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Full Length Research Paper

Student teachers' views about assessment and evaluation methods in mathematics

Mustafa Doğan

Education Faculty, Selcuk University, Meram, Konya, Turkey. E-mail: mudogan@selcuk.edu.tr. Tel: +905334101569. Fax: +903323238225.

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This study aimed to find out assessment and evaluation approaches in a Mathematics Teacher Training Department based on the views and experiences of student teachers. The study used a descriptive survey method, with the research sample consisting of 150 third- and fourth-year Primary Mathematics student teachers. Data were collected using a self-constructed questionnaire. Piloting, factor and reliability (α=0.87) analyses were performed. The final version of the questionnaire has three parts with a total of 46 questions. The results were analysed and tabulated using descriptive statistical techniques. A series of factor analyses was performed for the sample. Descriptive results show that the main aim of assessments and evaluations is to find out factual (pure) knowledge of mathematics. Classic paper-and-pencil tests have been mainly used, and they usually have theorem-proof questions. The findings confirm that alternative assessment methods are rarely used in the department. Moreover, the used assessment methods hardly emphasize understanding, creativity, performance, and real-world applications.

Key words: Assessment and evaluation, alternative assessment, mathematics education, trainee teachers.

INTRODUCTION

It is accepted that the traditional aspects of educational outcomes are based on pure (factual) subject knowledge and its memorisation. On the other hand, modern aspects of educational outcomes concentrate on the progressive side of knowledge and its applications with individual involvement. They offer alternative dimensions along with applications in teaching and learning mathematics, such as real-life problems, modelling, association, reflection, and construction. In this context, beyond teaching based on traditional approaches that aim at the basic steps of knowledge, application, and evaluation in teaching, alternative learning is based on the new approaches' intent to analyse, construct, accommodate, and transfer higher-order permanent understanding. Many educators have advocated the use of alternative assessment, formative assessment, or assessment for learning that could reflect the learning processes of students better than could traditional assessments that focus only on the learning outcomes of students (Wong, 2007). They believe that the use of alternative assessment (formative assessment or assessment for learning) in classroom instruction can empower students as learners and thus improve student performance (Sadler, 1998; Black et al., 2004).

The Turkish Ministry of National Education recently introduced a new mathematics curriculum in primary and secondary schools in Turkey (MEB, 2005). The ministry assumes that the new curriculum is designed to use new developments in education for all of its components, including assessment and evaluation. New perspectives in assessment and evaluation include alternative techniques such as portfolio, project, performance, investigation, problem solving, students' dairy, observation list, peer evaluation, and attitude scales, along with other traditional tests techniques to facilitate the learning of mathematics. Mathematics education authorities hold positive views about using these assessment techniques to help students learn mathematics better. It is believed that alternative methods for elementary mathematics classrooms can help students achieve curriculum objectives. It is also essential for assessment to cover the learning processes and performance outcomes of students. Assessment tasks and procedures built into the learning process could help students engage in their own learning.

As teacher development is an essential element in any educational change, it is important to provide help, such as examples of assessment practices, to empower teachers

to develop assessment practices that support the new curriculum (Orpwood, 2001; Black et. al., 2004; Wong, 2007). Moreover, the views of trainee teachers about assessments have the potential to improve teaching and increase student learning and satisfaction.

Thus, it is very important to pay attention to faculties of education those supply teachers for primary and secondary schools. Up-to-date research on the professional development of teachers with reference to assessment reform in classroom mathematics teaching has not yet been clearly seen in Turkey. Therefore, this study aimed to examine the attitudes of student teachers toward assessment methods in a Primary Mathematics Department in Turkey. Explicit research questions relate to the use of and attitudes toward assessment methods in a primary mathematics teacher training department.

LITERATURE REVIEW

Alternative assessment

Alternative assessment is assumed to differ from standard assessment techniques and traditional modes of assessment. It seeks to make learning more significant and to provide a stronger link between teaching and assessment. Alternative assessment approaches are used to assess the knowledge and skills of students that are not well captured by traditional assessment methods. Alternative assessment is based on a philosophy and a goal that differ from those of traditional assessments. It is supported by the philosophy of constructivism, which emphasises the importance of students constructing and supplying responses rather than selecting or choosing them. A primary purpose of alternative assessment is to promote learning – not only to verify learning. As such, alternative assessment is both formative and diagnostic.

The main purpose of alternative assessment is to provide a formative assessment of student learning. It focuses on both the finished work and the progress of students. Teachers are able to share information with students, provide descriptive feedback, and discuss goals so as to improve performance. Traditional assessments are not suitable for dynamic learning environments. Alternative assessment, however, provides direction for future work and teaching. Thus, an integrated approach that includes alternative assessment techniques with clear applications has to be taken into account for teacher education. The applications have to include the active engagement of students in the learning process, enhancing the students learning, and improving instruction by providing ways of applying knowledge, thinking critically, solving complex problems, or creating a product. Alternative assessment makes it possible not only to sample all that has been learned in a specific area but also to address the potential, motivation, and confidence of students (Johnsen, 1996; Stiggins, 2007). The general purposes of alternative assessment are to motivate students to do their best work, build the self-confidence and self-concept of students, show improvement in students' work over time, and show the best work of students in a specific area (Johnsen, 1996).

Alternative assessment places greater emphasis on the development and implementation of meaningfully contextualised teaching and assessment. Grading and scoring in alternative assessment is more informative, because it includes the specific criteria used in the evaluations. The learning, knowledge, skills, and abilities demonstrated by students during assessment are based on the use of specific criteria. Alternative assessment tasks more closely resemble real-world learning tasks, and they encompass both individual and group activities. They are open-ended tasks that require students to solve a problem, create a product, or to generally apply the knowledge and skills they have learned.

Teachers, mathematics education, and assessment

Winterbottom et al. (2008) declare a well-known fact when they say that "educational values are derived from personal experiences". Hence, depending on personal experience, values associated with subject discipline may derive from the belief systems of trainees; they may be adopted from strong subject-based cultures or from their wider subject teaching communities and reinforced by the values of their mentor (and other teachers), particularly given that the practice of trainees may be strongly directed by those teachers. Hence, teacher education in relation to assessment may require explicit adaptation to particular subject disciplines. Brown (2004) clearly states that "teachers' pedagogy is influenced by their beliefs about teaching, learning and assessment".

Harrison (2007) confirms that a central challenge internationally for teacher educators is the measurement and demonstration of specific outcomes in teacher education. He also states that teacher knowledge and teacher expertise clearly have significant influences on the learning of pupils. He considers this recognition of minimum levels of academic qualification to do certain aspects of the teaching job successfully. These provide some international measure of predetermined baselines of preparedness to teach. Therefore, the goal of mathematics teacher education is to prepare practitioners who are knowledgeable about and competent in creating conditions that result in meaningful student understanding of mathematics. In this perspective, Chamberlin et al. (2008) conducted a research with a group of mathematics teachers on their perceptions of assessments of their mathematical knowledge in a professional development course. They were surprised by the overall results. For example, the teachers felt that the assessment impacted their learning by pushing them to learn more than they would have had they not been assessed. As a group, their

experiences generally consisted of learning more, of increasing their learning efforts, and of experiencing positive affective results. They increased their learning efforts because they were being assessed and evaluated. Some described working harder, returning to their notes to revisit material, and staying ‘‘focused’’ since there was ‘‘no time to space out and miss important concepts.’’ In addition, the assessments stimulated more active participation. Moreover, none of the teachers commented that the assessments decreased their learning efforts.

Sainsbury and Walker (2007) mention four functions of assessment that relate directly to student learning: motivating learning, focusing learning, consolidating and structuring learning, and guiding and correcting learning. They also note that assessment should be designed to meet the needs of students, teachers, institutions, and communities by illustrating something about learning that has occurred and the effectiveness of the teaching which has supported that learning. The link between assessment and learning is thus widely acknowledged and highly significant. Rust (2007) concludes that “any scholarship of assessment must therefore be predicated on the value that good assessment supports and positively influences student learning.”

In considering the aforementioned criteria, a comprehensive approach to assessment, beyond that of traditional testing and grading, is needed. On an encouraging note, instead of being an activity separate from instruction, assessment is now being utilised as an integral part of both teaching and learning (Onwuegbuzie, 2000). Thus, the current assessment reform movement in mathematics encourages mathematics education authorities to think more broadly about cognitive measures that assess student learning. In response, these authorities have begun incorporating innovative methods of assessment into their curricula and courses, the most common of these being alternative methods (such as authentic assessment, performance assessment, etc.).

Watt (2005) refers to several researches and summarises that assessment in mathematics has traditionally been measurement driven, with assessment used not only to rank students but also to keep the accountability of the educational system. She points out that there have been debates about the benefits and problems accompanying measurement-driven assessment. The instructional practices of teacher-led recitation of mathematical procedures, where teachers demonstrate and students are expected to reproduce a broad range of facts and mathematical operations in timed pencil-and-paper tests, have likely been responsible for the continuing association of this type of assessment with mathematics. Related to these two issues is the concern that the currently emphasised meaningfully contextualised mathematical abilities and higher-order cognitive processes are less effectively assessed via the traditional mathematics test than through alternative means, such as portfolio assessment. While it is not necessarily true that written tests are restricted to computation and routine skills, and while they are capable of assessing a wide range of mathematical capability if set appropriately, unfortunately many of these tests are not well written, and the traditional mathematics test typically focuses on repetition of learned procedures using small sets of problems (Watt, 2005). Even though traditional mathematics tests effectively assess aspects of mathematics that can be tested in an unambiguous and straightforward way, through the performance of students on routine skills and algorithms, there is a need to explore alternative assessment methods to assess other educational goals. To date, the reliance on the traditional mathematics test has been justified on the grounds of maximising reliability and ensuring comparability, but this has often been at the expense of validity (Watt, 2005).

The benefits of alternative assessment have been well established. For example, several researches have shown that alternative assessment practices are associated with improved academic achievement (Hargreaves, 2005; Hodgen and Marshall, 2005; Wiliam et al., 2004). Doig (2006) claims that “mathematics educators, among others, have been provoked to call for summative assessment to be replaced with alternatives that, they claim, provide information that is of value for improving teaching and learning”. He supports this view with research evidence from references in the area for several countries. Further, he argues that “this type of test review could play a significant role in supporting and educating teachers and in helping to lay the foundations for better practice”.

In alternative assessment frameworks, students should have a clear understanding of what they are expected to do and learn. In partnership with their instructors, students “monitor and adjust their own progress and play a role in communicating evidence of their own learning to those who need it” (Stiggins, 2005). Some forms of alternative assessments have the potential to provide students with the opportunity to complete assessments at a place and time that is convenient for them. These assessments should also provide students with “the freedom to explore areas of perceived weakness and to make mistakes without revealing these to those responsible for the final assessment or to peers without this being a deliberate decision on their part” (Challis, 2005: 534).

Janisch et al. (2007) clarify the main benefits of using alternative assessment methods in the classrooms:

“*The theoretical framework for using alternative assessment in the classroom includes considering learners as constructors of knowledge; finding authenticity in materials and activities; employing dynamic, ongoing evaluation tools; and empowering students. By putting these ideas into practice, individual attributes of initiative, choice, vision, self-discipline, compassion, trust, and spontaneity can be promoted in students.”*

Research on alternative assessment has focused on the

development and evaluation of these assessments. Researches surveying students' experiences in or attitude towards alternative assessments have been used to measure the extent to which these assessments have been accepted by students as a tool to support their learning. Results have shown that students reported positive experiences with formative assessments. For example, students have positive feelings about computer-based assessments (Miller, 2008). It is unknown, however, which aspects in particular influenced these experiences. It is suspected that a number of factors can influence the overall experiences of students with these assessments.

Theoretical consideration

Winterbottom et al. (2008) state that the values and practice of teachers and trainee teachers in relation to assessment are underpinned by three factors:

(1) Making learning explicit (MLE), which means eliciting, clarifying, and responding to evidence of learning, and working with students to develop a positive learning orientation.
(2) Promoting learning autonomy (PLA), which entails widening the scope for students to take on greater independent control over their learning objectives and the assessment of their own and each other's work.
(3) Performance orientation (PO), which is concerned with helping students comply with performance goals prescribed by the curriculum through closed questioning and measurement by marks and grades.

They clarify that only PO prioritises performance gains; the others explicitly focus on learning processes and orientations. Identification of these three constructs is consistent with the wider consideration of practices associated with assessment of learning (AoL) and assessment for learning (AfL). AfL occurs when the teachers' use of assessment is integral to the processes by which they facilitate student learning.

The situation in Turkey

Prospective mathematics teachers usually receive good preparation in teaching the traditional curriculum. However, the new primary and secondary mathematics curricula differ from the traditional mathematics curriculum. Therefore, teachers need to learn the knowledge, skills, attitudes, assessment methods, and teaching skills to teach. They should be encouraged to expand their repertoire of student assessment strategies to include such techniques as performance assessment, authentic assessment, problem solving, and portfolio. The new curriculum materials appear to be effective vehicles for the teachers' learning as well. Teachers have to be involved in the development of learning materials as well as the teaching strategies and assessment tools, which must be tailored adequately to the cognitive and affective characteristics of students as mentioned by the curriculum (MEB, 2005). Hopefully, in the near future, the teachers will serve as leaders and coordinators of the learning environment and will use the alternative assessment methods, if they are equipped with the necessary requirements.

The active learning for which the curriculum strives in order to stimulate and motivate the students also stimulates and motivates the teachers. Teachers better understand that the traditional paper-and-pencil assessment tools frequently used in mathematics courses are inadequate for such a program that is accompanied by a wide range of pedagogical interventions.

On the other hand, there are some implementation pitfalls in using alternative assessments. First of all, departments may try to change everything at once without adequate buy-in from the staff. Assessment decisions always should be related to the purpose of the assessment and the content to be assessed. Teachers need to be involved in the changes and need time to decide how best to change the strategies that they use with their students and to incorporate the changes into their practice. Changing learner outcomes and assessments without teacher input and buy-in often results in resistance to change or ineffective shortcuts to change (Corbett and Wilson, 1991). Secondly, professional development and teacher involvement in assessment design are important components of the alternative approach. The primary goal is to change what and how teachers teach rather than to measure performance for accountability purposes.

The assessment methods targeted in this study included those suggested in the New Turkish Primary Mathematics Syllabi as well as the curriculum literature in mathematics education. These are the following:

Traditional methods:

a. Classic pen-and-paper tests.
b. Multiple-choice tests.
c. True-false tests.
d. Short fillings.

Alternative methods:

a) Oral tasks, where students give short answers, project (or seminar) presentations, and debates.
b) Practical tasks, with students using instruments to apply or deduce mathematical principles.
c) Authentic assessment, which is centred around meaningful, individualised student activities, and is developed and constructed so that it is comparable with how individuals behave in real-world situations.
d) Teacher observation of students, in structured or unstructured activities and evaluation of the quality of

student task engagement.
e) Student journals, where students keep reflective accounts of their mathematics learning and processes of understanding, from which the quality of their task engagement and development may be explored by the assessor.
f) Student self-assessment, with students judging the quality of their own and their peers' mathematical understanding and progress.
g. Involving parents in the assessment process, asking them to observe, reflect on, and evaluate their child's mathematical understanding and progress (MEB, 2005).

METHODS

Purpose of the study

Our research question was: "How do prospective teachers perceive the used assessment methods in the Primary Mathematics Department?" In a professional Mathematics Teacher Education Department, assessment has to be used for each of the purposes such as; monitoring students' progress, making instructional decisions, evaluating students' achievement, and evaluating programs (NCTM, 1995). Therefore, the main goal is being to support and enhance the mathematical learning of the student teachers. The opportunities and obstacles associated with assessment methods in mathematics, as seen through the eyes of a group of student teachers, are presented here. A real situation with a circumstance that the students experienced during their training at the department is explored. Therefore, the survey aimed to determine the real position of assessment and evaluation from the perspectives of the students, and to draw implications for pre-service (and in-service) teacher education.

Survey

The survey was conducted with a self-constructed questionnaire. The instrument comprises three parts. The first part consists of 3 demographic, 2 ordering, 5 short open-ended, and 2 multiple-choice questions. The second part is a Likert-Type Attitude Scale that contains 33 statements. The first step in developing the scale entailed the collection of items from different literature. The second step was modifying and rewriting unsuitable items in the pool and developing new special ones for the specific aim. The final step was designing and piloting the questionnaire. It was a 1 to 4 scale inventory (in which 1 stands for "definitely adequate", and 4 for "definitely inadequate"). It consists of 33 items assessing the students' opinions regarding the extent to which the assessment methods affect aspects of the educational process, particularly the learning and teaching of mathematics. The items measure how well each stated objective is being met based on the students' perceptions of their current experience. It is believed that items are most appropriate for the undergraduate level where students have the experience and knowledge needed to accurately assess the importance of particular learning objectives. The third part of the questionnaire has a single open-ended question about the issue.

Validity of the survey

The Likert-Type Attitude Scale was mainly used to conduct this study, particularly to identify and determine the beliefs and conceptions of future primary mathematics teachers. Construct validity refers to the degree to which a scale measures an intended hypothetical construct. This evidence of validity can be established by relating the scale or the instrument of interest to some other measures consistent with the hypothesis or the construct being assessed. Statistically, construct validity can be assessed through the use of a factor analysis procedure. The aim of this analysis is to identify the main components or categories that underline the scale. To check the construct validity a principal components factor analysis with varimax rotation was conducted. The analysis yielded three factors with eigenvalues exceeding unity, and the factor solution accounted for 38.55% of the total variance.

Factor 1: (Individual aspects of assessment), made up of 14 items, accounted for 25.92% of the total variance (eigenvalue=8.55).

Factor 2: (Progressive aspects of assessment), made up of 12 items, accounted for 6.51% of the total variance (eigenvalue=2.15).

Factor 3: (Traditional aspects of assessment), made up of 7 items, accounted for 6.11% of the total variance (eigenvalue=2.01).

Reliability of the survey

The set of all items was tested for reliability using an internal consistency method which yielded reliability coefficients of (Cronbach's alpha) α=0.87. Furthermore, the internal consistency and homogeneity for the three categories of the scale were assessed using Cronbach's alpha as well. Resultant indices evidence satisfactory levels of internal consistency (Cronbach's α=0.79, and 0.77 and 0.65 respectively). The values of Cronbach's alpha of two factors are relatively high. The minimum advisable level is 0.70 (Nunnally and Bernstein, 1994). This implies that the measurement errors of these scales are relatively low and thereby the collected data on the two factors can be considered reliable. On the other hand, the reliability of factor 3 is moderate satisfactory (0.65). Nevertheless, this can be attributed to the procedure used to estimate Cronbach's alpha, which is highly dependent on the number of items of each scale (Norusis, 2002). Thus, the low value of the Cronbach alpha of this scale is partly due to the fact that only seven questionnaire items were used to measure this factor. Based on these results, the three categories were judged to have adequate internal reliability.

Sample

The empirical material is from the Primary Mathematics Department of the University of Selcuk. The Primary Mathematics Department is an 8-semester (4-year) programme meant to serve as a teacher training course at the university. The focus on the students of the department may therefore well be sampling the views of most students with respect to assessment methods. It will be of particular interest to explore these student teachers' views, to identify the range of assessment practices used, and to examine encouragements or constraints. Such examination can contribute to better understanding the major assessment methods for lecturers. The questionnaire was administered to the students at the end of the academic year. The sample consisted of 150 third- (93) and fourth-year (57) students (82 female and 68 male). All students were in face-to-face contexts. Therefore, the researcher explained how to complete the questionnaire to reduce any misunderstandings and to ensure response rate. One important limitation of this study lies in its phenomenological nature; the impacts described here are based primarily on the students' responses.

Data analyses

This paper reports the quantitative and qualitative analyses results of

Table 1. Used assessment methods (%).

	Classic pen-and-paper test	Multiple-choice test	Homework, Presentation, etc.	Project	Performance, authentic, etc.
Factual (mathematics) subject lectures	96.7	2.7	0.7	-	-
Pedagogic lectures	15.3	62.7	20.0	0.7	1.3

Table 2. Using different types of methods and using different methods more than one (%).

	Always	Usually	Rarely	Never
Different types of methods	1.3	28.2	68.5	2.0
Using different methods for a same course	-	14.2	81.1	4.7

the survey. Data were mainly analysed using quantitative descriptive statistical techniques. Descriptive analyses included percentages, means, standard deviations, and frequency distributions. A factor analysis was also conducted to see possible components of the scale. Responses to the open-ended questions were analysed qualitatively. Selected responses are used to explore quantitative results and are reported here as well.

RESULTS AND DISCUSSION

We were interested in the perspectives of the prospective teachers on the impact of the used assessment methods on their learning and experiences in the department. Thus, the results describe the student teachers' perspectives of the assessment methods. We first describe the student teachers' overall experiences with the methods; then, we unpack more specific properties of the assessment process that, according to the student teachers, affect the learning and teaching of mathematics.

Quantitative results

This part of the study presents the main findings of the survey which reflects the views of student teachers about and attitudes toward the used assessment methods at the Primary Mathematics Teacher Training Department. Percentages show the agreement level of the students with various aspects of educational outcomes of assessment and evaluation methods. Mean scores here are considered in the intervals as:

$1.00 \leq \bar{x} \leq 1.74$; "definitely adequate";
$1.75 \leq \bar{x} \leq 2.49$; "adequate";
$2.50 \leq \bar{x} \leq 3.24$; "inadequate";
$3.25 \leq \bar{x} \leq 4.00$; "definitely inadequate".

Multiple-choice questions results

Table 1 presents the responses of the students to "mainly used assessment methods in the department". The students reported that "classic pen-and-paper tests" are the most preferred (96.7%) method in pure (factual) subject lectures. Here, classic pen-and-paper tests represent the traditional methods which usually contain theorem-proof type questions and routine examples about taught content. This result indicates that the method still keeps its importance at the department. Multiple-choice tests are usually preferred for pedagogic lectures. Alternative methods are hardly used.

There are also two multiple-choice questions in the survey. The first question is "whether or not any different types of assessment methods have been used for the courses". The second one is "whether or not a course has been assessed by using different types of methods". Table 2 presents the results for both of the questions. The students state that different types of methods are rarely used. Moreover, different types of the methods are hardly ever used for assessing various aspects of a same course. When these results are combined with the findings in Table 1, it becomes clear that only classic paper-and-pencil tests are used for pure (factual) subject lectures and multiple-choice tests are used for pedagogic lectures. Therefore, only the same types of traditional methods are used for same kind of lectures; alternative methods are not preferred and are not used.

Factor analysis

Tables 3 and 4 present the results of factor analyses of the prospective primary mathematics teachers' responses to the 33 Likert-type items. The rating-scale data were analysed using deterministic (Principal Components Factor Analysis) methods. A factor analysis (SPSS Version 15.0 for Windows) of data from the instrument was conducted to ascertain whether there was a factorial or one-dimensional structure within the data sets. Therefore, a series of factor analyses was performed for the sample which identified non-directly observable factors based on the student teachers' responses. Exploratory factor analysis indicated that approximately 66.5% of variance coverage was provided by a 10-factor solution. In essence, the survey is

Table 3. Explained total variance, KMO, and Bartlett's test.

Component	Initial Eigenvalues			KMO measure of sampling adequacy		0.816
	Total	% of variance	Cumulative %			
1	8,556	25.929	25.929	Bartlett's test of sphericity	Approx. chi-square	1673.143
2	2,150	6.516	32.445		df	528
3	2,017	6.114	38.558		Sig.	0.000

acceptable as long as the results are reported as percentage agreement with each item. Because the instrument does not work as a measure of a single trait, the responses for each item within any one report should not be summed or aggregated, and no single item should be used as an indicator of overall results. The 10 factors were related to teachers' concerns and were identical to those mentioned in the specification table of the questionnaire. This finding provides support to the construct validity of the questionnaire used to collect data on trainee teachers' concerns about assessment (Cronbach, 1990). It has been observed that the eigenvalues of only three components out of ten are greater than the expected value of two. For a clear interpretation of the extracted components, a factor analysis with Varimax rotation was applied to the data. The varimax rotation revealed a multidimensional solution, indicating that each item in the survey was evaluating a different aspect of assessment. This suggested that all items in this version of the survey should be retained.

The factor analyses with varimax rotation created three main factors. These factors together explained 38.55% of the total variance in all scale items. Thus, factor scores for each dimension were estimated, by calculating the average of the items that comprised each factor. No items with low loading values were identified. Table 4 presents the mean scores, the relevant values of standard deviations, and Cronbach's alpha values for each factor. Accordingly, all three factors are named intentionally; so far, they seem to be appropriate to the literature.

High levels of correlation coefficients are observed for every item within the components. In the social sciences, the common minimum cut-off loading value is 0.30 (Stevens 1996; Tabachnick and Fidel, 2001). The first part of the Table 3 presents the results of explained variance. The three components explain 38.5% of total variance with higher eigenvalues. The second part of the table presents Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test and Bartlett's Test of Sphericity. The KMO value was 0.81, which indicated that the sample was suitable to run factor analysis (a minimum value of KMO = 0.60 is acceptable; Stevens, 1996). Similarly, high significance level of Bartlett's Test of Sphericity indicates that the factor model is appropriate for the scale.

Factor 1: Individual aspects of assessment

The first factor has 14 items. The items in this factor usually are about desired individual characteristics and outcomes of an assessment process. Therefore, the factor is named "Individual Aspects of Assessment (IA)". The mean scores of almost all the items (except for two of them) in the IA factor are greater than 2.50 (that is, inadequate). Correspondingly, the IA factor overall mean score ($\bar{x}$ =2.66) is "inadequate" as well. Therefore, the student teachers consider the used assessment methods as not adequate to measure identified characteristics of assessments for this factor.

Factor 2: Progressive aspects of assessment

The second factor has 12 items. The items in this factor usually are about the progressive characteristics of an assessment process. Therefore, the factor is named "progressive aspects of assessment (PA)". The mean scores of almost all the items (except for one of them) in the PA factor are greater than 2.50 (that is, inadequate). Correspondingly, the PA factor overall mean score ($\bar{x}$ =2.76) is "inadequate" as well. Therefore, the student teachers consider the used assessment methods as not adequate to measure the progressive aspects of assessments.

Factor 3: Traditional aspects of assessment

The third factor has 7 items. The items in this factor usually are about the general and typical (traditional) characteristics of an assessment process. Therefore, the factor is named "traditional aspects of assessment (TA)". The mean scores of most items (except for two of them) in the TA factor are "inadequate". However, the TA factor overall mean score ($\bar{x}$ =2.46) is "adequate". Therefore, the student teachers consider the used assessment methods as adequate overall to measure the traditional aspects of assessments.

Descriptive statistics results of the Likert-type statements

Table 5 presents the overall responses of the student primary mathematics teachers to the 33 Likert-type items about assessment methods. The items (translated from the original Turkish) are listed in order of level of agreement,

Table 4. Means, standard deviations, and Cronbach's alpha coefficients of the three factors identified by exploratory rotated factor analyses[a]

Items	Communalities	Component(factor) loadings	Item $\bar{x}$	S_x	Factor $\bar{x}$ (S_x)
Factor 1					
Suitability to subject	0.238	0.403	2.24	0.64	2.66(0.18)
Routine problem solving	0.284	0.345	2.45	0.62	
Achievement level	0.320	0.534	2.52	0.67	
Decision making	0.372	0.568	2.54	0.65	
Association	0.393	0.416	2.62	0.70	
Learning style	0.322	0.552	2.65	0.73	
Self-confidence	0.470	0.601	2.65	0.80	
Inclusion of open-ended questions and problems	0.322	0.444	2.67	0.74	
Communication	0.386	0.536	2.74	0.81	
Investigation	0.545	0.635	2.80	0.77	
Assessing the process	0.335	0.457	2.80	1.82	
Individual abilities	0.467	0.602	2.86	0.68	
Actively involvement in the learning process	0.520	0.668	2.89	0.74	
Individual differences	0.362	0.548	2.91	0.76	
Reliability (α)		0.795			
Factor 2					
Memorisation	0.428	-0.648	1.47	0.74	2.76(0.47)
Mental reasoning	0.390	0.549	2.51	0.69	
Reflection	0.371	0.526	2.57	0.71	
Analysing	0.525	0.551	2.65	0.65	
Performance	0.408	0.510	2.72	0.73	
Construction of the knowledge	0.424	0.548	2.72	0.66	
Meta cognitive skills	0.501	0.609	2.95	0.70	
Application	0.192	0.429	3.07	0.72	
Affective and psychological aspects	0.392	0.454	3.08	0.74	
Permanence	0.382	0.437	3.12	0.73	
Creativity	0.584	0.733	3.14	0.74	
Inclusion of real-life problems	0.284	0.386	3.18	0.72	
Reliability (α)		0.776			
Factor 3					
Theoretical knowledge	0.352	0.425	1.73	0.64	2.46(0.41)
Pure (factual) knowledge	0.166	0.337	2.11	0.61	
Suitability to content (content validity)	0.412	0.615	2.52	0.74	
Appropriateness to teaching techniques	0.402	0.591	2.58	0.74	
Inclusion of problems which have different ways of solving	0.422	0.545	2.68	0.71	
Reflecting the relationship between active participation in the class and obtained achievement	0.482	0.636	2.78	0.74	
Contribution to struggle with learning deficiencies	0.271	0.433	2.87	0.74	
Reliability (α)		0.655			

(a): Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization.

not in the order in which the items are presented in the questionnaire. The results reveal varied views about assessment and evaluation methods by pre-service mathematics teachers in Turkey.

Overall, it can be seen that more than three quarters of the respondents expressed that the preferred assessment methods adequately measure traditional aspects of mathematics (such as memorisation, factual knowledge,

Table 5. Descriptive statistics results of 33 Likert-type statements (%).

Statements	Definitely adequate	Adequate	Inadequate	Definitely inadequate	$\bar{x}$
Memorisation	65.8	25.5	4.7	4	1.47
Theoretical knowledge	38.3	50.3	11.4	0	1.73
Pure (factual) knowledge	14.1	60.4	25.5	0	2.11
Suitability to subject	7.4	65.5	23	4.1	2.24
Routine problem solving	3.4	54.7	35.8	6.1	2.45
Mental reasoning	5.4	43.9	44.6	6.1	2.51
Achievement level	3.5	47.9	41.7	6.9	2.52
Suitability to content (content validity)	4.1	50.3	34.7	10.9	2.52
Decision making	2	48.3	42.9	6.8	2.54
Reflection	5.4	40.3	46.3	8.1	2.57
Appropriateness to teaching techniques	4.1	44.9	40.1	10.9	2.58
Association	3.4	40.1	47.6	8.8	2.62
Analyse	3.4	34.5	56.1	6.1	2.65
Learning style	3.4	40.8	43.5	12.2	2.65
Self-confidence	6.8	33.3	47.6	12.2	2.65
Inclusion of open-ended problems and questions	4.1	37	46.6	12.3	2.67
Inclusion of problems which have different ways of solving	4.1	35.1	49.3	11.5	2.68
Performance	4.7	30.9	51.7	12.8	2.72
Construction of the knowledge	3.4	29.5	58.4	8.7	2.72
Communication	4.8	35.2	40.7	19.3	2.74
Reflecting the relationships between active participation in the class and obtained achievement	4	30.9	48.3	16.8	2.78
Investigation	4.1	29.7	48.6	17.6	2.80
Assessing the process	3.4	36.6	50.3	9.7	2.80
Individual abilities	1.4	27.9	53.7	17	2.86
Contribution to struggle with learning deficiencies	3.4	24.2	54.4	18.1	2.87
Actively involvement in the learning process	2.7	25.7	51.4	20.3	2.89
Individual differences	4.1	21.1	54.4	20.4	2.91
Meta cognitive skills	2.7	20.4	59.2	17.7	2.92
Application	2.7	15.5	54.1	27.7	3.07
Affective and psychological aspects	2.7	14.8	54.4	28.2	3.08
Permanence	3.4	12.8	52	31.8	3.12
Creativity	3.4	11.5	53.4	31.8	3.14
Inclusion of real-life problems	0.7	17.6	45.3	36.5	3.18

routine problem solving, etc.). Only a smaller number of the students accept that the used methods adequately measure the progressive aspects of mathematics (such as application, performance, reasoning, etc.).

Definitely adequate:

The student teachers are in definite agreement with only two statements. Nearly all of the students (91.3%) think that the used assessments are most suitable to assess their ability to memorise. Similarly, they state that the methods are appropriate for measuring theoretical knowledge (88.6%) about the taught subjects.

Adequate:

The student teachers accept the methods as adequate for three statements. They consider the methods adequate for measuring pure (factual) subject knowledge (74.5%). The methods are seen as suitable for the taught contents of the lectures (72.9%). They also believe that the applied methods are adequate (58.1%) for measuring routine problem-solving abilities.

Inadequate:

The student teachers' views are almost divided into two

regarding five statements. Nearly half of them think that the methods are inadequate (50.7%) to measure their ability of mental reasoning. Similarly, the methods inadequately measure their achievement level (48.6%) and decision-making ability (49.7). Likewise, the methods are not appropriate for the used teaching methods (51%). Nearly half of the students think that the assessment methods do not consistently (45.6%) involve contents of the lectures. This finding, indicating that the methods neither consistently nor equally involve the content of the lectures, clearly indicates that there are validity problems in the assessment process.

The other statements in the scale (total of 23) were considered inadequate to measure the stated aspects. The methods do not have association with other subjects and connections to applications (56.4%). Moreover, the methods are not able to reflect the students' learning (reflection) (54.4%), and do not reflect the relationship between active participation in the class and obtained success (65.1%). The methods are also not suitable for their learning styles (55.7%).

Most of the students (62.2%) also think that the used methods are not suitable for measuring the ability to analyse, which is one of the important steps of learning. Additionally, the majority of the students feel that they do not have the self-confidence to deal with the assessment methods (59.8%). This indicates that the methods are far from giving self-confidence to the prospective mathematics teachers.

The students state that the assessments seldom have open-ended questions (58.9%) and the problems have different ways of being solved (60.8%). Similarly, the methods do not adequately measure the performance (64.5%), construction of the knowledge (67.1%), learning process (60%), individual ability (70.7%), individual differences (74.8 %), meta-cognitive skills (76.9%), and communication ability (60%) of the students. Furthermore, the students view the methods as insufficient to contribute to dealing with learning deficiencies (72.1%). They are aware of the fact that the methods do not force them to make investigations (66.2%) and to involve themselves actively in the learning process (71.7%). Nearly all of the students assume that the methods do not involve applications of the knowledge (81.8%) and real-life problems (81.8%). Furthermore, the methods are not able to measure the affective (emotional) dimensions and psychological aspects of the educational process (82.6%), stability of learning (83.8%), and creativity (85.2%).

Briefly, the student teachers think that the used assessment methods are adequate to measure the traditional aspects of mathematics. The methods are inadequate, however, to assess the progressive aspects of educational outcomes. For example, nearly all of the students think that the methods adequately measure memorisation and theoretical knowledge, which do not usually have applications. On the other hand, the methods do not contain real-life problems, applications, creativity, investigations, etc. When the results in the tables are combined, the classic pen-and-paper tests retain their importance, concentrating on measuring the traditional (standard) aspects of mathematical knowledge. Thus, the assessment and evaluation process of training the prospective teachers is still carried out in the traditional way. This reality is established again by the views of the students.

Qualitative results

A total of 68 (46 females, 22 males) students (out of 150) in the sample responded to the open-ended question. All responses were categorised. The categorisation created 37 different situations with 45 different views. It has been observed that the situations are very similar to those in the scale. A total of 18 (12 female, 6 male students) carefully commented statements were selected and are reported here. A systematic approach depending on factor analyses has been adopted to report the selected comments. Students made very clear and exploratory comments about the created factors.

The results of quantitative analyses (mean scores) of the items (with a few exception) in all three factors are in the interval of "inadequate" level. Correspondingly, the factors' overall mean score is "inadequate" as well. Therefore, the student teachers consider the used assessment methods as not adequately measuring the stated aspects of the used assessment methods. This quantitatively significant result is confirmed qualitatively by the students' responses to the open-ended question as well.

Factor 1: Individual aspects of assessment (IA)

The scale items in this factor are about the individual aspects of an assessment process. The student teachers made very clear comments on different aspects of this factor such as motivating more active participation in the learning process, improving self-confidence, realising individual differences, individual ability, learning style, decision making, etc. A male student concentrated on actively participating in both learning and assessing the processes:

"Applied measurement techniques in the pure math courses are not contributing enough. Because, students are not actively involved in the processes…"

Similarly, a female student focused on process and performance:

"Attendance, taking responsibility in the learning process, performance in the lectures, projects, etc., should have to be taken into account of evaluation".

Another male student expressed his feelings about

self-confidence and related success:

"These assessments reduce students' self-confidence, thus success level is falling."

A female student stressed the importance of individual differences:

"Everyone has different character and psychology. This fact is not to be forgotten."

A male student concentrated on individual skills and mental abilities:

"More questions should be aimed at using our skills and improving mental abilities…"

Another female student summed up different aspects as:

"Mental reasoning, individual differences and the process should not be ignored… do not only concentrate on the results".

Factor 2: Progressive aspects of assessment (PA)

The items in this factor are usually about the progressive side of an assessment process. The student teachers consider the used assessment methods as not adequate to measure the progressive aspects of an assessment process. This awareness is confirmed by the students responding to the open-ended question. The students stated that the methods do not adequately assess affective dimensions and individual aspects such as meta-cognitive skills, mental reasoning, psychological aspects, etc. A male student clearly stated that:

"Rather than only abstract knowledge, more activities with application steps of analysis, synthesis and evaluation should be involved"

Moreover, students distinguish the difference between permanent learning and memorisation:

"The obtained knowledge (learning) should be permanent… not to be intended to measure memorisation…" (Male)

"All are about memorisation… Asking the proof of a theorem in the same manner forces students to memorise…" (Female).

A male student expressed his feelings about the used assessment methods as:

"Traditional exams direct to memorisation… It is not possible to develop ourselves and produce anything. Student-centred assessments and evaluations (homework, project, etc.) should be included."

Factor 3: Traditional aspects of assessment

The items in this factor are usually about the general and typical characteristics of an assessment process. The student teachers consider the used assessment methods as adequate to measure typical characteristics of the assessment process. For example, the used methods are seen as adequate for measuring pure mathematical knowledge. On the other hand, the methods inappropriately suit teaching models. Moreover, the methods do not contribute to dealing with learning deficiencies and do not reflect real achievement levels. A female student clearly stated her feelings about the whole training process including assessment:

"Please stop seeing students as a computer. Do not only install theoretical knowledge. Everybody knows the theoretical knowledge, but do not know where and how to use it…."

Another female student stressed the importance of student participation as:

"Students' participation has to be increased by activities such as homework, projects, presentations, etc."

General comments

Students also made valuable comments about different aspects of assessments in general. For example, a female student established a connection between affective dimensions and future professional teaching as:

"There must be more activities to improve the student's interest and attitudes towards the teaching profession."

Another female student made a connection between knowledge, its application and professional teaching:

"… memorisation-oriented. Do not contain real-life (authentic) problems. Far from the information that we can use in professional teaching."

Students did not only state their feelings about the used methods, they also gave ideas about alternative methods and even made further suggestions. For example, a female student found alternative methods more enjoyable and attractive:

"I pleasantly spend time while doing projects and assignments…" (Female)

Even more, a female student discovers her capacity with alternative methods:

"… I can only learn with these (alternative) kinds of examinations.

I sometimes feel myself doing above my capacity."

A female student suggested:

"Alternative methods should be developed which enable students express themselves better."

Another female student well summarised the possible advantages of alternative methods both for learning and teaching. She also made a suggestion:

"Assignments, presentations, etc., give us confidence. They prepare us for teaching. In this way, we have to do research which increases our knowledge more effectively... Different ways of assessment methods have to be tried which prepare for and improve teaching practices."

These results indicate that the methods usually concentrate on abstract knowledge without considering affective dimensions. The alternative methods are considered as taking the individuals into account, focusing remarkably on affective dimensions. Especially, the students' approaches to, experiences in, and attitudes toward assessment and evaluations methods clearly affect their construction of knowledge and success. These generally consist of learning more, of increasing their learning efforts, and of experiencing positive affective results (Chamberlin et al., 2008). This consideration clearly means that the student teachers are unhappy and depressed with the used methods. The trainee teachers may see the methods as authoritarian one-way activities that are imposed by the teachers. Furthermore, this fact may effect construction of attitudes to mathematics, which is very important in teaching and learning.

Moreover, the student teachers' experiences validate that the methods inadequately measure progressive aspects such as creativity, application, performance, association, construction, and reflection. Similarly, the methods do not adequately involve real-life problems and open-ended problems.

CONCLUSIONS AND RECOMMENDATIONS

All of these results reveal the student teachers' views about the assessment and evaluation methods used in the primary mathematics department. They give some clear messages for mathematics education. First of all, it is clear that assessment and evaluation are based on traditional methods which are not able to reflect the different aspects of mathematics education. Secondly, the prospective teachers graduate from the department without a sufficient background in assessment and evaluation methods in mathematics education. Thus, it is essential to take into consideration questions over the assessment and evaluation methods in teacher training in Turkey. After this examination, effective action must be taken on alternative assessment and evaluation methods. Hence, teachers should get an opportunity to become familiar with the new methods and have reasonable experience to be able to use these methods in their professional teaching. It is also important to integrate new developments into teacher training on time. This importance is related to the nature of mathematics and the pedagogical aspects (teaching and learning) of mathematics.

Taking into account the above considerations, instead of using classic assessment and evaluation techniques in the mathematics departments, understandable and effective alternative methods have to be used to assess student performance which mainly concentrates on process. Thus, the student's success is going to be assessed not only by grades but by the learning process, feedback from students, progress and improvements, and peer evaluations as a whole. These activities have to combine knowledge with the ability in accordance with experiences of meaningful understanding, and flexible and individual learning style. For example, contextualized assessment with constructed responses could be an alternative along with portfolios, rubrics, projects, and teachers' observations about students to evaluate student performance. The contextualized assessment is performed in contexts that are realistic, relevant, meaningful, and useful to individual students. As suggested by Combs et al. (2008), student evaluations of assessment methods typically serve a purpose that they are used for instructor development and course improvement. Assessment and evaluation activities at all levels of education have to concentrate on student performance with alternative techniques that concentrate mainly on the process of learning mathematics. That means assessment and evaluation activities have to be planned in accordance with learning environments. The interest of these student teachers in the process of learning could be increased, as could their satisfaction from the assessment methods. These results are in alignment with the main goal of the new Turkish primary mathematics curriculum and teacher training courses. Thus, all mathematics teachers have to be trained in alternative assessment and evaluation methods along with their applications in mathematics. Consequently, the prospective teachers are going to accept the ongoing concern over assessment and most probably are going to use the alternative methods in their professional teaching.

REFERENCES

Black P, Harrison C, Lee C, Marshal, B, Wiliam D (2004). Working Inside the Black Box: Assessment for Learning in the Classroom. Phi Delta Kappan, 86(1): 9–21.

Brakke DF, Brown DT (2002). Assessment to Improve Student Learning. New Directions for Higher Education, p. 119.

Brown GTL (2004). Teachers' Conceptions of Assessment: Implications for Policy and Professional Development. Assess. Educ., 11(3): 301–318.

Chamberlin MT, Farmer JD, Novak, JD (2008). Teachers' Perceptions of Assessments of Their Mathematical Knowledge in a Professional

Development Course. J. Math. Teacher Educ., 11: 435–457.
Challis D (2005). Committing to Quality Learning Through Adaptive Online Assessment. Assess. Eval. Higher Educ., 5: 519–527.
Combs KL, Gibson SK, Hays JM, Saly J, Wendt JT (2008). Enhancing Curriculum and Delivery: Linking Assessment to Learning Objectives. Asses. Eval. Higher Educ., 33: 187-102.
Corbett HD, Wilson BL (1991). Testing, Reform and Rebellion. Norwood, NJ: Ablex Publishing Corporation.
Cronbach LJ (1990). Essentials of Psychological Testing. NY: Harper & Row.
Darling-Hammond L, Wise A (1985). Beyond standardization: State standards and school improvement. Elem. Sch. J., 85(3): 315-336.
Doig B (2006). Large-Scale Mathematics Assessment: Looking Globally To Act Locally. Assess. Educ.: Principles, Policy Pract., 13(3): 265-288.
Hargreaves E (2005). Assessment for Learning? Thinking Outside the (black) Box. Cambridge J. Educ., 35(2): 213–224.
Harrison J (2007). The assessment of ITT Standard One, Professional Values and Practice: Measuring Performance, or What? J. Educ. Teach., 33(3): 323-340.
Hodgen J, Marshall B (2005). Assessment for Learning in English and Mathematics: A Comparison. Curriculum J., 16(2): 153–176.
Janisch C, Liu X, Akrofi A (2007). Implementing Alternative Assessment: Opportunities and Obstacles. The Educational Forum, Vol. 71.
Johnsen S (1996). What Are Alternative Assessments? Gifted Child Today, 19(4): 12-14.
Ministry of National Education (MEB) (2005). Primary Mathematics Curriculum 6-8 Grades (İlköğretim Matematik Dersi Öğretim Programı ve Kılavuzu 6-8. Sınıflar). Ankara.
Miller T (2008). Formative Computer-Based Assessment in Higher Education: The Effectiveness of Feedback in Supporting Student Learning. Assess. Eval. Higher Educ., pp. 1–11.
National Council of Teachers of Mathematics (NCTM) 1995. Assessment Standards for School Mathematics. Reston: VA: NCTM.
Nunnally F, Bernstein I (1994). Psychometric theory. New York: McGraw-Hill.
Norusis M (2002). SPSS11.0 Guide to Data. Upper Saddle River, NJ: Prentice Hall.
O'Day JA, Smith M (1993). Systemic school reform and educational opportunity. In S Fuhrman (Ed.), Designing coherent educational policy: Improving the system. San Francisco: Jossey-Bass, pp. 250-311.
Onwuegbuzie AJ (2000). Attitudes toward Statistics Assessments. Asses. Eval. Higher Educ., 25: 4.
Orpwood G (2001). The Role of Assessment in Science Curriculum Reform. Assess. Educ., 8(2): 135–151.
Rust C (2007). Towards a Scholarship of Assessment. Assess. Eval. Higher Educ., 32(2): 229–237.
Sadler DR (1998). Formative Assessment: Revisiting the Territory. Assess. Educ., 5(1): 77–84.
Sainsbury EJ, Walker RA (2007). Assessment as a Vehicle for Learning: Extending Collaboration into Testing. Assess. Eval. Higher Educ., 33(2): 103–117.
Stevens J (1996). Applied multivariate statistics for social sciences. Mahwah, NJ: Lawrence Erlbaum.
Stiggins R (2005). From Formative Assessment to Assessment for Learning: A Path to Success in Standards Based Schools. Phi Delta Kappan, 87(4): 324–328.
Stiggins R (2007). Assessment through the Student's Eyes. Educ. Leadersh.,, 64(8): 22–26.
Tabachnick BG, Fidel LS (2001). Using multivariate statistics. Boston: Allyn & Bacon.
Watt HMG (2005). Attitudes to the Use of Alternative Assessment Methods in Mathematics: A Study with Secondary Mathematics Teachers in Sydney, Australia. Educ. Stus. Maths., 58: 21–44.
Wiliam D, Lee C, Harrison C, Black P (2004). Teachers Developing Assessment for Learning: Impact on Student Achievement. Assess. Educ., 11(1): 49–65.
Winterbottom M, Taber KS, Brindley S, Fisher LG, Finney J, Riga F (2008). Understanding Differences in Trainee Teachers' Values and Practice in Relation to Assessment. Teach. Dev., 12(1): 15–35.
Wong MW (2007). Assessment for Learning and Teacher Development: The Experience of Three Hong Kong Teachers. Teach. Dev., 11(3): 295–312.

APPENDIX

Survey (Translated from original Turkish)

Assessment methods survey

Please, tick or fill the appropriate choice of the following statements.

1. Gender: Female Male

2. Grade: ……

3. Mainly used assessment methods at pure (subject knowledge) lectures (put in order starting from 1)
   Classical paper and pencil tests Multiple choice tests
   Homework, presentations etc. Project
   Performance

4. Mainly used assessment methods at pedagogical lectures (put in order starting from 1)
   Classical paper and pencil tests Multiple Choice tests
   Homework, presentations etc. Project
   Performance

5. Whether or not any different types of methods have been used for a same course?
   Always Usually Rarely Never

6. Whether or not a course has been assessed by using different types of methods?
   Always Usually Rarely Never

	Definitely adequate	Adequate	Inadequate	Definitely inadequate
1. Pure knowledge	☐	☐	☐	☐
2. Creativity	☐	☐	☐	☐
3. Performance	☐	☐	☐	☐
4. Reflection	☐	☐	☐	☐
5. Application	☐	☐	☐	☐
6. Construction of the knowledge	☐	☐	☐	☐
7. Memorisation	☐	☐	☐	☐
8. Meta cognitive skills	☐	☐	☐	☐
9. Analyse	☐	☐	☐	☐
10. Theoretical knowledge	☐	☐	☐	☐
11. Learning style	☐	☐	☐	☐
12. Individual abilities	☐	☐	☐	☐
13. Routine problem solving	☐	☐	☐	☐
14. Mental reasoning	☐	☐	☐	☐
15. Achievement level	☐	☐	☐	☐
16. Actively involvement in the learning process	☐	☐	☐	☐
17. Individual differences	☐	☐	☐	☐

18. Decision making	☐	☐	☐	☐
19. Communication	☐	☐	☐	☐
20. Self confidence	☐	☐	☐	☐
21. Investigation	☐	☐	☐	☐
22. Association	☐	☐	☐	☐
23. Assessing the process	☐	☐	☐	☐
24. Permanence	☐	☐	☐	☐
25. Contribution to struggle with learning deficiencies	☐	☐	☐	☐
26. Appropriateness to teaching techniques	☐	☐	☐	☐
27. Inclusion of real life problems	☐	☐	☐	☐
28. Suitability to subject	☐	☐	☐	☐
29. Inclusion of open-ended questions	☐	☐	☐	☐
30. Inclusion of problems which have different ways of solving	☐	☐	☐	☐
31. Suitability to content (content validity)	☐	☐	☐	☐
32. Reflecting the relationship between actively participation in the class and obtained achievement	☐	☐	☐	☐
33. Affective and psychological aspects	☐	☐	☐	☐

Please, state your views about the above issues, if you have any: ……..
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Thank you very much

Mustafa Doğan