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Massed practice, distributed practice, and motor ability: Which one affects fencing attack skills using moving targets?

Práctica masiva, práctica distribuida y habilidad motora: ¿cuál afecta las habilidades de ataque de esgrima utilizando objetivos en movimiento?

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Abstract. The main aim of this research was to determine the influence of learning methods and motor skills on the learning outcomes of fencing attack skills. A 2 x 2 factorial design was used in this study to investigate two learning methods (massed practice and distributed practice) and two categories of motor ability (high and low). A total of 40 students were involved in this study and divided into four groups (A_1B_1, A_1B_2, A_2B_1, and A_2B_2), each group consisting of 10 people. Each group was given treatment for 16 meetings. The research data were analyzed using the t-test and analysis of variance at a significance level of $\alpha = .05$. The results of the research found (1) there was a significant difference in influence between massed practice and distributed practice learning methods on fencing martial arts attack skills ($F = 72.654$; $p < .01$), (2) there was no significant difference in learning outcomes for fencing martial arts attack skills between groups that have high motor ability versus low motor ability ($F = 3.144$; $p > .05$), and (3) there was no significant interaction between massed practice, distributed practice, and motor ability learning methods with fencing attack skills ($F = .0001$; $p > .05$). Massed practice learning methods appear to be superior in improving fencing attack skills compared to distributed practice.
Keywords: Learning methods, massed practice, distributed practice, motor ability, fencing attacks

Resumen. El objetivo principal de esta investigación fue determinar la influencia de los métodos de aprendizaje y las habilidades motoras en los resultados del aprendizaje de las habilidades de ataque en esgrima. En este estudio se utilizó un diseño factorial 2 x 2 para investigar dos métodos de aprendizaje (práctica masiva y práctica distribuida) y dos categorías de habilidad motora (alta y baja). En este estudio participaron un total de 40 estudiantes y se dividieron en cuatro grupos (A_1B_1, A_1B_2, A_2B_1 y A_2B_2), cada grupo constaba de 10 personas. Cada grupo recibió tratamiento durante 16 reuniones. Los datos de la investigación se analizaron mediante la prueba t y el análisis de varianza a un nivel de significancia de $\alpha = .05$. Los resultados de la investigación encontraron (1) hubo una diferencia significativa en la influencia entre los métodos de aprendizaje de la práctica masiva y la práctica distribuida en las habilidades de ataque de las artes marciales de esgrima ($F = 72.654$; $p < .01$), (2) no hubo una diferencia significativa en resultados de aprendizaje para las habilidades de ataque de artes marciales de esgrima entre grupos que tienen alta capacidad motora versus baja capacidad motora ($F = 3,144$; $p > .05$), y (3) no hubo interacción significativa entre la práctica masiva, la práctica distribuida y el aprendizaje de la capacidad motora métodos con habilidades de ataque de esgrima ($F = .0001$; $p > .05$). Los métodos de aprendizaje de práctica masiva parecen ser superiores a la hora de mejorar las habilidades de ataque de esgrima en comparación con la práctica distribuida.
Palabras clave: Métodos de aprendizaje, práctica masiva, práctica distribuida, habilidad motora, ataques de esgrima.

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Introduction

Recently, scholars have paid a lot of attention to fencing, resulting in a trend of increasing research on fencing. This is natural because fencing is one of the sports competed in the Olympics (Chen et al., 2017). This sport involves two athletes and is carried out to attack using a sword according to the type of weapon being competed (Bottoms et al., 2013). In other words, fencing is an art sport in managing a sword to carry out attack and defense, which is carried out by two people in a confrontation of abilities, reflexes, skills, and techniques aimed at stabbing the opponent (Elfateh, 2016). That is why fencing is considered a sport with open skills (Borysiuk et al., 2019).

Generally, in fencing the attack movement starts from an en-guard position (ready position), with feet shoulder-width apart where the back foot forms a 90-degree angle with the front foot, then straightens the arm holding the weapon and pushes off the back foot while lifting and kicking the front foot. them to attack (Sinclair & Bottoms, 2013; Czajkowski, 2009). In fencing, attacks are one of the important components that must be mastered. The fencer must be able to analyze the opponent's movements before starting the initial attack movement (Roi & Bianchedi, 2008; Hagemann et al., 2010) after which the fencer must react to stab quickly to get points. The skills in carrying out this attack cannot be achieved without continuous training. That is why intensive training is needed so that abilities increase and performance when competing becomes optimal (Yiou & Do, 2000).

In fencing, attacks are very important to get attention because players with the attacking type are more efficient and profitable compared to the defensive type. That is why, several scientists have been recorded as trying to carry out studies related to attacks in fencing. For example, Witkowski et al. (2020) examined the effect of training on strike performance between arms holding a weapon. However, this study only

focuses on the comparison of fencing abilities between right and left hands during training and competition. Gutiérrez-Davila et al. (2013) developed a form of attack training with moving/changing targets. However, this is only for those who are professionals in fencing. Another study also examined the optimization of attack movements in fencing with biomechanical studies (Czajkowski, 2005). Other researchers try to focus on discussing the forms of mistakes made before and during the attack (Borysiuk et al., 2019; Gutiérrez-Cruz et al., 2016). Because attacks are very important in fencing, this is often used as an object of research in universities (Balkó et al., 2016; Bottoms et al., 2013). However, on the other hand, there are no studies that discuss how to teach fencing, especially attacks, using the latest learning methods. In other words, studies discussing fencing learning on campus are still very limited. However, in the context of coaching, this is relatively important to reveal. Apart from that, previous research also did not consider the motor skills of the research subjects even though this is an important indicator concerning sports skills (Čoh & Milovan, 2004).

Based on more than 5 years of experience teaching fencing on campus, the current problem is that fencing learning is not optimal, so the ability to attack does not show encouraging results. This is also evidenced by the declining performance of students in fencing and the small number of students who become professional fencing athletes. With these facts, the author is of the view that efforts are needed to improve the learning system by using more comprehensive methods involving motor ability factors. For this reason, we are trying to examine the theme of attacks in fencing by using the latest learning methods and considering motor abilities.

One learning method that is very suitable for use in movement learning is the mass practice and distributed practice learning method. This learning method focuses on using rest periods and repetition of movements. Massed practice is carried out continuously with little time for rest (Murray & Udermann, 2003; Studer et al., 2010). The massed method is very practical and useful for practitioners by using limited time to teach movement skills (Panchuk et al., 2013). In contrast to that, the distributed practice learning method is carried out by using lots of rest time in each learning session (Rohrer & Taylor, 2006). This break is used for relaxation and is given correction by the teacher and is used to observe others in making improvements if there are inappropriate movements in learning (Ahmadvand et al., 2016).

Meanwhile, motor skills are an important indicator for each individual in achieving motor skills (Tortella et al., 2016) However, in studies dealing with fencing, this variable's influence has not been widely investigated. On the other hand, research results from. Cigrovski et al. (2012) found that motor skills have a significant influence on learning sports skills. Therefore, the author sees this variable as important to investigate its role concerning fencing attack skills.

However, to the best of our knowledge, knowledge regarding the influence of learning methods is still limited because not much research has been done in this regard. In other words, we see that no research has attempted to test the effect of massed practice and distributed practice learning methods by considering motor skills on fencing martial arts attack skills. Therefore, this research was conducted to examine the influence of learning methods (massed practice vs. distributed practice) and motor skills (high vs. low) on the learning outcomes of fencing martial arts attack skills.

Material and Methods

Participant

The subjects of this research were students of the Health and Recreation Physical Education study program, Faculty of Sports Science, Makassar State University, who had a fencing course programmed. The age range of participants was 19-20 years with an average age of 19.62 ± 1.05 years. To determine the research sample, the Barrow Motor Ability Test (Barrow, 1954) was used, which consisted of a standing broad jump, softball throw, zig-zag run, wall pass, medicine ball put, and 50-meter sprint. From the test results, 40 samples were taken from 27% of the highest scores (20 people) and 27% of the lowest scores (20 people), while the results of these were not used as samples. After that, the low motor ability group (B_2) was divided randomly into 2 groups of 10 people each, which would be given treatment in the form of massed learning models (A_1B_2) and distributed practice (A_2B_2). The same thing also applies to the high motor group (B_1). All participants involved in this study have provided informed consent. The following is the distribution of sample groups in this study (table 1):

Table 1.
Experimental sample clustering

Motor Ability (B)	Model Pembelajaran (A)		Total
	Massed Practice (A_1)	Distributed Practice(A_2)	
High Motor Ability (B_1)	10 (A_1B_1)	10 (A_2B_1)	20
Low Motor Ability (B_2)	10 (A_1B_2)	10 (A_2B_2)	20
Total	20	20	40

Instruments

Data on fencing martial arts attack skills was taken using the Kuhadja fencing test which was developed and modified by researchers because the previous form of test only used stationary targets and only assessed the results of the attack without paying attention to the process of the attack movement. This instrument has a reliability value of 0.68. The Kuhadja fencing test is a form of test that attacks with a circle-shaped target that moves like a clock pendulum (figure 1). Apart from that, this test also evaluates the movement process (ready position, position during attack, and, final position of attack) which is assessed by 3 experts in the field of fencing.

The attack target is divided into 5 areas starting from the center point with a radius of 5 cm (point 5), the second circle 10 cm (point 4), the third circle 15 cm (point 3), the fourth circle 20 cm (point 2) and the last circle 25 cm (point 1). Before starting, students take the ideal attack distance and perform a series of attack test movements (1 step forward, 2 steps back, 1 step forward, then attack). The test starts when the target is shaken, and at the same time, the time is run. The time used is 30 seconds for each participant. The value obtained is a combination of the movement process and the points obtained when attacking via the T-score. The motor ability variable was taken using the Barrow Motor Ability Test (Barrow, 1954) which consists of six tests as described in the participant section.

Figure 1. Modification of the kuhadja fencing test. The targets are not static but moving.

Procedure

The type of research used was an experiment with a 2x2 factorial design (Fraenkel et al., 2012) which compares the effects of massed practice (A_1) and distributed practice (A_2) learning models both independently and together with motor abilities (B) as moderator variable and fencing attack skills as the dependent variable. This research was carried out for 6 weeks or 16 meetings with 90 minutes per meeting. Each group received treatment material in the form of en-guard, forward steps, backward steps, attacking without a target, attacking with a stationary target, attacking with a moving target, and a combination of attack movements with a stationary target and a moving target. Before starting learning activities, 10 minutes of preparation is carried out to warm up and explain the objectives and overview of the day's learning as well as provide motivation. In learning using massed practice, the material presented is carried out using minimal rest time, so that there are more repetitions of movements (Seabrook et al., 2005). After repeating the movement for 15 minutes, students are given a break for 1 minute. Meanwhile, in the distributed practice learning model, the material is distributed by studying item by item and using more rest time compared to the massed practice model (Magill, 2015; Rohrer & Taylor, 2006). After doing the exercise for 15 minutes, students are given a break for 5-7 minutes, after which they return to continuing the learning material. The instructor always controls the learning process and ensures that all students do it seriously. After carrying out treatment using a learning model for 16 meetings, a data collection process was carried out in the form of a fencing attack skills test (Kuhadja Fencing Test).

Statistical analysis

The research data were analyzed by assumption tests such as the normality test using the Kolmogorov-Smirnov (K-S) and Shapiro-Wilk (S-W) and the homogeneity test using the Levene statistic test. Descriptive statistics are used to determine the mean and standard deviation (SD) for each treatment group. After that, the analysis continued with the t-test and one-way analysis of variance. If a significant difference in effect is found, further analysis is carried out with Tukey HSD. The significance level used is $\alpha = 0.05$. All data analysis was carried out with the help of IBM SPSS 20 software.

Result

The results of the descriptive analysis show that the A_1B_1 group has a higher average value than the A_1B_2 group, while the A_2B_1 group has a higher average value than the A_2B_2 group (table 2). The results of the normality test show that all data is normally distributed as evidenced by the probability value p-value > .05. The same results were found in the homogeneity of variance test, namely that the p-value was greater than .05.

Table 2.
Results of descriptive analysis for each group

Groups	N	Min	Max	Mean	SD	95% CI	K-S	S-W
A_1B_1	10	105	134	114.90	8.425	108.87 – 120.93	.202	.901
A_2B_1	10	84	112	95.00	8.433	88.97 – 101.03	.138	.949
A_1B_2	10	104	119	110.80	4.917	107.28 – 114.32	.143	.960
A_2B_2	10	79	103	90.80	7.269	85.60 – 96.00	.166	.971

Note: K-S = Kolmogorov-Smirnov; S-W = Shapiro-Wilk

The results of the difference test between the pretest and posttest data on the messy practice method found that there was a significant difference between the pretest and posttest scores (t = -15.331; p < .01). This indicates that the messy practice method has a significant influence on the learning outcomes of fencing attack skills. The same thing was found in the distributed practice method, namely that there was a significant difference between the pretest and posttest scores (t = -15.234; p < .01). This indicates that the distributed practice method has a significant influence on the learning outcomes of fencing attack skills. Thus, it appears that the results of this study show that both methods have a significant influence on the learning outcomes of fencing attack skills (table 3).

Table 3.
Results of the influence of methods on fencing attack skills

Method	N	Mean	SD	MD (Pretest-Posttest)	95% Confidence Interval		t
					Lower	Upper	
Pretest MP	20	92.90	7.96	-17.95000	-20.40065	-15.49935	-15.331*
Posttest MP	20	110.85	7.73				
Pretest DP	20	91.85	7.18	-17.95000	-11.92905	-8.67095	-15.234*
Posttest DP	20	102.15	7.91				

Note: MP = massed practice; DP = distributed practice; *p < .01

The results of the analysis of variance are summarized in Table 4 and found that there was a significant difference in the learning outcomes of fencing attack skills between groups that received massed practice and distributed practice learning models (F = 72.654; p < .01). In the motor ability variable, it was found that there was no significant difference in the learning outcomes of fencing attack skills between groups with high motor ability and low motor ability (F = 3.144; p > .05). Further results showed that there was no significant interaction between learning method and motor ability with the results of fencing attack skills (F = .0001; p > .05).

Table 4.
Results of changes and interactions between research variables

Variable	Motor Ability	Mean	SD	Mean Square	F
Massed Practice (MP)	Tinggi	114.90	8.425		
	Rendah	110.80	4.917		
	Total	112.85	7.036	3980.02	72.654*
Distributed Practice (DP)	Tinggi	95.00	8.433		
	Rendah	90.80	7.269		
	Total	92.90	7.960		
Motor Ability (MA)	Tinggi	104.95	13.097		
	Rendah	100.80	11.906	172.22	3.144$^{n.s}$
	Total	102.88	12.531		
Method*Motor Ability	-	-	-	.025	.0001$^{n.s}$

Note: *p < .01; $^{n.s}$ = Non-significant

Considering that there were significant differences, the analysis continued with further analysis using Tukey HSD (table 5). The results of further analysis found that the A_1B_1 group was significantly different from the A_2B_1 and A_2B_2 groups. Then group A_2B_1 was significantly different from groups A_1B_1 and A_1B_2. For group A_1B_2 it is significantly different from A_2B_1 and A_2B_2. With these results, it appears that there are significant differences when the groups are compared based on learning methods (Massed vs. Distributed). This confirms the findings of the previous analysis which showed that there was a difference in influence based on method, whereas based on motor ability there was no significant difference.

Table 5.
Results of further analysis with Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower	Upper
A_1B_1	A_2B_1	19.900*	3.310	.000	10.99	28.81
	A_1B_2	4.100	3.310	.607	-4.81	13.01
	A_2B_2	24.100*	3.310	.000	15.19	33.01
A_2B_1	A_1B_1	-19.900*	3.310	.000	-28.81	-10.99
	A_1B_2	-15.800*	3.310	.000	-24.71	-6.89
	A_2B_2	4.200	3.310	.588	-4.71	13.11
A_1B_2	A_1B_1	-4.100	3.310	.607	-13.01	4.81
	A_2B_1	15.800*	3.310	.000	6.89	24.71
	A_2B_2	20.000*	3.310	.000	11.09	28.91
A_2B_2	A_1B_1	-24.100*	3.310	.000	-33.01	-15.19
	A_2B_1	-4.200	3.310	.588	-13.11	4.71
	A_1B_2	-20.000*	3.310	.000	-28.91	-11.09

*The mean difference is significant at the 0.05 level.

Discussion

The main aim of this study was to examine the influence of learning methods (massed practice vs. distributed practice) and motor skills (high vs. low) on the learning outcomes of fencing martial arts attack skills. The research results found that both methods had a significant influence on the learning outcomes of fencing attack skills (p < .01). Even though both methods had a significant influence, this research also found that there was a significant difference in the influence between massed practice and distributed practice on the learning outcomes of fencing attack skills (F = 72.654; p < .01). If we look at the average value, it appears that the massed practice method has a greater value than the distributed practice method (112.85 > 92.90). This indicates that the massed practice method has a greater influence on improving fencing attack skills compared to the distributed practice method.

The results of this study verify previous studies which found distributed practice to be superior in the motor learning process (Dail & Christina, 2004). Even though the two learning models (massed practice and distributed practice) both focus on the repetition of movements being learned, there are fundamental differences between the two methods.

This is what led to the discovery that there were significant differences between the two methods. One of the arguments why the distributed practice method is superior is because this method uses less rest time in the learning process. This follows what was stated by Murray & Udermann (2003) and Studer et al. (2010) that the pause time for rest in the mass practice method is small. In contrast to that, in the distributed practice method there is a lot of rest time in each learning session (Rohrer & Taylor, 2006). This rest time according to Ahmadvand et al. (2016) is used for relaxation by participants and teachers to provide corrections or improvements if there are inappropriate movements in the learning process.

Apart from that, if we look at the moderator variable, namely motor ability, it appears that overall the massed practice learning method is superior to the distributed practice learning model, both in the high motor ability group and in the low motor ability group. These results are in line with research in the field of motor skills (Ahmadvand et al., 2016; Studer et al., 2010; Dail & Christina, 2004). However, other scientific references show that there are research results that favor the distributed practice method. For example, research in the field of rereading learning (Fini et al., 2010), in the field of learning basic mathematics (Schutte et al., 2015), reading skills (Seabrook et al., 2005; Sobel et al., 2011), science (Vlach & Sandhofer, 2012), foreign language vocabulary (Cepeda et al., 2009) and medical rehabilitation (Krishnan, 2019) show that the distributed practice method is very well applied in the learning process. Apart from that, research in the context of motor learning also found distributed practice to be superior (Dail & Christina, 2004; Shea et al., 2000; Taylor & Rohrer, 2010). This means that there are inconsistent results between this research and previous research that examined these two methods.

The next result of this research was that there were no significant differences between the high and low motor groups in the learning outcomes of fencing attack skills. These results are different from other studies that examine motor ability. Generally, the higher a person's level of motor ability, the easier it will be for them to master new movements in sports skills (Rahyubi, 2012). In other words, there is a link between physical activity and motor (Wood et al., 2020). In line with this, several studies on motor ability also state this (see for example: (Czajkowski, 2009; Hijazi 2013; Burdukiewicz et al., 2016). Theoretically, people who have good basic motor skills will find it easier to master specific skills in martial arts sports (Roslan & Abdullah, 2020). On the other hand, someone who has poor motor skills must be given a new cognitive approach (Diamon & Lee, 2011) so that skills learning outcomes can be achieved more effectively. The question then is, why are the results of this study different from other studies as explained above?

First, as explained in the methods section, there were only ten participants involved in this research in each group. The small number of research subjects involved in this study will statistically tend to influence the finding of no significant differences. Fraenkel et al., (2012) stated that in rigorous experimental research, the ideal number of samples in each cell is 15 people. By referring to this opinion, the number of samples in each group is relatively small. This is what we suspect influences the research results, especially in the motor ability variable. Second, the participants in this study were students studying in the sports studies program. This means that almost every day students will be faced with learning related to motor skills (sports). We suspect that the sports learning process that students go through on campus has contributed to the finding that there is no difference in motor ability.

The results of further research were that there was no significant interaction between learning method and motor ability with the results of fencing attack skills ($F = .0001$; $p > .05$). These results were found because there were no significant differences in the motor ability variable. That is why, when these three variables are linked to one another, the results of this study show that there is no significant interaction. Thus, these results confirm the results of previous analyses which found there were no differences in motor ability.

Even though we have tried to uncover things related to learning methods and motor abilities with the results of learning fencing attack skills comprehensively, we think there are two limitations to this study. First, this study only focuses on intervention methods and uses motor ability variables as moderator variables and attack skills as dependent variables. That means, in this study the main focus is on the psychomotor aspects of students. On the other hand, psychological dimensions such as anxiety (Putra et al., 2021; Putra & Guntoro, 2022), mental (Sutoro, Guntoro, & Putra, 2023; Putra, Kurdi, et al., 2024; Putra, Sutoro, et al., 2024), happiness (Wandik et al., 2021), satisfaction (Putra, 2022), religiosity (Guntoro & Putra, 2022), motivation, and learning style (Putra, 2017) we think is also very close in influencing skills (sport) learning outcomes. So, it is not only the motor dimension that is influential in sports, but the psychological aspect also contributes to it (Guntoro et al., 2023). Second, although the research design used is relatively sophisticated, the number of subjects involved in each group is relatively small. On the other hand, experts in the field of research methodology recommend that the minimum number of each cell/group be 15 people when the experiment is carried out strictly (Fraenkel et al., 2012).

Based on the limitations above, a suggestion that can be given for future research is to add psychological variables to be investigated apart from motor variables so that the information presented will be more comprehensive. Apart from that, future studies also need to consider increasing the number of research subjects and aim for a minimum of 15 people in each cell/group. Apart from that, it is also interesting to explore investigations at the student level so that there is

more diverse information and not just limited to college-level subjects.

Conclusion

Based on the results and discussion above, it can be concluded that (1) There is a significant difference in influence between massed practice and distributed practice learning methods on fencing attack skills ($F = 72.654$; $p < .01$), (2) There is no difference in learning outcomes fencing attack skills were significant between groups with high motor ability and low motor ability ($F = 3.144$; $p > .05$), and (3) there was no significant interaction between massed practice, distributed practice, and motor ability learning methods. fencing attack skills ($F = .0001$; $p > .05$). Massed practice learning methods appear to be superior in improving fencing attack skills.

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