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Research article

GENDER DIFFERENCES IN LEARNING MOTOR SKILLS FOLLOWING A VIDEO DEMONSTRATION IN PRIMARY SCHOOL CHILDREN

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Abstract. *The first aim of the study was to determine if there are significant gender differences in newly applied motor skills tests in primary-school children concerning the protocol applied. The second aim was to determine how the newly implemented protocol using a video demonstration of the task affects the differences in outcome between boys and girls compared to the standard motor skills assessment protocol without a video demonstration. The total number of participants was 327, consisting of 186 boys and 141 girls aged 10.5 years. The students were divided into two subgroups based on the protocol applied. The sample of variables consisted of four motor skills assessment tests: the shuttle-run, partial curl-up, 90° push-ups, back-saver sit-and-reach (right and left leg) tests. A three-factor variance analysis investigated the effects of protocol and gender on the result in each test. Statistically significant differences between boys and girls were obtained in the initial measurement and after applying the protocols in the mentioned tests. In the back-saver sit-and-reach (right leg) test, the difference was not significant in the initial measurement with the standard protocol, while it was significant after it was applied. In the curl-up test, there were no differences in scores between boys and girls when using both protocols. Differences in the outcomes after the application of the video demonstration protocol were evident in both genders, and a markedly significant increase occurred in the application of the tests 90° push-ups and curl-up tests, which assess strength.*

Key words: *Students, Primary Education, Test Protocol, Demonstration*

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INTRODUCTION

The importance of motor abilities comes to light when performing both everyday and kinesiological activities. Differences in the level of motor abilities are attributed to individual differences (Mišigoj-Duraković, 2008). Individual differences in the dynamics of growth and development are a source of variability in the forms, functions and all abilities of the human body (Malina, Bouchard, & Bar-Or, 2004 according to Mišigoj-Duraković, 2008). With the onset of school age, most nerve structures are already developed and a fundamental movement pattern has been established, making this age ideal for the adoption of basic abilities (Mišigoj-Duraković, 2008). Learning or adopting new motor knowledge often requires coordination and control of limb movements, but also of the whole body when performing, constrained by time and space with the ultimate goal of mastering the shown task. Different forms of information may be given to the participant in order to help reach a solution (Magill, 1993; Magill & Schoenfelder-Zohdi, 1996). In any situation where a particular type of motor knowledge is to be adopted and learned, the performer is provided with information on the proper form of movement or technique. This information is most often related to the coordination of the performer's bodily movements, including the sequence, form and timing of the movements of an individual limb (Wulf, 2007). When it comes to physical and health education classes (TZK), the training practice most often consists of descriptions and "live" demonstrations, and it is on this principle that metric protocols to assess the level of motor skills in students were applied (Findak, Metikoš, Mraković, & Neljak, 1996; Metikoš, Mraković, Prot, & Findak, 1990; Mraković, Findak, Gagro, Juras, & Reljić, 1986; Novak, 2010; Prskalo, 2011). The development and application of information and communication technology in all social spheres of life has not bypassed the field of education. It resulted in the application of technologically advanced protocols a decade or more ago, significantly improving the process of learning and the adoption of motor skills. Thus, particular task adoption protocols, that use a model video showing the performance, were applied, and studies that compared such a mode of presenting information with a method consisting of a model point-light demonstration, confirmed the advantage of the video performance (Horn, Williams, Scott, & Hodges, 2005; Hayes, Hodges, Scott, Horn, & Williams, 2007; Rodrigues, Ferracioli, & Denardi, 2010), while the difference between the two modes has not been confirmed in research (Horn, Williams, & Scott, 2002).

Furthermore, the information presented via a model video performance and the effectiveness of such information presentation mode compared to some other protocols have been confirmed (Guadagnoli, Holcomb, & Davis, 2002; Maryam, Darush, & Mojtaba, 2009; Vrbik, 2015; Vrbik, Krstičević, Sporiš, & Madić, 2015). Differences and relations between the boys' and girls' motor abilities levels have been the subject of interest of many researchers. Different results on gender differences have been obtained in this area of research, and some authors have confirmed the existence of gender differences in motor skills among primary school students (Malina et al., 2004; Pejčić & Malacko, 2005; Katić, Srhoj, & Pažanim, 2005; Delaš, Miletić, & Miletić, 2008). With regards to the research that has confirmed the benefit of a model video performance presentation as an efficient way of information presentation, and research confirming the existence of differences in boys' and girls' motor skills, the question of the difference in the cognitive processing of information, and thus the impact on differences in results arises.

Based on all of the above, two aims have been set for this study. The first aim is to determine if there are significant gender differences in newly applied tests for assessing motor skills in primary-school boys and girls concerning the protocol applied. The second aim is to determine how the newly implemented protocol using a video demonstration of the task affects the differences in outcome between boys and girls compared to the protocol of motor skills assessment without video demonstration.

METHODS

The sample of participants

The participants in this research were third and fourth grade students from four elementary schools that belong to the urban area of the towns Petrinja and Sisak (Croatia). The total number of students that participated in the research was 327, consisting of 186 boys and 141 girls, aged 10.5 years, with an average height of 145 cm and an average mass of 38.7 kg. The students were divided into two subgroups, based on the protocol applied: the Standard Protocol (N=183; 110 male and 73 female) and Video demonstration protocol (N=144; 76 male and 68 female). All the participants in this research attended regular physical education classes and did not previously have experience with most of the given motor tasks, and were completely healthy during the tests. The research was approved by the Scientific and Ethical Committee of the Faculty of Kinesiology, the University of Zagreb, the Senate of the Zagreb University, while the head-masters of the schools allowed participation before the beginning of the research. Additionally, the parents of each child signed a written agreement for participation in the research and they were informed about the object and the aim of the research.

The sample of variables

The sample of variables in this research included four tests for motor skill assessment (the shuttle-run, partial curl-up, 90° push-up, back-saver sit-and-reach).

The Shuttle-run: a participant stands outside the start line in a high starting position, head turned in the direction of the movement. At the sign "Ready! Steady! Go!", the student runs to get the sponge, picks it up, runs back to the start-finish line, puts the sponge behind the line, runs back to get the second sponge, takes it and runs back behind the start-finish line. The task is done when the participant puts the second sponge behind the start-finish line (Malina et al., 2004; Welk & Meredith, 2010; Novak, 2010; Vrbik, 2015).

The Curl-up: a student is lying on the mat with his/her knees bent at 140°, hands extended along the body, palms facing the mat. Under his/her feet, a measuring tape is put in line with the top of the middle finger, and a piece of paper is put under his/her head. The student starts doing the task at the given mark, lifting the head and shoulders while sliding, hands on the measuring tape, head back on the paper every time. The test is finished when a 75% lift of the upper body is achieved, when the student repeats a mistake for the second time while doing the activity, or is not able to continue the performance of the motor activity (Welk & Meredith, 2010; Novak, 2010; Vrbik, 2015).

The 90° push-ups: a student is in the position of the back press, hands shoulder width apart or a bit wider, legs straight and spread a little, feet on the mat, back straight. The student goes down with the hands towards the mat until the upper arm is parallel with the

floor, and then lifts back to the starting position. The task is done when the student is not able to continue the task or the second correction is done during the performance (Welk & Meredith, 2010; Vrbik, 2015).

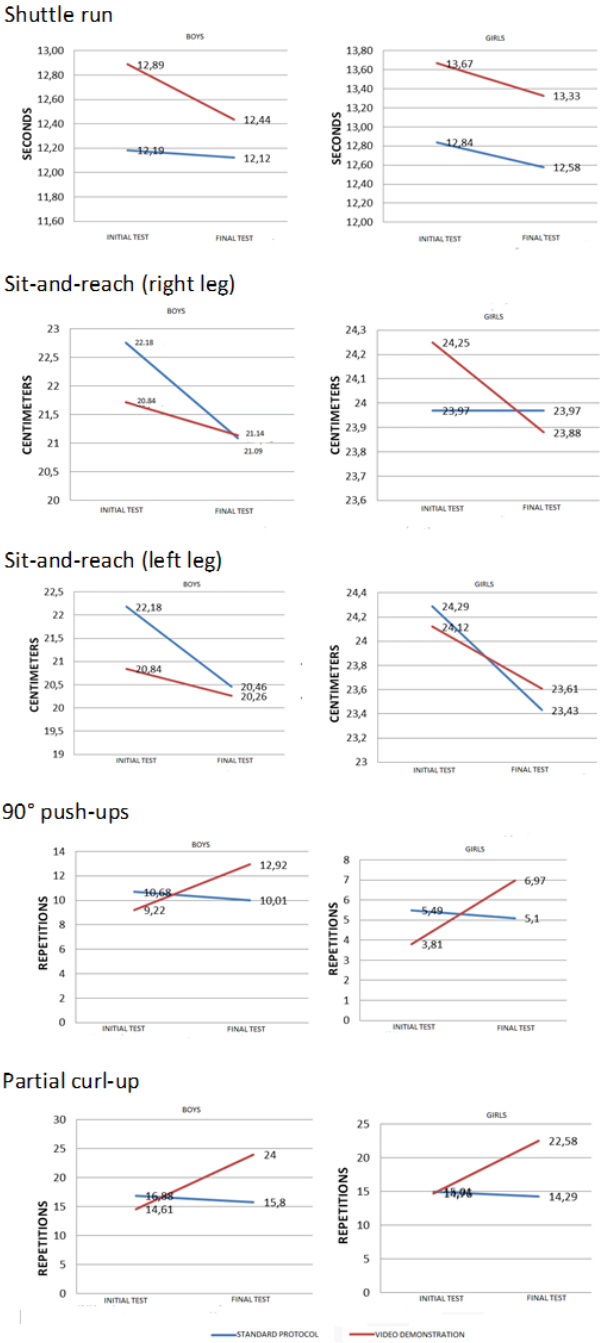
The Back-saver sit-and-reach: a student sits in front of the measuring device, one leg fully extended, while the other is bent at the knee with the foot on the mat. The arms are extended in front, above a measuring scale, palms together, both facing the mat. With both palms the student bends forwards over the measuring tape and holds the last position for one second (Welk & Meredith, 2010; Vrbik, 2015).

The tests back-saver sit and reach, and shuttle-run were repeated three times, while the other tests were done once. The research was conducted during the regular physical education classes of the 2013/2014 school year, in May and the beginning of June. In the same period, lasting two weeks, the experiment was done in both groups in two treatments. The first treatment included the initial testing of all the students in the tasks. The second treatment consisted of testing after the treatment in each task, using the method of random choice and applying different metric protocols. Before the experiment, both groups of participants prepared by doing a 5-minute warm-up that included joint rotations and basic games appropriate for the age of the students.

Statistical analysis. SPSS (version 20.0, SPSS Inc., Chicago, IL) was used for the statistical analysis. Means and standard deviations of all the variables were calculated. The normality of the distribution was tested using the Kolmogorov-Smirnov test, and it showed appropriate normality of the distributions for all the studied variables. An analysis of variance was used to determine the difference between each test used to assess motor skills in each individual protocol. To determine the differences in the experimental protocols, but also between genders and measurements, a three-way factor analysis of variance with repeated measures was conducted. The magnitude of the effect of an individual protocol in an individual test was obtained as part of an analysis of variance that calculates the partial eta squared, and Cohen's d from the formula $ES = \frac{\text{Mean after protocol} - \text{Mean initial measurement}}{\text{Standard deviation initial measurement}}$. The level of significance was set at the level $p \leq 0.05$ and all data are reported as means±SD.

RESULTS

The Kolmogorov-Smirnov test was used to determine the normality of data distribution for each variable by gender and protocol. The test confirmed that the distributions were not significantly different from the normal distribution. The results of the arithmetic mean (± SD) of boys and girls in each test in both protocols at the initial measurement and after application of the protocol, as well as the differences obtained, are shown in Table 1. Statistically significant differences between the boys and girls were obtained at the initial measurement and after application of the protocols in the shuttle run, 90° push-ups, and the left leg back-saver sit-and-reach tests. In the right leg back-saver sit-and-reach test, no significant difference was obtained in the initial measurement with the standard protocol, although the value of the arithmetic means shows a higher value in girls. In the test estimating core strength, the curl-ups, the values of arithmetic means in both protocols showed equal values in boys and girls. The effects of individual protocols on boys and girls before and after treatment are shown in Graph 1.



Graph 1 The effects of individual protocols on boys and girls before and after treatment

The resulting differences in the video demonstration protocol results were evident in both genders, and a marked increase was observed in strength assessment tests (the curl-ups, 90° push-ups).

Table 1 Differences between boys and girls in selected tests after each protocol

			Baseline	Sig.	After intervention	Sig.
Test	Protocol	Gender	Mean±SD	p	Mean±SD	p
Shuttle run	Standard protocol	M	12.19 ± 1.13	0.000	12.12 ± 1.21	0.009
		F	12.84 ± 0.93		12.58 ± 0.98	
	Video demonstration	M	12.89 ± 1.20	0.000	12.44 ± 1.04	0.000
		F	13.67 ± 1.38		13.33 ± 1.30	
Sit-and-reach (right leg)	Standard protocol	M	22.76 ± 5.34	0.134	21.09 ± 4.93	0.000
		F	23.97 ± 4.89		23.97 ± 5.26	
	Video demonstration	M	21.72 ± 5.65	0.005	21.14 ± 5.39	0.002
		F	24.25 ± 5.44		23.88 ± 5.43	
Sit-and-reach (left leg)	Standard protocol	M	22.18 ± 5.35	0.012	20.46 ± 5.10	0.000
		F	24.29 ± 4.96		23.43 ± 5.25	
	Video demonstration	M	20.84 ± 6.05	0.000	20.26 ± 5.96	0.000
		F	24.12 ± 5.76		23.61 ± 5.54	
90° push-ups	Standard protocol	M	10.68 ± 8.56	0.000	10.01 ± 7.48	0.000
		F	5.49 ± 6.01		5.10 ± 4.95	
	Video demonstration	M	9.22 ± 7.08	0.000	12.92 ± 8.78	0.000
		F	3.81 ± 5.04		6.97 ± 7.89	
Partial curl-up	Standard protocol	M	16.88 ± 11.47	0.240	15.80 ± 11.16	O.437
		F	15.01 ± 9.38		14.29 ± 9.37	
	Video demonstration	M	14.61 ± 9.47	0.930	24.00 ± 14.66	0.513
		F	14.76 ± 11.20		22.58 ± 16.34	

Legend: F-female; M-male; SD-standard deviation; Sig.-significance.

DISCUSSION

Variance analysis showed that there were significant gender differences in all motor abilities tests for both protocols applied, except in the core strength test of curl-ups, which showed no significant differences in either of the protocols. The lack of gender difference in this test is equivalent to the conclusion reached by Malina and associates (2004), stating that the differences in the strength of the abdominal muscles of the torso at that age are negligible and that they become significant only in adolescence. The obtained differences are significant for the boys in tests used to assess upper torso agility and strength (the shuttle run and 90° push-ups), while the result is significant for the girls in the flexibility assessment test (the right leg and left leg sit-and-reach test).

Malina and associates (2004) confirmed that the agility measured by the shuttle run test improved significantly in boys and girls between the ages of 5 and 8, and continued to improve with less effect but continuously until the ages of 13 or 14 in girls, and the age of 18 in boys. At that age, there is also a difference evident in upper body strength tests, which indicates a linear improvement from the ages of 5 to 13 and 14 in boys. Girls are significantly more flexible than boys at that age, and the differences are most pronounced during adolescent growth momentum and sexual maturation. In the strength assessment

and torso endurance tests (the curl-ups), linear improvements occur from the ages of 6 to 13 in boys, and up to 14 in girls. Gender differences during this period are negligible and they begin to manifest only in adolescence. Similar research findings and conclusions were outlined by Zurc, Pišot, and Strojnik (2005), whereby they point out that significant differences diminish between the ages 7 and 12, whereas later on in boys the abilities increase rapidly until the age of 17, while in girls they remain at the level reached at the age of 12. Prskalo, Jenko, Petračić, Šerbetar, and Šuker (2007) found that there were differences between boys and girls aged 9 and 10. Result differences confirm the research findings to date that indicate better results for girls in flexibility tests and in explosive strength tests for boys. In this research, when presenting information on the performance of a new motor task that was used to assess the level of motor abilities of primary and secondary school students, two different metric protocols were used. Regardless of the protocol applied, the research, following the previous research on primary school children's motor abilities, confirmed the existence of differences between boys and girls in all of these tests, except in the test assessing core strength (the curl-ups).

Furthermore, the result differences after applying the video demonstration protocol are evident in both genders, and a markedly large increase occurred in the strength assessment tests (the curl-ups and 90° push-ups) (Graph 1), which supports this method of protocol application, and was confirmed in the research of Vrbik et al. (2015). The administration of the video demonstration protocol for the agility test (shuttle run), produced increases of 3.5% in boys and 2.5% in girls compared to increases in the standard protocol of 0.5% and 2.02% for boys and girls, respectively. Administration of both protocols in the flexibility test (the back-saver sit-and-reach test), resulted in a decrease in both boys and girls. After the administration of the video demonstration protocol, the evaluation of the effect of each protocol on the result showed there was also a slight decrease in this test with both genders compared to the standard protocol. In the strength dimension assessment tests, substantial result differences were established after the administration of the video demonstration protocol, and consequently, of the scope of the effect of the protocol. The effects value of ES=0.52, which, according to Cohen’s effect size index represents the mean index value (Pallant, 2009), is equivalent to a 40.1% boys' improvement in the 90° push-ups video demonstration test, while an improvement of 82.9% in girls, also with a mean effect value of 0.63, represents a significant increase in the results compared to a 6.3% and 7.1% increase in boys and girls respectively after the administration of the standard protocol, which speaks enough of the difference and the benefit the video demonstration protocol has produced. The video demonstration protocol produced a similar effect in the "Lifting the torso out of a brief lying position with legs folded" test. There was a large effect value achieved by Cohen’s index of 0.99 with a 64.3% improvement in boys, and a medium to high effect by Cohen’s index of 0.7 resulting in a 52.9% improvement in girls, over the standard protocol where there was a 6% improvement in boys and a 4.8% improvement in girls.

As stated earlier, there are differences in anthropological characteristics between boys and girls of a primary school age, and this research has confirmed some of them. Additionally, it confirmed that there are gender differences in the way the information presented was then processed and adopted. In most tests, there was a significantly higher percentage increase in boys than in girls’ scores, when administering the video demonstration protocol. When performing a complex motor task, third and fourth grade boys are more likely to use explosive and repetitive strength combined with flexibility and static strength. Furthermore, Katić and associates (2005) concluded that core strength in third-grade students has a major

impact on the frequency of movement; that is, the integration of strength and speed. They also found a greater advantage of boys in motor learning than in motor performance, and this advantage is even greater during adolescence. The participants' age and effort during exercise are a significant factor in determining gender differences in motor performance (Dorfberger, Japha, & Karni, 2009). The morphological-motor functioning in boys changes over the years, in the third grade, the general motor factor responsible for the overall motor functioning is already formed, while in the fourth grade the morphological development takes the leading role in the overall morphological-motor development (Lasan, Pažanin, Pejčić, & Katić, 2005). In girls, according to Katić, Bala, & Barović (2012), motor-cognitive functioning transitions from the cortical level to the subcortical, and at the age of 10 to 14, cognitive functioning is significantly implied by their motor efficiency, and is associated with a motor unit involving regulation of muscle tone and agility/coordination, whereas, in boys, there is an association between cognitive ability and the speed regulator of upper extremity movement (Katić et al., 2012). Observing movement has been confirmed to cause brain activity similar to that of performing movement. Through film and video observation, the cognitive performance perspective can be increased, enhanced and improved. Improving the cognitive model through observation and learning has been confirmed to improve the performance of the movement itself (Pike, 2008). Students' perception thereby plays an important role in learning effectiveness (Hayes et al., 2007). It has also been determined that boys have an advantage over girls when it comes to motor learning, and that it also improves during adolescence (Dorfberger et al., 2009). Based on previous research, a significant explanation for the differences in motor test results can be sought through the influence of the social factor, since the development of motor skills is part of a child's socialization process (Zurc et al., 2005), while at the same time previous participation in the performance of particular motor activities significantly affect the learning speed of a complex motor task (Katić et al., 2012). When conducting testing, it is necessary to establish objective conditions for assessing the level of fundamental motor abilities by age and gender. The effectiveness of the demonstration and the information given in the form of instructions depends on the student's existing skills related to the type of task or skills already learned (Hodges & Franks, 2002); therefore, the goal should be to strive towards the adaptation of the task to a student's capabilities and abilities. It is for this reason that the differences in motor abilities and their impact on learning and performance, especially in jumps and runs, should be taken into account during the teaching process (Delaš et al., 2008). Students can adopt a relative movement pattern after only five observations and three performance attempts, but when the student is restricted to using the demonstration during early practice, they immediately begin to process the newly adapted solution rather than seek an entirely different one (Horn et al., 2005). Given the number of displays – task demonstrations, which is five displays for the video demonstration protocol compared to 1 display for the standard protocol, with the same number of student-watched performances as they wait for their performance, a greater number of display views results in more accurate cognitive processing of the task performance. Therefore, the performance of the movement itself is significantly more accurate (Horn & Williams, 2004). More accurate movement performance results in better technique, and therefore less energy and information consumption during the performance of the task, which also has an impact on the result. Also, one of the factors that influence the result is certainly motivation. Considering the gender of the model that demonstrated the task, in some previous studies cited by Horn and Williams (2004), the participants had no motivation to perform the task when the model was a person of the opposite sex. In this

study, compared to some of the earlier ones cited by Horn and Williams (2004), the results obtained are contrary to their claims, and thus closer to the conclusion that the gender of the model did not affect the performance of the participants, because in the video demonstrates the model is a female, whereas in the standard protocol the model was male. This was confirmed by the good results boys achieved in the video demonstration protocol, whereby they were probably additionally motivated, and wanted to show they can perform better than a female (model). Contrary to this reasoning, the assumption is that girls perceived the video performance model as an equal to themselves, and it is certainly an important fact that in all the classes that participated in the survey, the teacher was female. With regards to the standard protocol, there were no significant changes in the girls' and boys' results, and therefore the influence of the model's gender can be disregarded. This is supported by the fact that the demonstration of tasks by male models is not new to the students, and that this is something that they have all encountered before. When observing an expert performance display, depending on previous familiarity and knowledge, attention and the ability to notice details and specific movement parts increases (Keats, 2008), and regardless of gender, a certain degree of attention is required in everything we do.

CONCLUSION

In light of the objectives set, the following facts can be ascertained as the conclusion to this research. The first one is that boys, at the age of 10.5, scored better on agility and strength tests regardless of the protocol used. Girls achieved better results in the flexibility test in both protocols administered, and there were no significant result differences obtained in the core strength assessment test (the curl-ups), in either protocol used. Another finding of the study is that following the video demonstration protocol, the boys achieved more significant result differences, and thus the effect of the video demonstration protocol was higher compared to the standard protocol in boys and girls. Greater scope of the effects and differences in the results were achieved on the shuttle run and curl-up tests in boys compared to girls in the video demonstration protocol and boys and girls in the standard protocol. In the 90° push-ups test, a similar scope was achieved by both boys and girls in the video demonstration protocol, and this difference is much larger compared to the results achieved with the standard protocol. Also, in both girls and boys, there was a result decrease in the back-saver sit-and-reach test with both protocols applied, although the difference in the decrease was also smaller for video demonstration protocols for both genders, compared to the standard protocol. In order to see if the effects of the video demonstration protocol applied were retained among the boys, a retention measurement should be administered in future research. Additionally, in order to improve the diagnostic procedure in the field of kinesiology, and in order to obtain representative tests appropriate for the students' age, a larger battery of tests should be administered.

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RAZLIKE PO POLU PRILIKOM UČENJA MOTORIČKIH VEŠTINA VIDEO DEMONSTRACIJOM DECE OSNOVNOŠKOLSKOG UZRASTA

Prvi cilj studije bio je da se utvrdi postoje li značajne razlike po polu u novoprimenjenim testovima motoričkih sposobnosti dece osnovnoškolskog uzrasta u vezi sa primenjenim protokolom? Drugi cilj bio je da se utvrdi na koji način novoimplementirani protokol pomoću video demonstracije zadatka utiče na razlike u ishodu između dečaka i devojčica u poređenju sa standardnim protokolom za procenu motoričkih sposobnosti bez video demonstracije? Ukupan broj učesnika bio je 327, tj., 186 dečaka i 141 devojčice uzrasta 10.5 godina, podeljenih u dve podgrupe na osnovu primenjenog protokola. Uzorak varijabli sastojao se od četiri testa za procenu motoričkih sposobnosti: šatl-ran, parcijalni trbušnjaci, sklekovi do 90°, test gipkosti u sedu sa dohvatom (desna i leva noga). Trofaktorskom analizom varijanse istraživani su efekti protokola i pola na rezultat u svakom od testova. Utvrđene su statistički značajne razlike između dečaka i devojčica na inicijalnom merenju. U testu gipkosti u sedu sa dohvatom (desna i leva noga) standardnim protokolom razlika na inicijalnom merenju nije bila statistički značajna, dok je bila značajna nakon primene video demonstracije. U testu parcijalnih trbušnjaka nije bilo razlike u rezultatima između dečaka i devojčica u oba protokola. Razlike u ishodima nakon primene protokola video demonstracije bile su evidentne u oba pola, a statistički značajan porast utvrđen je u primeni testu sklekovi do 90° i testu parcijalnih trbušnjaka, kojima se procenjuje snaga mišića.

Ključne reči*: učenici, osnovno obrazovanje, test protokol, demonstracija*