TEACHER EVALUATION: A TOOL FOR IMPROVING QUALITY OF MATHEMATICS EDUCATION

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ABSTRACT
This paper discusses teacher evaluation techniques as tools for improving quality of teachers of mathematics at all levels of education in terms of process and content. Different evaluation and assessment techniques used by mathematics teachers were presented. Concept of evaluation in Mathematics and Mathematics Education with goals/purpose and objectives of evaluation in Mathematics and Mathematics Education were discussed. Procedures and methods of evaluation or features of an evaluation tool in Mathematics and Mathematics Education were extensively discussed. Also, different methods of planning adapted for the evaluation of learning outcomes and consideration of evaluation reports (feedback to feed forward) in Mathematics and Mathematics Education were looked at. Equally, challenges and solutions to effective evaluation in Mathematics and Mathematics Education were presented.

Keywords: Test, Measurement, Evaluation, Assessment

INTRODUCTION
The purpose of this paper is to present a process and content for evaluating existing basic Mathematics and Mathematics Education programmes so as to identify the changes needed to support the required educational reforms. The evaluation and assessment of students in the area of Mathematics is a critical role of mathematics educators (Lewallen & DeBrew, 2012). It is a process that includes data collection, interpretation, and formation of judgments and conclusions about a student’s Mathematics performance (Mahara, 1998). It has two interrelated functions which are achieved formatively and summatively. Formatively, evaluation is intended to provide feedback on the learning which has taken place and to identify areas requiring remediation, while summative evaluation aims at making judgments to determine if the student’s performance meets laid down academic and professional requirements. Additionally, evaluation helps in the maintenance of professional standards and the protection of the public by ensuring that those that graduate from Mathematics programmes have attained the requisite skills and are safe to practice (Goldenberg & Dietrich, 2002). However, literature reveals that the evaluation of the Mathematics performance of Mathematics and Mathematics Education students has been a long-standing concern for mathematics
educators (Andre, 2000; Neary, 2001; Seldomridge & Walsh, 2006; Lasater, 2007). There is evidence of both faculty and student concerns (Isaacson & Stacy, 2009).

It is recognized that Mathematics evaluation is a complex process and a challenge both for novices and seasoned educators (Isaacson & Stacy, 2009). Its problems and challenges are diverse. For example, Goldenberg and Dietrich (2002) indicate that the creation of learning environments in which students receive fair and timely evaluations can be problematic. Furthermore, there is evidence that failing a student is deemed stressful for mathematics educators (McGregor, 2007), more especially for novice and part time educators (Lewallen & DeBrew, 2012). The specific grading of Mathematics students has its own challenges and problems, some of the concerns being the subjectivity and variability involved in assigning a grade, and grade inflation (Andre, 2000; Seldomridge & Walsh, 2006).

Graded assessment refers to the practice of assessing and reporting levels of performance that recognize merit or excellence beyond a pass grade (Andre, 2000). It involves assigning a numerical score as a measure of the student’s Mathematics competence. Evaluation can either be norm referenced or criterion referenced, grading being a form of norm referenced evaluation. Norm referenced evaluation ranks students within their group, whereas criterion referenced evaluation rates each student against the standards for successful performance without comparisons among students (O’Connor, 2006). The idea of grading students’ Mathematics competence has been debated in literature with evidence of a preference for criterion referenced assessments (Andre, 2000). However, it is argued that grades represent the quality of student learning and are a measure of student achievement (Andre, 2000; Neary, 2001; Seldomridge & Walsh, 2006; Lasater, 2007). A common problem associated with grading is the tendency to create a competitive environment that makes the students develop anxiety about their Mathematics grades (Diekelmann & Schulte, 1992). The challenges associated with Mathematics evaluation are clear and it is essential that these should be carefully thought through and controlled to ensure that goals of evaluation are achieved. In this paper, the words evaluation and assessment will be used interchangeably.

The use of separate descriptors, formative and summative evaluation in Mathematics and Mathematics Education curriculum, may appear to imply that there are two different kinds of assessment or two different ways of collecting information about students; however, it would be incorrect to make this interpretation in Mathematics and Mathematics Education programmes (Harlen, 2006). Rather, the descriptors refer to the use made of data, the interpretations of the data obtained from questionnaires, measures or observations. As such, formative refers to the interpretations of data that are useful for improving instruction and learning, thus the phrase, “assessment for learning”. Summative refers to interpretations of
assessments data in terms that represent a summary of student achievement; that is, what students have learned or achieved at a given point in their education, thus the phrase, “assessment of learning” (Cohen, Manion, Morrison & Wyse, 2010). In either case, the score or grade is a marker of performance; each can be interpreted differently to serve either of the two purposes – formative or summative. The difference between the two labels does not imply two methods for assessing student learning, but rather, their interpretation. These interpretations underlie decisions about what evidence is to be collected, the reasons for the information to be acquired, and the way the evidence collected is used.

Globalisation and knowledge economy demand a renewed vision on pedagogy in Mathematics and Mathematics Education. This paper presents a framework of learning and assessment integration for pedagogical revision in the context of Mathematics and Mathematics Education. Being one of the teaching models, this framework, termed the Self-directed Learning Oriented Assessment (SLOA), is grounded on the cognitive learning theory and underpinned by the belief that all assessment activities should contribute to learning. In SLOA, the learning-assessment integration is considered from three perspectives. First, is the assessment of learning which informs the learner about how much has been learned, and identifies the gap between intended learning goal and current students’ achievement. Second, is the assessment for learning, in which assessment is a vehicle for informing the learner how to enhance future learning. That is, feedback from assessment is used to feed forward for further improvement and adjustment. Third, assessment as learning means the learner internalises assessment as part of learning and becomes a self-directed learner/good problem solver. In this case, evaluation of Mathematics and Mathematics Education programmes acts in a circular pattern. The use of SLOA framework will encourage Mathematics and Mathematics Education students’ participation and highlight the role of individual Mathematics and Mathematics Education students’ self-evaluation and self-assessment. By returning ownership of learning to the student, the framework makes assessment a transparent process and consequently accountable at all levels of education. That is, using this model, Mathematics and Mathematics Education students will be autonomous by taking ownership of learning processes and being able to solve practical problems solo without any scaffolding from a tutor or facilitator.

Mathematics and Mathematics Education programmes offer some advanced education in areas that support critical thinking, Mathematics reasoning and analytical skills, prepare Mathematics teachers for a broader scope of practice and further professional development as well as facilitate understanding of complex issues affecting teaching delivery. Therefore, the Mathematics and Mathematics Education school must have a policy that addresses all issues in
the educational programmes and effective use of information and communication technology (ICT) in evaluation (World Health Organization (WHO), 2007).

CONCEPTS OF TEST, MEASUREMENT, EVALUATION AND ASSESSMENT IN MATHEMATICS AND MATHEMATICS EDUCATION

The terms test, measurement, evaluation, and assessment are occasionally used interchangeably, but most users make distinctions among them. Test is usually considered the narrowest of the four terms; it connotes the presentation of a standard set of questions to be answered at the end of a lesson, unit, week, month or term. A test can be in form of an essay or an objective type. As a result of a person’s answers to such a series of questions, we obtain a measure of the characteristic of the person judged as being proficient or not. Measurement however, often connotes a broader concept: We can measure characteristics in ways other than by giving tests. Using questionnaires, observations, rating scales, or any other device that allows us to obtain information in a quantitative form is measurement. Also, measurement can refer to both the score obtained and the process used in getting the score.

Evaluation, on the other hand, has been defined in a variety of ways. Stufflebeam, Madaus and Kellaghan (2000) stated that evaluation is the process of delineating, obtaining, and providing useful information for judging decision alternatives. Used in this way, it encompasses but goes beyond the meaning of the terms test and measurement. A second popular concept of evaluation interprets it as the determination of the congruence between performance and learning or instructional objectives. Other definitions simply categorize evaluation as professional judgment or a process that allows one to make a judgment about the desirability or value of something. One can evaluate with either qualitative or quantitative data depending on the instrument used to collect such a data. In Mathematics and Mathematics Education, laboratory activities, measurement devices/scales and other means can be used to evaluate a patient’s condition and causes of such a condition.

It is important to point out that we never measure or evaluate people. We measure or evaluate characteristics or properties of people: their scholastic potential, knowledge of Mathematics or Mathematics Education, honesty, perseverance, ability to teach, and so forth. This should not be confused with evaluating the worth of a person. Teachers, parents, and students do not always seem to keep this distinction clearly in mind.

As classroom instruction in Mathematics and Mathematics Education can be for an individual, a group or a whole class, so also its evaluation. Depending on the nature of the topic to be covered and the stated instructional objectives, the instruction can be delivered in the classroom, laboratory or outside the classroom. For a successful classroom delivery, a Mathematics and Mathematics Education instructor should be able to understand the
heterogeneous nature of the students and categorize them according to their differing learning abilities. Each Mathematics and Mathematics Education class must have five clusters of students with different learning abilities. The two outliers that are at the extreme (gifted and talented; and those with learning difficulties) are problematic to the Mathematics and Mathematics Education instructor. The other three (more able, able, and less able) are the ones at whose pace the Mathematics and Mathematics Education instructor is moving. Once you are teaching or evaluating Mathematics and Mathematics Education students, you have to put at the back of your mind this distinction in order to have a successful lesson delivery.

Thus, measurement is not the same as evaluation. Two students may obtain the same measure (test score), but we might evaluate those measures differently. Suppose at the end of the first year in a Mathematics or Mathematics Education programme, it was observed that one of two students engaged in laboratory practical was able to demonstrate some expertise in some difficult concepts to be taught in their second year, will evaluations of those outcomes be the same? One student progressed at an above-average rate, and the other at a below-average rate, so evaluation of the two students will not be the same.

The term assessment is also used in a variety of ways. Much of the time, the word is used broadly like evaluation; or it is often used to indicate the use of both formal and informal data-gathering procedures and the combining of the data in a global fashion to reach an overall judgment. At times, particularly in Mathematics and Mathematics Education, assessment is used more particularly to refer to the Mathematics diagnosis of an individual’s problems. According to Lorin (2003), assessment is the process of gathering information to make informed decisions. Before anyone engages in assessment, he or she must know why the assessment is being made (the purpose), what information is needed to make the decision (the basis), when the information is needed (the timing), and how the information is best collected (the method).

WHAT IS EVALUATION IN MATHEMATICS AND MATHEMATICS EDUCATION?

Evaluation is a systematic way of learning from experience and using the lessons learned to improve current activities and promote better planning by careful selection of alternatives for future action. It is a process that revolves around in Mathematics and Mathematics Education programmes. This involves a critical analysis of different aspects of the development and implementation of a programme and the activities that constitute the programme, its relevance, its formulation, its efficiency and effectiveness, its costs and its acceptance by all parties involved. Evaluation is defined as an effort involving collection, analysis and interpretation of data in order to judge the achievement of a programme’s
objectives (Phillips, Palfrey & Thomas, 1994). Other definitions include evaluation’s role as a process of assisting decision making in a specific area of concern (Calder, 1994). Rossi and Freeman (1993) defined evaluation as the systematic application of social research procedures for assessing the conceptualisation, design, implementation and utility of social intervention programmes. Patton (2002) uses the term evaluation as any effort to increase human effectiveness through systematic data-based inquiry and defines evaluation research as the systematic examination of accomplishment and effectiveness in program and services like Mathematics and Mathematics Education.

GOALS AND OBJECTIVES OF EVALUATION IN MATHEMATICS AND MATHEMATICS EDUCATION

The evaluation of Mathematics and Mathematics Education training programmes concerns all aspects of the institution and its programmes, including Mathematics practice and support. The evaluation of the training programmes therefore seeks to ensure that the programmes:

1. are consistent with the health needs of the community in terms of professional competence, ethical behaviour, cost effectiveness, accessibility, promotion of public health, and benefit to the community, among other aspects

2. meet the quality requirements of the school, as regards to:
   a. the necessary human, material, physical (infrastructure) and financial resources, in both quantity and quality;
   b. the process of staff recruitment, development and retention;
   c. a curriculum that is dynamic and responsive to community needs and enables the achievement of the learning objectives;
   d. a system of student and teacher evaluation;
   e. a mechanism for monitoring the implementation and review of the curriculum.

The best way to decide on the purpose of evaluation is to identify all who might use the evaluation results, and then to discuss with them what they want the evaluation to do, how they would use the results, what difference the information would make, and whether it would be possible to do something about the problems disclosed by the evaluation.

PURPOSE OF EVALUATION IN MATHEMATICS AND MATHEMATICS EDUCATION

According to Joel and Harold (2003), one of the most difficult tasks for most teachers is assessing the performance of their students, determining to what extent each individual student has attained the level of mastery defined by the course objectives. This task is a necessary one for a number of reasons:
a) Students need to know whether, or to what extent, they are succeeding in mastering the material;

b) There is the need to certify successful completion of a body of material (a theme or unit of a course) as a part of the students’ curriculum or course of study (the Mathematics or Mathematics Education or some general science requirement); and

c) In the case of students enrolled in professional programmes (Mathematics, Mathematics Education, physical science, etc.), there is the need to certify competence to practice that profession.

It should be clearly understood that we are talking about the assessment of individual students (the assigning of grades), not the evaluation of a teaching program or some learning activity (how we, as teachers, are doing). Nor are we considering the issue of student achievement of standards, whether locally or nationally defined. The issue is determining how each of the Mathematics and Mathematics Education students is performing relative to the teacher or national expectations (target output).

It has been observed that examinations drive the curriculum. That is to say, whatever the intended educational objectives and course goals are, students’ learning behaviours will be determined by the examinations administered. If the goal is to establish an active learning environment in which students are expected to learn the facts and learn to apply them but the examinations test only the students’ ability to regurgitate memorized facts, it will be unlikely that the students will engage in meaningful learning. Thus, the assessment tools that are employed in a course have an enormously important role in determining how and what students will learn. The message here is a simple one, a teacher must test what he says he values. Thus, the process of assessing students’ performance in a course must begin with a close look at the set educational objectives. What will be discovered is that some objectives which are stated in lower order thinking form (knowledge of facts, being able to solve quantitative problems) are relatively easy to assess, while other objectives which are stated in high order thinking form (being able to formulate a testable hypothesis, being able to write a scientific report) are very much harder to test. According to Dwyer and Stufflebeam (1996), there are many uses to which assessment can be put. These are summarized as follows:

a) evaluation for the purpose of instructional improvement, usually conducted by trained evaluators;

b) evaluation for the purpose of professional accountability and development, usually conducted by teachers themselves in the form of records of performance which they present to interested parties;
c) evaluation for the purpose of administrative supervision, usually conducted by school principals through in-class observations;

d) evaluation to examine the relations of student performance with classroom processes, usually conducted by university researchers;

e) evaluation for the purpose of protection of student interests such as employability and college readiness, usually conducted by independent observers; and

f) evaluation for the purpose of the awarding of merit pay to teachers or individual schools, usually taking the form of supervisor evaluations and student achievement.

Dwyer and Stufflebeam (1996) provide an extensive literature review regarding these uses of assessment. These uses are thought to relate to teacher evaluation. However, they can also come into play in the evaluation of school administrators and school systems. All of the various assessment uses identified earlier are associated in some way with the process of instruction; those emphasized in this text have to do with the improvement of classroom teaching, teacher or administrator professional development, and research into the relations among classroom processes and student achievement. To use assessment productively, the instructor must be familiar with types of tests he or she can use in his or her work as well as with certain properties that tests must possess in order to be of any use in the teaching-learning endeavour.

EVALUATION PROCEDURES IN MATHEMATICS AND MATHEMATICS EDUCATION

In a standards based approach to education and training informed by constructivist ideology and motivated by high stakes accountability, assessment–informed instruction is the expectation as is continuous improvement. Assessment–informed instruction requires the educator (teacher, trainer, planner, instructional designer or administrator) to plan, deliver, and adjust instruction based on students’ or trainees’ evolving mastery of learning and skill standards until the desired mastery is achieved.

The teaching/assessment cycle is outlined in Figure 1 based on learning standards and how teaching is conducted and evaluated. Once teaching is launched, continuous formative assessment is engaged as is re-teaching based on assessment results. The assessment/re-teaching cycle is repeated until suitable mastery is demonstrated via summative assessment. Then a new teaching/assessment cycle begins. The teaching/assessment cycle in Mathematics and Mathematics Education assumes that instruction and assessment are planned and executed in conformity to specified learning and performance standards in Mathematics and Mathematics Education. With the teaching/assessment cycle as our application framework, the relationship between knowledge, learning, and intellectual skills in Mathematics and
Mathematics Education is presented. Also, the relationship/distinction between measurement, assessment, and evaluation must be clearly understood.

![Figure 1: Teaching/Assessment cycle](image)

**Figure 1: Teaching/Assessment cycle**

**METHODS OF EVALUATION OR FEATURES OF AN EVALUATION TOOL IN MATHEMATICS AND MATHEMATICS EDUCATION**

There are two types of evaluations: internal and external which can be for the administrative affairs of the programme and or for academic programmes. Programme evaluation ranges from curriculum to the administrative set-up of Mathematics and Mathematics Education institutions. While the performance evaluation has to do with the learning outcomes as provided in the curriculum, the administrative evaluation has to do with evaluation of programme implementation. The basic ingredient for a successful evaluation in Mathematics and Mathematics Education is the performance of the students in a test or examination. The test/examination is normally prepared by the instructor/school internally or by an external body.

Two features of tests are worth noting at this point: their reference and their source. Concerning the former, a test can be criterion-referenced or norm-referenced. Criterion-referenced tests are developed to assess the degree to which specific instructional objectives have been met, and norm-referenced tests are tests developed to compare students’ performance with that of others. In addition to its reference, a test’s source is an important consideration for the instructor preparing to embark on the teaching-learning effort. There are two major sources of tests used in education: internal, in which the instructor himself or herself develops the instrument, typically for use with his or her own students; and external, in which the test is developed by someone other than the teacher, typically for use by more than one instructor with more than one group of students. Combinations of the reference and source
categories can produce four different kinds of tests available to the instructor. Table 1 shows the combinations possible between the reference and source categories of assessment instruments.

The cell values in Table 1 show the proximity of each type of test to instructional objectives in Mathematics and Mathematics Education. Well-developed criterion-referenced teacher-produced tests (Cell 1) are more likely to “map on” to the objectives of some instructional effort than are tests with higher cell numbers. Criterion-referenced externally-produced tests (Cell 2) are more likely to “map on” to the instructional objectives than are tests with higher cell values, and so on. On the other hand, the cell values going from highest to lowest show the relevance of test types to assessing student performance by reference to a population of Mathematics and Mathematics Education trainees. For example, well-developed norm-referenced externally produced tests (Cell 4) are more likely to provide a realistic comparison of a teacher’s class with student populations of Mathematics and Mathematics Education trainees at the national level than are test types with lower cell values.

### Table 1: Reference and Source Categories of a Test

<table>
<thead>
<tr>
<th>Reference</th>
<th>Source</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Norm</td>
<td></td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

*Source: Cohen, Manion, Morrison & Wyse (2010)*

A test being one of the measures used to evaluate a Mathematics and Mathematics Education programme can be essay type or objective type (multiple choice, fill in the blank, matching, and so on). The essay type requires judgement of students’ achievement based on declarative (factual and conceptual), procedural and metacognitive skills of an individual Mathematics and Mathematics Education student (Brookhart, 2007). The essay test measures all the six levels (knowledge, understanding, application, analysis, synthesis and evaluation) of cognitive dimension of Bloom’s Taxonomy for teaching, learning and assessment. It is a type of test that involves lower order thinking (knowledge, understanding and application) and higher order thinking (analysis, synthesis and evaluation). The objective type of a test on the other hand stops at the first three levels (lower order thinking) of knowledge, understanding and application (Brookhart, 2007). In this paper, internal evaluation that is conducted by the teacher has been extensively presented and discussed. The external examination is not within the scope of this paper.

**Stages in the Evaluation Process in Mathematics and Mathematics Education**
In this paper, the evaluation of Mathematics and Mathematics Education teaching practices and evaluation procedures of training institutions and their programmes are described in four stages:

**Figure 2: Stages in the Evaluation Process**

**Planning for Evaluation of Learning Outcomes in Mathematics and Mathematics Education**

This is the level at which a Mathematics and Mathematics Education teacher/facilitator plans his programmes of activities for a particular theme/topic/lesson by stating some desired objectives to be achieved at a prescribed time. It is here that an instructor presents his intended learning outcome and evaluation procedures. The intended learning outcomes must be stated in line with how the learning outcomes should be evaluated.

**Performing Internal Evaluation of Learning Outcomes in Mathematics and Mathematics Education**

The intended learning outcomes in Mathematics and Mathematics Education can be evaluated using different methods and tools at different times of instruction. The evaluation can be before, during or after a particular lesson delivery, unit, week, month or term. The evaluation can be conducted using a test, interview, practical, or observation.

**Conducting an External Evaluation in Mathematics and Mathematics Education**

External evaluation or assessment of Mathematics and Mathematics Education is normally conducted by an external body to assess programme performance of Mathematics and Mathematics Education programme curriculum. This is normally conducted by a team of experts for a period of time to evaluate both academic and human resources within a college or school of Mathematics and Mathematics Education.

**Consideration of Evaluation Reports (feedback to feed forward) in Mathematics and Mathematics Education**

After each assessment/evaluation, a teacher or school management will use the result for some academic purposes. The evaluations function as a feedback that will be used to feed forward. The result of the evaluation informs the decision for planning the next lesson. This
process is repeated over and over to correct mistakes and abnormalities in the previous lessons. Planning and re-planning of lessons in a Mathematics and Mathematics Education programme adequately prepare student Mathematics teachers towards becoming good problem solvers.

**Tools/Instruments for Evaluation in Mathematics and Mathematics Education**

There are many kinds of assessment instruments, so many, in fact, that some sort of classificatory scheme is necessary to facilitate their discussion. One useful framework, developed by Fox (1969) will be used to discuss the various types into which assessment instruments can be divided: questioning tools, observation tools, measurement tools and technology-based assessment tools. Questioning tools are assessment instruments raw responses which are taken at face value and used as the information of interest. While the information gathered with questioning and observation tools are used in their original form, measurement tools are interpreted on the basis of some frame of reference or standard. Measurement tools are designed to assess constructs such as achievement, intelligence, self-concept, personality and depression. They can take the form of tests, used to evaluate performance by reference to some set of criteria; projective techniques, used to elicit a respondent’s thoughts or feelings by the use of ambiguous cues, responses based on which the investigator can deduce something about the subject’s personality; inventories, used to provide indications of whether or not any number of attributes are true of the respondent; sociometric techniques, in which members of a group are asked to indicate with which group members they would want to interact in various ways, enabling the instructor to ascertain the group’s overall cohesiveness; and scaling techniques, used to elicit indications of judgment of magnitude concerning some set of stimuli.

Technology-based assessment tools include the use of electronic gadgets which are mostly computers, in the assessment of Mathematics and Mathematics Education programmes. In particular, computer based assessment tests are often used to assess students’ progress in practical and theoretical aspects of Mathematics and Mathematics Education practices. All of the technologies that are now available to teachers wherever it is they teach can contribute to creating a learning environment in which the students are continuously challenged to build and test their mental models. The main challenge is choosing the technology that provides Mathematics and Mathematics Education instructors with the best opportunity to help their students reach the desired learning outcome as designated in the Mathematics and Mathematics Education curriculum.

Table 2, adapted from Martinez-Pons (1996), summarizes the forms of assessment instruments available to the educational researcher, their subtypes, the way in which they are used, and their typical assessment targets.
Table 2: Types of Assessment Instruments and their Use

<table>
<thead>
<tr>
<th>Instrument Attribute Subtypes</th>
<th>Instrument Type</th>
<th>Observation</th>
<th>Measurement</th>
<th>Technology-based Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questioning</td>
<td>Interviews</td>
<td>Systematic</td>
<td>Tests</td>
<td>Simulation</td>
</tr>
<tr>
<td></td>
<td>Questionnaires</td>
<td>Random</td>
<td>Projectives</td>
<td>Graphics</td>
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<td></td>
<td>Checklists</td>
<td></td>
<td>Inventories</td>
<td>Power point</td>
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<tr>
<td></td>
<td>Critical</td>
<td></td>
<td>Sociograms</td>
<td>Presentation</td>
</tr>
<tr>
<td></td>
<td>incidents reports</td>
<td></td>
<td>Scaling techniques</td>
<td>Animations</td>
</tr>
<tr>
<td>Approach</td>
<td>Information provided by an informant is usually taken as given</td>
<td>Information obtained directly, without the aid of an informant, is used as the data</td>
<td>Information provided by an informant or through direct observation is interpreted according to some standard</td>
<td>Computers, Graphing calculators</td>
</tr>
<tr>
<td>Typical Assessment Target</td>
<td>Opinions</td>
<td>Social processes</td>
<td>Intelligence</td>
<td>Diagnosis</td>
</tr>
<tr>
<td></td>
<td>Demographics</td>
<td>Individual behaviour</td>
<td>Academic achievement</td>
<td>Prescription</td>
</tr>
<tr>
<td></td>
<td>Social processes</td>
<td>Grounded theory research</td>
<td>Personality</td>
<td>Projection</td>
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<tr>
<td></td>
<td>Attitudes</td>
<td></td>
<td>Depression</td>
<td></td>
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<tr>
<td></td>
<td>Motivation</td>
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</tr>
</tbody>
</table>

Source: Martinez-Pons (1996)

CHALLENGES OF EFFECTIVE EVALUATION IN MATHEMATICS AND MATHEMATICS EDUCATION

According to Khodaveisi, Pazargadi, Yaghmaei and Bikmoradi (2018), the main challenges with Mathematics and Mathematics Education programme evaluation could be categorized with themes, each included 3 subthemes: managerial issues (inefficiency of management, inadequacy of policies and strategies, ineffective evaluation planning); administrative issues (inefficient and affected evaluators, inappropriate implementation, and inefficacy of approaches and tools); and structural issues (inappropriate culture, Mathematics education complexity, lack of alumni follow-up system). Again, according to Bvumbwe and Mtshali (2018), six main themes namely: curriculum reforms, professional regulation, transformative teaching strategies, collaboration and partnership, capacity building and infrastructure and resources are the major challenges of effective delivery in Mathematics and Mathematics Education. All the aforementioned challenges could be presented under planning, management, supervision, implementation, and evaluation issues. The solutions presented subsequently are all based on the challenges advanced.

SOLUTIONS TO THE CHALLENGES OF EFFECTIVE EVALUATION IN MATHEMATICS AND MATHEMATICS EDUCATION

Joel and Harold (2003) provided the following as some solutions to the challenges:
i. Strengthening Mathematics centres and professional associations

ii. Technical support to regulatory bodies as regulatory frameworks change due to health care adaptations

iii. Adoption of innovative teaching and learning approaches

iv. Innovative ways of Mathematics training: simulated learning

v. Use of technology to facilitate student exposure to Mathematics scenarios not common in Mathematics settings

vi. Deliberate teaching of Mathematics reasoning, critical thinking, and problem solving skills

vii. A coordinated and collaborative approach
   a. To training of Mathematics teachers and Mathematics educators
   b. In professional practice, health system planning, practice and delivery of services

viii. Offering students opportunities to explain their solutions to a problem offers the teacher an opportunity for providing feedback about students’ performance.

CONCLUSION

Internal and external evaluation, as described in this paper, can help decision-makers and those in charge of health care activities to institute objective educational reforms. It is up to those concerned to use these tools to give a new direction to professional training and practice for the benefit of communities, health professionals and policy-makers. Careful planning is required to ensure that technologies are implemented in a way that optimizes usability, access, and cost. To increase access to education for schools/colleges and students, policy-makers should facilitate the development and testing of innovative technology for education such as simulation, distance learning, and virtual worlds. Mathematics and Mathematics Education Centre of Nigeria and policymakers should support increasing use of teaching technologies both to prepare schools and colleges to teach effectively and efficiently and also to prepare Mathematics teachers for practice in complex teaching delivery systems.

REFERENCES


