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Evaluation of the Subtraction in Natural Numbers Unit

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Abstract

Problem Statement: The written objectives in curriculum design are hypothetical. In other words, objectives that are part of the curriculum are empirical. Therefore, evaluation of the relevancy and efficiency of the objectives is necessary. To evaluate curriculum relevancy and efficiency requires studies in terms of behavioural objectives and written objectives. Studies based on behavioural objectives include studying to determine (1) the accessibility level of each behavioural objective and (2) the level of support that behavioural objectives provide for each other. Studies based on written objectives reqire studying (1) inclusion of the objective by the behavioural objectives under that objective, (2) the level of the realisation of the objectives and (3) the consistency of the objectives amongst themselves. The current study is an example of studies based on behavioural objectives.

Purpose of Study: The purpose of this study is to determine the level of accessibility of the objectives belonging to the subtraction in natural numbers unit in the 3rd grade Mathematics Curriculum of two different classes at Şht. Tuncer Primary School (ŞTPS) and Necati Taşkın Primary School (NTPS) in the Nicosia district and the relevancy of the mentioned objectives.

Methods: Research was conducted with 43 students in two classes from two different primary schools. The research was prepared according to the pretest–posttest model. A Cognitive Entry Behaviour Test (CEBT) and a formative test were used.

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Findings and Results: According to the results of the research, 3rd grade primary school students acquire the subtraction skill in natural numbers at a mastery learning level (75%). No significant difference was observed between the success of the two primary schools included in the research regarding their subtraction skills with natural numbers. The decrease in the learning of this skill was seen mostly in the behavioural objectives requiring the decomposition of tens or hundreds.

Conclusions and Recommendations: The anticipated behavioural pattern with regard to the subtraction skill in natural numbers in the 3rd grade Mathematics Curriculum of the primary schools used in this study did not prove to be consistent. Therefore, while teaching subtraction, a teaching sequence should be followed by refering to the progressivity relationship related to the subtraction skills.

Keywords: Curriculum evaluation, subtraction skill, accessibility of behavioural objectives, prerequisite relationships.

Curriculum development includes the processes of designing, implementing, evaluating and re-planning curriculum based on evaluation results (Çilenti, 1988; Erden, 1993). A curriculum design includes objectives, educational experiences and evaluation elements (Ertürk, 1978; Olivia, 1988; Orstien & Hunkins, 1988; Taba, 1962; Tyler, 1973). Models and approaches that deal with different components of the curriculum can be used in curriculum evaluation studies (Ertürk, 1978; Olivia, 1988; Orstien & Hunkins, 1988). However, since the objectives of a curriculum affect the other elements of that curriculum, the evaluation of the objectives is primarily important. The written objectives in curriculum design are hypothetical. In other words, objectives that are part of the curriculum are empirical (Ertürk, 1978). Therefore, evaluation of the consistency and relevancy of the objectives is necessary. In addition, previous research has proven that written objectives in curriculum design may not appear within the anticipated progressivity (Demirkayık, 2000; Kahramanoğlu, 2000; Kelecioğlu, 1989; Şahan, 2007; Tertemiz, 2005; Uyganör, 2008; Yazıcı, 2009).

According to Özçelik (1992), with students who do not have crucial defects with regards to their learning instincts and pre-conditions but still cannot learn or cannot bring their learning above a certain level although they study with the accompaniment of a sufficient and effective educational service, the curriculum may be considered as not being effective and strenuous enough. Evaluating the relevancy and efficiency of the curriculum requires studies in terms of behavioural objectives and objectives. Studies based on behavioural objectives include studying to determine (1) the accessibility level of each behavioural objective and (2) the level of support that behavioural objectives provide for each other. Studies based on objectives require studying (1) inclusion of the objective by the behavioural objectives under that objective, (2) the level of the realisation of the objectives and (3) the consistency of the objectives amongst themselves (Baykul, 1992). The current study is an example of studies based on behavioural objectives.

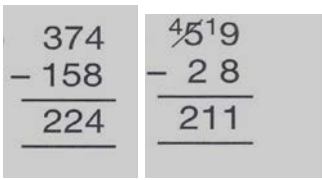
The accessibility of a behavioural objective by a student is demonstrated by 75% or more of the students being able to give the correct answer to a question that has

sufficient validity and reliability, and which tests that particular behavioural objective (Baykul, 2000). Baykul (1992) explains the calculation of the accessibility degree of a behavioural objective as follows:

> The accessibility degree of a behavioural objective can be operationally explained with the expression as "with the condition of providing the required circumstances to acquire the behavioural objective, from the ones who do not possess the behavioural objective at the beginning of the education, the percentage possesing the behavioural objective at the end of the education". According to this description, the level of the accessibility of a behavioural objective can be calculated such as: a sufficienly valid and reliable question of testing the particular behavioural objective is asked to the group; the percentage of the people giving the right answer is calculated. Then the education is implemented by providing the required circumstances for motivation and education. At the end of the education the same question searching for the mentioned behavioural objectives or something parallel to that question is asked again and the percentage of the ones giving the right answer is calculated once more. The difference between the first and the second percentages gives the accessibility level of this behavioural objective. (p. 89)

Most of the objectives in the cognitive domain that contribute to school learning contain a rigid step-by-step relationship (Özçelik, 1992). Within this relationship, the behavioural objectives that possess prerequisite attributes affect the learning of the behavioural objectives that are supposed to be learned at the next stage. Prerequisite behavioural objectives have crucial effects in estimating success (Bloom, 1976; Özçelik, 1989). The behavioural objectives in mathematics are especially powerful in the sense of prerequisite relationships (Özçelik, 1992). Before starting the teaching of a new unit or a new topic, the powerful prerequisite relationships between the behavioural objectives in mathemetics require observation of the students to see whether thay have the basis or facilitator behavioural objectives with respect to the acquiring of the desired behavioural objectives in this topic (Baykul, 1992). Therefore, in teaching mathematics, it is necesssary to give importance to the relationships between behavioural objectives and, even more importantly, to determine these relationships while preparing teaching plans and take them into consideration while teaching (Tertemiz, 2005).

The subtraction skill has an important place in learning mathematics. The subtraction skill is required to acquire other high level objectives in the mathematics curriculum. In this context, the teaching done regarding this skill needs to be in the right sequence. following the right sequence while teaching this skill and accordingly being aware of the prerequisite relationship between the behavioural objectives covering the subtraction skill increase the quality of the education and the success in learning. The points that the teacher needs to focus on and the supplementary teaching method are determined this way as well. The most common misconceptions among primary students are subtraction skills (Cauley, 1988; Cockburn & Littler, 2008). The mistakes that students often make with respect to subtraction are as follows (Cockburn & Littler, 2008; Gagné at all, 1993: 352-355; Haylock, 2005: 62-65; Lawton, 2008: 59; Resnick, 1984):



The above examples demonstrate that subtraction mistakes are caused by defects in the students' prerequisite behavioural objectives. Here the learning defect is due to not knowing the decomposition of tens or hundreds or knowing the decomposition principle incorrectly. Therefore, while teaching subtraction, pre- and post-aspects of the behavioural objectives must be known for effective teaching. Moreover, in Ball's (1988) research it was found that teacher candidates have misconceptions about place values and, accordingly, with subtraction skills. This finding shows that, in courses related to mathematics teaching at teacher academies, to have effective teaching about the decomposition of tens and hundreds and place values it is necessary to focus on the sequence of the teaching.

To be the most effective for new learning, prerequisite skills must be thoroughly learned—that is, learned mastery. Presumably, this degree of learning makes the prerequisite skills easier to recall and, therefore, more readily accesible for new learning. According to Gagné and Mesker (1996), prerequisite relationships in learning act as crucial guides in planning and implementing teaching. First of all, they assist the teaching to be complete. It is not possible for any teaching dimension to be left out after determining all the prerequisite relationships. Secondly, it provides the determination of a correct sequence for teaching. Students make an effort to learn only the skills for which they possess the prerequisite behavioural objectives. These two advantages, completeness and correct sequencing, greatly enhance the chances that the desired learning outcome will be achieved, because they ensure a key condition for intellectual skill learning: mastery of prerequisites.

After determining the elements of a unit, the next task is to determine the progressivity relationship amongst these elements. For the students to learn the elements of a unit easily and effectively, what kind of a sequence should be followed? In other words, which elements of the unit should be taught as prerequisite to the others? (Özçelik, 1992).

According to Driscoll (2005), prerequisite relationships provide the teacher with the important dimensions to be focused on and cause the teaching to be more effective. At the same time, determining prerequisite relationships amongst behavioural objectives while determining the learning defects of the students will help teachers not only with their teaching but also with supplementary teaching activities. The current study possesses an important aspect as it provides data that serves for such an objective. The research question of the study is as follows:

What is the degree of relevancy of the objectives of the subtraction in natural numbers unit that is taught in the 3rd grade Primary School Mathematics Curriculum?

To examine the main purpose, the following research sub-questions were asked:

1. Is there a significant difference between high and low socio-economic status (SES) schools in regards to the subtraction of natural numbers skill?

2. What is the degree of realization of the objectives and behavioural objectives belonging to the subtraction in natural numbers skill?

3. What pattern is formed by the prerequisite relationships of objectives and behavioural objectives belonging to the subtraction in natural numbers skill?

Method

Research Design

The aim of this research was to determine prerequisite relationships of objectives and behavioural objectives related to the subtraction in natural numbers unit that is taught in the 3rd grade Primary School Mathematics Curriculum. The research was conducted in two classes and was prepared according to the pretest–posttest model. Niether of the classes was held as an experimental group; therefore, this research has a descriptive aspect (Balcı, 2007). The objective-based studies approach was used to evaluate the program for this research (Stufflebeam & Shinkfield, 2007: 160).

Study Group

The study was conducted with 3rd grade primary school students from two different classes at Şht. Tuncer Primary School (ŞTPS) and Necati Taşkın Primary School (NTPS) in the Nicosia district during the 2008-2009 academic year. The socio-economic status of NTPS was determined to be low-scale, while ŞTPS was high-scale. There were 43 students in total, 24 from ŞTPS and 19 from NTPS. The Cognitive Entry Behaviour Test (CEBT) and pretest scores of the students included in the research are presented in Table 1.

Table 1

Students' CEBT and pretest scores

Score Description	School	N	$\overline{X}$	SD	t	p
CEBT	NTPS	19	11.42	1.34	-.877	.385
	ŞTPS	24	11.75	1.11		
Pretest	NTPS	19	4.42	3.48	-1.449	.155
	ŞTPS	24	6.08	3.92		

As can be seen from Table 1, no significant difference was found between either the CEBT scores (t= -.877, p >.05) or the pretest scores (t= -1.449, p> .05) of the students from both schools. Based on these findings, the subtraction skills of the

students from both classes included in the research were corresponding previous to the research.

Procedure

During the research, the operations below were performed successively.

1. Necati Taşkın and ŞTPS in Nicosia district were determined as socio-economically low-scale and high–scale schools, respectively. Since implementing scientific criteria to categorise the schools according to their socio-economic backgrounds was beyond the resources of the researcher, this categorization was done based on the general aspects of the students' and schools' environment.

2. In both classes, CEBT and a formative test (as the pretest) were administrated.

3. The objectives belonging to the substraction unit in the 3rd grade Mathematics Curriculum of the primary schools were shown to the 3rd grade teachers at both of the schools used in the research. The teachers were asked to implement their teaching according to the sequence of the desired behavioural objectives.

4. The teachers were asked to use Baykul's *Primary School 3rd Grade Mathematics Course Book*, with which they could follow the sequence best.

5. Five days of teaching were held with both classes. During the teaching, both teachers were asked to teach using conventional methods. In other words, there was no intervention regarding the teachers' teaching methods.

6. At the end of the five days, a formative test was administered in both classes as a posttest to measure the objectives learned related to subtraction.

Research Instruments

CEB. Preparation of the test: A test dealing with all of the desired behavioural objectives related to subtraction in the 2nd grade of primary schools was developed. A CEBT that included 14 questions measuring 14 behavioural objectives belonging to those objectives was prepared.

1. The objectives related to subtraction skills in the 2nd grade were determined through the Primary Education Mathematics Curriculum 5+3.

Objective 1: Comprehension of subtraction in two-digit natural numbers.

Objective 2: Subtraction skill in two-digit natural numbers.

2. A achievment test was prepared that included 28 questions in total—two questions related to each of the 14 behavioural objectives belonging to the two objectives.

3. The achievment test was administered as a pilot study to 88 students from 3rd grade primary school classes from two schools not including the research group in the 2008-2009 academic year.

4. Questions with a discrimination index above .30 with regards to the 14 questions were chosen.

5. The KR – 20 reliability coefficient of the test was calculated as .84.

Formative Test. For the research, a formative test was developed to determine the prerequisite relationships of the desired behaviours related to subtraction. The following phases were developed:

1. Objectives and behaviours with regard to 3rd grade subtraction within the Primary School Mathematics Program 5+3 were determined.

Objective 1: Subtraction skill in one- and two-digit natural numbers.

Objective 2: Subtraction skill in three- and four-digit natural numbers.

2. A pilot test was prepared that included 24 questions (two questions related to each of the 12 behaviours) belonging to the two objectives.

3. At the beginning of the 2008-2009 academic year, the pilot test was administered to 65 3rd grade students from two primary schools that were not included in the research group.

4. Questions with a discrimination index above .30 with regards to the 12 behavioural objectives were chosen.

5. These questions were numbered from 1 to 12. Each behavioural objective was arranged to have the same number as its question. For example, the 1st behavioural objective's question number was 1st in the test.

6. The KR – 20 reliability coefficient of the test was calculated as .80.

Data Analyses

While developing the cognitive entry behaviour and formative tests used in the research, The Iteman program was used to calculate the index for item discrimination. In the analysis of the data obtained to answer the first sub-question of the research, the "t" test was used amongst the independent groups. In regards to the second sub-question, there is a method in the literature that can be used to find out the degree of support amongst the behavioural objectives related to subtraction skill (Reckase & McKinley, 1982; Ekstrand, 1982). Nevertheless, in the current research the commonly used tetrachoric correlation technique was used (Baykul, 1997; Baykul, 2000).

Findings and Results

The findings of the research are presented in the tables below.

The findings of the first sub-question

The natural number subtraction-related pretest, posttest and achievment scores of the students participating in the research are presented in Table 2.

As can be seen from Table 2, no significant difference was found in the achievment scores related to the subtraction skills of the students from the 3rd grade of Necati Taşkın and ŞTPS who participated in the research (t=-.271, p=.788). Based on this finding, there is no difference between the success of the students from both schools.

Table 2
Findings Related to the Subtraction Skill in Natural Numbers

School	N	Pretest scores $\overline{X}$	Pretest scores SD	Posttest scores $\overline{X}$	Posttest scores SD	Achievment scores $\overline{X}$	Achievment scores SD	t	p
NTPS	19	4.42	3.49	8.10	2.87	3.68	1.49	-.271	.788
ŞTPS	24	6.08	3.92	9.92	2.57	3.83	1.99		

The findings of the second sub-question

The realization degree of the desired behavioural objectives related to the natural number subtraction skill is presented in Table 3.

Table 3
The Realization Degree of the Desired Behavioural Objectives Related to the Subtraction Skill

Behavioural objective/question	Pretest scores %	Pretest scores SD	Posttest scores %	Posttest scores SD	t	p
1.	.4884	.50578	.9070	.29390	-5.499	.000
2.	.3721	.48908	.9535	.21308	-7.638	.000
3.	.5116	.50578	.6977	.46470	-2.235	.031
4.	.6977	.46470	.9535	.21308	-3.406	.001
5.	.3256	.47414	.6512	.48224	-4.090	.000
6.	.2791	.45385	.4419	.50249	-2.203	.033
7.	.8372	.37354	.9070	.29390	-1.138	.262
8.	.3953	.49471	.6279	.48908	-3.177	.003
9.	.5581	.50249	.9535	.21308	-5.240	.000
10.	.2093	.41163	.5581	.50249	-4.743	.000
11.	.4884	.50578	.8837	.32435	-5.240	.000
12.	.1860	.39375	.5814	.49917	-5.240	.000
Total	5.3488	2.82176	9.1163	3.78521	13.953	.000

As can be seen from Table 3, between the pretest and posttest scores of the 43 students included in the research a significant difference was found in every behavioural objective apart from number 7. The mean of the students' posttests was calculated as 9.12. In a 12-question test, this is equal to a 76% success rate. Based on this finding, the success of the students is at the border of the mastery learning level (75%). In addition, behavioural objectives 3, 5, 6, 8, 10, and 12 were acquired below the mastery learning level (75%). These behavioural objectives include the decomposition of tens or hundreds. These learning difficulties may have been caused by the defective learning of the prerequisite behavioural objectives. Özçelik (1989) explains the case as follows:

> For example, if the second question of the test searches for the behavioural objective "a" and the third one searches for "b" and behavioural objective "a" is a prerequisite for learning of behavioural objective "b" , the answers to the second

> question searching for behavioural objective "a" of the students who do not answer the third question or give a wrong answer to the said question, can be looked at. The ones giving a wrong answer to the second question as well, could not learn behabiour "b" probably due to the fact that they could not learn behavioural objective "a". The ones giving the right answer to the second question could not learn just behavioural objective "b" and their defect is caused by a known difficulty. (p. 241)

To make such a generalization, we need to come up with a pattern that displays the prerequisite relationships of the behavioural objectives. This pattern was created for the third sub–problem of the research. Also, the teaching sequence of subtraction in natural numbers was explained.

Findings of the third sub-question

The tetrachoric coefficients related to all of the items were calculated and the items with significant relationships amongst themselves were determined. The tetrachoric coefficients related to all of the items are presented in Table 4.

Tablo 4

Tetrachoric Coefficients Related to All Items

items		2	3	4	5	6	7	8	9	10	11	12
1	rho	0.32	0.60	0.32	0.54	0.49	0.09	0.51	0.32	0.42	0.30	0.45
	p	0.57	0.08	0.57	0.11	0.14	0.83	0.12	0.57	0.20	0.48	0.17
2	rho		0.52	0.95	0.47	0.07	0.63	0.44	0.52	0.37	0.57	0.39
	p		0.22	0.18	0.26	0.86	0.27	0.28	0.46	0.36	0.29	0.33
3	rho			0.52	0.80	0.62	0.60	0.76	0.24	0.77	0.15	0.69
	p			0.22	0.00*	0.01*	0.08	0.00*	0.56	0.00*	0.62	0.00*
4	rho				0. 47	0.07	0.63	0.44	0.52	0.37	0.57	0.39
	p				0.26	0.86	0.27	0.28	0.46	0.36	0.29	0.33
5	rho					0.41	0.54	0.92	0.47	0.92	0.63	0.87
	p					0.09	0.11	0.00*	0.26	0.00*	0.04*	0.00*
6	rho						-0.08	0.46	-0.07	0.48	-0.52	0.29
	p						0.80	0.05	0.86	0.04*	0.09	0.22
7	rho							0.51	0.32	0.61	0.67	0.45
	p							0.12	0.57	0.06	0.12	0.17
8	rho								0.44	0.88	0.61	0.98
	p								0.28	0.00*	0.05	0.00*
9	rho									0.37	0.57	0.39
	p									0.36	0.290	0.33
10	rho										0.68	0.78
	p										0.03*	0.00*
11	rho											0.555
	p											0.078

*p<.05

The power index (p) of the items was checked to determine the pre-, post- and prerequisite relationships. By bringing forward the items with a high power index, the teaching sequence below and in Figure 1 was formed. A teaching sequence of items 11, 3, 5, 8, 12, 10, 6 was observed. Thus, the questions related to the stated behavioural objectives and teaching sequence should be as follows:

Question: 11	Question: 3	Question: 5	Question : 8	Question : 12	Question : 10	Question : 6
675	73	42	143	431	512	5A
−324	− 8	− 34	− 5	− 151	− 36	− B3
						13

The progressivity relationship of the said behavioural objectives should be as presented in Figure 1 below.

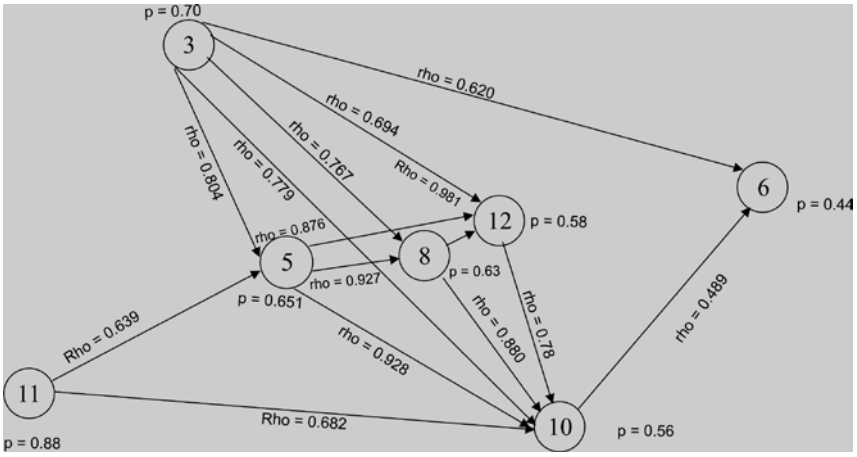


Figure 1: The progressivity relationship of the behavioural objectives is related to learning the subtraction skill in natural numbers.

The following can be seen from Figure 1:

- The prerequisites of behavioural objective 6 are behavioural objectives 3 and 10.
- The prerequisites of behavioural objective 10 are behavioural objectives 8, 12, 11 and 3.
- The prerequisites of behavioural objective 12 are behavioural objectives 8 and 3.
- The prerequisites of behavioural objective 8 are behavioural objectives 3 and 5.
- The prerequisites of behavioural objective 5 are behavioural objectives 11 and 3.

Based on this finding, The following observations can be made regarding the behavioural objectives for which the degree of learning remained below mastery learning:

The reason for behavioural objective 6 not being learnt is the defective learning of behavioural objectives 10 and 3. The reason for behavioural objective 10 not being

learnt is the defective learning of behavioural objectives 8 and 12. Behavioural objective 12 is not learnt because of the defective learning of behavioural objectives 8 and 3. The reason for behavioural objective 8 not being learnt is the defective learning of behavioural objective 3. Thus, the teaching service provided to the students with regards to teaching the said behavioural objectives was not sufficient and effective. Rationally, although the effect of the teaching service and the effect of the prerequisite relationships are thought to be separated easily, both effects are most of the time interpenetrated (Özçelik, 1992). however, the current study does not deal with the effectiveness of the quality of the teaching service. This particular factor is excluded from the current research.

Conclusion and Recommendations

There is no significant difference between the success in the natural number subtraction skill of the two schools included in the research. In light of this, it can be said that the effectiveness of subtraction skills teaching in the third grade mathematics program of this district is at the same level in both socio-economic levels of students. Third grade primary school students included in the research acquire the subtraction skill at the mastery learning level, but some behavioural objectives were learnt lower than the mastery learning level. The low levels in learning the subtraction skill are mostly seen in the behavioural objectives related to the decomposition of tens or hundreds (behavioural objectives 3, 5, 6, 8, 10, and 12). These findings are parallel with other research findings (Cockburn ve Littler, 2008; Gagne et al., 1993; Lawton, 2008; Haylock, 2005).

The anticipated behavioural pattern related to subtraction skills learning in the third grade mathematics curriculum did not prove to be consistent. The new pattern that was constructed due to the current research can be seen in Figure 1. Comments on the mentioned progressivity relationships can be seen below:

Question 11

675

- 324 What is the result of the subtraction?

A) 3 5 1 B) 3 6 1 C) 9 5 5 D) 9 9 9

Comment. To answer this question, prerequisite behaviours for 3rd grade students are not necessary as it is anticipated that subtracting one one-digit number from another is learnt by students in the 1st grade. Therefore, the behaviour that this question tests should be up front in the sequence, not in position 11.

Question 3

7 3

- 8 What is the result of the subtraction?

A) 7 5 B) 8 1 C) 6 5 D) 7 1

Comment. The solution to this question includes a behaviour that requires the skill of the decomposition of tens or hundreds. Since in the implemented test there is no question testing the decomposition of tens or hundreds or place values of a number, the prerequisite behaviour of question 3 did not come up in the questions in this test. Therefore, the reason for not exceeding mastery learning in this question may be due to a defect in the behaviours of change in decimal fractions and place values. Another probability is that the teaching of the behaviour that the 3rd question tests is not effective.

Question 5

4 2

- 3 4 *What is the result of the subtraction?*

A) 8 6 *B) 1 8* *C) 7 6* *D) 8*

Comment: To solve this question, one must be able to solve questions 3 and 11. In light of this, learning the task needed to solve questions like question 5 becomes easier in the subtraction of three-digit natural numbers if decomposition is not required.

Question 8

1 4 3

- 5 *What is the result of the subtraction?*

A) 1 3 8 *B) 1 4 8* *C) 1 3 5* *D) 1 4 2*

Comment. To solve this question, one must know the 3rd behaviour. The cognitive operations that students need to do here and in behaviour 8 do not show any big difference amongst themselves. As a matter of fact, their item difficulty degree turned out to be the same.

Question 12

4 3 1

- 1 5 2 *What is the result of the subtraction?*

A) 3 2 1 *B) 3 7 9* *C) 5 8 3* *D) 2 7 9*

Comment. To solve this question, one must be able to solve questions 3 and 8. Decomposition appears twice in the question. Therefore, to solve question 12, an acquirement is needed on top of the knowledge required to solve questions 3 and 8. Questions 3 and 8 are prerequisites of question 12.

Question 10

5 1 2

- 3 6 *What is the result of the subtraction?*

A) 5 2 4 *B) 5 4 8* *C) 4 7 6* *D) 4 8 6*

Comment. Questions 10 and 12 both require the skill of change in decimal fractions. Question 10 is more difficult than question 12 because place value 10, after exchanging the 1 from place value 10 to place value 1, becomes zero. Correspondingly, one hundred is needed to be added from the hundreds place value in the number, but students tend to forget this.

Question 6

5 A

- B 3

1 3 *What are the numbers that will replace A and B in the subtraction?*

A) A = 6 *B) A = 0* *C) A = 0* *D) A = 6*

B = 6 *B = 6* *B = 4* *B = 4*

Comment. This question includes an equation. To solve this question, one must know subtraction and place values. Due to the fact that there are missing numbers in both the minuend and the subtrahend, the question becomes more difficult. This behaviour should be taught at the end of the teaching.

Based on the conclusions above, the suggestions below were developed:

1. While teaching subtraction, a teaching sequence should be followed by referring to the progressivity relationship related to the subtraction skills.

2. Teachers need to search for the reasons for students' mistakes and prepare supplementary teachings based on these by referring to the progressivity relationships shown in Figure 1.

3. After giving importance to the prerequisite relationships, the quality—in other words, the relevancy—of the teaching service of the mathematics curriculum can be inferred. To this end, different methods for teaching behavioural objectives related to subtraction skills including the principle of equality and change in decimal – hundred fractions where students make most of their mistakes can be tested (Carpenter et al., 2003; Haylock, 2006).

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Doğal Sayılarda Çıkarma Ünitesinin Değerlendirilmesi

(Özet)

Program geliştirme; bir programın tasarlanması, uygulanması, değerlendirilmesi ve değerlendirme sonuçlarına göre yeniden düzenlenmesi süreçlerini kapsamaktadır. Program tasarısında hedefler, eğitim durumları ve değerlendirme öğeleri vardır. Program değerlendirme çalışmalarında programın farklı boyutlarını ele alan model ve yaklaşımlar uygulanabilir. Ancak, bir programda yer alan hedefler, programın diğer öğelerini de etkilediğinden öncelikle hedeflerin değerlendirilmesi önemlidir. Program tasarısına yazılan hedefler hipotetiktir. Bir başka deyişle programda yer alan hedefler denencel niteliktedir. Hedeflerin sağlamlılık ve tutarlılıklarının değerlendirilmesi gerekir.Yapılan araştırmalar program tasarısına yazılan hedef davranışların öngörülen aşamalılık içerisinde olmayabileceğini göstermiştir.

Önkoşullar davranışlarında ve öğrenme güdüsünde önemli eksikleri bulunmayan öğrenciler, etkili ve yeterli bir öğretim hizmeti eşliğinde çalışmalarına karşın öğrenemiyorlar ya da öğrenmelerini belli bir düzeyin üzerine çıkaramıyorlarsa, uygulanmasına çalışılan öğretim programının sağlam ve işe yarar bir program olmadığı düşünülebilir. Programın sağlamlığını ve işe yararlılığının değerlendirilmesi, davranış ve hedef bazlarında çalışmayı gerektirir. Davranış bazında çalışma, (1) her davranışın ulaşılabilirlik derecesinin ve (2) davranışların

birbirini destekleme derecesinin saptanması çalışmalarını içerir. Hedef bazında çalışma, (1) bir hedefin altındaki davranışların o hedefi kapsama durumu, (2) hedeflerin gerçekleşme derecesi ve (3) hedeflerin birbiriyle tutarlılığı çalışmalarını gerektirir. Eldeki çalışma davranış bazında çalışmaya örnektir.

Okul öğrenmelerinde yer alan bilişsel hedeflerin büyük çoğunluğu sıkı bir aşamalılık ilişkisi göstermektedir. Bu ilişki içerisinde önkoşul niteliğinde olan davranışlar bir sonra öğrenilecek olan davranışların öğrenilmesini etkilemektedir. Önkoşul davranışlar başarıyı kestirmede ise yüksek bir etkiye sahiptirler. Özellikle matematik dersindeki davranışlar önkoşul ilişkiler açısından çok güçlüdür. Matematikte davranışlar arasındaki ön-şart oluş ilişkilerinin güçlü olması, yeni bir ünitenin veya konunun öğretimine başlamadan önce, bu konuda planlanan davranışların kazanılmasına temel teşkil eden veya kolaylaştırıcı olan davranışlara öğrencilerin sahip olup olmadıklarının da izlenmesini gerektirir. Bu bakımdan matematik öğretiminde, davranışlar arasındaki ilişkilere önem verilmesi, hatta öğretim planları yapılırken önce bu ilişkilerin çıkarılması ve öğretimde göz önüne alınması gerekmektedir. Çıkarma becerisi matematik programında önemli bir yere sahiptir. Bir başka deyişle çıkarma işlemi matematik programında yer alan diğer üst düzey hedeflerin kazanılmasında gerekli olan bir beceridir. Bu bağlamda bu beceriye ilişkin yapılacak olan öğretimin doğru bir sırada olması şarttır. Bu becerinin öğretilmesinde nasıl bir sıra izlenmesi ve buna bağlı olarak da çıkarma işlemini kapsayan davranışların nasıl bir önkoşul ilişki oluşturduklarının bilinmesi öğretimin niteliğini ve öğrenmedeki başarıyı artırır. Aynı zamanda öğretmenin hangi noktalara daha fazla önem vereceği ve ek öğretimde nasıl bir yol izleyeceği de belirlenmiş olur. İlkokul öğrencileri arasında en yaygın kavram yanılgısı çıkarma işleminde görülmektedir.

Öğrenmede önkoşul ilişkiler öğretimin planlanmasına ve uygulanmasına ciddi boyutta rehberlik sağlamaktadır. Birinci olarak, öğretimin tam olmasına yardımcı olurlar. Tüm önkoşul ilişkilerin belirlenmesi ile herhangi bir öğretim boyutunun dışta kalması mümkün değildir. İkincisi, ise öğretim için uygun bir sıranın belirlenmesini sağlarlar. Önkoşul ilişkiler öğretmenin hangi önemli boyutlara odaklanılması gerektiğini sağlayarak öğretimin daha verimli olmasını sağlar. Aynı zamanda öğrencilerin öğrenme eksikliklerinin belirlenmesinde davranışlar arasında önkoşul ilişkilerin neler olduğunun saptanması da gerek öğretim esnasında gerekse ek öğretim faaliyetlerinde öğretmenlere yardımcı olacaktır. Bu çalışma böyle bir amaca hizmet edebilecek verilerin elde edilmesini sağlayacağından önemli bir nitelik taşımaktadır.

Araştırmanın Amacı

İlkokul 3. Sınıf Matematik Dersi Programı'nda yer alan doğal sayılarda çıkarma işlemine ilişkin davranışlar arasındaki ilişki tutarlı mıdır? Sorusuna yanıt bulmak araştırmanın temel amacıdır. Bu amaç doğrultusunda aşağıdaki sorulara yanıt aranmıştır.

1. Mevcut programın uygulanması ile oluşan çıkarma işlemi becerileri farklı sosyo ekonomik düzeydeki okullardaki öğrencilerin öğrenme düzeyleri arasında fark yaratmakta mıdır?
2. Doğal sayılarda çıkarma işlemine ait hedef ve davranışların gerçekleşme derecesi ne düzeydedir?

3. Doğal sayılarda çıkarma işlemi becerilerine ait davranışların önkoşul ilişkileri nasıl bir örüntü oluşturmaktadırlar?

Araştırmanın Yöntemi

Araştırma bir program değerlendirme çalışmasını içermektedir. İki sınıf üzerinde yürütülen çalışma öntest-sontest modeline göre düzenlenmiş ancak sınıflardan herhangi biri deney grubu yapılmamıştır. Araştırma, 2008-2009 öğretim yılında Lefkoşa ilçesine bağlı olan Şht. Ertuğrul ve Necati Taşkın İlkokullarının 3. sınıflarından seçilen 2 şubedeki 43 öğrenci üzerinde yürütülmüştür. Araştırmada ölçme aracı olarak Bilişsel Giriş Davranışları ve İzleme Testi uygulandı. Verilerin analizinde ise 't' testi, ve tetrakorik korelasyon teknikleri kullanılmıştır.

Araştırmanın Bulguları

Araştırma kapsamına alınan her iki okulda da öğrencilerin doğal sayılarda çıkarma işlemine ilişkin gösterdikleri başarı arasında bir farkın olmadığı söylenebilir. Öğrencilerin sontest puanlarının artitmetik ortalaması 9.12 olarak hesaplanmıştır. 12 soruluk bir testte bu oran yüzde 76'lık bir başarıya denk gelmektedir. Bu bulguya gore, öğrencilerin başarısı tam öğrenme ölçütünün (%75) sınırında olduğu söylenebilir. Tüm maddelere ilişkin elde edilen tetrakorik korelasyon katsayıları hesaplanmış ve aralarında anlamlı ilişki bulunan maddeler belirlenmiştir. Bu maddelere ilişkin öncelik-sonralık ve önkoşul ilişkilerini belirlemek için maddelerin güçlük indekslerine (p) bakılmış ve yüksek olanlar öne alınacak şekilde yeni bir aşamalılık örüntüsü oluşturulmuştur. Bu örüntü 3. Sınıf Matematik Programında öngörülen sırala ile tutarlı bulunmamıştır.

Araştırmanın Sonuçları ve Öneriler

Araştırma sonuçlarına göre, ilkokul 3. sınıf öğrencileri doğal sayılarda çıkarma işlemini tam öğrenme ölçütü (% 75) düzeyinde kazanmaktadırlar. Araştırmaya alınan iki ilkokulun doğal sayılarda çıkarma işlemine ilişkin başarıları arasında anlamlı bir fark yoktur. Doğal sayılarda çıkarma işleminde öğrenme düşüklüğü en çok onluk-yüzlük bozma gerektiren davranışlarda olmuştur. İlkokul 3. Sınıf Matematik Programı'nda yer alan doğal sayılarda çıkarma işlemine ilişkin öngörülen davranış örüntüsü tutarlı çıkmamıştır. Bu nedenle çıkarma işleminin öğretim sırası eldeki araştırmada ortaya çıkan aşamlılık ilişkisine göre yapılmalıdır. İlerki araştırmalarda öğrencilerin en çok hata yaptıkları onluk-yüzlük bozma gerektiren davranışların ve eşitlik ilkesini içeren çıkarma işlemine ilişkin davranışların öğretiminde farklı yöntemler test edilebilir.

Anahtar Sözcükler: Program değerlendirme, çıkarma işlemi becerisi, hedef davranışlara ulaşılabilirlik, önkoşul ilişkiler.