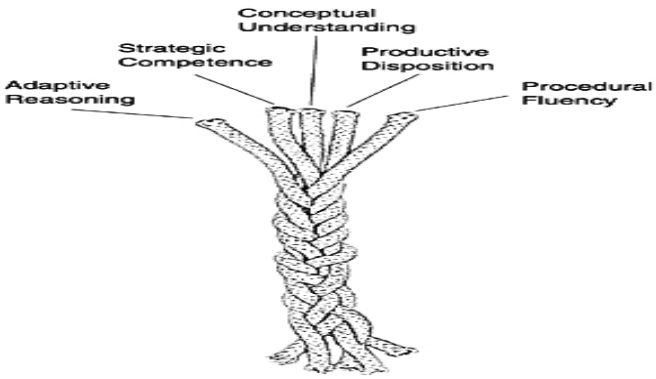

Figure 1. Five Strands of Mathematics Proficiency. Source: NRC 2001

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As NRC (2001) suggested mathematics proficiency have five interwoven and interdependent strands namely conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition which provides a framework for discussing the knowledge, skills, abilities and beliefs that constitute mathematical proficiency.

An area that has been neglected to some extent in learning of mathematics is an emphasis on learner reflection. This new vision for teaching and learning of mathematics can be fully realized if students are encouraged to reflect on their learning which engraved them with the habits of continuous growth,meaning integration, information rehearsal and enhanced propensity for learning. It is observed that the instructional dynamisms rooted in reflective learning practices could energize the mathematics learning space by capacitating learners to configure mathematical concepts, to construct, deconstruct and reconstruct solution strategies and managing mathematical tasks with perseverance. The teaching learning actions delivered through problem based learning strategy emphasize learning by doing and hands on problem solving which encourage them to analyse, interpret and predict information and be supported to foster new understandings based on past experiences. Learners are expected to master the competency and process skills that have shifted away from mechanical computation, rote learning and routine problem practice activities toward an increased emphasis on reasoning, conceptual understanding, strategizing solution paths, posing real world problems and creating perseverance in tackling challenging mathematical tasks. Translating the pedagogical principles associated with the concepts of self-evaluation and reflection on learning into pragmatic classroom action is a major challenge facing teachers, tutors and educational developers in secondary education. This can be achieved by analyzing authentic problems and situating these problems in a staged manner to embark learners into the habit of thinking about their experiences.

Habituating reflection through Problem based learning

Problem Based Learning is a term used within educators for a range of pedagogic approach that encourage students to learn through the structured exploration of a research problem. It describes techniques that make students take an active, task oriented and self directed approach to their own learning and provide

students with insights into the research process. It is a way of constructing knowledge using problems as the stimulus and focus for student activity and is based on the idea that individuals fashion their understanding largely through what they experience (Ronis, 2008). It starts with problems rather than with explosion of disciplinary knowledge helping students identify problems, pose their questions, research answers, report results and create a stake in their own learning. PBL moves learners towards the acquisition of knowledge and skills through a staged sequence of problems presented in context, together with associated learning materials and support from teachers. The emphasis of PBL is on learning processes of enquiry which proceed by asking what needs to be known to address and improve a particular situation. The multiplicity of learning approaches, active participations in the construction of new knowledge , sufficient time for metacognitive activities like knowledge assimilation and reflection, scope for socialization and risk taking and making connection emotionally, physically and cognitively to the content; all delineates PBL process in equipping the learners with higher thinking abilities .

In PBL the learner may encounter the following ingredients.

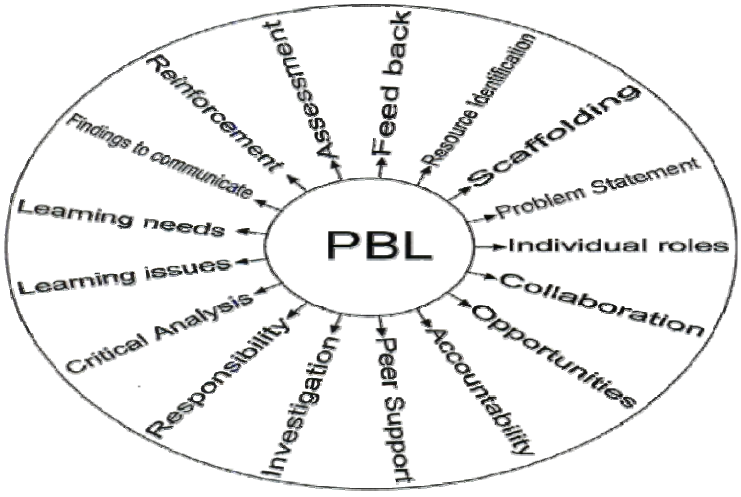


Figure 2. PBL Ingredients

PBL process in action

Mathematics rests on the premise that learning is an active process in which learning mathematics is something pupils do, not something that is done to them. PBL process engage learners actively in self directed learning processes with a concerted group effort. This exploratory method of learning is so effective for mathematics education as it captures pupils' interest and forge significant learning links, amplify deeper understanding and expatiate retention of new information. The characteristic, approaches and principles underlying PBL can be compiled in to certain guidelines as a framework for designing and implementing PBL process in mathematics classes. There are many ways in which PBL can be implemented to synthesize mathematics and make it more creative, relevant and global. It offers how the learners frame problem heuristics; how they participate in the learning process; how they discern the resources for needed information; how the teachers can make use of the community as a learning resource and explains how such activities can be initiated and integrated into classroom learning.

The kernel of PBL is a real world-planning problem in which the learner takes the ownership of the problem and the problem solving process. The teacher acts as a cognitive facilitator challenging pupil's thinking process. In this study the investigator adopted the path ways of PBL proposed by

Shepherd and Cosgriff (1998) namely problem presentation, problem investigation, problem solution and problem evaluation.

A vignette of PBL phases is as in Figure 4.

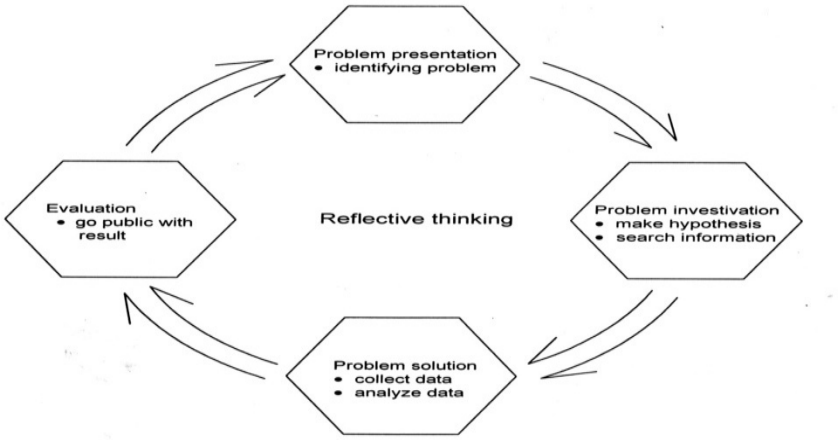


Figure 3. Vignette of PBL Pathways

Children today are growing up in a world permeated by mathematics. A knowledge system which capacitates the learners to visualize the world through a mathematical lens is the dare need of the nation. Moreover it is necessary for the citizen to use accurate, logical, precise and rigorous thinking now that even before. Learners have to develop not only their powers of mathematical thinking but also a positive attitude and a capacity to take responsibility for their own progress. A reflective mind set to mathematics learning provides its stake holders the whole momentum to architect such a system of knowledge and wisdom to manage one's own future.

Statement of the problem

This study was mainly meant to establish the effectiveness of problem based learning strategy in resurging mathematics learning space at secondary level by attuning reflective dispositions .

Objectives of the Study

The study mainly focused on attaining the following objectives:

2) To test the effectiveness of the select problem based learning strategy in enhancing reflective thinking level of pupils at secondary school level

3) To explore the effect of the select problem based learning strategy in attuning reflective dispositions among pupils at secondary school level

3) To analyse how the select problem based learning strategy is effected to intensify the learning of mathematics in the experiential space among certain cohorts of pupils in an interactive set up at secondary school level.

Hypothesis of the Study

The following hypothesis was formulated for the study:

1) The select problem based learning strategy is effective in enhancing reflective thinking level of secondary school pupils.

Methodology in Brief

The present study attempted to empower the student folk at secondary school level with reflective dispositions pursuing advanced mathematics proficiency by the select problem based learning strategy. For attaining the set objectives of the investigation both quantitative and qualitative methodology were adopted by the investigators for the study. The quasi-experimental design with pre test posttest non equivalent group design was employed for the quantitative segment and focus group discussions and strategy evaluation profoma were adopted for the qualitative segment of the present study.

Participants of the study

The sample or participants of the study primarily consisted of141 pupils at secondary school level

Analytical supports and techniques of the study.

The analytical supports and techniques employed for the present study were:

4) Scale of reflective action

5) Lesson design based on Problem based learning design

6) Focus group 'questioning route'

7) Strategy evaluation proforma

The investigator prepared lesson designs based on problem based learning strategy in standard IX mathematics and were treated to the experimental group. The control group was treated with the prevailing activity oriented approach.

For the present study the investigator developed and standardized a Likert scale type of tool to assess the level of reflective thinking among pupils at secondary level. This tool intends to measure whether the learners engage in action oriented reflective thinking and if so its level of attainment. . The constructs for the development of the scale were derived in accordance with the work of Mezirow, (1991) and Kember et al. (2000) and were depicted as in Figure 3.

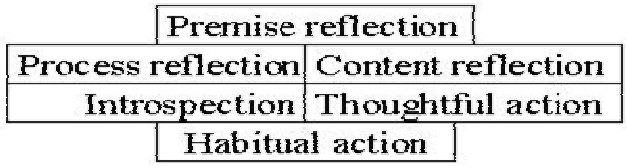


Figure 3. Constructs of Reflective Thinking

After having a comprehensive analysis, the investigator selected the three constructs namely content reflection, process reflection and premise reflection for developing the scale of reflective action. The constructs habitual action, thoughtful action and introspection are not included in the instrument, as investigator felt that the instrument should focused on assessing outcomes with regard to the level of reflective action displayed by pupils.

To supplement the quantitative data the investigator has adopted qualitative approach to evaluate the praxis of the select problem based learning strategy by the pupils who have participated in the experiment through set strategy evaluation proforma. For this purpose strategy evaluation proforma was prepared to collect pupil's independent views about the select strategy. The proforma was prepared with 10 items concerning the different characteristics of the reflective activities initiated through problem based learning strategy.

As the qualitative endeavor of the study focus group discussion technique was employed to investigate the impact of the select reflective learning designs in embracing the new learning perspectives and insights pursuing mathematically proficient learners. In the context of the study two specific cohorts of pupils were subjected to focus group discussion with an intention to unfold the conceptualization and impression of the select sample of pupils regarding the magnified influence of the select learning design procedures in registering higher performance outcomes. In this study the investigator has designed a questioning route to assist group members to relax, open up, think deeply, and consider alternatives. They also allowed synergy to occur, which produces greater insight and invites openness and avoid bias. They are planned to generate a broad yet focused, in depth discussion on the context and various components of the phenomena. The questions were used in a semi-structured way to ensure coverage of important issues yet allow for flexibility in responding to group initiated concerns. Each of the two focus group discussion session was held within a span of two weeks with two sessions at their respective schools. The data obtained through this discussion were codified and analysed properly that enabled the investigator to paint a portrait of combined local perspectives of the issue at hand.

Statistical procedures employed

1) T-test of significant difference between means
2) ANCOVA
3) Adjusted means

Analysis and interpretation

To find out the effectiveness of Problem based learning strategy in promoting reflective learning practices in respect of reflective thinking level of pupils the investigator analyzed the pretest and post test scores of the control group and experimental group who were exposed to Problem based learning strategy.The mean and standard deviation of the posttest scores of reflective thinking level were estimated. The critical ratios were found out based on the data presented in Table 1.

Table 1. Data and Results of the Test of Significance of the Mean Post test Scores of Reflective Thinking Levels between Experimental Group and Control Group

Sl. No.	Sample	Control group			Experimental group			Critical Ratio	Level of significance %
		Mean	S.D	N	Mean	S.D	N		
1	Total	63.48	11.10	75	98.95	18.59	66	13.30	0.01
2	Urban	63.48	10.48	36	97.24	20.44	32	8.64	0.01

3	Rural	65.87	11.89	39	99.55	17.65	34	9.67	0.01
4	Male	65.17	10.85	37	98.03	17.59	30	9.20	0.01
5	Female	64.33	11.54	38	99.72	19.60	36	9.71	0.01

This result shows that the performance of the experimental group and control group in the posttest scores of reflective thinking levels are not similar. The table values show that the higher mean scores are associated with the experimental group. This means that experimental group shows better performance than the control group in their level of reflective thinking for the total sample and locale wise and gender wise sub samples.

Single factor ANCOVA with pre experimental status in level of reflective thinking as covariate was employed to investigate the effectiveness of Problem based learning strategy in promoting reflective learning practices in mathematics over present activity oriented approach. For this purpose the sum of squares, mean squares of variance along with corresponding degrees of freedom and the F-ratios were calculated for total sample, locale wise and gender wise sub samples separately. The details are given in Table 2.

Table 2. Summary of ANCOVA of Pre test and Post test Scores of Level of Reflective Thinking in the Experimental and Control Groups for Total Sample

Source	Type III sum of squares	df	Mean square	F- value	Significance level %
Model	632325.706 9(a)	1	632325.706	1128.493	0.01
Control post	632325.706	1	632325.706	1128.493	0.01
Error	36421.294	65	560.328		
Total	668747.00	66			
a R squared = 0.946 (Adjusted R squared = 0.945)					

The obtained F- ratio (1128.493) is significant as the level of significance is 0.01%.

It can be inferred from the covariance analysis that after a linear adjustment was made for the effect of variation due to differences in the pre-experimental status in the level of reflective thinking as measured by the covariate, there is statistically significant difference between the experimental group and control group in the post test scores of total sample. This means that the experimental group performed better than the control group in their posttest of reflective thinking level.

Adjusted mean comparison

An additional analysis was done in order to determine which one of the two groups based on Problem based learning design cause difference from another in terms of the variation in the criterion mean. Adjusted means of scores of level of reflective thinking for the experimental group was calculated using regression equations for the total sample. The details are given in Table 3.

Table 3. Adjusted Mean of the Post test Scores of Experimental Group for Total Sample

Sl. No.	Sample	Mean of control group	Mean of experimental group	Adjusted mean of experimental group
1	Total	63.91	98.95	106.17

It can be concluded from the result that experimental group is better than the control group with regard to the post reflective thinking level scores. This better performance is due to the effectiveness of Problem based learning design which was treated to experimental group in promoting reflective learning practices in mathematics. Thus it is evident from the analysis that problem based learning strategy enhances the level of reflective thinking of secondary school pupils. The conceptualization and modeling of the select Problem based learning design required a change in the mind set on the part of learners towards reflective orientations. During the problem based learning strategy intervention, as learners were able to see otherwise abstract concepts functioning in their familiar world, significant learning links were formed. In addition, the reflective dialogues carried out with respect to mathematical task analysis created feedback spirals and monitoring systems that assisted the learners to access a wide repertoire of problem solving strategies. That is why the select sample of pupils in experimental group exhibited better levels of reflective thinking.

Effectiveness of Problem based learning strategy in praxis

In order to assess the praxis of Problem based learning strategy in the daily classroom experiences of secondary school pupils; the self-evaluation of the effectiveness of the select strategy was gathered through the strategy evaluation proforma developed by the investigator for this special purpose. The details of the data are given in Table 4.

Table 4. Self-evaluation of the Appropriateness of Problem Based Learning Strategy towards Proliferating Reflectivity of Secondary School Pupils

Sl. No.	Observations	Responses of pupils		
		To a great extent	To some extent	Not at all
1	Helps me to discern the credible sources and resources	85%	15%	Nil
2	I can steer the learning process myself	80%	20%	Nil
3	The relevance and retention of learning increase	83%	17%	Nil
4	I can select the solution strategies of problems confidently	83%	17%	Nil
5	I could manage challenging tasks in PBL classes	86%	14%	Nil
6	Helps to develop inter personal skills.	82%	18%	Nil
7	Helps to reduce my stress level while learning	81%	13%	Nil
8	Makes learning attuned to a relevant context	85%	15%	Nil
9	Enables me to see learning as a lifelong process	89%	11%	Nil
10	Enables to monitor adequacy of personal performance	81%	19%	Nil

The select sample of pupils at secondary level who were exposed to the Problem based learning design are of the opinion that PBL strategy makes learning attuned to the world of work as it happens in a relevant context (85%). indicates that the pupils could participate in the learning actively and steer the learning process themselves (89%) and it helps to reduce their stress level while learning as it provides

timely peer support in active decision making and planning (87%) that embraces the mathematics learning scenario. Thus, the analysis of the data depicted in the Table 4 announces that PBL could make out confident and reasonable decision making in selecting solution strategies of problematic situations in life with a reflective outlook among secondary school pupils.

Focus group Discussion

The select Focus groups of the study comprised of below average pupils from rural sub sample and above average pupils from urban sub sample respectively who were exposed to Problem based learning design. The pupils from urban sub sample are of the opinion that in PBL approach development of self directedness is emphasized incorporating the abilities to handle mathematical tasks, monitor progress, make appropriate decision in applying apt strategies and modify actions after independent and collective critical reflection. Hence learning goes beyond the recall of knowledge or responding passively to given situations to the development of abilities and attitudes needed for investigating on their own. The urban pupils highly commented that studying in groups, with others could help students broaden horizons of thinking and improve the quality of learning in terms of autonomy, responsibility and higher order thinking. The pupils from rural area have registered more confidence in mathematics learning after indulging in Problem based learning experiences as they are helped in investigating issues that are grounded in the context of their own domains. Since the group could engage in the framework of problem solving sequence of seeking information from a variety of sources, justifying their decisions, discussing, finding and weighing consequences in order to construct viable and possibly innovative solutions of mathematical problems in contexts, the learning process become more enjoyable, appealing and rewarding.

The leading punches of Problem based learning designs highlighted by the two focus groups to energise the sharpening of mathematical thinking were listed below:

- Learning is considered as an active and meaningful enquiry where knowledge is built by learners.
- Learning of knowledge is in an embedded context which informs a need for that knowledge.
- Learners could themselves engage in questioning, revising and entertaining various dimensions of the issues they uncovered within the mathematical task.
- Create a rich foundation for solving problems and prepares them to be competent enough for future learning
- Familiarizing with the use of more than one resource and to deal with more than one perspective.
- Responsible and independent learning habits are nurtured.
- Enhancing skill of analysis and proposing well grounded solution.
- Dynamic and interactive nature of the process
- Learning activities are designed and conducted in integrated teaching – learning – assessment framework.
- Improve the individual, group, personal awareness and communication skills.
- Maximize competency development at individual levels.

These imprints of the select Problem based learning design encultured mathematical thinking in resolving problematic tasks among the pupils.

Major Findings and Conclusions

- Problem based learning strategy is effective in enhancing the level of reflective thinking of secondary school pupils.
- The select Problem based learning strategy has strength in proliferating reflective dispositions among the pupils at secondary level.
- the select problem based learning design could move through an organizational structure of reflectivity that authorize the pupils' development in all spheres to enculture mathematical thinking in resolving problematic tasks .

Thus the findings mentioned above conclusively point towards the fact that the select problem based learning design is effective in radiating reflective dispositions subsequently enriched proficiency in mathematics among secondary school pupils.

Discussion of results

The effectiveness of the problem based learning strategy for promoting reflective practices in mathematics was investigated through the correct embedded stance of both quantitative and qualitative approaches of research. The results of the study enunciated in this regard underpin the idea that an effective mode of capitalizing on the learning can be to enable the learners to progress in their conception of knowledge structure through the praxis of reflection. The ascendance in the performance unfurled by the experimental group who were treated with the PBL lesson designs may be due to the concomitant features attributed to the select design to enculture reflective dispositions towards learner's justifying and defending participation to provoke, mediate, capture and improve social and mathematical discourses .The overarching primacy in the performance unfolded by the select experimental group of sample may be due to the higher cognitive structure and the intense programmic focus captivated through the phased execution of the PBL design process in every mathematical intervention. It gave the learners a chance to draw on their own experiential knowledge and allows them to reflect on the very process of their own thinking and meaning making of mathematical tasks.

The active trends of PBL lesson design for nurturing a reflective tune in upbringing mathematical brilliance and skill were enacted through the select strategy evaluation proforma employed to the experimental group who were exposed to the PBL learning design. It is exuded from the analysis that the PBL design could expatiate the metacognitive repository to hone the mathematical skills for generating newer streams of fruitful life situations. The investigator could recognize that PBL design could act as a pivotal discursive site for developing invaluable life skills such as problem solving, independent thinking, self directed learning skills and metacognitive judgments and monitoring by setting rich environment for learning mathematics in participatory and investigative ways. It has offered opportunity for cognitive, psychological, emotional and ethical developments by which learners are attuned to the pursuit of excellence and edification. The above findings of the study accentuated that the stance of learning rooted in reflective pedagogy has affordances in metacognitive growth detriment to the progressive mechanism of rigorous mathematical thinking.

This observation is in accordance with the claim (Wu & Forester, 2003 as reported by Kumar and Natarajan,2007) that PBL elevates learning issues from being considered at the level of cognition to

being validly considered at the level of meta cognition as well. Shinic and Jeveremovie (2010) argued that PBL is a student centered instructional strategy in which students solve problems and reflect on their experiences emphasizing critical thinking and problem solving skill with students.

In a nutshell, for successful mathematics learning to occur students require constant engagement in conscious reflection on their own mental processes and structures wherein they will be encultured to be open minded, responsible and whole hearted towards mathematical task engagement. Hence the pedagogical dynamisms encompassed with the radiance of reflective learning practices can potentially lead to the development of a strong mathematical identity by re-thinking, re-structuring and re-culturing the fundamental shifts in the landscape of mathematics education and can thereby expand the horizons of effective knowledge management.

Implications of the study

- The study acclaimed that learning through PBL has improved the learners' social interactive and public communication skills. In PBL classes students present the solutions in a systematic and well organized way, showing thorough understanding of subject matter, speak clearly and confidently and explain learning idea using simple terms. They are able to present ideas logically and smoothly without excessive dependence on the original plan and respond properly to questions or ideas raised. The positive symbiosis between effective communication and competent problem solving spurs both cognitive and intellectual growth in learners. Since the task of conducting presentation is consigned to individual team members on a rotational basis even reticent and shy students are forced to articulate their ideas in class openly and this gradually boosts their confidence in public speaking. Thus the study underscores the positive impact of incorporating pedagogical tools blended with PBL design elements into the curriculum development.
    - A significant implication of the study is the specific emphasis given to the collaboration dimension of mathematics learning embedded within the PBL design. Learning is inherently social in nature and the interchange of ideas and multiple perspectives from team members enhance this process. Learners should be encouraged to work collaboratively in teams to seek solution by integrating other participants' outlooks and opinions to form viable solution yet maximizing individual talents. Dialogue between learners and facilitators and among learners themselves drives the quest for knowledge instead of the monologues in the form of teacher talk and hence it should be encouraged. Through this study the investigator emphasizes the need to develop a collaborative learning environment wherein learners could expand their horizons of all strands of mathematics scholarship by forging critical openness in collaborative activities. Faculty members are to be enforced to make an executive decision to use social synergy as a silver bullet to pierce the armour of secondary school mathematics education.

BIBLIOGRAPHY

- Barell, J. (2007). Problem based learning (IIEd.). Thousand Oaks, CA: Corwin press.
- Burton, N., Brundrett, M., & Jones, M. (2008). Doing your educational research project. Thousand Oaks, CA: Corwin press.

- Cotic, M ., and Zuljan, M.V. (2009) .Problem based instruction in mathematics and its impact on the cognitive results of the students and on affective motivational aspects. Educational Studies, 35(3), 297 – 310.
- Kids: KaAMS. Paper presented at the meeting of the American Educational research association. New Orleans, Louisiana.
- Kilpatrik, J., Swafford, J., & Findell, B. (Eds) (2001). Adding it up: Helping children learn Mathematics. Mathematics Learning Study Committee, National Research Council, http://www.nap edu.catalog/ 9822.html.
- Koszalka, T.A., Song, H.D., and Grabowski, B.L. (2001). Learner's perceptions of design factors found in problem – based learning (PBL) that support reflective thinking. Annual proceedings of selected Research and Development (and) Practice, Papers presented, 1 – 2, IR 021504, ED 470092.
- Kumar, M., and Natarajan, U. (2007). A problem based learning model: show casing an educational paradigm shift. The Curriculum Journal, 18, 89 – 102.
- Mertens, D.M. (2010). Research and evaluation in education and psychology. (3rd Edn.). Thousand Oaks: London, Sage publications.
- NRC, (2001) National Research Council. Mathematics learning study: Center for Education, Division of Behavioural and Social Sciences and Education, Adding it up: Helping children learn mathematics. Edited by J. Kilpatrick et al., Washington, DC: National Academy Press.
- Ronis, D.L. (2008). Problem based learning for Math & Science; Integrating inquiry and the internet II Edn. Thousand Oaks, CA: Corwin press.
- Shinic.G. and Jeveremovie, A. (2010) .Problem based learning in formal and informal learning environments. Interactive Learning Environments, I First article, 1-17,DOI:10 1080/10494820.2010.486685.
- http://www.edel.edu/pbl
- http://www.higp. hawaii.edu/kaams/resource/reflection.htm
- http://www.hss.coventry.ac.uk./pbl/

LANDSCAPE OF THINKING MAPS DESIGN WITH AN ACCENT ON REFLECTIVE LEARNING HABITS

DR.O.S. ASHA & PROF. (DR.) A. SUDHARMA

Abstract: As individuals reflect on their learning they gain important information about how they perceive the efficacy of their planning, experimenting, data gathering, assessment and self modification. The purpose of reflective practices is to get learners into the habit of thinking about their experiences. The select strategy namely, Thinking maps capacitate the learners to start internal and external voices of reflection making a commitment to modifications, plans and experimentations. In this study, the investigator developed a learning design based on Thinking maps as a strategy for promoting reflective learning practice among secondary pupils with special emphasis on mathematics learning. The conclusions point towards the fact that Thinking maps design has tremendous effect in shaping a culture of reflective practices in mathematics learning.

Introduction

Reflection is more than just thinking; it is a recursive intellectual process involving action (experience),reaction(reflection), more action (experimental) and more reflection(Cormish & Jenkins,2012).As individuals reflect on their learning they gain important information about how they perceive the efficacy of their planning, experimenting, data gathering assessment and self modification. These experiences provide opportunities to practice the habit of continuous growth through reflection, called as the reflective practice spiral. Reflective practice has many potential benefits for academic development; enhanced overall effectiveness; increased capacity for change; transformation of practice; development of personal qualities; and establishment of supportive relationship between those involved in the reflective process (Rogers, 2001). From the organizational perspective reflective practice is a powerful norm that is required for continuous improvement of learning practices that result in high levels of student achievement. Reflective practice is the means by which learning, renewal and growth continue throughout the development of education. Through systematic inquiry and analysis, it is a way for individuals to create meaningful and enduring change by changing themselves. Reflective practice requires an environment of support. It requires an organizational climate that encourages trust and openness of communication, critical dialogue, risk taking and collaboration. It requires people to be willing to analyze their own behavior and explore thoughts, feelings and actions. It respect the right of individuals to exercise self direction and even more, enhances their ability to exercise control over their own learning and their own actions. The purpose of reflective practices is to get learners into the habit of thinking about their experiences. The select strategy namely, Thinking maps capacitate the learners to start internal and external voices of reflection making a commitment to modifications, plans and experimentations.

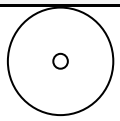
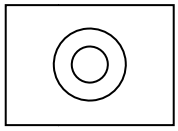
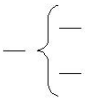
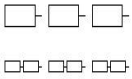
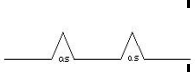
Thinking maps

Thinking maps as a language of visual tools integrate the creative dynamism of webs, the analytical structure of content specific learning and continuous cognitive development and reflections fostered through conceptual mapping (Hyerle ,2009).They offer a greater range of thinking, communication and reflection for empowering learners at every level to transform static information into active knowledge. These visual tools illuminates direct pathways from lower order applications to higher order thinking; from remembering content information to transforming it into conceptual understanding. They are the explicit visual representations of thinking process that foster and encourage lifelong learning. . Through this language all learners convey, negotiate and evolve meanings with others and within themselves through visual patterns of thinking. Thinking maps are really a meta language for learning-an interrelated set of thinking patterns for communicating and synthesizing our thinking. Five essential qualities of thinking maps namely graphically consistent, flexible, developmental, integrative and reflective lead directly to more complex orders of thinking.(Hyerle,2009).Thinking maps encapsulates eight visual-verbal learning tools, each based on a fundamental thinking skill defined and animated by maps and introduced as a common visual language for

thinking and learning across whole learning communities(Hyerle, 2004). These eight cognitive skills' each represented and activated by graphic primitives are used together as a set of tools for showing relationships and as a common language for meaningful learning. It identifies the coherence and interdependency of the eight fundamental cognitive skills that ground in thinking and learning .The eight cognitive skills are defining in context, describing attributes, comparing and contrasting, classification, part-whole spatial reasoning, sequencing, cause and effect reasoning and reasoning by analogy.

Table 1.

Graphic Primitives and their Specificities

Primitives	Name of Map	Specificities	Expanded Maps
	Circle Map	• Used for seeking context • Effective brain storming tool • Frame of reference	
	Bubble map	• Process of describing attributes • Identify traits • Identify properties	
	Double Bubble Map	• Comparing two things • Contrasting two things • Prioritizing information	
	Tree Map	• Inductive and deductive classification • Categorize • Sort • Organize	
	Brace Map	• Identifying part-whole relationships • Analyse • Break into parts • Support spatial reasoning	
	Flow Map	• Sequencing • Ordering • Showing time lines, cycles, actions, steps, directions • Relations between sub stages	
	Multi Flow Map	• Seek cause-effect • Shows inter relationships of feedback effects	
	Bridge Map	• Creating and interpreting analogies • Develops analogical reasoning • Metamorphic concepts of deeper content learning	

Each cognitive process is closely attuned to and reflects the cognitive pattern and is influenced, animated and transformed by the cultural frames that surround these behaviors. This means that everyone may understand and utilize the cognitive process of categorization, but the categories carry a different language, content, process for development and forms within and across cultures.

Reflective Learning Design

Learning designs denote the overall structure and out line, sequential parts and general forms through which educational activities flow. It offers a consistent framework for thinking strategically about engaging learners in their own meaning making process to organize for learning. In this study, the investigator developed a learning design based on Thinking maps as a strategy for promoting reflective learning practice among secondary pupils with special emphasis on mathematics learning. The phases schematized for developing Thinking maps are **Brainstorming stage, organizing stage, Lay out stage, Synchronizing stage and Finalizing stage.**

In developing learning designs using Thinking maps as a reflection strategy where visual representational technique is mainly used as an instructional format to support learners in transforming static information in to active knowledge, the investigator made use of a learning cycle comprising of six sequential stages proposed by Atkin's and Murphy (1994).They are **Awareness ,Description,Analysis,Evaluation and Learning**

The select Thinking maps design was formulated by the correct embedding of the sequential stages of both Thinking map strategy and Atkin's and Murphy's stages of lesson development appropriately. 'Awareness' is the initial phase of the select Thinking maps design in which learners are made aware of the new and challenging learning event, experience and action . The learners set the goals of the mathematical task through brainstorming and list out the maximum contextual elements without implicit prioritization. During the 'description' phase, the learners arrange the constituents of conceptual as well as procedural knowledge in to meaningful groups or subgroups. They are facilitated to effectively translate issues and situations in to manageable sub task through inducing proper motivation and synergy to reflect on the issue at hand. The learners lay the organizational groundwork for the action ahead by making connections between past and present. In the 'analysis' phase the learners engage in a coherent series of activities like challenge assumptions, imagine and explore alternatives and identify learning. They use a consistent hierarchy in which the thematisation of elements in subgroups is made and begin to think in terms of the primitive of the Thinking maps suitable to each subgroup to visualize the interconnection. Thus, cognitive networks of knowledge structure are incrementally constructed by drawing linkages between the foundational base of prior knowledge and the body of the new knowledge gathered. The 'evaluation' phase of the lesson demarcated by judging the quality of learning efforts namely deepening awareness of oneself, developing strength, pursuing interests clarify values, increase knowledge about relationship and how to function socially. The learner draft the Thinking maps by synchronizing the primitive and linking the elements of learning outcomes through all levels of reflective actions. The final phase of the learning design namely 'learning' highlights the new learning and describes the future plan of action in the light of new understanding by promoting transfer of learning, goal setting, planning of strategies. The learners clean up and finalize the presentation of the map so that it can externalize internal structural state of behavior. The cognitive impression of Thinking maps design is given in Figure 1.

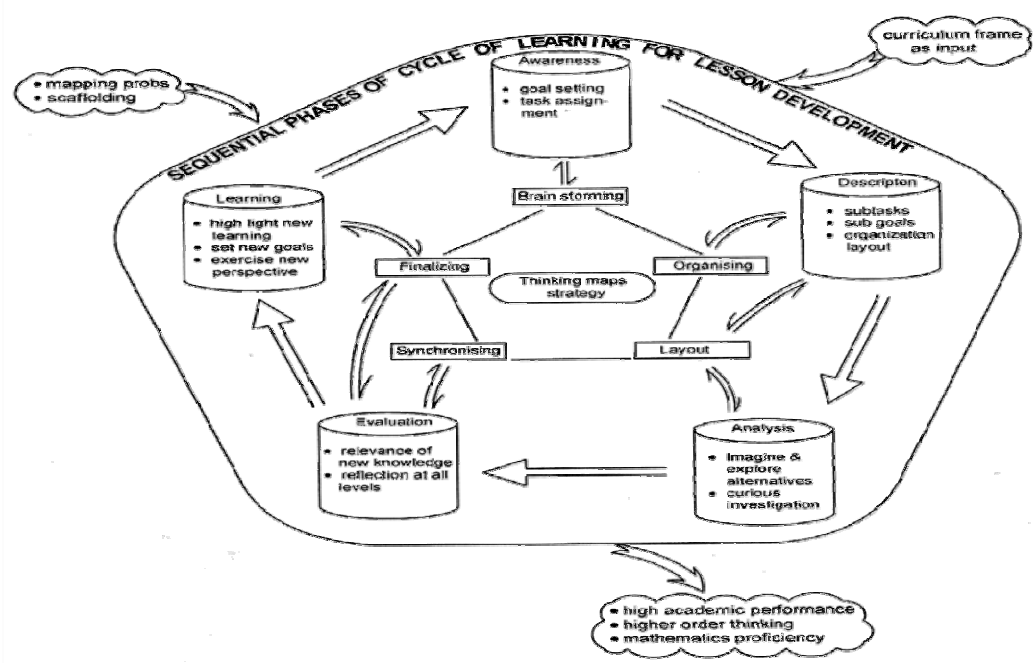


Figure 1. Cognitive Impression of Thinking Maps Design

The aforesaid reflective learning designs are prescriptive in orientation that offers guidelines as to what methods to use to best attain a given educational goal. The select learning design process is depicted as a multi staged iterative process of situating and contextualizing problems appropriate to the level of capacity of learners and to get reflective feedback.

The problem

This study was mainly meant to develop and establish the effectiveness of Thinking maps design in engraving reflective learning habits among secondary school pupils with special reference to mathematics learning.

Objectives

4) To test the effectiveness of Thinking maps design in enhancing reflective thinking level of pupils at secondary school level

5) To analyse the praxis of Thinking maps design in proliferating reflectivity among secondary school pupils

Methodology

The present study attempted to empower the student folk at secondary level with a reflective mindset by exposing them to Thinking maps design with special reference to mathematics learning. For attaining the set objectives of the study both quantitative and qualitative methodology were adopted. The quasi-experimental design with pre test posttest non equivalent group design was employed for the quantitative segment and the strategy evaluation proforma for the qualitative segment.
The sample for the study primarily consisted of 149 pupils at secondary school level

The investigator prepared lesson designs based on Thinking maps design in standard IX mathematics and were treated to the experimental group. The control group was treated with the prevailing activity oriented approach. For the present study the investigator developed and standardized a Likert scale type of tool to assess the level of reflective thinking among pupils at secondary level. This tool intends to

measure whether the learners engage in action oriented reflective thinking and if so its level of attainment. . The constructs for the development of the scale were derived in accordance with the work of Mezirow, (1991) and Kember et al. (2000).

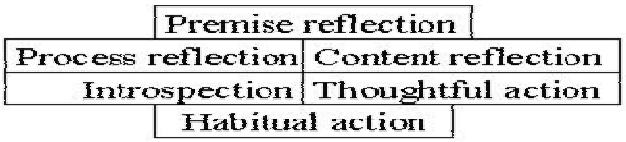


Figure 2. Constructs of Reflective Thinking

After having a comprehensive analysis, the investigator selected the three constructs namely content reflection, process reflection and premise reflection for developing the scale of reflective action. The constructs habitual action, thoughtful action and introspection are not included in the instrument, as investigator felt that the instrument should focused on assessing outcomes with regard to the level of reflective action displayed by pupils.

To supplement the quantitative data the investigator has adopted qualitative approach to evaluate the praxis of the select Thinking maps design by the pupils who have participated in the experiment through set strategy evaluation proforma. For this purpose strategy evaluation proforma for Thinking maps design was prepared to collect pupil's independent views about the select strategy. The proforma was prepared with 10 items concerning the different characteristics of the reflective activities initiated through Thinking maps design.

Analysis and Interpretation

The investigator analyzed the pre test and post test scores of the control group and experimental group who were exposed to Thinking maps design to find out the effectiveness of it in enhancing reflective thinking level of pupils at secondary level.

To find out whether any significant difference exists between the experimental and control group, the mean and standard deviation of the posttest scores of reflective thinking level were estimated. The critical ratios were found out based on the data presented in Table 2.

Table 2.

Test of Significance of the Mean Post test Scores of Reflective Thinking Levels

Sl. No.	Sample	Control group			Experimental group III			Critical Ratio	Level of significance %
		Mean	SD	N	Mean	SD	N		
1	Total	64.09	10.06	75	101.78	18.66	74	14.44	0.01
2	Urban	63.47	10.33	36	98.93	19.57	35	9.53	0.01
3	Rural	65.87	11.89	39	104.63	17.55	39	11.11	0.01
4	Male	65.17	10.85	37	102.84	17.705	37	10.59	0.01
5	Female	64.33	11.54	38	100.79	19.74	37	9.48	0.01

The critical ratios obtained for total sample, locale wise and gender wise sub samples are significant as the level of significance is 0.01%. This means that there exists a significant difference between mean post test scores of reflective thinking levels of experimental group and control group. The higher means associated with the experimental group shows that this group is better than the control group in their performance in the level of reflective thinking for the total sample, locale wise and gender wise sub samples.

Single factor ANCOVA with pre experimental status in the level of reflective thinking as covariate was employed to investigate the effectiveness of Thinking maps design in promoting reflective learning practices in mathematics over present activity oriented approach. For this purpose the sum of squares, mean squares of variance along with corresponding degrees of freedom and the F-ratios were calculated for total sample. The details are given in Table 2.

Table 3.

Summary of ANCOVA of Pre test and Post test Scores of Levels of Reflective Thinking

Source	Type III sum of squares	df	Mean square	F-value	Significance level %
Model	666353.611(a)	1	666353.611	1079.952	0.01
Post control	666353.611	1	666353.611	1079.952	0.01
Error	40106.389	65	617.021		
Total	706460.000	66			
a R squared= 0.943 (Adjusted R squared = 0.942)					

The obtained F-value (1079.952) is significant as the level of significance is 0.01%

It can be inferred from the covariance analysis that after a linear adjustment was made for the effect of variation due to differences in the pre-experimental status in the level of reflective thinking as measured by the covariate, there is statistically significant differences between the experimental group III and control group in the post test scores of total sample and locale wise and gender wise sub samples. This means that the experimental group performed better than the control group in their post test of reflective thinking level.

Adjusted mean comparison

Adjusted mean scores of level of reflective thinking for the experimental group were calculated using regression equations for the total sample.

Table 4.

Adjusted Mean of the Post test Scores of Experimental Group III for Total Sample.

Sl. No.	Sample	Mean of control group	Mean of experimental group	Adjusted mean of experimental group
1	Total	63.91	101.78	99.45

It can be concluded that the experimental group shows better performance than the control group with regard to the reflective thinking level scores. This better performance is due to the effectiveness of Thinking maps design which was treated to experimental group in promoting reflective learning practices in mathematics. Thus it is apparent from the analysis that Thinking maps design enhances the level of reflective thinking of secondary school pupils. The select Thinking maps design provides new avenues for the mathematics learning communities to develop their capacities to be creative and flexible in procedures, to persevere and be systematic in reasoning and strategizing and to be reflective and self aware of cognitive patterns of mathematical thinking to the degree that they can readily apply these patterns to challenging performance of mathematical task analysis. That is why a significant change in the learner's level of reflective thinking is evidenced by the pupils who were exposed to the select Thinking maps design.

Effectiveness of Thinking maps strategy in praxis

In order to assess the praxis of Thinking map strategy in the daily classroom interactions of secondary school pupils, the self evaluation of the effectiveness of the select strategy was gathered through the strategy evaluation proforma developed by the investigator for this purpose. The details are given in Table 5.

Table 5.

Self-evaluation of the Suitability of Thinking Map Strategy towards Proliferating Reflectivity.

Sl. No.	Observations	Response of teachers	
		To a great extent	To some extent
1	Increase knowledge and deeper understanding in mathematics	83%	17%
2	Organize information towards framing of problem schemata	84%	16%
3	Scaffold me to synthesize ideas deleting the extraneous details	84%	16%
4	Direct and construct networks of knowledge to problem solution.	90%	10%
5	Evolved to a balanced visual imaging for information processing	85%	15%
6	Unleash visual strength in activating solution procedure optimally.	88%	12%
7	Set forth a logical progression of ideas to reach at generalizations	89%	11%
8	Self reflective on the evolving forms of my thinking	86%	14%
9	Amplify capacity to collaborate and communicate abstract concepts	84%	16%
10	Develops the disposition for creativity and flexibility	83%	17%

The select sample of pupils at secondary level who were exposed to the Thinking maps strategy has expressed their views regarding the capacity of the strategy to direct and construct networks of knowledge on the way to problem solution fluently and creatively (90%). They have also expressed their opinion that Thinking maps strategy helped them to unleash their visual strength in activating solution procedures at optimum level (88%) and to set forth a logical progression of ideas to reach at generalizations and conclusions (89%). A close examination of Table 3 accentuates that Thinking map strategy induces a reflective modality among the pupils at secondary level in amplifying the capacity to collaborate and communicate abstract concepts in mathematics.

Major Findings

- Thinking maps design is effective in enhancing the level of reflective thinking of secondary school pupils.
- The select Thinking maps design has strength in proliferating reflective dispositions among the pupils at secondary level.

The results extracted from the experimental section of the investigation and from the subsequent qualitative analysis of the data have established the effectiveness of the Thinking map design in tuning a reflective mind set to mathematics learning among pupils at secondary level for social fabric and learning to be lifelong. The experimental intervention of the select Thinking map design demanded the learners to indulge in and interact with the set sequential phases of Thinking map design. This intervention posits the learners with diverse concepts, procedures and resources related to the mathematical task which forms the base of further processing and expanding of the task elements. These activities are supported by reflective

discourses with previous experiences at individual and group level. As the students are provided with common graphic starting points they are able to construct and communicate different patterns of thinking about content concepts related to the problematic situation. The design intervention embarked the learners to engage in a coherent series of activities like identify resources, detect mathematical relationships, form mental representation of problems, explore alternatives, seek analogies, navigate solution strategies, devise novel solution methods and identify learning boosted with content, process and premise level reflective practices. The learners worked in groups challenging each other's conceptualizations and ideas which culminate in the setting of a dynamic class of heuristic researchers and skilled entrepreneurial performers. Learners could monitor the learning progress and could evaluate their own efforts at individual and social contexts like deepening awareness of oneself, praxis of the thinking potentials, developing interest and clarifying values. They could develop the disposition for creativity, curiosity and flexibility for 'venturing to the edge' of their thinking. Students should call upon their disposition for ingenuity, originality and insightfulness to express this form of thinking. They could develop more orders of thinking through an organizational control over ideas and self control to support more systematic and analytical thinking and created a framework onto which future information can be added.

The qualitative version of data analysis through the select strategy evaluation proforma regarding the perception of the learners about the activational domains of the Thinking map design also corroborates the effectiveness of the set design in capitalizing the learners with the essential skills and potentials to process and manage the mathematical tasks endorsed to them. It is emanated from the result that the set design could act as a metacognitive tool to have an awareness and control of one's cognitive processes and the regulatory mechanism used to mathematical problem solving. These findings are supported by the results of Chiou&Chei (2008) and Chiou (2008) which reported that mapping strategy could stimulate individual reflection, generate new knowledge, provide scope for viewing knowledge from another angle and can enhance student's learning achievement. Fraser and Spinner (2002) reported that concept mapping strategy could make dramatic results in the understanding of mathematical concepts, attitude towards mathematics and perception of the classroom environment.

In a nutshell, the investigator derived a concluding remark from the varied spectrum of the study to validate the efficiency of the developed Thinking map design that the select design is a promising curriculum transaction modality in mathematics for activating the learners' reflective habits of mind.

Implications

The enculturation process into this new design of instruction requires both cognitive and psychological realignment of the contextual constructs of the set task. Learners have to call upon to become more open minded and receptive of cognitive networks and patterns of the exercise tasks. In order to adapt to this new design implementation facilitators should assume a multifaceted guiding role and create an interactive classroom learning culture through discussion and discourses. When learners combine the use of visual tools with the habits of mind to crystallize their thinking, they could see their own accommodating ideas and thus gain new sense of themselves as efficacious thinkers and problem solvers. Educators and instructional facilitators need to ensure that learners consciously apply Thinking maps into their daily learning by redesigning the materials they already use in their classrooms. Educational administrators, policy analysts, scenario planners and knowledge managers should promote appropriate training programme for all the stake holders of this innovative pedagogical tool is another indispensable condition for the implementation of thinking maps design.

The experiential space embedded with the pedagogical task grounded in reflective dispositions requires students to play the role of decision makers in being able to evaluate different perspectives and take multiple views into account so as to make an informal decision. In this stance of reflective culture cognitive patterns and networks of knowledge structures are incrementally constructed by drawing

linkages between the fundamental base of prior knowledge and the body of new knowledge gathered from current learning activities. The practitioners should note that facilitation should provide a variety of resources and recursive set of activities to acquire and integrate new knowledge schemes.

When students reflect on their work, become more adept at describing the skills and strategies they use to solve complex problems and apply those same strategies in a variety of contexts consequently discover their metacognitive process for learning. They transform their roles as a learning community by joining as partners in the instructional process. These impressions of reflective designs under the present study affirm that practitioners in all disciplines should find new dynamisms and tools synchronized with reflective orientations to expand their repertoire of pedagogical mechanisms for a better learning community.

REFERENCES

Chiou, C.C. (2008). The effect of concept mapping on student's learning achievements and interests. *Innovations in Education and Teaching International*, 45 (4), 375-387.

Chiou, C.C. (2009). Effects of concept mapping strategy on learning performance in business and economics statistics. *Teaching in Higher Education*, 14(1), 55 – 59.

Chiou , Chei-chang. (2008). The effect of concept mapping on students' learning achievements and interests. *Innovations in Education and Teaching International*, November, 1, Taylor & Francis group.

Cornish,L. and Jenkins,K.A..(2012)Encouraging teacher development through embedding reflective practice in assessment. *Asia –Pacific Journal of Teacher Education*,40:2,159-170.

Hyerle, D. (2009). *Visual tools for transforming information into knowledge*. Thousand Oaks, CA: Corwin press.

Hyerle, D., Alper, L., & Curtis, S., (Eds.) (2004). *Student success with thinking Maps*. Thousand Oaks, CA: Corwin press.

Kember, D., et al. (2000). Development of a questionnaire to measure the level of reflective thinking. *Assessment and Evaluation in Higher Education*, 25(4), 381-394.

Lee,W.O.(2012)Education for future oriented citizenship: implications for the education of twenty first century competencies, *Asia –Pacific Journal of Teacher Education*,32:4,498-517.

Mezirow, J. (1991) .*Transformative dimensions of adult learning*. San Francisco, Jossey-Bass.

Rogers,R.R.(2001)Reflection in higher education:a concept analysis.*Innovative Higher education*,26,5-23.

FINE-TUNING A REFLECTIVE MINDSET AMONG ADOLESCENTS THROUGH REFLECTIVE JOURNALING.

DR.O.S. ASHA & PROF. (DR.) A. SUDHARMA

Abstract

Reflective writing is a way of learning that helps to evaluate our own learning performance as a learner. By engaging in Reflective journaling learners are taking an active role in learning and recognizing their personal responsibility for learner driven learning. This paper emanates from a research study which examined the effect of reflective journaling in fine-tuning a reflective mindset among secondary school pupils. A mixed method approach was employed for the investigation. The findings conclusively point towards the fact that Reflective journaling strategy has tremendous effect in shaping a culture of reflective practices among secondary school pupils. No doubt, regular Reflective journaling is extolled by those learners who ought to become lifelong learners

In alignment with modern society's demands for a more knowledge based citizenry, educational ecologies have to undergone structural reforms with a paradigm shift from didactic instructional modes to approaches that are constructivist and logically rational in character that develops a repertoire of diversified competencies. In today's accountability driven culture learners need a profile of skills not only for managing this knowledge transition but for decision making, problem solving, self direction and self empowerment as they have never needed them before this century. Instead of being arbitrators of knowledge, educators need to provide contextual strategic scaffolding for learners to engage in reflective processing, adaptive reasoning, strategic competence, divergent thinking and critical understanding. Educational institutions should presumably be an oasis of knowledge generation and pulsars of quality learning churning out solutions of global validity to a problem-ridden world. Educational practices need to provide avenues that help individuals recapture, sustain and liberate the natural self organizing learning tendencies inherent in all human beings. And it is in this context that reflection should assume an undeniable place in the curriculum of promoting effective learning and excellence among our learners. As individuals reflect on their learning they gain important information about how they perceive the efficacy of their planning, experimenting, data gathering discourses, assessment and self modification. These experiences provide opportunities for enriching the habit of supporting learning and performance orientations. Reflective practice is a way of thinking that fosters personal learning, behavioral change and improved performance. It requires people to be willing to analyse their own behavior and explore thoughts, feelings and actions.

Educators need to intensify reflection as an important part of strengthening of learning and thus the greater specificity and precision in the learning outcomes. Because reflection is part of the thought process, there is a potential danger that academicians and educators assume that all students are automatically reflective learners. But literature reviews reveal that reflection does not occur by chance; it has to be fostered through specific exercises, techniques and tools. Reflective practice adopts very different set of strategies incorporating key principles drawn from constructivism; experiential learning and situated cognition (Osterman & Kottkamp, 2004). Reflective learning strategies namely, reflective journaling, portfolio, mapping and the like can have noticeable effect on learner engagement, metacognitive stance of learning

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habits and performance levels. It provides opportunities for learners to design; construct and manage their own learning episode which enables them to become innovators, self-worth practitioners of learning. Farrah ,M.(2012)in his study assessed the benefits of keeping reflective journal writing on improving English writing skills, increasing motivation, enhancing creativity, and critical thinking among university students and found positive results .

Reflective journaling

Dewey (1963) noted that, "Thinking is the accurate and deliberate institution of connections between what is done and its consequences" P (151). In other words it is reflection on activities that make them meaningful experiences. Dewey mentioned that one way to organize these reflections is by writing about them after its occurrence. With an attempt to make the connections, the journals provide such opportunities and the writing and subsequent sharing of reflections can contribute significantly to developing a culture of inquiry. Journaling makes invisible thoughts visible. It provides a means of describing practice and identifying and clarifying thoughts, beliefs perspectives, challenges and hopes for practice. It is a way to put our thoughts linearly or sequentially on paper and offers a private place for honest accounting and review.

Journal writing has been recognized by educators as an effective strategy and a formal tool to promote reflective thinking and learning. Writing about what we do and what we think and what we have learnt disciplines us to become more thoughtful, reflective and analytic. Our writing needs to demonstrate active and reflective engagement in the experiences and ideas we encounter. Reflective learning journals enable us to create a record of reflective thought and meaning we are making while engaging in learning process. If the journaling is done conscientiously, the reflection in each learning journal will be unique as each learner has his own response to any one experience. Regularly writing up our learning in a journal has the potential to provide us with a systematic approach to our development as a critical, reflective and constructive learner.

The reflective writing in a learning journal may be considered as a cyclic process which is really an aid to learning often in the form of a raw material of learning. We could almost say that the reflective Journals are the learner's personal curriculum in a written form. The investigator reflected upon the varied theoretical versions of journal stages, the model proposed by Brown & Irby, (2001) is found to be the most suitable one for the present study as it touches deeper levels of reflection. This model reflective cycle of journaling comprising five stages of reflection namely, select, describe, analyze appraise, and transform was adopted and was depicted in Figure 1.

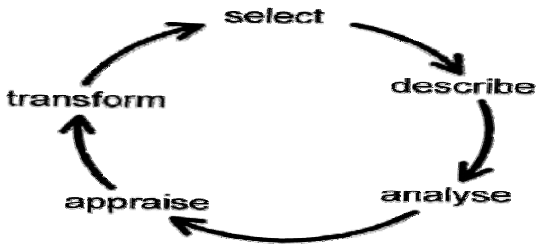

Figure. 1. Reflection Cycle of Journaling

Journals can be created in different shapes, sizes and forms. The design and structure of the Journal is significant rather than the recording mode. Brookfield (1995) suggested that students write about whatever seems important, but also be provided with a set of question as initial prompts. The

questions focus on what the students learned about themselves and their emotional moments, significant or surprising events and the area of satisfaction or dissatisfaction. In the present study as the learners fall into adolescent group, the investigator made use of a semi structured journaling format in which the facilitator provided journaling prompts throughout the programme. This made the investigator to assess the reflective writing of learners objectively and scientifically.

Reflective writing helps us to focus and participate in the development of an effective independent and active learner. It helps us to discover the strategies and processes that work well for us and to evaluate our own performance as an independent learner which will effect in recognizing the responsibility for becoming lifelong learners. Thorpe (2004) suggested that reflective learning journals are recognized as a significant tool in promoting active learning among nursing students. While writing in a journal, we not only record what happened or what was observed, but also develop new understanding, and insights and thereby new hypothesis and new perspectives of the phenomena. Reflective journaling empower the above mentioned orbits of a learner which is schematically represented as in Figure.2

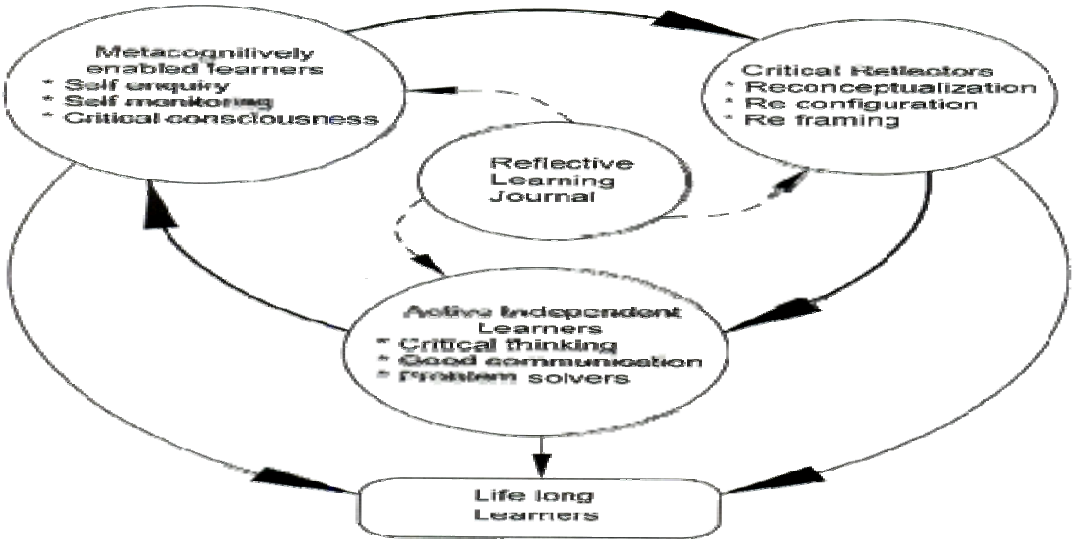

Figure 2. The Orbit of Reflective Journals

Reflective writing is a way of learning and helps to evaluate our own learning performance as a learner. By engaging in Reflective journaling learners are taking an active role in learning and recognizing their personal responsibility for lifelong learning. No doubt, regular Reflective journaling is extolled by those learners who ought to become lifelong learners.

Statement of the problem

This study was mainly meant to establish the effectiveness of reflective journaling strategy in fine-tuning a reflective mindset among secondary school pupils

Objectives of the Study

The study mainly focused on attaining the following objectives:

6) To test the effectiveness of Reflective journaling strategy in enhancing reflective thinking level of pupils at secondary school level

7) To analyse the praxis of reflective journaling strategy in proliferating reflectivity among secondary school pupils

Methodology in brief

The present study attempted to empower the student folk at secondary level with a reflective mindset by exposing them to reflective journaling with special reference to mathematics learning. For attaining the set objectives of the study both quantitative and qualitative methodology were adopted. The quasi-experimental design with pre test posttest non equivalent group design was employed for the quantitative segment and the strategy evaluation proforma for the qualitative segment.

Participants of the study

The sample or participants of the study primarily consisted of 144 pupils at secondary school level

Analytical supports of the study.

- Lesson design based on Reflective journaling
- Scale of reflective action
- Strategy evaluation proforma for Reflective journaling

The investigator prepared lesson designs based on reflective journaling strategy in standard IX mathematics and were treated to the experimental group. The control group was treated with the prevailing activity oriented approach.

For the present study the investigator developed and standardized a Likert scale type of tool to assess the level of reflective thinking among pupils at secondary level. This tool intends to measure whether the learners engage in action oriented reflective thinking and if so its level of attainment. . The constructs for the development of the scale were derived in accordance with the work of Mezirow, (1991) and Kember et al. (2000) and were depicted as in Figure 3.

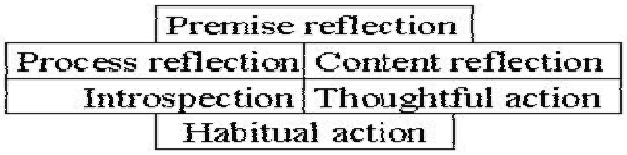

Figure 3. Constructs of Reflective Thinking

After having a comprehensive analysis, the investigator selected the three constructs namely content reflection, process reflection and premise reflection for developing the scale of reflective action. The constructs habitual action, thoughtful action and introspection are not included in the instrument, as investigator felt that the instrument should focused on assessing outcomes with regard to the level of reflective action displayed by pupils.

To supplement the quantitative data the investigator has adopted qualitative approach to evaluate the praxis of the select reflective journaling by the pupils who have participated in the experiment through set strategy evaluation proforma. For this purpose strategy evaluation proforma for Reflective journaling was prepared to collect pupil's independent views about the select strategy. The proforma was prepared with 10 items concerning the different characteristics of the reflective activities initiated through reflective journaling.

Statistical procedures employed

T-test of significant difference between means, ANCOVA, Adjusted means

Analysis and Interpretation

The investigator analyzed the pre test and post test scores of the control group and experimental group who were exposed to Reflective journaling strategy to find out the effectiveness of it in enhancing reflective thinking level of pupils at secondary level.

To find out whether any significant difference exists between the experimental and control group, the mean and standard deviation of the posttest scores of reflective thinking level were estimated. The critical ratios were found out based on the data presented in Table 1

Table 1 Data and Results of the Test of significance of the Mean Post test Scores of Reflective Thinking Levels between Experimental I and Control groups

Sl. No.	Sample	Control group			Experimental group I			Critical Ratio	Level of significance %
		Mean	S D	No. of pupils	Mean	S D	No. of pupils		
1	Total	63.91	11.09	75	100.23	21.04	69	12.68	0.01
2	Urban	63.47	10.33	36	102.11	20.58	34	10.14	0.01
3	Rural	64.68	11.76	39	98.40	21.98	35	8.02	0.01
4	Male	65.17	10.85	37	101.55	21.73	33	8.81	0.01
5	Female	64.33	11.54	38	99.03	20.63	36	9.17	0.01

This result shows that the performance of the experimental group and control group in the post scores of reflective thinking levels are not similar. The table values show that the higher mean scores are associated with the experimental group. This means that experimental group shows better performance than the control group in their level of reflective thinking for the total sample, locale wise and gender wise sub samples.

Single factor ANCOVA with pre experimental status in the level of reflective thinking as covariate was employed to investigate the effectiveness of Reflective journaling in promoting reflective learning practices in mathematics over present activity oriented approach. For this purpose the sum of squares, mean squares of variance along with corresponding degrees of freedom and the F-ratios were calculated for total sample. The details are given in Table 2.

Table 2 Summary of ANCOVA of Pre test and Post test Scores of Level of Reflective Thinking in the Experimental and Control Groups for Total Sample

Source	Type II sum of squares	df	Mean square	F-value	Significance level %
Model	672529.381(a)	1	672529.381	900.5	0.01
Control post	672529.381	1	672529.381	900.5	0.01
Error	30780.619	68	746.774		
Total	723310.000	69			
a R squared = 0.930 (Adjusted = R squared = 0.929)					

The obtained F- value (900.58) is significant as the level of significance is 0.01 %

An additional analysis was done in order to determine which one of the two groups based on Reflective journaling strategy cause difference from another in terms of the variation in the criterion mean. Adjusted means scores of level of reflective thinking for the experimental group was calculated using regression equations for the total sample.

Table 3 Adjusted Mean of the Post test Scores of Experimental Group for Total Sample

Sl. No.	Sample	Mean of control group	Mean of experimental group	Adjusted mean of experimental group
1	Total	63.91	100.23	99.23

The criterion means were adjusted to avoid the effect of the covariate from the final result. The obtained adjusted mean of the experimental group for total sample is found greater than the corresponding mean of control group. It can be concluded from the result that experimental group is better than the control group with regard to the post reflective thinking level scores. This better performance is due to the effectiveness of Reflective journaling strategy, which was treated to experimental group in promoting reflective learning practices in mathematics. Thus it is evident from the analysis that Reflective journaling strategy enhances the level of reflective thinking of secondary school pupils. The exposure to the Reflective journaling strategy enforced the pupils to reflect on experiences in a variety of ways and at varied levels that enabled the internalization of vital issues and charting the development of self efficacious learning. Even though ample opportunities for activity orientations are there in the prevailing transaction modes, the investigator has seen that the better performance of experimental group may be because of getting opportunities to analyse their own problem solving behaviour with special reference to what they did in the classes and how it happened and why it occurred, including their observations of individual and peer reflections as to how to work more effectively in future.

Effectiveness of Reflective journaling strategy in praxis

In order to assess the praxis of Reflective Journaling strategy in the day-to-day classroom interactions of secondary school pupils, the self-evaluation of the effectiveness of the select strategy was gathered through the strategy evaluation proforma developed by the investigator for this special purpose. The details are given in Table4.

Table 4 Self-evaluation of the Appropriateness of Reflective Journaling Strategy towards Proliferating Reflectivity of Secondary School Pupils

Sl. No.	Observations	Responses of pupils		
		To a great extent	To some extent	Not at all
1	Enables me to record my learning progress	85%	15%	Nil
2	Aids me to make clear expression of thoughts	89%	11%	Nil
3	Increase skill in crystallizing issues in the learning space	92%	8%	Nil
4	Demonstrates self awareness and self development	82%	18%	Nil
5	Integrates the experiences with theory	80%	20%	Nil
6	Opportunity for self analysis led to enhanced enjoyment	90%	10%	Nil
7	Highlights learning dysfunction and their causes.	79%	21%	Nil
8	Helps to shape and self regulate the learning progress	81%	19%	Nil
9	Highlights the remedial actions to recharge myself	78%	22%	Nil
10	Made me to engage in experimenting with new world making perspectives	86%	14%	Nil

The select sample of pupils at secondary level who were exposed to the Reflective journaling strategy argued that the select strategy has dispensed a milieu for self analysis as a liberating and self authenticating experience provided in the keeping of a reflective journal (90%) which paved the way for amplifying mathematical scholarship. From Table 3 it can be inferred that the pupils are satisfied with the select strategy, as it has aided them to fulfill the general academic expectations such as clear expression of thoughts (89%). A great proportion of pupils advocated that they were equipped with the skills and competencies in articulating and crystallizing issues and arguments in the learning space by practicing this strategy (92%). Thus through a close analysis of the data procured through strategy evaluation proforma, the investigator could reiterate the strength of Reflective journaling strategy in proliferating the reflective potentials among the learners at secondary school level.

Major Findings and Conclusions

- Reflective journaling strategy is effective in enhancing the level of reflective thinking of secondary school pupils.
- The select reflective journaling strategy has strength in proliferating reflective dispositions among the pupils at secondary level.

Thus the findings mentioned above can conclusively point towards the fact that Reflective journaling strategy has tremendous effect in shaping a culture of reflective practices among secondary school pupils.

Discussion of results

The effectiveness of Reflective journaling strategy was tested through a mixed method research design in which both experimental approach and self assessment mode of data gathering were blended harmoniously. The findings derived in this context diligently resonates the range of potentialities of reflective journaling in transforming the pupils at secondary level into a culture of reflective thinking with special reference to mathematics. Reflective journals provide a space to conduct a retrospective analysis of the observations and responses to situations to improve future practice envisaging new scenarios of mathematical applications. It enables the learners to have awareness and control of one's own cognitive processes and regulatory mechanisms. The upswing in the performance shown by the select experimental group over the control group may be due to the capacity of journaling strategy in propelling a culture of inquiry, the skill set to meet the cognitive fluency and willingness to engage in cognitive housekeeping. They are practiced to emerge with heightened metacognitive abilities and enhanced creativity and perspectives to transfer the thinking process across disciplines and outside school. The journaling prompts provided throughout the design served as the strategic scaffold and cognitive trigger that assisted learners to ponder over the many learning issues of the problem.

As a plenary session, a select strategy evaluation proforma was administered to the experimental group, which substantiated that the journaling strategy could have encouraged the learners to dispense reflective thinking as soon as they could manage to set their own mental frame to expand the range and variety of their reflective writing. The use of these exercises regularly in class situations can stimulate reflective consideration of issues and events and can entail the development of dialogue between the learner and the mathematical event or issue or the person or the organization.

These trends are in accordance with the following observations.

Moon (2004) reported that a learning journal is essentially a vehicle for reflection and is an accumulation of material that is mainly based on the writer's processes of reflection. Connell (2006) reported that reflective journal, has become an increasingly popular tool used by numerous faculty across many disciplines in higher education as it has the potential to encourage reflection and learning.

As a concluding remark the investigator advocated that the emphatic accrual in the performance of the select Reflective journaling group of learners is due to the upshot of the active engagement and facilitation of a cluster of intelligent behaviors centered around creative thinking and of the enhanced enjoyment and satisfaction delivered through the opportunity for self analysis and self expression as a liberating and self authenticating experience provided to the learners.

Implications of the Study

The major implications of the study are described below:

- A reflective model of learning experience enables the learners to have meaningful learning by making visible both teachers' and learners' thinking processes. Facilitators should employ a range of cognitive tools involving enquiry, dialogue, discussion, regulation, documentation, presentation to provide students with strategic road maps that assist them in their line of analysis they employed that led to their final decision.
- The present study underscores the use of learning journals as a method of engaging learners in the exercise of reflective actions and their transcripts in relating classroom theory to situations of practice outside the classroom. The study participants indicated that they got a rare opportunity to reflect upon their own experiences and were able to share their journal entries regarding what has

worked and has not worked; and were able to learn innovative ideas for using journals in their own learning. This implies the need of transacting an ambience of journal writing among the school practitioners as well as all levels of learners so that effective learning takes place.

- The findings of the study suggest that educators should concern themselves more with the development of a reflective environment and practice of reflective scaffoldings than teaching students how to reflect. This might account for a slow adoption of reflection within the curricula and the stake holders should be encouraged to examine the fruit of reflection in many contexts and arenas. Hence it is high time to orient the educational practitioners at all levels to habituate reflective learning practices in their daily classroom transactions for building productive learning population as well as for their professional development by the educational planners and administrators.
- The present study emphasizes the core competencies necessary for the good practice of reflective activities as observation of critical moments, communication, judgment, decision making and collaborative work This implicates broadly to the role of reflective conversations in all the pedagogical functions claiming that it can encourage access to diverse range of opportunities and activities bringing improvement forward. It is the quality of the conversation that is important and so the curriculum framers, teacher educators and practitioners at various levels need to design a structure for better use of reflective conversations into the routine of classroom practice

BIBLIOGRAPHY

Brookfield, S.D. (1995). Becoming a critically reflective teacher. San Francisco: Jossey-Bass.

Brown, G. & Irby, B.J. (2001) .The principal portfolio (3rd Ed). Thousand Oaks, CA: corwin press.

Connell, T., and Dyment, J. (2006).Reflections on using journals in higher education: a focus group discussion with faculty. Assessment and Evaluation in Higher Education, 31(6), 671 – 691.

Dewey.J. (1963). Democracy and education. New York: Macmillan.

Farrah,M.(2012.) Reflective Journal Writing as an Effective Technique in the writing Process. An - Najah University Journal Res. (Humanities). Vol. 26(4), 2012

Kember, D., et al. (2000). Development of a questionnaire to measure the level of reflective thinking. Assessment and Evaluation in Higher Education, 25(4), 381-394.

Mertens, D.M. (2010). Research and evaluation in education and psychology. (3rd Edn.). Thousand Oaks: London, Sage publications

Mezirow, J. (1991) .Transformative dimensions of adult learning. San Francisco, Jossey-Bass.

Moon, J.A. (2004). A handbook of reflective and experiential learning. London and New York. Routledge-Falmer

Osterman, K.F., & Kottkamp, R.B. (2004). Reflective practice for educators (2nd ed.) California: Corwin press.

Thorpe,K. (2004) .Reflective learning journals: From concept to practice. Reflective Practice, 5(3), 328-343.