

Features of Problem Based Learning Lesson Plan That Fits into the Realities in the Teaching and Learning of Mathematics for Pre-service Teachers in Ghana

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Abstract

The traditional method of teaching Mathematics has been criticised by researchers as learner passive paving the way for Problem Based Learning (PBL) strategy into the teacher education curriculum in Ghana. This development has aroused concerns about the effectiveness of lesson plans designed for teaching using the traditional method. Consequently, the introduction of a PBL lesson plan that is learner-centred, interactive, and involves the cooperation of learners in small group activities has become indispensable. The study seeks to determine the features of the PBL lesson plan that fits into the realities in the teaching and learning of Mathematics for pre-service teachers at the colleges of education in Ghana. The methodology employed in this study involved a literature review of a traditional lesson plan for pre-service teachers in Ghana alongside a proposed PBL lesson plan for pre-service teachers through a qualitative analysis before the enactment of the instructional process. The result and discussions of the two lesson plans placed the PBL lesson plan as a more constructive and a deeper reflection of the three domains of learning (cognitive, affective, and psychomotor) which are crucial in stating instructional objectives and for teaching Mathematics. The paper recommended that the PBL strategy should be integrated into the teacher education curriculum in Ghana since its features better fit into the realities in Mathematics education in Ghana.

Keywords: *Problem based learning, Traditional Teaching method, Lesson plan, Pre-service teachers, and Mathematics education.*

Introduction

The teaching and learning of Mathematics are a process and not an event. The process requires competent tutors with appreciable pedagogical skills to be able to deliver Mathematics contents effectively to shape the cognitive, affective and psychomotor skills of pre-service teachers. A tutor's in-depth understanding of a subject matter is not singlehandedly a panacea for effective teaching. The ability of a tutor to deliver content to a group of learners requires a structured approach guided by a lesson plan artefact. This lesson plan has been widely acclaimed as a mandatory tool if one wants to trek the path of teaching and learning according to researchers.

Largely, it is accepted in the teaching and learning process that lesson plan helps the teaching and learning process to be valuable and meaningful. On the contrary, an ill-prepared lesson plan results in unfocused and

unproductive teaching and learning experiences. Many tutors generally believe that designing a lesson plan before an instructional process will lead to more effective teaching (Conkell and Imwold, 1992; Lederman and Niess, 2002). MacDonald and Phillips (2005) assert that planning a lesson allows the teacher to reflect on what to achieve and how best this can be done. A detailed lesson planning is important as it provides tutors the approach to better understand the content, student learning, and pedagogical content knowledge (Shen et al., 2007). Important to this is that lesson planning needs to focus on educational experiences that would stimulate learning than simply the delivery of content.

An instructional process in a formal classroom setting either takes the form of a teacher-centred or learner-centred approach. The teacher-centred approach describes a traditional method of teaching as against a learner-centred approach described as a problem-based learning

in the context of this paper. Research has revealed that these teachers use traditional methods in the teaching of Mathematics (Ampiah et al., 2004). Enu, J et al., (2015) conducted a study on the topic “factors influencing students’ Mathematics performance in some selected colleges of education in Ghana”. The study revealed that the expository approach of teaching Mathematics (just listening to teachers and copying notes from the board) was the major method of instruction by most tutors. The study revealed that 88% of Mathematics tutors use lecture method of instruction, 10% also use questioning and answering method of teaching whilst 2% use heuristic methods involving the use of small group discussion as the least methods of instruction (Enu et al., 2015).

Ghana Ministry of Education (2017) in a publication “The National Teacher Education Curriculum Framework” advocated for teachers to be competent in the use of different pedagogical strategies including project-based, enquiry based, and problem-based instructions and learning strategies, to meet the diverse needs and learning styles of learners. Irrespective of the kind of strategy to be employed and the level of content knowledge, the need for pre-service teachers to be exposed to how a typical lesson plan is prepared prior to an instructional process cannot be overlooked.

Problem based learning strategy reflects a social process in which students are engaged in dialogue and discussions (Hanley, 1994) and empowers teachers and students for critical thinking and creating changes in old teaching methods (Sawada, et al, 2002). Problem based learning (PBL) in Mathematics classrooms also fosters cooperation in small groups (Schmidt, et al, 2007). This effect could be achieved through a well-designed lesson plan that arranges and delivers content of a lesson coherently and confidently. The purpose of the paper is to examine the features of a typical PBL lesson plan relative to a typical lesson plan for a traditional Mathematics classroom at the colleges of education in Ghana. The paper briefly reviews literature on lesson plan and the domains of learning. It will then state the objective of the study, and the methodology employed in the study. Furthermore, it will compare a typical traditional lesson plan with a proposed PBL lesson plan. The paper also

discusses the outcome of the comparison and finally makes recommendations.

Literature Review

This aspect of the paper will cover definitions and features of a lesson plan, and the three domains of learning. According to Scrivener (2005), planning a lesson involves imagining the lesson before it is enacted and this includes prediction, anticipation, sequencing, organising and simplifying. This planning could be unit planning, weekly planning and/or daily planning (Anderson, 1989). Anderson emphasised that the lesson plan which is planned daily is very significant for teachers. Woodward (2009) states that constructing a lesson plan and planning a lesson must take into consideration the learners, the contents to deliver, materials, and activities that could go into the lesson.

Amin (2010) defines a lesson plan as a set of planned activities in the learning process to reach a certain goal. A lesson plan is also considered as a blueprint, a guide map for action or a comprehensive chart of classroom teaching and learning activities (Aggarwal 2002). Aggarwal describes it as elastic but a systematic approach to the teaching of the concepts, skills, and attitudes. From the foregoing, a lesson plan could be described as an artefact that sets the tone for effective teaching and learning by considering the content to teach and how to teach it with respect to the teacher, the learner, and the environment. This requires a systematic and coherent manner to shape the knowledge, attitude and skills of the learner. The lesson plan could vividly indicate the lesson objective, the activities to support the attainment of the objective, the teaching and learning materials, and the evaluation of the objectives within a stipulated time frame.

Most experts agree that a lesson plan should indicate the instructional objectives, the instructional materials, the procedure, the media, and an assessment technique. Brown (1975) indirectly enumerated the content of a lesson plan as:

- a. What kind of things do you want the pupils to learn?
- b. What are your precise instructional objectives?
- c. What is the most appropriate sequence of the topic and the task?
- d. What are the most appropriate methods?

e. How could teach and learning be evaluated?

In the context of Ghanaian education, the Schools Partnership Programme (2016) wrote a book entitled 'Teaching Practice Tutor Handbook' and approved by the Ghana Ministry of Education. The book outlined a lesson plan format for pre-service teachers in Ghana. These include:

- a. Day/Duration.
- b. Topic/Sub-topic/Aspect.
- c. Objectives/Relevant Previous Knowledge (RPK).
- d. Teacher/learner activity.
- e. Core Points.
- f. Evaluation/Remarks

The colleges of education in Ghana are required to take the pre-service teachers through the objectives for the lesson, the sequence and the phases of the lesson plan format (Schools Partnership Programme (2016).

The author argues that a lesson plan must be goal-oriented and must have specific and measurable instructional objectives. The plan must reflect the appropriate teaching and learning materials that will be employed and must be carefully designed to reflect an activity-based method of instruction that is learner-centred, cooperative, interactive, and enhance communication. Where it requires the use of problem-based learning as the instructional strategy, the class must be configured in small groups.

The Three Domains of Learning

The Cognitive, Affective and Psychomotor are generally categorised as the three domains of learning according to literature. The cognitive domain was pioneered by Benjamin Bloom (1956), popularly referred to as Bloom's taxonomy though he was not the sole author but the first. Literature compiled by Hoque (2016) reveals that the affective domain was championed by Krathwohl (1964) as the first author whereas the psychomotor domain was not fully described until in the 1970s by E.J. Simpson (1972) and R. H. Dave (1975).

Learning skills primarily related to mental processing reflect the cognitive domain of learning which involves processing information, constructing understanding, applying knowledge, problem-solving and conducting research. A number of added features can be very useful to educators as they try to construct

prime learning experiences (Krathwohl, 2001) as against the earlier version proposed by Bloom (1956). The cognitive domain is categorised into six sub-domains from simple to complex as follows:

- a. Knowledge – The ability to recall specific facts, methods and processes. Learners are expected to be able to label, define and/or identify terms involving lower-order thinking.
- b. Comprehension – The ability to understand the meaning of what is known. Learners are able to find solutions to assigned problems. This involves questions that require lower-order thinking and the use of illustrative verbs such as explain, convert or summarise.
- c. Application – The ability to apply knowledge in a new situation. Learners are able to explain how the solution to a problem was arrived by the use of such things as rules, methods, concepts, and principles. This also requires somewhat lower-order thinking.
- d. Analysis – The ability to differentiate facts and opinions and break down materials into its component parts for ease of understanding. This requires higher-order thinking and the use of illustrative words such as differentiate and illustrate, among others.
- e. Synthesis – The ability to integrate different concepts to form a sound pattern where new meaning can be established. Learners combine the part of the process in new situations and it requires higher-order thinking. Illustrative verbs include categorise, combine and organise could be used.
- f. Evaluation – The ability to come up with judgements about the importance of concepts. Learners are able to create a variety of ways to solve the problem and select the best method suitable for the problem. It requires the highest-order thinking. The sub-domain requires the use of illustrative verbs such as appraise, contrast, support, among others.

The affective domain, on the other hand, reflects the learner's attitude, emotions and feelings but not only the cognitive (mental) functions. The domain also addresses values, appreciation, enthusiasm and motivation on the part of the learner and the facilitator. The

affective domain is categorised into 5 sub-domains, which are listed from the lowest level to highest level as (a) Receiving, (b) Responding, (c) Valuing, (d) Organisation and (e) Characterisation. These are briefly explained as follows:

- a. Receiving - This requires paying attention to details to express the awareness of feelings and emotions. An example is listening attentively and closely to the classroom activities. Illustrative verbs that are used include ask, give, follow, among others.
- b. Responding – Requires active participation of a learner in given activities. Learners participating in a group discussion may reflect a PBL classroom to complete an assigned task. Illustrative verbs that are used include answer, assist, comply, and practice among others.
- c. Valuing – This is the ability of a learner to realise the worth of something and express it. Proposing a plan (e.g. a PBL lesson plan) to improve skills and a facilitator sharing know-how to achieve a learning outcome are examples. Illustrative verbs include describe, explain, complete, follow, initiate, and read.
- d. Organisation – This is the ability to bring together different values, resolve conflicts and create a unique value system. An example is learners spend time in a PBL classroom and share ideas freely with their peers. This helps to identify strengths and weaknesses. The use of illustrating verbs such as: adhere, alter, arrange, combine, compare, among others are used.
- e. Characterisation – The learner’s ability to internalise value and allow that to impact on behaviour. An example includes practicing cooperation in a small group activity and maintaining good study habits. Some illustrative verbs include act, discriminate, display, modify, practice and qualify.

The Psychomotor domain of learning as described by Simpson (1972) involves objectives that are specific to discrete physical functions, reflex actions and interpretative movements. The psychomotor domain comprises utilising motor skills and coordinating them. The domain has seven sub-domains which are mentioned from the lowest to the highest as follows:

- a. Perception – The ability to apply sensory information to obtain a cue that guides motor activity. Example is relating to the sound of the drum to the type of dance move. This involves the use of illustrative verbs such as choose, describe, detect, among others.
- b. Set – The readiness to act. This includes mental, physical and emotional set. An example is demonstrating how to state lesson objectives during an instructional period to achieve learning outcomes. Illustrative verbs include: begin, display, explain, and show.
- c. Guided Response – The ability to imitate a displayed behaviour or to utilise trial and error. This involves the early stages of learning a complex skill. Example: a pre-service teacher emulates the teaching skills of a facilitator during teaching. Illustrative verbs include: assemble, build, and construct are used.
- d. Mechanism – The ability to convert learnt responses into habitual actions with proficiency and confidence. A pre-service teacher is able to teach with a lesson plan after practicing how to prepare a lesson plan and rehearsing with it. Illustrative verbs include sketch, fix, assemble, and dissect.
- e. Complex Overt Response – The ability to skilfully perform complex patterns of actions. Example: Teaching contents chronologically without looking at the lesson plan. Verbs such as organise, construct, assemble, etc. are used.
- f. Adaptation – The ability to modify movement patterns from well-developed skills to meet special events. An example is modifying a lesson plan for the traditional teaching method to suit a PBL lesson plan. Illustrative verbs include adapt, alter, change, reorganise.
- g. Origination – Creating a new movement pattern for a specific situation or a particular problem. An example is designing a typical problem-based learning lesson plan for the teaching of college of education Mathematics. The use of verbs such as create, design, and originate are examples.

The author asserts that a good lesson plan must recognise and integrate the six sub-domains of the cognitive domain of learning. The preparation, organisation, and sequencing of

learning activities could reflect these thinking domains to achieve the expected learning outcomes. Furthermore, instructional objectives could be stated to reflect the affective domains and the psychomotor skills with the use of the appropriate illustrative verbs. This implies that a lesson plan, be it PBL or traditional type must state objectives that are specific, measurable, achievable, realistic, and within a time frame to elicit expected learning outcomes. Literature points to the fact that the traditional teaching method has not been helpful in the teaching of Mathematics in Ghana (Enu, et al., 2015). This has created doubt on the effectiveness of a traditional lesson plan and necessitated the need to investigate into the effectiveness of a PBL lesson plan relative to the traditional lesson plan. This is explored in subsequent sections of the paper.

Objective of the Paper

The paper seeks to assess a proposed PBL lesson plan and how the plan dovetails into the teaching and learning of Mathematics for pre-service teachers at the colleges of education in Ghana.

Methodology

This was an investigation that involved a description and content analysis of a proposed

PBL lesson plan. A review of the teacher education manual prescribed by the Schools Partnership Programme (2016) and sanctioned by the Ghana Ministry of Education for pre-service teachers was done alongside a proposed PBL lesson plan. This was done to ascertain how each lesson plans justified learner-centredness, cooperation, interactivity, communication, and small group activities as tenets of a PBL lesson for effective Mathematics teaching and learning as proposed by Boye (2019). The two lesson plans were compared and the contents were analysed qualitatively prior to its implementation on the targeted pre-service teachers.

Result and Discussion

This involves critically describing and analysing the contents of the proposed PBL lesson plan as against the lesson plan for the traditional methods of teaching mathematics for pre-service teachers. This is aimed at differentiating between the two with the view to bringing out the supposed advantages the proposed PBL lesson plan has over the current traditional lesson plan. The traditional lesson plan used at the colleges of education in Ghana and the proposed PBL lesson plan are as shown in tables 1.1 and 1.2 respectively.

Table 1.1. A typical Lesson Plan for Traditional Teaching Method

Week Ending		Class:	
Subject		Average Age:	
Reference		Number on Roll:	

Day/Duration	
Topic/Sub-topic/Aspect	
Objective/RPK	
Teacher/Learner Activity	
Core point	
Evaluation/Remarks	

Adopted from Schools Partnership Programme (2016).

Table 1.2. Proposed Problem Based Learning Lesson Plan – Stage 1

Subject		Course	
Topic		Duration	
Overview of lesson:			
Specific objectives	By the end of the lesson, the student should be able to:		
Skills	Students will use problem-solving skills, creative skills, critical and observational skills to comprehend, apply, analyse, synthesise and		

	evaluate.
Knowledge	Students will learn: <ul style="list-style-type: none"> To distinguish between....
Attitude	<ul style="list-style-type: none"> Problem solving, creativity, and critical thinking. Cooperation, Communicate skills, Learner-centred, Interactivity, Small group activity.
RPK	Students are able to:
Classroom configuration	Small groups (between 4-8 students) in a semi-circle or such that the groups face the marker board.
Resources/TLM	

Stage 2

Phase	Researcher Activity	Student Activity
Introduction (duration)		
Main Activity (duration)	Activity 1. Activity 2 Activity 3. Etc	
Conclusion (Duration)		
Activity sheet		

By comparing the two lesson plans, one could notice that both provide preliminary information (class, subject, number on roll, duration, topic, etc) about the targeted group (pre-service teachers). This is important as it gives direction and informs the content of the lesson plans. The lesson objective, relevant previous knowledge (RPK), teacher and learner activity, and evaluation are headings that are featured in both traditional and PBL lesson plans.

Conversely, the PBL lesson plan has certain features that make the lesson plan artefact distinct and more promising in the attainment of the expected learning outcomes. For instance, the PBL lesson plan provides an overview of the lesson to be taught for a specific instructional period. The PBL lesson plan has other features such as skills, knowledge, attitude, classroom configuration, and teaching and learning materials/resources. Specifically, the teacher and learner activities under the PBL are intended to reflect the tenets of the PBL lesson (small group activity, learner-centredness, cooperation, interactivity, and communication) as proposed by Boye (2019). Undoubtedly, pieces of literature from experts in the field of Mathematics education continue to recommend a pedagogical approach that makes the learner more active than passive and this characterises

the PBL process. More importantly, the design of a PBL lesson to encompass the tenets and the subsequent implementation in the teaching of pre-service Mathematics could address the gaps created by the traditional lesson plan. This has called for a PBL lesson plan that puts the pre-service teacher at the centre of the teaching and learning process interspersed with problem-solving activities.

Generally, the lesson objectives, activities, and evaluation components of both lesson plans support the cognitive domain of learning as postulated by Bloom (1956) and highlighted in the literature above. In particular, however, the PBL lesson plan amply covers some aspects of the affective (attitude) and psychomotor domains (skills) pioneered by Krathwohl (1964) and Simpson (1972) respectively. More so, the PBL lesson plan is accompanied by an activity sheet that has homework or tasks that stimulate learners' lower-order and higher-order thinking to reflect the three domains of learning: cognitive, affective and psychomotor skills of the learners. The PBL lesson plan sets the tone for the design and implementation of a more constructive and learner-centred method of teaching college of education Mathematics that will inure to the benefit of pre-service teachers.

Conclusion and Recommendations

The successful outcome of an instructional period requires detailed planning, organisation, and effective delivery of content based on a carefully designed lesson plan. Lesson plan has been discovered and widely accepted in the teaching and learning environment as a mandatory tool for teaching. A lesson plan is viewed as a set of planned activities in the learning process to reach a certain goal (Amin, 2010). The paper discussed two categories of lesson plan: a lesson plan used for traditional teaching method at the colleges of education in Ghana (Schools Partnership Programme (2016)) and a proposed PBL lesson plan for pre-service teachers in Ghana.

The components of a lesson plan as championed by Brown (1975) above could be summarised as topic, objectives, activities, method and evaluation. Similarly, the Schools Partnership Programme (2016) indicated that a lesson plan for pre-service teachers could have features such as duration of the lesson, topic/sub-topic, objective, relevance previous knowledge, and teacher-learner activity. Others are core points and evaluation. These were reflected in both lesson plans except that the *class configuration* was not captured in the Schools Partnership Programme (2016) for the traditional teaching method. The absence of the regrouping of the class into smaller units under the traditional setup impedes the constructiveness of effective teaching as championed by the PBL approach. Furthermore, the PBL lesson plan better reflects the affective and psychomotor domains (i.e. attitude and skills) of learning. Again, the practicality of the teacher-learner activity fits into the realities of pre-service teachers teaching and learning of Mathematics at the colleges of education.

Finally, the proposed PBL lesson plan sought to make the teaching and learning of Mathematics learner-centred, interactive, cooperative, and enhance communication. This could be achieved in small group activities that are learner dominated. This is expected to make the teaching of Mathematics interesting and promising as the approach could bring out the creative skills and problem-solving abilities in the pre-service teacher that will eventually make them good teachers in the future.

The following are recommended as part of measures to improve upon the teaching and learning of Mathematics by pre-service teachers using PBL lesson plan:

- a. The Government of Ghana and stakeholders involved in the teacher education reforms should adopt PBL strategy in the teaching and learning of Mathematics.
- b. The National Council for Tertiary Education (NCTE) in conjunction with the various universities in-charge of the colleges of education in Ghana should advocate for the use of PBL approach in teaching.
- c. The Ministry of Education should identify and assemble PBL resource persons to design and implement a PBL refresher course for tutors at the colleges of education.
- d. The Ghana Education Service should organise PBL workshops and seminars for in-service teachers as part of their professional development strategies.

References

- [1] Aggarwal, J. C., (2002). *Principles, Methods & Techniques of Teaching* (2nd ed). New Delhi: Vikas Publishing House Pvt. Ltd.
- [2] Amin, M (2010). *Serba-Serbi Pengajaran Bahasa Buku 2*, (Surabaya: Edfutura Press), 78- 81
- [3] Ampiah, J., Akyeampong, A. K., and Leliveld, M. (2004). *Science, mathematics and ICT (SMICT), secondary education in sub-Saharan Africa - country profile Ghana*. Centre for International Cooperation (CIS), Vrije Universiteit Amsterdam.
- [4] Anderson L.W (1989): *The Effective Teacher*: McGraw Hill Book Company: Singapore.
- [5] Bloom, B.S. (Ed.). Engelhart, M.D., Furst, E.J., Hill, W.H., Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*. New York: David McKay Co Inc.
- [6] Boye, E.S. (2019). Problem based learning in the teaching and learning of Mathematics in Ghana: A literature review. *Texila International Journal of Academic Research*. ISSN: 2520-3088 DOI: 10.21522/TIJAR.2014.SE.19.02.Art008
- [7] Brown, G (1975). *Micro Teaching*, London: Methuen and Co. Ltd.
- [8] Conkell, C. & Imwold, C. (1992). Planning practices and attitudes of physical education teachers. *Physical Educator*, 49(2), 1-5.

- [9] Dave, R.H. (1975). *Developing and writing behavioral objective* (R J Armstrong, ed.) Educational Innovators Press.
- [10] Enu, J, Agyman, O. K., and Nkum D. (2015). Factors influencing students' mathematics performance in some selected colleges of education in Ghana. *International Journal of Education Learning and Development*, 3(3), 68-74.
- [11] Hanley, S. (1994). On Constructivism. Retrieved from <http://www.inform.umd.edu/UMS%2BState/UMDPProjects/MCTP/Essays/Constructivism.txt>.
- [12] Hoque, M.E, (2016). Three Domains of Learning: Cognitive, Affective and Psychomotor. *The journal of EFL Education and Research*, Vol.2: ISSN-2520-5897.
- [13] Krathwohl, D.R., Bloom, B.S., and Masia, B.B. (1964). Taxonomy of educational objectives: The classification of educational goals. Handbook II: Affective domain. New York: David McKay Co.
- [14] Lederman, N.G. and Niess, M.L. (2000). If you fail to plan, are you planning to fail? *School Science and Mathematics*, 100(2), 57-61.
- [15] MacDonald, J .and Phillips, R.A.D. (2005). Developing teaching briefs and plan teaching sessions. *Education for Primary Care*, 16, 496-498.
- [16] Ministry of Education (2019). Presentation on the New Curriculum Reform for Basic Schools, Accra, Ghana: Ministry of Education.
- [17] Sawada, D., Piburn, M. D., Judson, E., Turley, J., Falconer, K., Benford, R., and Bloom, I. (2002). Measuring reform practices in science and mathematics classrooms: The reformed teaching observation protocol. *School Science and Mathematics*, 102(6): 245-253. <https://doi.org/10.1111/j.1949-8594.2002.tb17883.x>.
- [18] Simpson E.J. (1972). *The Classification of Educational Objectives in the Psychomotor Domain*. Washington, DC: Gryphon House.
- [19] Schmidt, H. G., Loyens, S. M. M., Van Gog, T., and Paas, F. (2007). Problem-based learning is compatible with human cognitive architecture: Commentary on Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42, 91–97.
- [20] Schools Partnership Programme (2016). *Teaching Practice Tutor Handbook: Ghana Ministry of Education under Creative Commons Attribution-Share Alike 4.0 International*. <http://www.t-tel.org>. Version 1.0 January 2016.
- [21] Scrivener, J (2005). *Learning teaching* (2nd ed), Oxford: Macmillan.
- [22] Shen, J, Poppink, S, Cui, Y. and Fan, G. (2007). Lesson planning: A practice of professional responsibility and development. *Educational Horizons*, 85(4), 248-258.
- [23] Woodward T (2009): *Planning Lesson and Course*: Cambridge University Press, Cambridge.