CORRELATED-FEATURES SEQUENCE AND COGNITIVE STRATEGY EDUCATION BASED ON DIRECT INSTRUCTION MODEL IN MATH SKILLS OF STUDENTS WITH SPECIAL NEEDS

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ABSTRACT
Math skills are one of the most important skills in daily and academic life for the individuals with special needs. As math skills have a hierarchical structure, students often encounter problems in math skills. Math education needs to be effectively designed for students with special needs. A well-designed curriculum constitutes the basis of the success. The Direct Instruction model differs from other models as it focuseson the generalization with long-term practices and the design of the curriculum. In Direct Instruction model, instruction needs to be analyzed in terms of content and the teacher needs to determine which association types the subjects are divided into within the content analysis. From the simple to the complex, association types are categorized as verbal associations (simple facts, verbal chains and discriminations), concepts, correlated-features sequence and cognitive strategies. The main purpose of the current studyis to examine correlated-features sequence and cognitive strategy education based on the Direct Instruction model in math skills of students with special needs.
Keywords: Students with Special Needs, Math Skills, Correlated-Features Sequence Instruction, Cognitive Strategies Instruction, Direct Instruction Model.

Math, which has become an inseparable part of daily life activities, is becoming more and more important in the world (National Council of Teachers of Mathematics, 2000). Math has a significant place in everyone's life and math education is one of the most leading academic subjects which is considered critical for all individuals in both developed and developing societies.In classrooms, adaptations and arrangements are required in teaching mathematics not only for the students with special needs but for all students. It is pointed out in the studies that effective math education constitutes the basis of success of individuals in business and real life in the future (Bryant, Bryant, Kethley, Kim, Pool & Seo, 2008). Especially, individuals with special needs are required to have adequate acquisitions in math-related processes in order to adapt to the social life. As new concepts,terms, symbols and skills are being learned, previous skills need to be remembered and applied,as well.
The report of the National Mathematics Advisory Panel (2008) states the need for math curriculum that encourages student success and use the researched-based instructional strategies in maths. Achieving a level of mastery with basic math concepts for student is quite critical. Also special need of the student can further compromise student learning (Spear-Swerling, 2005). For instance, the studies show that students with learning disability have problems in recalling (Kavale&Forness,1992; Scruggs &Mastropieri, 1986; Cooney, & Swanson, 1986) and that children with emotional& behavioral disorder often have troubles with attention, memory and high-level thinking skills (Shaywitz, Escobar, Shaywitz, Fletcher, & Makuch, 1992).Individuals with special needs may have more difficulty in acquiring concepts, recalling the mathematical processes and rules as well as making them functional, and in analyzing mathematical problems (Butler, Miller, Lee & Pierce, 2001). Additionally, it was reported that students with special needs tended to drop out twice more than normally-developing students (Blackorby& Wagner, 1996). As math displays a high-level hierarchy (pre-requisite skills), the problems especiallyin the basic skills (for example, counting with fingers/not having fluency in basic addition) make the processes more complicated (addition with carrying, etc.). Acquisition of a math skill greatly depends on the previous math skills. Therefore, math education needs to be designed in the best way that students can learn effectively. Instructional procedures, which are effective in functional math subjects, in accordance with the performances of the individuals with special needs are very important in understanding and applying academic subjects.

In effective instruction practices, one of the most important factors that affect the success of the student is the quality of the teacher (Billingsley &McLeskey, 2004). Therefore, it is very important for special education teachers to have the necessary educational background and experience to teach math skills to the students. Including effective teaching principles to help students acquire and generalize math concepts and skills are directly related to the quality of the education (Scarlato & Burr, 2002).Other factors that affect the success of the students are curriculum and instructional materials. In a review of research literature, (Kame'enui, Carnine, Dixon, Simmons ve Coyne, 2002; Lenz &Deshler, 2004), it is recommended to develop the curriculum and instructional materials with the purpose of helping the individuals with special needs learn and acquire skills. It is necessary to pay attention to develop a systematic strategy instruction in educational environments for the

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individuals with special needs or for the individuals at risk. A graduated instructional sequence into instruction aims to help students advance to abstract levels of math understanding using the concrete semiconcrete-abstract sequence (Maccini & Ruhl, 2000). In this context, National Council of Teachers of Mathematics (NCTM, 1980) have eight recommendations to offer math education in a dynamic and forward-thinking approach in accordance with the necessities of the time. Five of these recommendations cover the students with special needs. These are; 1)It should focus on math problem-solving studies at school, 2)It should focus on the basic skills in math rather than calculating skills, 3)Math curriculum should evaluate the student performance and success rather than traditional tests, 4)Computer technology or calculator which may help in math classes should be provided, 5)Math studies should be supported with various intense activities within a flexible curriculum. Also a schema-based instruction to encourage students represent the underlying math structures to solve the problems (Xin, Jitendra & Deatline-Buchman, 2005). Hence, it facilitates contextualized problem-solving skills and generalization to contextualized problem types (Bottge, 1999). Worries with the low math performance of U.S. students followed to more logical standards for teaching and learning mathematics, as well as greater student accountability.The National Council of Teachers of Mathematics (NCTM, 1989, 2000) developed standards for teaching math that mirror a greater focus on awareness with concepts (i.e., emphasizing meaning rather than meaningful memorization), mathematical reasoning, andproblem-solving skills that can be easily adapted into real-life situations.
The way to put these recommendations into practice may be to professionally develop the teachers and to enable them to use effective materials, and to encourage the teachers to use research-based practices (Sener&Belfiore, 2005).Walberg (1990) summarized the results of approximately 8000 studies.Based on the summary, one of the two common traits of the instruction methods supported with experimental evidences is overachievement expectation, and the other is incentives (Özyürek&Tuncer, 2003). One of the practices supported with experimental evidences is the Direct Instruction model. The most comprehensive research that tested the efficiency of the Direct Instruction model is Follow Through Project. Follow ThroughProject is the biggest educational research in history. The research was conducted with approximately 100.000 students in 170 residential areas. The Model was experimentally proved to be efficient with other studies conducted after the project as well.

According to the Direct Instruction model, wordproblem solving instruction was proved to be efficient in the studies with different groups with special need. It was observed that the practices conducted by Bayram, 2006, Tuncer, 2009 and Karakoç (2002) according to the Direct Instruction model increased thewordproblem solving performances of visually-impaired students. Furthermore, researchers examining cognitive strategies especially focus on teaching of multiplication (Irish, 2002), the teaching of test-solving steps (Kretlow, Lo, White, & Jordan, 2008) and addition & subtraction in fractions (Test & Ellis, 2005)in mathematics. There are extensive studies on other academic subjects such as physical sciences (King-Sears, Mercer, &Sindelar, 1992) and social sciences (Brigham, Scruggs, &Mastropieri, 1995). Yet, it is remarkable that uncorroborated traditional methods (e.g. modality instruction) rather than proven practices are often used at schools (Ysseldyke & Burns, 2009). The main purpose of the current study is to examine correlated-features sequence and cognitive strategy education based on Direct Instruction model in math skills of students with special needs and then to discuss the reflections of the studies in the literature.

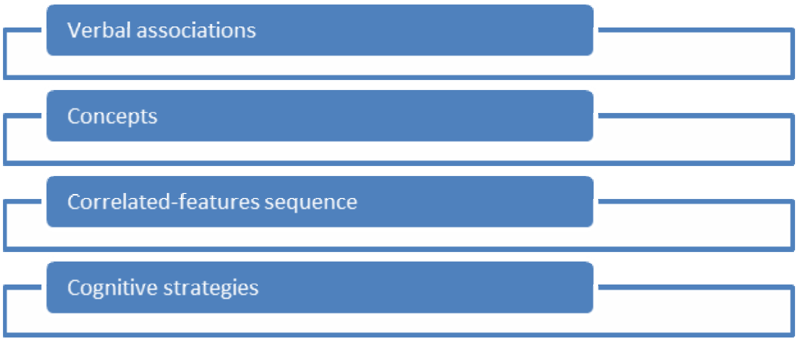
Direct Instruction Model

Direct Instruction Model was developed for the teaching of cognitive skills.The Model is described as a teacher-centered instruction model which focuses on curriculum design for the success of the student and which includes generalizable teaching strategies as well as written teaching processes (Engelmann &Carnine, 1991; Tuncer& Altunay, 2004).Direct Instruction Model, theoretically based on the studies of Engelmann and Carnine (1981), emphasizes that the changes on students can be assessed and evaluated when a planned instruction is systematically offered to the students. In the model, the most significant characteristic of the instruction skills is that they do not vary from practice to practice and according to the personal styles of teachers.In Direct Instruction model, the role of the teacher in the learning process iswell-definedand instruction skills are practically explained. It is suggested in thisapproach that every child can learn when the factors of the teaching process offered to the student are well-controlled. In instructive approaches like Direct Instruction model, the importance of the factors such as supporting the curriculum in learning-teaching activities, selecting the examples to be presented for the teaching process, observing the improvement of the student, and systematically correcting the mistakes of the student is pointed out (Tuncer&Altunay, 2004).

The fact that the Direct Instruction model designs the instruction materials as well as the teaching process contributes to the students' reaching their objective in a short time. While designing the curriculum in Direct Instruction model, firstly, the content analysis should be conducted; in other words, it should be reviewed in terms of association types and "Big ideas" (Kameenui& Simmons, 1990; Kozloff, Lanunziata, Cowardin&Bessellieu, 2000/2001; Tuncer& Altunay, 2004). The second important factor is open communication. Open communication is to organize a presentation in order that a student can make a maximum number of generalization out of the examples. The examples to be presented are carefully selected and arranged in an order so that the student can see the related and unrelated qualities of the concept. The third factor is the format of the instruction. Based on the association type with planned instruction, the teacher's way of presenting the examples, the questions to be asked to the students, and how to make a correction in incorrect responses are specified (Watkins & Slocum, 2003). The fourth factor is the ordering of skills. It is the teaching of easier skills before the harder ones (Carnine, Silbert, Kameenui& Tarver,2004). Lastly, Direct Instruction Model has an organization which can be called as strand curricula (Przychodzin, Marchand-Martella, Martella& Azim, 2004). Thanks to the strand curricula, students have the chance to utilize various concepts and skills in wider concepts and to perform distinguishing practices (Watkins & Slocum, 2003). Carnine (1980) lists the help reduction, which is required in any well-designed curriculum, as follows: (1)from proceeding with open problem-solving strategies towards more closed problem-solving strategies, (2)from a simpler presentation towards a more complex context, (3)from performing a skill by taking clues towards performing it without a clue, (4)from massed exercises towards distributed exercises, (5)from instant feedback towards delayed feedback, (6)from the teacher as the information source to the student as the information source. There are four basic elements of the arrangement of teaching process in Direct Instruction Model. These are to group the students based on their educational needs, to utilize the instructional time, written teaching processes and to continuously evaluate the performance of the student.

Association Types in Direct Instruction Model

The fact that the teacher can discriminate the association types is very useful in instruction presentation and practice phases. Being aware of the type of association is very critical in terms of how to organize the class, how to select the examples, and what changes can be practiced on the teaching process.



Verbal Associations and Concepts

Verbal Associations are defined as the combination of a special stimulus and a special response type which constitutes the basis of high-level information (Kameenui& Simmons, 1990; Tuncer&Altunay, 2004). Verbal associations are categorized as simple facts, verbal chains, and discriminations. Basic addition (3+2= 5) (simple facts), line counting, rhythmic counting (verbal chains) and numerical reading (discriminations) can be given as an example to verbal associations. Instruction phases are modeling, guided practice and independent practice. In modeling phase, the teacher instructs verbally or visually.In guided practice phase, the teacher and the student repeat the information together until it is ensured that students can express the information (Kameenui&Simmons, 1990; Marchand-Martella, Slocum, & Martella, 2004). Independent practice is the phase where the students express the information independently (Kameenui& Simmons, 1990). Modeling and guided practice phases are the critical phases to enable the student to perform the independent practice.

Concepts differ from verbal associations in terms of content variation as well as example connection in order to use them (Kameenui&Simmons, 1990). There are narrow and wide range of examples, example selection and sequence in concepts; however, in verbal associations, discriminating the other examples or recalling an example or examples arranged in order are required. A teacher who knows how to classify the concepts can specify the instructional requirements of concepts (example selection, sequence, presentation of teacher, etc.). The instruction of the concepts within the same concept variation shows similarity (Kameenui&Simmons, 1990). For instance, the example sequence is the same in the instruction of "tilted" concept and "under" concept within the same concept variation; however, the example sequence differs in different concept groups. For example, the way followed in example selection and sequence to teach "more and less" concepts should be different from the way followed to teach "triangular prism, cube and sphere" concepts.

Correlated-Features Sequence

Kameenui and Simmons (1990) describe the correlated-features sequence as the proposition that determines the special relationship between at least two facts, discriminations or concepts. It is suggested that correlated-features sequence instruction can be utilized in order to present the connection between a stimulus and another event that occurs simultaneously, but cannot be observed (Tuncer&Altunay, 2004). “If the bottom number is higher than the top number, we break the decimal”, “when we multiply a decimal with ten, we shift the comma to the right for one digit”, “even if the place of the numbers changes, the result does not change in an addition process” can be given as an example to the correlated-features sequence.

The propositions regarding the correlated-features sequence also show which examples will be presented and how these examples will be figured for the presentation (Kameenui& Simmons, 1990). Two questions are asked in the presentation of examples in correlated-features sequence. The first question enables to follow a routine by applying the rule specified in the proposition, and the second question enables to make a connection between the result and the proposition. For example, the teacher asks, "should we break a decimal?", and the student answers, "Yes". The teacher asks, "How do you know?", and the student answers, "the bottom number is higher than the top number".

Correlated-features sequence instruction differs as one-dimension inclusion and multiple-dimension inclusion. One-dimensional correlated-features sequence involves the relationship of an event or concept with another event or concept. If this relationship is one-dimensional, there are some principles to follow in order to organize a correlated-features sequence presentation. The correlated-features sequence to be taught in order to determine how to select the examples and how to arrange them in order is stated as a proposition. In order to determine if the proposition is a concept or if it contains another type of association, the proposition is resolved and the presentation sequence of the examples is determined based on this. As there are nouns in the proposition in some correlated-features sequences, the examples are sequenced as in the noun presentation. For example, the "on" concept is mentioned in the correlated-features sequence as "it is a full hour if the minute hand is on 12". As the “on” concept is a non-comparative sequences concept, the presentation is performed according to the example sequence of the non-comparative sequence concept. The teacher gives 3 positive "full hour" examples (01:00, 04:00, 08:00), and 2 negative examples considering that the first negative example is the least different example (08:10), and then asks the evaluation questions. An example of one-dimensional correlated-features sequence instruction is given in Table 1.

Some correlated-features sequences contain multiple dimensions. In such correlated-features sequences where two features are together, the presentation starts with the positive example. Some correlated-features sequences carry one or another of a few dimensions. In such correlated-features sequences, the presentation starts with the negative example. If the presentation starts with the negative example, the assessment is clearly seen (Engelmann &Carnine, 1991).Most of the rules in math field constitute the basis of high-level cognitive strategies. For example, the fact that a student learns when to use the carrying method makes it easier to make "addition with carrying" by using the rule of carrying method later. Therefore, it is very important for the student to learn these rules and to use them fluently in order to utilize them within cognitive strategies.

Table Example 1and 2 show two sequences that derive from the fact; If you make the top and bottom of the fraction the same, you make a fraction the same, you make a fraction that equals one whole. The first sequence treats the relationship as a single-dimension discrimination and places a choice-response test. The second sequence treats the relationship as a transformation and requires the learner to different transformation responses. The sequence starts with a negative and three positives, The learner needs to categorize each example (Engelmann, S. & Carnine, D., 1991).

TableExample 1.
A Choice-Response Sequence

Example		Wording
1.	5/4	My turn. Does this fraction equal one? No. How do you know? Because the top and bottom are not the same.
2.	4/4	My turn, again. Does this fraction equal one? Yes. How do you know?Because the top and bottom are the same.
3.	98/98	Your turn. Does this fraction equal one? How do you know?
4.	7R/7R	Does this fraction equal one? How do you know?
5.	7/7R	Does this fraction equal one? How do you know?
6.	14/8	Does this fraction equal one? How do you know?
7.	12/12	Does this fraction equal one? How do you know?
8.	81/5	Does this fraction equal one? How do you know?
9.	241P/241P	Does this fraction equal one? How do you know?

TableExample 2.
A Transformation Sequence

Example		Wording
1.	12D/___=1	I am going to show fractions that equal one, but part of each fraction is missing.
2.	12/___=1	My turn to say the fraction that equals one:12D over 12D. How do I know 12D over 12D equals one? Because the top and bottom are the same.
3.	2/___=1	My turn again: What fraction equals one? 12D over 12. How do I know it equals one? Because the top and bottom are the same.
4.	__/2=1	Your turn: Say the fraction that equals one. How do you know?
5.	__/17=1	Say the fraction that equals one. How do you know?
6.	__/3+R=1	Say the fraction that equals one. How do you know?
7.	100R/__=1	Say the fraction that equals one. How do you know?
8.	__/2=1	Say the fraction that equals one.How do you know?
9.	5R/__=1	Say the fraction that equals one. How do you know?

*Note:*Table 1 and 2 are taken from the book of *Theory of Instruction: Principles and applications*by Engelmann, S. & Carnine, D., 1991.

Cognitive Strategies

Kameenui and Simmons (1990) defined cognitive strategy as the process of using a series of simple facts, verbal chains,discriminations, concepts and rules together with the purpose of solving a problem.As a cognitive strategy contains various data such as concept and correlated-features sequence, students need to master these skills. Although the majority of the success of a student at school depends on recalling the information in exams and keeping them in mind is discussed, there are researches in literature regarding that cognitive strategies enhance the students' data-coding & memorizing skills, and contribute to the class performance of the students as well as their success in standard exams (Scruggs, T. E., Mastropieri, M. A., & Boon, R., 1998).Cognitive strategies need to be presented in a way to enable the student to reach high-level knowledge and generalization by using the previously-learned data (Gajria, M., Jitendra, A. K., Sood, S., & Sacks, G., 2007). Many skills taking part in math curriculum are cognitive strategy skills. Addition with multi-digit numbers (related skills: correlated-features sequence as addition with carrying if the number obtained after addition is not single-digit, discriminating the units, tens and hundreds digit, mastering the basic operations), hour-reading (related skills: counting up to 60 in fives, numerical reading, discriminating the hour and minute hand, past & to rules), calculating the slope of the line, etc. can be given as an example to the cognitive strategies which contribute to high-level thinking (Kozloff, 2004). Word problem solving skill is a cognitive strategy skill. Word math problems require the utilization of well-known math skills to solve an unknown problem. As the instruction of calculation skills are prioritized in math, students have difficulty in solving math problems (Tuncer, 2009).

Cognitive strategies instruction is designed in a way to reduce the help of the teacher from the maximum structuring to the minimum structuring. In a fully-structured presentation, the teacher leads the students with the help of the simplifying questions and/or instructions in order to enable them to create a new skill by using the previously-learned concepts and skills. And then, the teacher reduces the questions and instructions to help the student be independent in using the strategy.For example, after teaching the correlated-features sequence as "if the first number of the divided is equal to or higher than the divisor, we underline the first number" 420 | 2 "if the first number of the divided is lower than the divisor, we underline the first two numbers" 365 | 6, the presentation structured to do the process independently performs the process right after the worksheet practice structured by handing out the papers containing the division operations, as well as the worksheet practice less-structured by withdrawing the clues.It is observed that cognitive strategies instruction is an effective techniquewhich is used in both acquisition and long-term recall of important data (Sener&Belfiore, 2005). An example of cognitive strategies instruction is given in Table 3.

Table 3.shows an example(2).

Adding Two Numerals with Renaming

TEACHER	STUDENTS
PART A: STRUCTURED BOARD PRESENTATION	
(Write the following problems on the board.)	
36+27=	
48+26=	
26+16=	
1. Read this problem as 1 point.	36+27=how many?
2. What column do we start working in?	The ones column
3. What are the first two numbers we are going to add?	6+7
To correct: Point to 6 and 7. Repeat step 3.	
4. What is 6+7?	13
5. We have a problem. Thirteen equals 1 ten and 3 ones. We can’t have a 10 in the ones column, so we put the 1 ten at the top of the tens column. Where do we put the 10?(Write 1 over 3.)We write three ones under the ones column. Where do we put the three ones? (Write 3 under 7)	On top of the tens column. Under the ones column.
6. What are the first two numbers to add in the tens column?	1+3
What does 1 and 3 equal? (Pause)	4
Now what two numbers will we add?	4+2
What is 4+2?	6
How many tens do we end up with?	6tens
We end up with 6tens, so I will write 6 under the tens column. *(Write 6 in the tens column)*	
7. We are finished. *(Point to 63)* What does 36+27 equal?	63
Read the problems and say the answer. *(Repeat steps 1-5 with remaining problems.)*	36+27=63
PART B: STRUCTRED WORKSHEET PRESENTATION	
(Students have worksheet with the following problems.)	
45+38=	
57+37=	
36+16=	
47+26=	
1. Touch the first problem on your worksheet. Read the problem.	45+38=how many?

2. What column do you startworking*	The ones
What are the first two numbers you are going to add?	5+8
What is 5+8? *(Pause)*	13
3. There is a problem. What does 13 equal?	1 ten and 3 ones
Can we have a ten in the ones column?	No
So where do you put the ten?	On top of the tens column
Write 1 on top of the tens column. (*Monitor student responses)*	13 equals 1 ten and 3 ones
How many are left?	3
Write them under the ones column. *(Check)*	
4. Look at the tens column. What are the first two numbers to add in the tens column?	1+4
What is 1+4? *(Pause)*	5
Now what numbers will you add?	5+3
What is 5+3?	8
How many tens do you end up with?	8 tens
Write the tens under the tens column. (*Monitor student responses)*	
5. You have finished. What does 45+38 equal?	83
Read the problem and say the answer.	45+38=83
(Repeat steps 1-5 with remaining examples.)	
PART C: LESS STRUCTURED WORKSHEET	
(Give students a worksheet containing some problems that involve renaming and some that do not.)	
47+25= 78+21=	
53+24= 56+36=	
42-31= 75-23=	
78+18= 26+43=	
1. Everyone, read problem one on your worksheet.	47+25
What type of problem is this, addition or subtraction?	Addition
2. What are the first two numbers you add?	7+5
What is 7+5?(*Pause*)	12
3. Do you have to move a ten over to the tens column?	Yes
4. Now work the problem on your own. (*Pause)*	
5. What does 47+25 equal?	72
(*Repeat steps 1-5 with remaining problems)*	

Note: Table 3 is taken from the book of*Designing Effective Mathematics Instruction: A direct instruction approach* byStein, M., Kinder, D., Silbert, J., & Carnine, D. W., 2005.

Discussion

In Direct Instruction model, the instructions presented in the lessons based on the association types simplify the teaching practices of the teacher. The teacher does not hesitate about the teaching process and knows exactly how to withdraw the clues and how to present the examples.In the model, the most significant characteristic of the instruction skills is that they do not vary from practice to practice and according to the personal styles of teachers. In Direct Instruction Model, the role of the teacher is specified and the instruction skills are practically defined (Altunay, 2008). In Direct Instruction Model, factors influencing the learning process can be categorized as designing the teaching curricula, selecting the examples to be presented and their sequencing, monitoring student progress and correcting student mistakes. When teachers consider the principles of Direct Instruction model, they can easily observe the changes in student behaviours (Engelmann &Carnine, 1991; Tuncer& Altunay, 2004). Furthermore, it is observed that the students are highly motivated and learn permanently as a result of the instructions which progress cumulatively. Also, it is very important to include the expanded teaching and worksheet items in Direct Instruction model, so that the students can master their math skills. Moreover, the teachers need to know how to conduct strategic integration into the subjects, how to review and evaluate, and how to apply the process of correcting mistakes in math classes.

The present study contributes to the literature on teaching math considering correlated-features sequence and cognitive strategy education based on Direct Instruction model in math skills of students with special needs. In this context, it is vital that students with special needs continue to be taught correlated-features sequence and cognitive strategy education as well as test-taking strategies. Although valuable attempts have been suggested in order to conceptualize how to gain access to the general curriculum for students with special needs, more efforts are necessary to fulfill the gap.Teachers need to take into consideration the process through which the educational programs of students withspecial needs. Overall,it is critical to use evidence-based practices in education in order to accomplish effective results from the curricula created for the education of the individuals with special needs. Evidence-based practices are the instruction techniques which fill the gap between research and practice, and which are supported with significant researches in terms of their efficiency in developing the acquisition of students (Slavin, 2002). Yet, teachers need to use more evidence-based practices in their classrooms. There is a need to build a bridge between the teacher's practice in class and the research that highlights the effectiveness of the practice (Carnine, 1997; Cook &Schirmer, 2006).

While many of the support services and accommodations that students with special education might create a dependent environment while providing the support (e.g., notetaking), strategies suggest independency by decreasing external assistance. Strategies help students in taking the responsibility of their learning. Furthermore, generalizing strategic learning skills in new situations might be helpful for the well-being of the individuals with special needs.

In conclusion, as math skills have a hierarchical structuremath education needs to be designed in an effective way considering the requirements of the students with special needs. A well-designed and effective curriculum plays an important role, as well. In a review of research literature on the Direct Instruction model, it is noticeable that the Direct Instruction model differs from other models as it focuses on the generalization with long-term practices and the design of curriculum. In the present study, the Direct Instruction model is introduced as well as the significance and practices of the correlated-features sequence and cognitive strategies, which are the two of the association types described in the model, in math education.

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