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Evaluation of 12th grade of secondary mathematics curriculum: algebra learning domain

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Abstract

The primary aim of this study is to define reaching of attainment levels of algebra learning fields in 12th grade mathematics education programme. 425 12Th grade students, determined by stratified sampling method among elementary schools in Balıkesir city centre and 10 maths teachers have applied the study. As data collecting tool, pre and post test has been enhanced with the aim of defining the level in obtaining acquisitions of Algebra learning curriculum applications. The data obtained have been evaluated using descriptive analysis, t test for related samples and tetrachoric correlation. As a result of the study it has been concluded that; as a result of Algebra learning fields applications in Mathematic course curriculum, the students' Algebra test point averages are meaningful in favour of the post-test ($p<.05$) but for the reason that the post-test's absolute success point averages are under 0.75, the complete learning level has not been reached that the students' obtaining just about %40 of the acquisitions at the level of 75 has shown the learning process are not as sufficient as expected level for providing accessibility of learning process' and that there have been differences between acquisition levels put forward by the experts and tetrachoric correlation results.

Keywords: Keywords: Mathematic course curriculum, Algebra learning, accessibility of acquisitions.

1. Introduction

When the formation of basic algebraic concepts and the development of algebraic thinking is considered to be closely related to primary school age and the ongoing education of algebra; algebra learning applications, hence the effectiveness of the curriculum in mathematics emerges as an important element in terms of learning. To decide about the effectiveness of the curriculum can be performed with the evaluation of the curriculum. Because, the size of the curriculum evaluation is an extremely important tool to assess the effectiveness of learning experiences of students, to have an idea about the impact of curriculum and to determine the items need to be revised (Tyler, 1949). Before you start learning a new subject, it needs to be monitored whether students have the acquisition that targeted based on achievement acquisition or facilitate these gains in this regard. The reason, not to be able to reach some of the acquisitions might arise from either the related acquisitions which have not been learned before, or patterns that have not been formed appropriately (Baykul, 1992). This may make the failure inevitable in mathematics which has a strong pre-condition relationship. When curriculum is considered as a plan of expected acquisition at the end of observing learning students, and as a plan of activities to be used in performing them; an approach based on objective assessment of the curriculum stands out. In the models based on the monitored target, if products derived

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from the curriculum are appropriate and sufficient level with the plan, it is concluded that curriculum is robust and effective enough (Tertemiz, 2005). The curriculum to be robust means; behaviors that the curriculum addressing the group of students to be accessible and the pattern among the acquisitions to be appropriate to the subject fields and recency –priority relationship in learning (Baykul and Tertemiz, 2001). A curriculum that acquisition can be accessed, which does not contain any unnecessary acquisitions, and achievements listed in the appropriate manner can be considered robust (Baykul and Tertemiz, 2004: 42-43). In this study based on Tyler's curriculum evaluation approach, algebra learning fields accessibility of acquisitions level has been evaluated by comparing the hypothetical patterns among acquisitions to the patterns as a result of the learning applications in terms of 12th grade mathematics course curriculum acquisitions of algebra learning fields. The aim of this study is, to determine the accessibility of acquisitions in algebra learning fields of mathematics course curriculum in new secondary school 12th grade, and determine the pattern between acquisitions. This study is considered significant, regarding shedding light on learning algebra through curriculum level; which is known with learning problems and in terms of accessibility of acquisitions in algebra learning fields, which has a high pre-condition relationship and also revealing pre-condition relationship in each class level. In the study, 12th grade algebra learning fields was selected; because recently introduced 12th grade algebra curriculum content is providing a basis to general mathematics and analysis to 1st grade students studying in science and literature, engineering and education faculties. This study is expected to make a big contribution to the studies of determining the robust of algebra learning fields curriculum, and shed a light on development of curriculum in terms of algebra learning shortcomings.

2. Methots

In the study, the descriptive- qualified survey model, which aims to demonstrate the way that situation exists in (Karasar, 2006), is adopted. Population of this research in 2009-2010 academic year, consists of 12th grade students in formal secondary schools located in central district of Balikesir province. Stratified sampling method used in this research. Creating layers, average school achievement scores according to the Student Selection Examination rankings in 2009 obtained from the Ministry of Education, and average scores were used.

According to the layers determined, 100 students from top achievement level schools, 125 students from middle achievement level schools and 200 students from the lower achievement level schools participated in the survey.

2.1. Data collection tools and analysis of data

In accordance with the acquisitions of sub-learning fields in Secondary Education, 12th grade algebra learning domain such as "Functions", "Description of functions", "Piecewise functions" "Absolute Value", achievement tests were developed. To determine the validity of test substances, a technique developed by Lawshe (1975) was used; obtained pre-trial "Functions" test was applied to 200 students and the data were subject to analysis of substance. KR20 value of the test in substance analysis was 0.89. Achievement test, which is developed within the scope of research and in the light of the expert opinions, applied to sample group determined in 2009-2010 academic year in the central district of Balıkesir province, before and after each fields of learning algebra and program applications within the scope of sub-fields of learning. In order to determine the levels of accessibility of acquisitions, substance difficulty indices were calculated and accessibility of acquisitions levels were interpreted as criteria of .75 (Bloom, 1998). Regarding each substance, the differences between the pre-test and post-test score averages in tests, t test for related samples and the significance of difference among school levels in terms of accessibility of acquisition levels were evaluated considering analysis of covariance (ANCOVA); 0.5 is accepted as significance level. In addition, with the purpose of testing the differences between target accessibility of acquisitions level of schools with lower-middle and top level, analysis of covariance were made. tetrachoric correlation technique was used to determine the patterns of acquisitions. The data, obtained from the recent testing were used in the calculation of Correlation coefficients. For the existence of pre-condition relationship between any two acquisitions, the significance level was considered as .01 and the critical value of the correlation coefficient for (n = 425) was considered as 0.128 (Akhun,

1986). Based on the data obtained; by visualizing pattern, hypothetical pattern obtained from expert opinions was compared with the pattern obtained from tetrachoric correlation calculations and interpreted.

3. Results And Interpretation

3.1. Accessibility of acquisitions levels

"Functions" were applied before and after the summative test learning process and the meaning of differences between pre-test and post-test score average was evaluated In the light of obtained results, concerning the results of pre-test and post-test of the acquisitions in the fields of algebra learning; the substance difficulty indices (Pj) were calculated and these values were evaluated as accessibility of acquisitions levels. The absolute achievement score average of the pre-test and post-test were compared with t test for dependant samples. According to the results of the t-test "t" value was found to be significant at the level of .05. [t= -31.77: p< 0.5].

This result has revealed a significant increase in academic achievement. Related to the questions that measure each of the acquisitions; pre-test and post-test results obtained from the substance difficulty indices (pj) values belong to 12th grade students, studying the lower, middle and top level schools; also the differences between them and the results with calculated t values are given in Table 1 When the table is examined, according to the pre-test results, at the beginning of the learning process of students "Functions" explain the “bijective and injective function that belongs to the lower learning fields of the first acquisition; and it determines whether the given function is bijective or surjective”, “it explains the inverse function and determines whether the given function is the inverse function; if any, finds it” acquisitions were determined to be accessible by %75 percent of the students studying in middle and top level schools apart from the ones studying in the lower level schools. The reason for students, who could access the acquisitions at the beginning of learning process, can be the presence of the acquisitions such as “it explains bijective, surjective, injective, identity (unit), constant and linear functions" and "it finds the inverse of function with regard to composite process, draws an inverse graph of the given function" in 9th grade functions sub-learning fields of algebra learning. Additionally, students in general, could not access any of 8 acquisitions with the exception of the ones measured by 2nd and 3rd articles at the beginning of the learning process. When the final test results are analyzed, it is found out that; the top, middle and lower groups and average of all students could access %60 of acquisitions of "Functions" in the sub-learning fields." It determines the definition of functions, value and image set, it explains the duo and single functions and interprets the graphs" acquisitions could not be accessed by any of the groups. When the results of the studies in the literature examined, it can be said that students had difficulties in finding the definition, value and image sets of functions (Dogan et al,2003; Carlson and Oehrtman, 2005; Baştürk,2004). Another acquisition that could not be accessed by groups is "it explains the duo and single function, interprets the graphs" acquisition. The reason why students could not access this acquisition might be their lack of graph knowledge. The studies support this finding (Carlson and Oehrtman, 2005; Bakar and Tall; 1992). Also, in related studies it is found out that, students could not determine the definition and value sets of constant functions. In fact, when the explanations and questions in 1st acquisition related program are analyzed, it can be seen that there is no examples of the algebraic or arithmetic function which is not defined by a rule. For this reason, students might see the function as an algebraic expression and might not be able to determine the definition of set of values. Again, because the graph interpretation takes place alongside the duo and single functions in 5th acquisition, the accessibility of acquisitions could not be provided due to lack of students graph interpretation. The reason why the accessibility of acquisitions in "definition set of the function" sub-learning fields failed might be because students need the foreknowledge and definition knowledge of many subjects to fulfil this acquisition and they might be incomplete in these subjects. In the explanation related to the acquisition, there is an expression like "$f(x)$ and $g(x)$ are polynomial and functions such as $n \in Z^+$, $f(x)$, $\sqrt[n]{f(x)}$ and $\log_{f(x)} g(x)$ should be limited with finding the broad definition set". In this expression, the student should have knowledge of polynomial functions, quadratic equations and quadratic functions and inequalities, exponents and a logarithm is stated.

Table 1. 12th grade Secondary Mathematics Course Curriculum Program Accessibility of Acquisitions Levels of Algebra Learning Fields

Sub-learning Fields.	Target Acquisitions	Article No	Top Level				Middle Level				Lower Level				General			
			Pre Test (P_j)	PostTest (P_j)	Difference (P_j)	t	Pre-Test (P_j)	PostTest (P_j)	Difference (P_j)	t	Pre-Test (P_j)	PostTest (P_j)	Difference (P_j)	t	Pre-Test (P_j)	PostTest (P_j)	Difference (P_j)	t
Functions	1.Determines the definition of functions, value and image set.	1	.09	.56	.47	-7.13*	.07	.69	.62	-11.29*	.14	.57	.43	-8.54*	.11	.60	.49	-15.04*
	2.Describes bijective and injective function, and determines whether given function is bijective or surjective.	2	.75	.88	.18	-2.09*	.90	.94	.4	-1.09	.66	.92	.26	-6.68	.77	.91	.14	-6.33*
	3. Explains the inverse function and determines whether given function is inverse function. If any, finds it.	3	.75	.93	.18	-2.75	.75	.89	.14	-1.61	.74	.88	.14	-3.66	.75	.89	.14	-5.75*
	4. Explains ascending-descending and constant functions. Determines whether given function is ascending-descending in a range or constant.	4	.09	.88	.79	-13.36*	.05	.79	.74	-15.47*	.10	.75	.65	-13.89*	.08	.79	.71	-23.93*
	5. Explains dual and single functions and interprets.	5	.26	.51	.25	-2.95*	.19	.61	.42	-5.85*	.13	.73	.60	-12.20*	.18	.64	.46	-12.36*
Funct. Describ. Set.	1. Determines the broad definitions of set of functions with given rules.	6	.05	.79	.74	-13.61*	.10	.79	.69	-12.38*	.16	.70	.54	-10.20	.12	.75	.63	-5.41*
Piecewise Functions	1a. Draws a graph of the piecewise function and make applications.	7	.17	.25	.8	-1.23	.19	.33	.14	-2.13*	.21	.50	.29	-5.25*	.20	.39	.19	-11.33*
	1b. Draws a graph of the piecewise function and make applications.	8	.24	.52	.28	-3.37*	.13	.66	.53	-8.53*	.17	.60	.43	-7.99*	.17	.60	.43	-11.08*
Absolute value Functions	1a. Draws a graph of the absolute value function. Determines the solution to set of functions with absolute value and inequalities.	9	.03	.34	.31	-5.89*	.06	.33	.27	-5.05*	.05	.37	.32	-7.90*	.05	.35	.30	-11.08*
	1b. Draws a graph of the absolute value function. Determines the solution to set of functions with absolute value and inequalities.	10	.16	.73	.57	-7.54*	.14	.74	.60	-9.33*	.28	.41	.13	-2.332*	.21	.58	.37	-9.53*

* α = 0,05 is significant. (N_{topt}=100, N_{middle} =125, N_{lower} =200, $N_{general}$ = 425)

Based on studies in literature, when the overall low level of the accessibility of acquisitions on 10th grade polynomials, quadratic equations and inequalities, and logarithm subjects are considered, the reason why students could not access the acquisitions may be disclosed. When "piecewise functions" sub-learning fields acquisitions were examined, none of the groups could access the acquisitions. This might be due to students having problems with the concept of piecewise functions and interpretation of graphs. Indeed, the studies seem to support these findings (Vinner 1983; Breidenbach 1992). The reason for this might be, although it is not the first time student encountered the function subject, he might have encountered the piecewise function concept for the first time. When students' first encounters with the functions in 9th grade algebra learning fields are examined, it can be seen that piecewise presentation is not mentioned. This, as Vinner indicated, makes students to think, function graph is meant to be both smooth and continuous straight line or curved. Therefore, we are in the opinion that; an acquisition to help forming a basis for related acquisition in examining the graph drawing and presentation in 9th grade mathematics program is needed. It is determined that no group could access absolute value function acquisitions. The obtained results (Dogan et al., 2003) are in line with the results of their studies.

Based on the t values of difference between students' pre and post test scores, it is significant for the other acquisitions, with the exception of the acquisitions measured by article 3 and 7 for top level schools, acquisitions measured by article 2 and 3 for middle-level schools and acquisitions measured by article 2,3 and 6 for lower-level schools, and overall; a significant difference in t values of all the acquisitions at the level of .05 between pre-test and post test score average is concluded. These results, other than the acquisitions for top group measured by article3 and 7, middle group measured by article 2 and 3 and lower group measured by article 2, 3 and 6 show that learning applications are highly effective in improving the success on the basis of acquisitions. "It explains the inverse function and determines whether a given function is inverse, if any, finds it" acquisition which is measured by 3rd article with no significant difference in learning applications of top, middle and lower groups and due to " it finds the inverse of function with regard to composite process, draws an inverse graph of the given function" acquisition, the acquisition might be removed from algebra learning fields program. When it is examined in general, the percentage of the12th grade students' correct response to questions in the test prior to the learning process was observed as 0.26, whilst this ratio increased to 0.64 by the end of learning process. According to these results, it is interpreted as 12th grade mathematics program algebra learning fields applications certainly contributes to the achievement level of students, but accessibility of acquisitions level was inadequate at the level of 0.75. When the pre-test scores are checked, as a result of algebra learning fields applications, to demonstrate the difference between the groups of the accessibility of acquisitions level, descriptive data and ANCOVA with regard to absolute post-test unit are given in Table 2.

Table 2 ANCOVA Results and Descriptive Data with regard to Absolute Post-test Unit

School Levels	$\overline{X}_{\text{Pre-test}}$	**Monitored** $\overline{X}_{\text{Post-test}}$	**Corrected** $\overline{X}_{\text{Post-test}}$	**SS**	**n**
Top Level	26.00	63.90	63.83	12.94	100
Middle Level	26.00	67.76	67.69	16.29	125
Lower Level	26.20	64.15	64.21	18.52	200
Source of Variance	**Sum of Squares**	**sd**	**KO**	**F**	**p**
Pre-test	29614.40	1	29614.40	153.17	.000
Level	1157.10	2	578.55	2.99	.051
Failure	81392.89	421	193.33		

R^2=.294, Adj. R^2=.285, Homogeneity of regression test is insignificant. F (1,419) =2.225; p>.05. *p<.05

According to the findings obtained from the analysis of covariance, when the pre-test scores between the groups are checked in terms of 12th grade algebra learning fields accessibility of acquisitions levels; a significant difference between obtained corrected post-test averages [$F_{(2\text{-}421)}$ = 2.99; p>.05]. These results were interpreted to algebra learning fields accessibility of acquisitions levels were not affected from the entry behaviors of students prior to the learning process.

3.2. The pattern between acquisitions

What kind of patterns are there between acquisitions take place in secondary education 12th grade Mathematics Course Curriculum Program Algebra Learning Fields? Are these patterns consistent with the patterns anticipated by experts? On the purpose of finding answers to the questions, taking into account the pre-condition relationships with regard to 12th grade algebra learning fields acquisitions; discussions and focus group discussions with 10 secondary education mathematics teachers was conducted in order to determine the priori acquisition patterns. First, teachers created their priori inter acquisition, and then as a result of focus group discussions, priori acquisition took its final form. The resulting pattern is given in Figure 1.

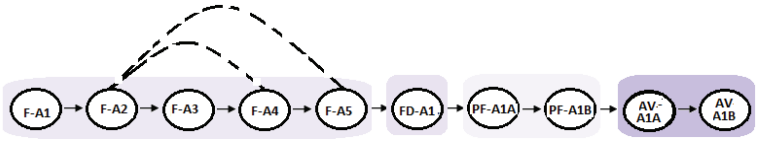

Figure 1 12th grade Algebra Learning Fields related Priori Acquisition Pattern

Using the data obtained from the final test results of 425 12th grade students, tetrachoric correlations of the substances in the test were calculated. The tetrachoric correlation results with regard to Algebra Learning fields acquisitions and the acquisition patterns obtained from these results are given in Table 3 and Figure 2.

Table 3 12th grade Algebra Learning Fields Acquisitions Tetrachoric Correlation Results

Sub-learning Fields		Sub-learning Fields									
		Functions (F)					Function Des. Set (FD)	Piecewise Functions (PF)		Absolute Value Functions (AV)	
	Nn	F-S1	F-S2	F-S3	F-S4	F-S5	FD-S1	PF-S1A	PF -S1B	AV-S1A	AV-S1B
	F-A1	1.000									
(F)	F-A2	0.404	1.000								
	F-A3	0.461	0.359	1.000							
	F-A4	0.184	-0.064	0.300	1.000						
	F-A5	0.246	0.093	0.123	0.124	1.000					
(FD)	FD-A1	0.240	0.048	0.493	0.610	0.223	1.000				
(PF)	PF-A1A	0.315	0.181	0.281	0.347	-0.013	0.316	1.000			
	PF -A1B	0.219	0.059	0.207	-0.349	0.341	-0.005	-0.143	1.000		
(AV)	AV-A1A	0.115	0.117	0.140	0.292	0.012	0.339	-0.050	0.503	1.000	
	AV-A1B	0.148	0.015	-0.012	0.346	0.328	0.367	-0.090	-0.112	0.139	1.000

Table value for significance is (N=425); 0,128 (Akhun.1986).

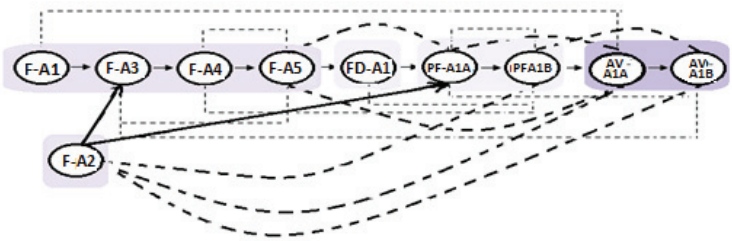

Figure 2 Acquisition pattern based on Tetrachoric Correlation Results related to 12th grade Algebra Learning Fields

When the tables and figures are examined, some differences between priori acquisition patterns presented by experts and results of tetracoric correlation are concluded. It can be seen that, pre-condition relationship between some acquisitions is lost and this situation caused a disconnection between the acquisitions. The most important reason for this outcome is, by the end of learning applications students have reached 40% of the acquisitions. Acquisitions that could not be reached reflected in the results of correlation and leads to a loss of some pre-condition relationships.

4. Conclusions and Recommendations

As a result of the research; in consequence of 12th grade secondary education mathematics course learning program in 2009-2010 academic year in algebra learning fields applications, students' algebra test score averages were found to be significant in favour of post- test and this case is interpreted as a result of increased success in learning and learning activities. However, the absolute success of the post-test scores remain below 0.75 was concluded that, the full level of learning could not be reached. In addition, the differences between priori acquisition patterns presented by experts and tetracoric correlation results were detected, and the pre-condition patterns among some acquisitions disappeared different than hypothetical patterns. In the light of findings from the research, the deficiencies in algebra learning acquisitions and acquisitions in relationship with pre-condition can be remedied in future research. Evaluating these acquisitions that could not be accessed, again in the program, helping the acquisitions to be added to the program, including the absolute value function and piecewise function subjects in as well 9th grade functions sub-learning fields; enabling the correct establishment of pre-condition patterns of 12th grade functions acquisitions may increase the robustness of the program.

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