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DYNAMIC ASSESSMENT, POTENTIAL GIFTEDNESS AND MATHEMATICS ACHIEVEMENT IN ELEMENTARY SCHOOL

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Abstract: Dynamic assessment is currently discussed in educational literature as one of the most promising practices in stimulating learning among various groups of students, including gifted and potentially gifted students. The present study investigates effects of dynamic assessment on mathematics achievement among elementary school students, with potential giftedness analyzed as additional predictor. Two samples of primary school students participated in a quasi-experimental study: the experimental condition consisted in application of dynamic assessment procedures, contrasted with regular classroom assessment in the control condition. Math achievement was measured with curriculum-based tests, and potential giftedness was estimated based on nomination scores assigned by classroom teachers and parents for each child. Results suggest that dynamic assessment procedures produce significant effects on math achievement among elementary school students, and potential giftedness enhances this effect. Study limitations and educational implications are discussed, and further research paths are indicated.

Key words: dynamic assessment; mathematics performance; primary school; potentially gifted pupils

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1. Introduction

Dynamic assessment is considered one of the most promising practices in evaluating both learning potential and academic performance, and builds its foundation on Vygotskian concepts of sociocultural learning and zone of proximal development. Supporters of dynamic assessment refer to a definition of the zone of proximal development which discusses the difference between children's individual performance and their possible performance after being assisted throughout a learning sequence by a proficient and experienced person (Muskett et al., 2012; Haywood, 2012). These ideas indicate not only the role of social interaction in learning and development, but also the importance of acknowledging the difference between children's performance in solving a task and their potential level of performance. Children may perform similarly in a task-solving situation, but may benefit differently from the assistance of experienced individuals.

The interactional nature of learning is emphasized by the followers of dynamic assessment, and one of the most influential approaches in this respect is the mediated learning process proposed by R. Feuerstein (Feuerstein & Rand, 1974). Mediation consists in a special interaction between the learner and a more experienced helper, who may be an adult or a peer characterized by a higher level of competence in solving a certain problem or task. The helpers assist the learners in identifying obstacles in a learning situation, in overcoming these barriers and ultimately re-assess performance after reducing (if not removing) their effects. Mediated learning is still one of the most influential dynamic assessment procedures, although various changes in this process have been proposed over the years. Dynamic assessment relies on mediation between the learning material or situation and the learner: using different approaches and based on developmental potential, experienced helpers indicate the paths to overcome difficulties in performing at higher levels, and therefore they are interested by the difference between pre-mediation and post-mediation assessment.

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On the other side, static assessment – which is largely used in educational settings - requires learners to respond to a number of tasks or solve problems without assistance or help, and provides rather late feedback which does not support real learning and development (Sternberg & Grigorenko, 2002). Static assessment usually ground important educational decisions, although they are seriously criticized from various perspectives, but they may be used in a dynamic manner. Thus, Lantolf & Thorne (2006) emphasize that difference between static and dynamic assessment procedures consists in the absence, respectively presence of mediation. In other words, a traditional static test becomes dynamic if the assessor mediates the process of learning.

Although dynamic assessment and traditional tests correlate similarly with future achievement measures, as indicated in a meta-analysis conducted by Caffrey et al. (2008), researchers have demonstrated that techniques and procedures associated with dynamic assessment can identify students who will respond to instruction, distinguish between students with and without language disorders and predict future educational placement beyond traditional tests.

A recent overview on the history of dynamic assessment (Haywood, 2012) concludes that although substantial and valuable progress had been made in research and classroom use of dynamic assessment procedures there are still issues to be solved, such as differences in applying dynamic assessment for the purpose of measuring learning potential and classroom or educational acquisitions, and connections between dynamic and static assessment procedures. In addition to this list of potential questions to be answered, we add that more empirical evidence would be needed for classroom application of dynamic assessment, in different subject-matters and especially in early and elementary education.

2. Using dynamic assessment with different groups of learners, including the gifted and potentially gifted: a brief literature review

Research studies emphasize the role of dynamic assessment in more accurate evaluation of learning potential and academic performance among different groups of disadvantaged students, such as students with low socio-economic status, students from linguistic minorities or with migration background, disabled students, but also very able or gifted students.

M. Barrera (2003) summarizes in his contribution results of two studies conducted with students with minority backgrounds who have limited English language proficiency and face referral to special education services because of frequent failures in formative and summative assessment. Based on these results, the author advocates for a mix of curriculum-based and dynamic assessment procedures, which may result in more accurate assessment of learning potential and academic performance. This type of approach was announced by some early contributors to the development of dynamic assessment: for example, Campione & Brown (1985) detailed their emphasis on transfer as part of dynamic procedures based on the need to provide reasonable context for assessing students with culturally diverse background, who are underserved by traditional static tests. Moreover, they state that unaided solving of performance tests items is a poorer predictor of subsequent academic performance and development than posttest achievement obtained after applying dynamic assessment procedures. Therefore, they express open support for dynamic assessment, with special attention oriented towards assessing students' learning processes and transfer skills rather than task-solving.

Recent works also address dynamic assessment applications in improving intervention and evaluation of verbally-impaired students: in a quasi-experimental pilot study, Hasson & Botting (2010) proposed an intervention based on assessors' mediation and support for transfer, which include language development tasks developed to assist children with specific language impairments, but their results were inconclusive. In a similar approach, Gillam & Ford (2012) developed an error-specific prompting system used as central technique for dynamic assessment of phonological awareness among school-age children with speech-sound disorders. They reported improvements in participants' performance, but discussed mainly clinical implications of their dynamic assessment programs, as phoneme awareness, which is rather imprecise when using norm-referenced static tests.

Dynamic assessment is equally supported in gifted education: several specialists advocate that benefits of associated procedures are as relevant for the gifted and talented as for the disabled and disadvantaged (e.g., Stanley et al., 1995; Kirschenbaum, 1998; Lidz & Macrine, 2001; Lidz & Elliott, 2006). Dynamic assessment is suggested especially for ensuring appropriate selection and inclusion in appropriate enrichment programs of gifted and talented students, but mostly of gifted disadvantaged and underserved students (with different cultural and linguistic background, disabled, with poor socio-economic status etc.). Beyond student placement, dynamic assessment is also considered a powerful tool for programming educational interventions, although this facet is less evident in the literature. As frequently indicated in the literature, dynamic assessment may be useful not only in the process of identifying and referring gifted children, but also in continuous nurturing their gifts and talents through flexible evaluation of their achievement, but most of all, of learning progress.

3. Methods

3.1. Aim and problems

As dynamic assessment procedures are still timidly applied in classroom settings and remain an asset generally limited to research and psycho-educational assessment of learning potential, the present contribution aims to uncover effects of dynamic assessment techniques and procedures on mathematics achievement among primary school students, and also the relevance of potential giftedness in producing higher levels of attainment. The inclusion of potential giftedness in the study addresses a rather neglected side of dynamic assessment interventions with potentially gifted students at early ages, namely their contribution in enriching educational experiences for this group of learners, which also supports higher achievement levels for the whole classrooms.

The small-scale quasi-experimental study conducted for fulfilling this general aim specifically addressed the following issues: primary classroom applications of dynamic assessment; the relation between static and dynamic in curriculum-based evaluation in primary classroom; and the role of potential giftedness in explaining potential differences in mathematics achievement when dynamic assessment is used in the classroom. Thus, the present contribution attempts to add relevant empirical information on the impact on dynamic assessment in early ages, and to further clarify the presumed enhancing effect of potential giftedness.

3.2. Research Hypotheses

The hypotheses of the present study state that:

H_1: Dynamic assessment techniques and procedures determine significant improvements of mathematics performance in elementary school students.

H_2: Potential giftedness enhances the effect of dynamic assessment techniques and procedures on mathematics performance in elementary school students.

3.3. Participants

The study included fifty primary school students, aged between 6 and 7 year attending two different preparatory grades (“clasa pregătitoare”) in a Romanian urban school. All students are of Romanian ethnicity, attended preschool and have an average socio-economic family background. Due to administrative difficulties and barriers, non-random assignment of participants has been used for the purpose of this quasi-experiment: one of the two classes has been treated as the experimental group (*N*= 24, 13 boys and 11 girls), while the other constituted the control group (*N*= 26, 12 boys and 14 girls). Informed consent for participation in the experiment has been obtained from children’s parents or legal guardians, within a parents conference organized at the beginning of the second school semester of the previous school year. Additionally, researchers also obtained children’s assent for the present research study.

3.4. Instruments and Procedures

The quasi-experiment followed a pretest – intervention – posttest design. Pretest and posttest situations included primary school students from both experimental and control groups, while the intervention which consisted in coherent frontal and individual dynamic assessment procedures was organized only for the experimental group.

Pretest and posttest have been based on two traditional (static) achievement tests designed by researchers in close collaboration with teachers. For ensuring content validity and correspondence with current assessment practices in elementary school, Romanian National Curriculum for Mathematics and Environment exploration in preparatory classes (MEN, 2013), as well as examples of tests previously used in national assessments for primary school students (MECT & CNCEIP, 2007) have been considered in designing the two math tests. Classroom teachers' suggestions were also included whenever appropriate, for ensuring continuity in teaching and assessment. The first test administered (pretest) included ten items, and the test administered after the intervention included nine items (posttest). Both assessment instruments are related to mathematics competences prescribed in the National Curriculum for preparatory grades. Item analysis revealed satisfactory level of difficulty and discrimination: for items included in the assessment instrument applied in the pretest phase (Test 1) difficulty indexes range between .65 and .90, while discrimination indexes range between .20 and .70; for items included in the assessment instrument applied in the posttest phase (Test 2) difficulty indexes range between .55 and .90, while discrimination indexes range between .20 and .80. Inter-rater (i.e., classroom teachers and researchers) reliability analysis resulted in high correlations coefficients: for Test 1 r= .993*, and for Test 2 r= .991*, *p= .00.

Math achievement tests and dynamic assessment procedures have been administered by classroom teachers, in order to avoid a potential effect of researchers' interaction with pupils. The teacher coordinating the experimental group was additionally informed and trained in dynamic assessment procedures.

Potential giftedness was investigated with two adapted forms (for teachers and parents) of Renzulli' s Scales of Behavioral Characteristics of Superior Students, published for the first time in 1971 and periodically revised since then. Although the current version of the instrument includes new scales for specific ability areas (Renzulli et al., 2013), in the present study the form translated and adapted for Romanian settings by C. Cretu (1999) has been administered. The two screening instruments cover the same dimensions: learning, mathematics and sciences, creativity, leadership and motivation. The form for teachers includes 51 items with six-point Likert scales (13 for learning; 8 items for mathematics and sciences; 11 for creativity; 8 for leadership; and 11 for motivation), while the form for parents includes 46 items with six-point Likert scales (10 for learning; 8 for mathematics and science; 10 for creativity; 8 for leadership and 10 for motivation). An average score of perceived ability level was computed for each form, and the mean of the two scores was used in later analyses. Internal consistency of all scales is satisfactory: alpha Cronbach coefficients range from .66 to .94 for the scales included in the form for teachers, and from .87 to .92 for the scales included in the form for parents. Moreover, scores for the scales of mathematics and science in both forms correlate positively with pupils' scores on math pretests: r= .40* (form for parents); r= .42*, *p< .01 (form for teachers), indicating good levels of convergent validity. Parents filled in the scales in a collective session, after signing consent forms, and teachers filled in one form for each child in the class.

Although promoters of dynamic assessment emphasize better results of individual feedback and assistance in overpassing errors, in the present study collective prompts and feedback dominated the plan of intervention. As often as possible, the teacher also applied dynamic assessment procedures individually. Experimental intervention consisted in mediation (Feuerstein & Rand, 1974) of all classroom assessment sequences planned and realized in eight weeks: more exactly, the teacher mediated students' experiences in contact with assessment material, aiming to transfer correct solving strategies in new learning situations. The teacher was instructed to intensify individual support for pupils who failed to solve correctly one or more items in Test 1, but dynamic assessment procedures have been planned for the whole class. Based on results for Test 1 obtained by the experimental class, the teacher communicated collectively types of errors, and also pointed individual tendencies in approaching the items. Students who failed one or more items have been asked to analyze their responses, to solve once again failed items and argue for the new approaches. The teacher intervened promptly for consolidating correct resolving strategies or for correcting again students' errors, if the case. In subsequent assessment situations organized during the experimental intervention, the teacher was instructed to indicate links between present and former assessment tasks, and offer both individual and collective support for correcting errors, similarly to the first procedure attached to the analysis of pupils' results on Test 1. In other words, all evaluation sequences during the experimental intervention included explicit teachers' efforts to clarify the types of errors, alternative ways of solving similar mathematical tasks and correct answers, and to encourage the students to become more autonomous in analyzing their own task-solving processes and consistently correcting their errors.

The intervention was mainly based on the idea of transfer (Campione & Brown, 1984): as soon as students corrected their errors and acquired a new solving strategy, the teacher tried to encourage the progressive transfer in new learning situations, based on pupils' individual zone of proximal development. Following recommendations of Haywood & Lidz (2007) the teacher was instructed to use individual and collective prompts and guiding questions (e.g., How should you proceed in solving this exercise or problem? What is the main question to be answered in this exercise or problem? What mathematical operations have to be resolved for finding the solution? Could you try to explain why did you choose this solution and not a different one? Did you solve similar exercises in the past, and if yes, was the path to the solution any different? Could you imagine solving similar tasks by employing the same strategy? In which real life situations can you apply this solving strategy?). Teacher also followed a checklist of own assessment behavior, emphasizing the need of continuous feedback and assistance in finding appropriate ways of solving math tasks.

3.5. Data Analysis

Analyses included *t* tests for independent samples (comparisons of initial math performance between the control and the experimental class for evaluating groups equivalence), and hierarchical regression analysis for testing effects of dynamic assessment and the role of potential giftedness on posttest math scores. Exposure to dynamic assessment procedures and techniques was coded as dummy variable and introduced as the first predictor in the regression analysis, while the second block also included the average nomination scores for potential giftedness.

4. Results

Pretest comparisons of math test results revealed no significant differences between students from the control group and the experimental group, $t(48)= .04$, $p> .05$, $d= .01$ (for descriptive statistics, see Table 1 below). The small effect size indicates a low practical significance of the pretest differences, and thus, rather similar levels of initial math achievement for participants in both control and experimental group.

Table 1. *Descriptive statistics for pretest mathematics achievement*

Pretests Mathematics Achievement	Means (*M*)	Standard deviations (*SD*)
Control class	87.61	11.2
Experimental class	87.50	7.36

Potential giftedness reported as average nomination scores has similar levels for both control and experimental classes, with no significant differences between the two groups, $t(48)= -.27$, $p> .05$, $d= -.08$ (descriptive statistics are included in Table 2).

Table 2. *Descriptive statistics for potential giftedness reported based on average nomination scores*

Potential giftedness reported based on nomination scores	**Means (*M*)**	**Standard deviations (*SD*)**
Control class	4.01	.87
Experimental class	4.08	.75

Posttest math tests results indicate changes in both control and experimental classes (see Table 3 for descriptive statistics). For differences within-groups, Cohen's effect size values suggest a small practical significance of the difference for the control class (d= .25), and a high significance of the pretest-posttest difference for the experimental group (d= .81).

Table 3. *Descriptive statistics for posttest mathematics achievement*

Posttests Mathematics Achievement	**Means (*M*)**	**Standard deviations (*SD*)**
Control class	89.61	8.11
Experimental class	95.50	6.25

To test the hypothesis that math performance on posttests is influenced by dynamic assessment (coded as a dummy variable) and potential giftedness (reported as average nomination scores) enhances this effect, a hierarchical multiple regression analysis was conducted. The correlation matrix for the variables included in the analysis (see Table 4 bellow) indicates significant correlations between exposure to dynamic assessment and math test scores, as well as between potential giftedness scores and posttest math scores.

Table 4. *Correlation matrix for exposure to DA, overall ability scores and posttest math scores*

Variables	**Exposure to *DA***	**Potential giftedness scores**	**Posttest math scores**
Exposure to *DA*	1		
Potential giftedness scores	.039	1	
Posttest math scores	.353(**)	.459(**)	1

Note: ***p* < .01. *DA* stands for dynamic assessment

In the first step of the regression analysis, exposure to dynamic assessment was included as the predictor of posttest math achievement, and results indicated that it accounted for a significant amount of variance in elementary school students' math performance, R^2 = .12, $F_{(1, 48)}$ = 6.82, p < .05. In the second step, exposure to dynamic assessment and potential giftedness scores were considered together in explaining posttest mathematics achievement, and results revealed both independent variables as significant predictors (see also Table 5 below).

Table 5. *Results of hierarchical regression analysis*

Variables and Models	**Posttest math scores**				
	B	SE B	β	p Value	Model R^2
Model 1					
Constant	89.61	1.42			
Exposure to dynamic assessment	5.38	2.06	.353**	.01	
				.01	.124*
Model 2					
Constant	72.62	4.75			
Exposure to dynamic assessment	5.11	1.83	.335**	.00	
Potential giftedness scores	4.22	1.13	.446**	.00	
				.00	.323**

Note: **p* < .05; ***p* < .01.

Further examination of these results shows an enhancing effect of potential giftedness reported based on nomination scores added to dynamic assessment on participants' math performances. Whereas the first regression model explains 12.4% of the total variation in posttest math scores, the second model adds significant explanatory power which rises up to 32.3%, $\Delta R^2 = 19.9$, $\Delta F_{(1, 47)} = 13.78$, $p< .01$.

5. Discussion

The findings of the present study show a significant effect of dynamic assessment techniques and procedures on elementary school pupils' mathematics achievement, in the sense that they produce increased posttest performance. Encouraging reflection on task completion, teacher's support and the hints/prompts in identifying potential errors and/or solutions helps elementary school pupils in the experimental class to overcome some difficulties in solving the tasks, to progress in their learning, and to achieve better in static math tests. In a quasi-experimental study conducted by Baek & Kyoung (2003) with Korean preschoolers (4-5 years of age), dynamic assessment was similarly found to produce significant positive effects on children's mathematical performance.

Pupils' potential giftedness proves to be an enhancer of this effect, as improvements in posttest math results vary along with children's average scores on giftedness nomination scales. Differentiation in instruction and assessment based on dynamic techniques has beneficial effects for both subgroups of elementary school pupils, as previously suggested in the literature (Stanley et al., 1995; Kirschenbaum, 1998; Lidz & Macrine, 2001). Moreover, Lidz & Eliott (2006) emphasize that dynamic assessment may have a central contribution in stressing qualitative aspects of learning and support Vygotskian principle of identifying both zone of present and proximal development, in order to understand students' learning needs. The aforementioned authors advocate for intensive use of dynamic assessment as an effective constructivist tool for differentiation and individualization in instruction and assessment, but they also suggest combining it with other learner and learning-centered methods and tools. In addition to improvements in terms of test performance, dynamic assessment proved to have relevant predictive value for anticipating students' future performance based on their zone of proximal development and the speed of its modification. Thus, in early and elementary educational dynamic assessment may offer important information about remedial or enriching educational interventions needed (Caffrey et al., 2008).

If the beneficial effects of dynamic assessment are enhanced by students' abilities, as indicated in the present study, remains to be clarified in further research and extended studies. The present study was not based on a clear distinction between gifted and non-gifted students, as the nomination scales collected teacher' and parents' perceptions on pupils' ability levels. However, it is worthy to mention that previous empirical studies based one experimental design draw a rather mixed picture: whereas some resulted in significant differences among gifted and non-gifted students (e.g., Calero et al., 2011), other studies suggest similar improvements in posttest conditions, regardless students' ability level (e.g., Stanley et al., 1995). Thus, the cited study conducted by Calero et al. (2011) resulted in significant higher pretest-posttest variations for gifted than for the non-gifted, while the study reported by Stanley et al. (1995) indicated fairly similar positive impact.

Although the present study adds relevant empirical data to the body of research documenting effects of dynamic assessment on elementary school students' performance in mathematics, some limits have to be discussed. The non-random sampling procedure and the rather small volume of the sample may constrain the generalizability of the results. However, we have to mention that as many other small-scale quasi-experimental research, the current research reports on moderate to large effect size indicating good practical relevance of the findings. Additionally, time and type of dynamic assessment procedures (task contingent rather than general and non-specific, and therefore non-contingent to the task) are also strengths of the current experimental design, despite limitations previously discussed.

6. Conclusion and implications

The small-scale quasi-experiment reported in this study resulted in significant effects of dynamic assessment procedures on elementary school students' performance in mathematics, and a certain enhanced effect was added when potential giftedness level was considered. The benefits of dynamic assessment are well documented in the literature, with a lack of empirical evidence for young ages and a raising interest for disadvantaged and underserved groups of students, as the potentially gifted. The present approach addressed the issue of dynamic assessment in elementary school and attempted to add new empirical evidence on effects of perceived ability levels in this context. To some extent, disabled and very able students are equally disadvantaged in mainstream schools and classrooms, despite the current care and preoccupation for inclusive practices. Dynamic assessment may have a place in the larger educational policy and practice effort to provide appropriately for the learning needs of each and every child, with a wiser time and resources allocation. It may be employed in both cognitive and classroom assessment, but also in instructional contexts with the purpose of improving school performance and achievement.

One may ask why is dynamic assessment so slowly embraced by education practitioners when theorists and researchers value it. The answer would be rather simple: teachers are still unfamiliar with dynamic techniques and procedures, as these remained in the care of diagnosis specialists evaluating children for referral to special educational programs. More than two decades ago, Lidz (1992) used to conclude that both teachers and school psychologists need more training on meanings and uses of dynamic techniques not only for cognitive assessment purposes, but also for classroom assessment, although they believed that all these procedures are time consumers and, therefore, dispensable. We argue that this call for more efforts in preparing teachers and support specialists in the school for the balanced used of static and dynamic assessment still makes sense and deserves more attention within teacher training institutions and programs.

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