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Description of Primary Education 1st Grade Students' Forms of Holding a Pencil as well as Their Grip and Compression Strengths

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Abstract

This study aimed to examine how first grade students in primary education held and gripped a pencil and their compressive strength using a descriptive research method. The participants of the research comprises first grade students attending a private school in the city center of Ankara (n=79). All of the four different sections in this private school were included in the research. In terms of the variable of holding the pencil, the following results were obtained with regard to the first grade students: Ratio of students keeping their index fingers below the 90°angle is more than half of the students participating in the research, 60% of the students positioned their forearms outward up to an angle of 45°, 80% of the students grasped the pencil with thumb and index finger, 63% of the students positioned their thumbs on the pencil, while half of the students grasped the pencil from the mid-point, 38.5 % of the students grasped it from the upper point, the Grip and compressive strengths of the first grade students were also determined in the study. Accordingly, the grip strengths of first grade students were in the range of 4-16.10 (kg) and grip strength varies by gender in favor of the males. One of the findings obtained in the study is that writing speed varies by gender. Accordingly, females write faster than males.

Key Words

Grip and Compressive Strengths, Writing and Holding Pen.

It can be said that if a human being is capable of transferring his feelings, thoughts, wishes, and designs onto paper or screen, this success is thanks to the pictogram that emerged thousands of years ago (Temur, 2009). The process of expressing oneself started with pictogram, continued with phonograms, and finally turning into the ideogram. People started to use writing system thanks to the invention of the alphabet (Akşit, 1981; Donoughue, 2009). Although there is no definite information regarding how writing was invented, however, cuneiform script, Egyptian hieroglyphics, the first Phoenician alphabet, and invention of the printing press can be seen as cornerstones in the history of writing.

Thanks to writing, people had the opportunity to record the important events they experienced, to store and protect the information, and this led the way to establishing communication with other people (Donoughue, 2009). In this way, writing became a part of communication skills and over time came to be part of educational activities. One of the elements influencing the effectiveness of the writing training process is previous experience. While some primary students have gained important experience regarding reading and writing (sound awareness, writing consciousness), others may not have had this experience. These experiences before starting school influence the readiness for reading and writing.

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Readiness is particularly important for writing activities. In addition to being at a certain level mentally, students should also have made an adequate psychomotor progress. Harrison (1976) emphasized that the readiness of students, especially those with learning difficulties consists of the following aspects which are required in learning to write:

Visual Perception: This is the capability to recognize objects, pictures and pieces of a whole.

Visual Spatial Relationships: Visual spatial relationships are related to size, height, similarity, and difference of objects as well as their relationships with other objects.

Visual-motor Skills: Visual motor skill refers to the ability to transfer spatial relationships recognized in the objects onto the paper.

Hand Eye Coordination: This is the skill of copying or drawing a figure or object seen.

Recall: This is the skill of recording previous perceptions in the long-term memory and accessing this information again when necessary (Özerk, Handorff, & Özerk, 2011).

The teaching process is as important as readiness in teaching of writing. Although most children become acquainted with paper and pencil before starting school, for many the teaching of variables such as holding the pencil, way of sitting and paper positioning is postponed to the first year of primary education. The first year of primary education can be rather late in terms of teaching of variables likely to affect the writing quality. In this sense, the preschool period can be seen as a period in which the children can acquire basic skills and should be the concern of both educational institutions and parents.

Reviewing the literature (Dennis & Swinth, 2001; Koziatek & Powell, 2003; Tseng, 1998; Ziviani & Elkins, 1986), it is seen that although there are different ways of holding the pencil but there is no definite agreed way of holding the pencil. The results of the studies examining the relationship between different ways of holding the pencil and writing speed and legibility can be evaluated. It is seen that various ways of holding the pencil stemming from variables such as the number of fingers on the pencil, forearm position and index finger gradient lead to differences in writing speed but these differences are not statistically significant (Koziatek & Powell, 2003; Tseng, 1986; Ziviani & Elkins, 1986). In their study on 4th grade primary students, Koziatek and Powell (2003) mention of six different ways of holding the pencil. Tseng (1998) and Dennis and Swinth (2001) have clarified how students grasp a pencil, which fingers they use when grasping the pencil and the support finger, as follows: the dynamic tripod grasp, the dynamic quadruped grip, static tripod grasp, four fingers grasp, index finger touching thumb, the four finger grasp, interdigital grip.

In this study, the examination of the students' ways of holding the pencil showed that the dynamic tripod grasp is the most frequently used (37 %) of the six different ways of holding the pencil, followed by the static tripod grasp; the four finger grasp, index finger touching thumb; and the least frequently used grasp types, which are the four finger grasp and interdigital (0.01%) grip. Different ways of holding the pencil influence the number of letters written per minute. However, although different ways of holding the pencil affect the writing speed between 1 one 5 letters per minute, it was not found to be statistically significant. In addition, no difference in favor of a particular way of holding the pencil was observed. According to Amundson (1995), the most frequent way of holding the pencil among students and adults is the dynamic tripod grasp.

Reviewing the literature, Ziviani and Elkins (1986) conducted an important study on the classification of ways of holding the pencil. In this study, the researchers demonstrated that there are different sub-dimensions of holding the pencil. Classification made in this study is as follows:

- Index finger according to the degree of flexion
  - Holding below 90 degrees
  - Holding above 90 degrees
- Forearm position
  - Outward up to 45 degrees
  - Outward more than 45 degrees
- The number of fingers used on the pencil shaft
  - Three finger grip
  - Two finger grip
- Thumb position
  - Crossing the index finger
  - On the pencil

In their study, Ziviani and Elkins (1986) examined a group of students aged 6-14 in terms of their ways of holding the pencil, writing speeds and mistakes.

According to the research results, students grasped the pencil in different ways in accordance with four variables mentioned above. However, it was found that this difference in grasping the pencil caused just a 1-3 letter change in of the average writing speeds which are not statistically significant. It was found out that the way of holding the pencil is also a factor in the legibility of the writing but as with the speed the differences obtained are not significant.

In the studies on writing (Ayres, 1912 cited in Ziviani & Elkins, 1986; Graham, Weintraub, & Berninger, 1998; Groff, 1961; Koziatek & Powell, 2003; Tseng & Hsueh, 1997; Ziviani, 1984; Ziviani & Watson-Will, 1998) the main variables are; holding the pencil, speed, legibility, gender, visual perception, muscular force and hand eye coordination.

Different results were obtained in the studies, which were thought to be due to the scale and sample. However, the common points were that writing speed increases as the person becomes older, the way of holding the pencil leads to a change in writing speed averages but these changes are not found to be statistically significant (Ayres, 1912 cited in Ziviani & Elkins, 1986; Groff, 1961) and that females write faster than males.

Although holding the pencil is an extremely crucial variable in writing, it is hard to say that children receive direct training in terms of how to hold and grasp the pencil properly and use the appropriate fingers. Children generally develop a way of holding a pencil that they feel is most comfortable. This way of holding the pencil may be the right or wrong way. There are many reasons why students' adopt the wrong way of holding the pencil; the most important being that, in the preschool period, parents do not provide the child with the appropriate guidance on the correct way to hold a pencil. Adopting an incorrect way of holding a pencil can continue throughout the individual's life. The second important reason is that even though painting and scribbling practices happen in pre-school educational institutions, not much importance is placed on how the child holds the pencil. Third factor may be that first grade teachers do not allocate sufficient time to train the children to hold their pencils correctly in the literacy teaching process.

A right handed student should place the paper on the desk inclined 40-45 degrees to the left. In the same way, posture should also be slanted to the left. The left hand is the support for a right handed student. In addition, eyes can change according to the posture, but on average they should be at a distance of 40 cm from the paper. A left-handed student should hold the paper at an inclination of 40-45 degree to the right and his/her posture should slant to the right. The student should use his/her right hand to support the paper. Another variable in effective and beautiful writing is the way of sitting. One of the elements enabling students to sit properly is the relationship between the student's height and their table or desk. A writer's way of sitting is generally considered as an important factor that influences the writing method and the quality of the handwritten product (Parush, Levanon, & Weintraub, 1998). It was observed that children incapable of holding their bodies up adequately have low muscle tone (contractile ability). Accordingly, it was found that children having lack of body stability are not able to adopt the appropriate posture activities such as writing which requires fine motor skills (Graham & Weintraub, 1996). Various factors influence correct seated posture of students including; paper position, writing hand, non-writing hand (the other hand), posture and eyesight (Croutch, 1976).

There are three important elements in teaching of writing; teacher, student and the activities. According to Bruinsma and Nieuwenhuis (1991), most handwriting researchers comparatively examined these three elements in teaching of writing. It was also mentioned during these comparisons that writing is a process containing three stages. (*i*) Prewriting practices (*ii*) Start-up phase (*iii*) Free or advanced level. A student completing these three stages can produce neat, legible, fluent handwriting. At this level the student can evaluate his/her own handwriting and see his/her mistakes and where he/she is deficient.

Akyol (2007) places importance on the adequate development of the shoulder, arm, wrist and finger muscles and stresses that children with incomplete muscular development have difficulty in motor development. Akyol also states that a development from big muscles to small muscles should be followed in muscular development.

It is possible to say that preparatory work for the muscular development of first grade students is not really adequate. It can be said that all students (affectively, physically, and cognitively) develop and grow at a certain level before they come to school. However, students with adequate development and growth process will be more ready for literacy activities. For that reason, parents and pre-school institutions should conduct activities such as cut and paste activities and clay games for to encourage the muscular development of children.

Grip and Compressive Strengths

Grip and compressive strengths are a function of the human hand (Smet, 2001) and enables many activities needed in everyday life. Accordingly, the hand has an important place in the life of the individual (Yim, Cho, & Lee, 2003). Considering the pre-school and first years of primary education, children can sustain their daily lives and move independently (e.g. eating, playing, holding the toys, grasping the crayons) with adequately developed muscles (Hager-Ross & Rösbland, 2002). It is emphasized that the fine motor skills are the primary variable influencing the daily life performance of children and adults. A great majority of the activities performed during the day depend on the adequateness of fine muscles developing in accordance with age (Surrey et al., 2001). Students spend 30% - 60% of a day at school by using their fine muscles (Case-Smith, Allen, & Pratt, 1996).

Surrey et al. (2001) emphasizes that fine muscle development is measured in three different types; fingertip pinch, three finger pinch (palmar), and key grip. Compressive strength is measured by using thumb and index finger tips in fingertip pinch; measured by using thumb, index finger, and middle finger in three finger pinch; and is measured by using thumb and index finger surface in the key grip.

It is seen in the literature that grip and compressive strengths are evaluated with units such as the kilogram, pound, and Newton. Studies conducted at various age levels show that grip and compressive strengths can vary even at the same age. For example, in the measurements conducted by Hager-Ross and Rösbland (2002) with a group of seven year olds, grip strengths were measured as an average of 8.9 (kg) in the males and an average of 8.2 (kg) in the female. In the same age group, Smet (2001) measured the average as 11.4 (kg) in males and 9.6 (kg) in females. Yim et al. (2003) suggested an average of 9.93 (kg) among males and the average of 8.5 (kg) among females.

Different values were found in the measurements of compressive strengths (fine muscle strength) as in the grip strength. Yim et al. (2003) found fingertip pinch grip was 1.27 (kg) in males and 1.08 (kg) in females; found three finger pinch (palmar) force 1.8 (kg) in males and 1.2 in females; and they found it 1.95 (kg) in males and 1.49 (kg) in females in the key grip. In the same age group, Surrey et al. (2001) gave the average value for females and males to be 2.5 (kg) in fingertip pinch grip, 3.5 (kg) for the three finger pinch, and 4.16 (kg) for the key grip. This difference emerging between the researches may be due to the sample chosen and socio-cultural differences. Although different results were obtained in the studies, it is possible to say that there are some similar findings. For example, compressive strength varies by gender in favor of males. Fine motor skills increase in accordance with age although they do not vary by gender (Hager-Ross & Rösbland, 2002; Surrey et al., 2001; Yim et al., 2003).

Method

This study aimed to examine how first grade students in primary education held and gripped a pencil and their compressive strength using a descriptive research method.

Participants

The participants of the research comprises first grade students attending a private school in the city center of Ankara (n=79). All of the four different sections in this private school were included in the research.

Data Collection Tools and Data Collection Process

In the study, different scales and tools were used for data collection. Scales and tools used for data collection are detailed below.

Writing Speed and Photography

A narrative text "İyilik Sever Kargalar (Bighearted Crows)" and writing speed test were used in order to determine the writing speeds of the first grade students participating in the research. This text, written in a cursive italic style, was distributed to the students so they could examine it. After students completed their examinations, the necessary explanations were made regarding the activity to be performed. The description of the process was as follows: "Please leave your pencils on the desk. When you are told "*You can start writing now*", copy the text given to you. While you are writing the text, I will ask you to stop once. When I say *"Stop writing"*, circle the letter you were writing. Then, when I say *"You can continue writing"* continue copying the text**.** While you are writing, I will take the photo of your hands holding the pencil**"**.

The hand grip strengths of primary education first grade students were measured via the *Saehan Hand Dynamometer* and their *compressive strength was measured* via *the Saehan Hydraulic Pinch Gauge*.

Grip and compression measurements were performed three times in the sitting position (shoulder in the neutral position, elbow at 90^0 flexion, forearm between pronation and supination and wrist is at $0\text{-}30^0$ extension and $0\text{-}15^0$ ulnar deviation) determined by American Society of Hand Therapists and widely used in the literature. The best value among these measurements was taken into consideration.

Data Analysis

Data collected in the study were analyzed using different statistical techniques according to the properties of the variables. Percentage (%) frequency (f) and the arithmetic average were used in the analysis of descriptive data; the difference of two-variable averages was determined via a t-test; the chi-square was used in determining the relationships of two categorical variables; the Kruskal Wallis test was used in the comparison where the number of participants was less than thirty.

Results

In this part, primary education first grade students' ways of holding the pencil and their grip and compressive strengths are described and examined in terms of several variables.

The first grade students' ways of holding the pencil were evaluated in terms of five different variables; index finger, forearm, the number of fingers, thumb, and the point of grasping the pencil. Considering the distribution relating these variables, it is observed that first grade students display two different ways of holding the pencil according to the degree of index finger flexion. Index fingers of 42.3 % of students form a flexion degree above 90° (n=33). On the other hand, more than half of the students (57.7 %) write with a flexion degree below 90°. Examining the relationship between holding the pencil and gender according to the degree of index finger flexion, it was seen that females had a tendency of holding the pencil above ninety degrees (n=33, 73.3 %) while males tended to hold the pencil below ninety degrees (n=21, 63.6 %). According to this finding, there was a relationship between holding the pencil and gender according to the degree of index finger flexion [$X^2 = 10.66$, $p < 0.001$].

Evaluating first grade primary education students in terms of forearm position, more than half (61.5 %) of students wrote with a forearm position outward up to 45° (n=48). Whether forearm position varies by gender was tested and it was found that there was no relationship between forearm position and gender [$X^2 = 0.106$, $p > 0.05$].

In terms of the number of fingers used on the pencil shaft, it was observed that there were generally two different ways of grasping the pencil. First way was to grasp the pencil with two fingers. However, these two fingers were the middle finger and thumb in some students (5.1 % (n=4)), they were the index finger and thumb in most of the students (82.1%, n=64). The second way was to grasp the pencil with three fingers (thumb, middle finger and index finger). 12.8% of students grasped the pencil in this way. It was found that there was no relationship between the number of fingers used on the pencil shaft and gender [$X^2 = 2.33$, $p > 0.05$].

Another variable observed in the first grade students is thumb position. While 62.8% (n=49) of students positioned their thumbs on the paper, 37.2% (n=29) of them held the pencil crossing their thumbs with the index finger. While 53.3 % (n=24) of male students kept their thumbs on the pencil, 46.7% (n=21) kept their thumbs in a position crossed by the index finger. While 75.8 % (n=25) of females kept their thumb in a position on the pencil, 24.2% (n=8) kept their thumbs in a position crossing with the index finger. It can be said that there is a relationship between the thumb position and gender [$X^2 = 4.09$, $p < 0.05$].

Holding patterns classified in terms of the point of grasping the pencil were observed in three different ways. Accordingly, while half of the students (52.6 %, n=41) grasped the pencil from the mid-point, 38.5 % of them (n=30) grasped the pencil from the upper point. It was observed that 9 % (n=7) of the students grasped the pencil from the lower point.

The minimum and maximum values as well as the average values of the grip strengths of the first grade primary education students are given in the table. In this study, it was determined that grip strength varies by gender in favor of the males ($t=4.33$, $p < .05$).

It was found that the minimum value of the compressive grip in key grip was lower than 0.5 while the maximum value is 2.60. Sex-based key grip pinch strength was found to be statistically significant in favor of males ($t= 3.08$, $p < .05$). Although the minimum and maximum values of the first grade students are equal in term of fingertip pinch strength, averages can be said to vary. Accordingly, the key grip compression strengths are higher than

the fingertip pinch strengths. The fingertip pinch strengths vary according to the gender (t=2.56, $p< .05$). According to gender the three finger grip strength, called the palmar strength, was found to be statistically significant in favor of the males (t= 3.23, $p< .05$).

The t test results showing the degree to which writing speed varies according to the variables of the degree of index finger flexion, forearm, and thumb position. Accordingly, the writing speeds of students flexing their index fingers above 90° are higher than those of the students flexing their index fingers below 90°. However, the difference between the averages according to the flexion degree is not statistically significant (t= 1.246, $p>$ .05). In terms of the forearm position, first grade students with forearm position outward up to 45° have higher writing speeds than the students with forearm position outward more than 45°. However, the difference between the averages resulting from different ways of holding the forearm is not statistically significant (t= 0.378, $p> .05$). Evaluating students in terms of the thumb position, it is seen that when the student holds the pencil in a way that the thumb crosses with the index finger the writing speed is faster, but this difference between the averages is not statistically significant (t= 1.06, $p> .05$).

Evaluating the first grade students in terms of the variable of the number of fingers on the pencil, it was observed that students grasping the pencil with two fingers write faster than those grasping the pencil with three fingers. However, this difference in mean ranks was not found to be statistically significant [$X^2_{(2)} = 0.97$, $p> 0.05$]. The impact of the point at which the student grasps the pencil on the writing speed was found significant in favor of grasping from the mid-point [$X^2_{(2)} = 6.82$, $p<0.05$]. Considering mean ranks, they can be sorted as grasping from the mid-point, grasping from the lower point and grasping from the upper point.

Testing whether writing speeds of the first grade students vary by gender, it is seen that there is a difference between the averages in favor of the females. This difference emerging in the averages according to the gender is also statistically significant (t= -3.131, $p< .05$). This finding can be interpreted as females being able to write faster than males.

Discussion and Conclusion

The findings related to first grade students' ways of holding the pencil (*index finger according to the flexion degree, forearm position, the number of fingers used on the pencil shaft, thumb position, the point of grasping the pencil*) and grip-compressive strengths and results obtained based on the findings can be discussed in accordance with the literature.

In terms of the variable of holding the pencil, the following results were obtained with regard to the first grade students:

- Ratio of students kept their index fingers below the 90°angle is more than half of the students participating in the research.
- 60% of the students positioned their forearms outward up to an angle of 45°.
- 80% of the students grasped the pencil with thumb and index finger.
- 63% of the students positioned their thumbs on the pencil.
- While half of the students grasped the pencil from the mid-point, 38.5 % of the students grasped it from the upper point.

Evaluating the findings obtained in the study in terms of the literature, it is seen that they show similarity with findings of Koziatek and Powell, (2003); Ziviani and Elkins (1986) and Amundson (1995) which suggest that most frequently used way of holding the pencil is the dynamic tripod grasp. It is possible to say that different ways of holding the pencil have different impacts on the writing speed. For example, evaluating the speed of writing letters per minute in this study, it was found that those having the highest writing speeds are the students with degrees of index finger flexion above 90° whereas the group writing fewest letters is made up of students grasping the pencil from the upper point. It can be said that different ways of holding the pencil led to a 1-5 letter change in writing speed averages but this difference between the averages is not significant. A significant difference was found just in terms of the point of grasping the pencil. Accordingly, a statistically significant difference was observed between the writing speeds of students grasping the pencil from the mid-point (standard) and those of the students grasping it from upper or lower points. The findings obtained in this study show similarity with the research findings stating that way of holding the pencil does not lead to a statistically significant difference in writing speed (Koziatek & Powell, 2003; Ziviani & Elkins, 1986;).

One of the findings obtained in the study is that writing speed varies by gender. Accordingly, females write faster than males. This finding sup-

ports the findings in the literature (Groff, 1961; Tseng & Hsueh, 1997; Ziviani, 1984; Ziviani & Watson-Will, 1998).

The Grip and compressive strengths of the first grade students were also determined in the study. Accordingly, the grip strengths of first grade students were in the range of 4-16.10 (kg) and grip strength varies by gender in favor of the males. Considering the compressive grip strengths, key grip, fingertip pinch and tripod compression forces vary by gender in favor of the males. The findings obtained from the study show similarity with previous research findings (Hager-Ross & Rösbland, 2002; Smet, 2001; Surrey et al., 2001; Yim et al., 2003).

This study was conducted only on first grade primary education students, that is, on a limited sample. Further research should be designed for different class levels by selecting large study groups in order to achieve normative values. This research can test to what degree variables such as holding the pencil, way of sitting, paper position, visual perception, recall, and legibility of writing affect the writing speed and legibility.

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