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Mind Map Technique in Physical Education: Development of Cognitive and Psychomotor Skills*

Beden Eğitimi ve Sporda Zihin Haritası Tekniği: Bilişsel ve Psikomotor Yetenek Gelişimi

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ABSTRACT: This study aimed to measure the success of teaching volleyball in the physical education course with the mind map technique. The study employed a quasi-experimental pre-posttest design with an experimental group and a control group. The study was completed with a total of 66 students, including 33 students in the experimental group and 33 in the control group. A pretest was administered to the groups to explore the cognitive and psychomotor skill levels of the students in relevant subjects to be taught. The experimental group was taught using mind maps in 40-min classes every week for 9 weeks, while the control group was taught using conventional teaching methods. At the end of the 9-week period, the tests were administered again. To collect data, a Volleyball Knowledge Test and a Volleyball Skill Test were used. The posttest results showed that the cognitive domain, overhead pass, and bump pass scores of the experimental group were higher. In the comparisons of the cognitive and psychomotor skill levels of the two groups, a statistically significant difference was found in favor of the experimental group in the cognitive and psychomotor domains.

Keywords: Cognitive, mind map, physical education, psychomotor, teaching methods.

ÖZ: Bu araştırmanın amacı, zihin haritası tekniği ile işlenen beden eğitimi dersinin voleybol ünitesindeki başarısını incelemektir. Araştırma deney ve kontrol gruplu yarı deneysel desenden oluşmaktadır. Çalışma, 33 deney 33 kontrol grubu olmak üzere toplamda 66 öğrenci ile tamamlanmıştır. Deney ve kontrol gruplarının bilişsel ve psikomotor düzeylerini ölçmek amacıyla öğretilecek konulara yönelik ön test uygulaması yapılmıştır. 9 hafta boyunca deney grubu haftada 40 dakika Zihin Haritası Tekniği ile ders işlerken kontrol grubu geleneksel öğretim yöntemiyle derslerini işlemeye devam etmiştir. 9 haftanın bitiminde deney ve kontrol grubunun bilişsel ve psikomotor düzeylerini ölçmek amacıyla testler tekrar uygulanmıştır. Verilerin toplanmasında Voleybol Bilgi Testi ile Voleybol Beceri Testi kullanılmıştır. Araştırmanın son test sonuçlarında; bilişsel alan, parmak pas ve manşet pas becerilerinin deney grubu lehine anlamlı olduğu belirlenmiştir. Sonuç olarak; Her iki grubun bilişsel ve psikomotor alan düzeyleri karşılaştırıldığında, bilişsel ve psikomotor alanda deney grubu lehine istatistiksel açıdan anlamlı bir fark bulunmuştur.

Anahtar kelimeler: Beden eğitimi, bilişsel, öğretim teknikleri, psikomotor, zihin haritası.

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The main purpose of the Physical Education (PE) course is to contribute to maximizing the physical, mental, social, and emotional development of children (Gülüm & Bilir, 2011). PE courses are difficult, including broad activities different from each other and involving the teaching of complex movements to students who have different talents, skills, and wishes. Studies have shown that Physical Education Teachers (PET) mainly use teacher-centered practices (Fernández & Espada, 2021; Serbes & Cengiz, 2015; Yıldız & Kangalgil, 2014) while the course has remained a course that gives priority to the psychomotor domain due to issues such as that student-centered practices take time, require experience, and that teachers might not know how to implement them in the class. By prioritizing only psychomotor development, it becomes difficult to address different learning areas, be able to accept individual differences, get outside of what is familiar, or include different senses in the instruction process. For PE instruction to take place, the three interconnected main criteria, which are the cognitive, motor, and affective domains, must always be integrated (Graham, 2008).

It is known that individuals have differences based on their characteristics, such as knowledge, preliminary learning, experience, interests, skill levels, areas of intellect, learning style, culture, socioeconomic levels, and personality structures (Yazar & Karataş, 2019, p. 15). Although it is known that not every student can learn in the same style (Pashler et al., 2008), during the instruction of a course, students are usually expected to gain knowledge only through verbal lectures. Cognitive, affective, psychomotor, and social skill levels affect the learning of students. Learning is subjective. Learning refers to the individual's internalization of what they have learned through various symbols, images, graphics, or models (Özden, 2014). According to today's educational approach, educators need to enrich and improve learning environments by integrating modern instruction methods and techniques with education technologies (Şeyihoğlu & Kartal, 2013; Sismulyanto & Putra, 2018). Enriched learning environments allow students to obtain more meaningful and permanent knowledge. While talking about abstract and hard-to-understand concepts, it is highly important to develop and use instruction activities that could mobilize the visual and intellectual characteristics of students (Köse et al., 2003). One of such activities is the Mind Map Technique.

Mind Maps were developed as a special note-taking technique by the British psychologist and brain researcher Tony Buzan. In addition to being a note-taking technique, it is also considered a useful technique in the areas of supporting creative thinking, planning, and problem-solving (Gou et al., 2021; Maltepe & Gültekin, 2017). This is an important method that will make learning processes meaningful in the case that learners determine the main points of the material they are studying hierarchically, establish connections among concepts, and create a framed form (Yazar & Karataş, 2019, p. 22). A mind map is a unique, strong technique that supports the natural thought process where all cortical skills, including word, image, number, logic, rhythm, color, and spatial awareness skills, are simultaneously used (Buzan & Buzan, 2019). Mind maps involve a 2-dimensional visual display where a keyword or visual is placed at the center, and associations, information, and recalls about the keyword or visual progress are shown on the lateral plane with different colors, symbols, and shapes. Mind maps, which are easier to prepare and use in comparison to many other instruction methods,

may be used in all learning processes, from the revelation of the existing knowledge of individuals to the assessment of the knowledge that is learned (İnel-Ekici, 2015).

The technique is based on making both hemispheres of the brain active at the same time and creating a balanced learning environment. The brain responds best to keywords, visuals, colors, and associations (Tucker et al., 2010). The brain tends to receive information that it is interested in and perceives, and at the same time, all meaningful learning takes place in a complex and rich, stimulating environment (Erdamar-Koç, 2016). The usage of different colors and shapes with the Mind Map Technique and the transformation of the process among students into artistic work lead to increased attention. Mind maps refer to the visualization of the relationships between knowledge and thoughts. Mind maps allow new knowledge to be meaningfully associated with existing knowledge (Brinkman, 2005). Maps make new knowledge more usable. The knowledge that becomes usable is processed easier (Davies, 2011). While mind maps prevent students from getting lost in the main concepts, they provide a bird's eye view of important points. The ability to establish a connection between old and new information may be accelerated by triggering emotions. According to Köksal (2015), emotions are very important for memory as they provide ease in the storage and recall of information. In addition to its benefits, a mind map also has some disadvantages.

Considering individual differences, every student expresses associations in a different way. Therefore, the dialogue between the teacher and the student needs to be good. As mind maps involve concepts, imaginations, and shapes within, they are a topic that needs to be thought about. Therefore, they may pose a time problem. Mind maps might not be suitable for every course or every topic. Mind maps, whose first purpose of emergence was note-taking but were determined to help the learning of individuals and increase their academic success and the permanence of their learning in time (Çömek et al., 2016; Gömleksiz & Fidan, 2013; Kartal & Turan, 2015), are known as a technique which not only brings innovation to the education environment but also has success proven by research. Studies have mostly focused on the effects of mind maps on academic success (Çömek et al., 2016; Gömleksiz & Fidan, 2013; Lai & Lee, 2016), their effects on the understanding of concepts and permanence (Evrekli et al., 2012; Kartal & Turan, 2015; Yorulmaz et al., 2021), their effects on the attitudes and motivation of students (Al-Jarf, 2021; Alsuraihi, 2022; Gömleksiz & Fidan, 2013; Kan, 2012), and their usability at the stage of education (Farrand et al., 2002; Gul et al., 2017; Ren & Jiang, 2019; Rezapour-Nasrabad, 2019; Wickramasinghe et al., 2012). There are also studies on increasing the achievement rates of the targeted cognitive outcomes of students (Al Naqbi, 2011; Astriani et al., 2020; Beydoğan, 2011; Blakh et al., 2021; Dhindsa et al., 2011; Lai & Lee, 2016; Stokhof et al., 2020) and those in the field of sports.

In the study conducted by Awad and Hegazy (2016) with 1st-year students at a Sports Sciences School to examine the cognitive and performance effects of using mind maps on basic handball movements, it was found that the mind map technique was more effective on the cognitive and performance-related aspects of students than verbal explanations. In a study carried out by Fouda (2016) lasting four weeks on 340 female students, it was aimed to determine whether the digital mind map technique influenced technical and numerical performance in athletic walking competitions, and a positive

effect was observed in both groups in the class carried out with the mind map and command methods. In their study lasting one month on the effects of the mind map technique on the attention and performance development of archery athletes, which included 20 athletes at the ages of 11-13, Ashraf & Hamouda (2017) concluded that the increase in attention and performance levels of the participants was in favor of the experiment group.

During the application of PE activities, teachers need to consider the cognitive, affective, and psychomotor development of students (Ministry of National Education [MoNE], 2018). Nevertheless, the structuring of curricula states that student-centered practices should also be used alongside teacher-centered practices. Conducting only teacher-centered practices during the teaching of classes would not be sufficient to reach the desired holistic development. Many studies in the national and international fields have shown that PE courses are mainly taught in a conventional, that is, teacher-centered manner (Saraç & Muştu, 2013; Serbes & Cengiz, 2015; SueSee & Barker, 2019; Yıldız & Kangalgil, 2014; Yıldız & Karakullukçu, 2019). PET see studies on education systems as an innovation, but they do not apply them (İnce & Hünük, 2010). The fact that PET is exposed to a single-type, teacher-centered education during their teacher training, directives are not strictly implemented on how to conduct work towards cognitive development in curricula, and their shortcomings in terms of experience leads them to accept innovations during classes but not apply them (Parker & Curtner-Smith, 2005; Syrmpas & Digelidis, 2014; Yıldız & Karakullukçu, 2019; Zeng, 2016). For this reason, PE courses have remained teacher-centered courses. Motor skills have often been considered the major content of physical education (Dyson, 2014). Learning in a domain such as physical education usually requires a unique knowledge construction process that is consistent with the nature of the knowledge and skills to be learned (Zhu et al., 2009).

While the literature review did not reveal any study in Turkey on the use of the mind map technique in relation to the field of PE, there have been few international studies on the topic. Previous studies have been mostly conducted in fields such as Science, Math, Medicine, and English, while most of such studies have focused on academic achievement, motivation, problem solving, and critical thinking, mainly in the cognitive domain. There are a few studies in the field of sports, and such studies have particularly focused on the psychomotor domain. Furthermore, in this study, not only the cognitive domain but also the psychomotor domain is investigated.

The fact that PET teaches students using the conventional method remains a problem. It is believed that this study will provide innovation for the field with a technique whose applicability in a course that prioritizes the psychomotor domain has been determined, as it is the first study in the literature conducted with a focus on the Volleyball Unit in the field of PE. The inclusion of the mind map technique, which increases individualization and supports cognitive development as a useful technique in addition to a spectrum of teaching styles, reveals the significance of this study for the literature. For conducting a balanced PE activity and turning problems encountered during education into positive outcomes, the individual differences of students should be kept in mind, and their high-level active participation and success should be aimed. The interests and skills that the student has should be considered during the instruction

process, and the educator should address different areas of intellect (Gülüm & Bilir, 2011).

This study aimed to investigate the effectiveness of the mind map technique in the teaching of the volleyball unit under the physical education course. Therefore, mind maps were used as comprehensive teaching-learning materials to impact the cognitive and psychomotor domains of students. For this purpose, the question of whether the volleyball unit taught with the mind map technique has an effect on cognitive and psychomotor development in 6th-grade students constituted the problem statement of the study.

Method

In this study, a quasi-experimental pretest and posttest design with a control group was adopted to determine the effects of volleyball courses taught with the mind map technique on the cognitive and psychomotor development of students. In this design, the data of the participants are analyzed as the dependent variable before and after the experimental procedure (Büyüköztürk, 2016, p. 19). The greatest weakness of experimental designs is that participants cannot be randomly assigned to the experimental and control groups. In experimental research to be carried out in educational settings, it is often impossible to disrupt the routine schedules of students or reorganize their classes according to the research design. For this reason, quasi-experimental designs are preferred over true experimental designs in educational research (Akbay, 2019, p. 169). While the mind map technique was implemented with the students in the experiment group in this study, the conventional instruction method was used in the control group. A pretest was applied to determine the initial cognitive and psychomotor skill levels of the students in both groups. After the implementation, posttest measurements were made by repeating the applied pretests to compare the cognitive and psychomotor development of the two groups.

Participants

The sample consisted of 66 students in classrooms coded 6-A (33) and 6-B (33) at a secondary school. The population consisted of all 6th-grade students enrolled at the Fatih Secondary School in the academic year of 2019-2020. The experimental and control groups were randomly determined between the two randomly selected classrooms of students.

Instruments

As the data collection instruments, this study used a Descriptive Information Form developed by the researcher to collect sociodemographic information, as well as the Volleyball Knowledge Test and the Observation Form involving the targeted outcomes of the overhand pass, bump pass, and underhand serve developed by Sivrikaya and Kaya (2009).

Volleyball Knowledge Test (Cognitive Domain)

This test was developed based on the targeted outcomes of the primary education curriculum specified by the MoNE (2018) to determine the cognitive skill levels of the students regarding the volleyball unit. Considering the targeted outcomes

in the unit specification tables, three questions were prepared to measure each targeted outcome. For the volleyball unit, a 24-question multiple-choice draft test was created to ensure content validity, and questions about each subject to be covered were included. The questions in the knowledge tests were submitted for the opinions of experts. The commission of experts was composed of 1 curriculum development specialist, one measurement and evaluation specialist, 2 PE experts, and 1 Turkish language expert. As a result of the feedback obtained from the experts, the necessary corrections were made, and the test was applied to a different group of 30 students. Matrices of 24 items were prepared for the volleyball unit. Factor load analyses were performed on the answers in these matrices. As a result of the calculations, the KR-20 reliability coefficient was found as .70. According to the results of these calculations, the draft tests were of medium difficulty, and their reliability was high. Following psychometric evaluations, the test for the volleyball unit with 21 questions was obtained as the final test. Every correct answer was worth 1 point, while every incorrect answer was worth 0 points. The KR-20 reliability coefficient of the test was determined to be .74. According to these findings, the volleyball knowledge test had a reliability level that made it applicable to this study.

Volleyball Skill Test (Psychomotor Domain)

The form was applied to follow the development of the students regarding their skills in terms of 3 targeted outcomes (overhand pass, bump pass, and underhand serve) in the volleyball unit and determine their skill levels. The form is a 5-point Likert-type scale with predetermined score categories as 1-9, 10-18, 19-27, 28-36, and 37-45. The cognitive (Volleyball Knowledge Test) and psychomotor (Volleyball Skill Test) assessment tests were used to determine the levels of the students regarding the volleyball unit before the education process. After the education process, by applying the same tests as posttests to the experimental and control groups, were used to determine the development levels of the skills provided.

Implementation Process

The volleyball unit taught with the mind map technique was held with a 9-week education process. The study was completed in a total of 11 weeks, including the pretests and the posttests. While the instruction process was carried out in the control group with the conventional approach by the PET employed at the school, it was carried out in the experimental group with the mind map technique by the researcher. One week before the study started, the students in the experimental group were shown the mind map technique. For determining the cognitive and psychomotor levels in the experimental and control groups before starting the study, the Volleyball Skill Test and the Volleyball Knowledge Test were used to gather pretest data by the researcher and 2 PET. Planning each topic to be taught for three weeks ensured that both groups learned the same topics at the same time. After nine weeks of the experimental process, by repeating the pretests as posttests, it was intended to determine the effects of the intervention on the cognitive and psychomotor development of the students.

Experimental Group

The PE courses were held in 2 class hours per week. In the study, before the intervention, the experimental group was introduced to the mind map technique for 40

minutes (1 class hour) for cognitive development and another 40 minutes taught with a spectrum of teaching styles (e.g., command, practice, reciprocal, self-check) for psychomotor development. Regular feedback was provided for the mind maps created by the students to be remembered during the implementation. The reciprocal, practice, and command styles were used during the implementation.

Control Group

The students in the control group held their classes with the conventional method for 40+40 minutes a week. In the conventional method, the practices were carried out in a teacher-centered manner. The courses are mainly aimed at developing psychomotor skills. The reciprocal, practice, and command styles were used during the implementation.

Data Analysis

The data obtained using the Volleyball Knowledge Test (Cognitive) and the Volleyball Skill Test within the scope of the study were analyzed using the SPSS 20 package software. Paired-samples t-*t*ests, independent-samples *t*-tests, Mann-Whitney *U* tests, and Wilcoxon Signed-Rank tests were utilized. In all analyses, $p<.05$ was accepted as statistically significant. The effect size was examined according to Cohen's *d* score (Cohen's $d= 1.254609$). The effect size was found to be large.

Ethical Procedures

Ethical approval was acquired from Balikesir University Ethics Committee with the decision numbered E.46199 and dated 02.10.2019.

Results

Before starting the analyses, the Shapiro-Wilk test was used to test whether the data showed a normal distribution, and Levene's test was used to test the homogeneity of the variances. Paired-samples and independent-samples t-tests were utilized in the measurement values that met normal distribution assumptions. In cases where the data were not normally distributed, the Mann-Whitney U test and the Wilcoxon Signed-Rank test were utilized.

Volleyball Knowledge Test Results

Table 1

Comparison of the Volleyball Knowledge Pretest and Posttest Scores

	Pretest - Posttest	*n*	Mean Rank	Rank Total	*z*	*p*
Experimental Group	Negative Rank	0	.00	.00	4.709*	.000
	Positive Rank	29	15.00	435.00		
	Equal	4	-	-		
Control Group	Negative Rank	12	14.38	172.50	1.486*	.137
	Positive Rank	19	17.03	323.50		
	Equal	2	-	-		

*Based on negative ranks

As seen in the results in Table 1, which shows the comparison of the test scores of the students on the Volleyball Knowledge Test, the difference between the two tests was significant in favor of the posttest in the experimental group. There was no significant difference between the pretest and posttest Volleyball Knowledge Test scores of the students in the control group (Z=1.486; p>.05).

Volleyball Skill Test Results

Table 2

Comparison of the Pretest and Posttest Volleyball Overhand Pass Scores

	Pretest - Posttest	*n*	Mean Rank	Rank Total	*z*	*p*
Experimental Group	Negative Rank	3	9.33	28.00	4.513*	.000
	Positive Rank	30	17.77	533.00		
	Equal	-	-	-		

*Based on negative ranks

As seen in Table 2, which shows the comparison of the overhand pass tests scores of the students in the experimental group, the difference between the test scores was significant (Z=4.513; p<.001) in favor of the posttest.

Table 3

Comparison of the Pretest and Posttest Volleyball Overhand Pass Scores

	Measurement	*n*	$\bar{X}$	*ss*	*sd*	*t*	*p*
Control Group	Pretest	33	18.17	5.88	32	-1.993	.055
	Posttest	33	19.30	5.35			

As seen in Table 3, there was no significant difference between the pretest and posttest overhand pass scores of the students in the control group ($t_{(32)}$=-1.993; p>.05).

Table 4

Comparison of the Pretest and Posttest Volleyball Bump Pass Scores

	Measurement	*n*	$\bar{X}$	*ss*	*sd*	*t*	*p*
Experimental Group	Pretest	33	17,49	5.24	32	-9.770	.000
	Posttest	33	25.70	3.99			
Control Group	Pretest	33	17.27	4.98	32	-4.943	.000
	Posttest	33	20.88	4.17			

As seen in Table 4, which shows the comparison of the bump pass test scores of the participants, there was a significant difference in favor of the posttest in the experimental group ($t_{(32)}$=-9.770; p<.001). There was also a significant difference

between the pretest and posttest scores of the control group in favor of the posttest ($t_{(32)}$=-4.943; p<.001).

Table 5

Comparison of the Pretest and Posttest Volleyball Underhand Serve Scores

	Pretest – Posttest	*n*	Mean Rank	Rank Total	*z*	*p*
Experimental Group	Negative Rank	3	8.50	25.50	4.557*	.000
	Positive Rank	30	17.85	535.50		
	Equal	-	-	-		

*Based on negative ranks

As seen in Table 5, which shows the comparison of the pretest and posttest volleyball underhand serve scores of the participants in the experimental group, there was a significant difference in favor of the posttest ($t_{(32)}$=-9.770; p<.001).

Table 6

Comparison of the Pretest and Posttest Volleyball Underhand Serve Scores

	Measurement	*n*	$\bar{X}$	*ss*	*sd*	*t*	*p*
Control Group	Pretest	33	13.99	4.52	32	-6.336	.000
	Posttest	33	21.00	6.10			

As seen in Table 6, which shows the comparison of the pretest and posttest volleyball underhand serve scores of the participants in the control group, there was a significant difference in favor of the posttest ($t_{(32)}$=-6.336; p<.001).

Total Success Score Results

Table 7

Comparison of the Total Volleyball Overhand Success Scores

Group	*n*	$\bar{X}$	*ss*	*sd*	*t*	*p*
Experimental	33	6.56	5.30	64	5.017	.000
Control	33	1.13	3.26			

As seen in Table 7, the mean total overhand pass success score of the experimental group was significantly higher than that of the control group ($t_{(64)}$=5.017; p<.001).

Table 8

Comparison of the Total Volleyball Bump Pass Success Scores

Group	*n*	$\bar{X}$	*ss*	*sd*	*t*	*p*
Experimental	33	8.21	4.83	64	4.127	.000
Control	33	3.61	4.20			

As seen in Table 8, the mean total bump pass success score of the experimental group was significantly higher than that of the control group ($t_{(64)}$=4.127; p<.001).

Table 9

Comparison of the Total Volleyball Underhand Serve Success Scores

Group	*n*	Mean Rank	Rank Total	*U*	*p*
Experimental	33	37.06	1223.00	427.000	.132
Control	33	29.94	988.00		

As seen in Table 9, the mean total underhand serve success scores of the experimental group and control group were not significantly different (U=427.000; p>.05).

Table 10

Comparison of the Total Volleyball Success Scores

Group	*n*	$\bar{X}$	*ss*	*sd*	*t*	*p*
Experiment	33	24.19	10.98	64	5.094	.000
Control	33	11.74	8.74			

As seen in Table 10, the mean total volleyball success score of the experimental group was significantly higher than that of the control group ($t_{(64)}$=5.094; p<.001).

Discussion

Volleyball Knowledge Test

Considering the results of the participants on the Volleyball Knowledge Test, which focused on the cognitive domain, the course that was held with the mind map technique in the experimental group was more effective than the course held with the conventional method in the control group. At the stage of providing theoretical knowledge, it was determined that the mind map technique allowed the participants to learn easily, helped them in the organization of information and in terms of making information visible, increased their creativity, interest, motivation, and attention, and allowed them to keep notes better. There are studies supportive of this result (Al Naqbi, 2011; İnel-Ekici, 2020; Polat & Aydın, 2020; Sari et al., 2021; Selvi & Chandramohan,

2018; Şimşek et al., 2020; Tavares et al., 2021; Wang & Dostál, 2018; Wette, 2017; Zeybek, 2020; Zheng et al., 2020; Zipp & Maher, 2013).

There was no statistically significant difference between the pre-test and post-test *Volleyball Knowledge Test* scores of the control group. Accordingly, the volleyball unit taught with the conventional method was insufficient in providing the students with cognitive skills. Carrying out PE courses, mainly in a teacher-centered manner, by using the command, practice, and reciprocal working methods, where less priority is given to the student's structuring of knowledge (Cothran et al., 2005; Fernándezrivas & Espada, 2020; SueSee & Barker, 2019; Yıldız & Karakullukçu, 2019) and focusing solely on the psychomotor domain, leads the cognitive development of the students to be held back (Chatoupis, 2018; Parker & Curtner-Smith, 2005). It is believed that this result arose as a consequence of giving priority to psychomotor development.

Considering the *success scores of the participants in the Volleyball Knowledge Test*, a statistically significant difference was determined in favor of the experimental group. Considering the findings above, it was determined that the mind map technique was more effective in developing the cognitive skills of the students than the conventional method. The students who used the mind map technique obtained more permanent and comprehensive knowledge, they established stronger connections among pieces of information, and they arranged their knowledge in an organized way in terms of visuals. This result supported the objective of the study. In the literature, there are studies compatible with the findings of this study.

Beydoğan (2011) used the mind map technique at the cognitive preparation stage. According to their findings, students who participated in the experiment were ahead at the stage of cognitive preparation compared to the control group. Dhindsa et al. (2011) used the mind map technique as a learning model to improve the metacognitive skills of students. Astriani et al. (2020) also found that the mind map technique improved metacognitive skills. Al Naqbi (2011) reported that the use of mind maps increased the thinking skills of students, the planning and organization of information, and students could renew their old knowledge in mind maps on different topics, which made it easier for them to recall their preliminary knowledge. Stokhof et al. (2020) revealed that in basic courses using the mind map technique, students advanced their learning within a broader scope, and by visual learning through mind maps, they had a better understanding and a detailed structure of the knowledge. In a study conducted by Ordu and Çalışkan (2022) with nursing students, it was shown that web-based mind maps improved the knowledge and nursing diagnosis skills of the students. Chen et al. (2022) found that mind maps improved memory, comprehension, and learning skill scores.

Although this study was not conducted in the same field as the studies mentioned above, the results were parallel. The findings in the literature have shown that mind maps help students make their knowledge visible, show them how much they know, allow them to correct their mistakes in real-time, affect their attitudes positively, and turn into an activity that students find (Abd Karim & Mustapha, 2022; Çelik, 2016; Kemankaşlı, 2018; Sabbah, 2015), and leading them to become more attentive and willing, thus increasing the effect on cognitive development. It is thought that the usage of colors and support with shapes and images allows information to be recalled and knowledge to be visualized. Various studies have revealed that visuals make the

learning and recall of information easier for students and support meaningful learning by making concepts more comprehensible (Abi-El-Mona & Adb-El-Khalick, 2010; Keskinkılıç-Yumuşak, 2013; Long & Carlson, 2011; Ordu & Çalışkan, 2022).

Considering the educational content at schools, every topic is connected to a previous topic. It was thought that the fact that the students in the experimental group created mind maps in every new class made it easier for them to establish connections between old and new information by allowing them to make additions to the mind maps they had created in the previous class. To support the learning of the students in the cognitive domain, classes were held with the 40-minute mind map technique in addition to practice. It may be stated that the fact that the knowledge of the students was set beforehand at the stage of their hand and body stances, times to rise and control the ball, increased their comprehension better than the conventional method.

Volleyball Skill Test

In this study, it was determined that the volleyball unit taught with the conventional method fell short of providing the students with skills. On the other hand, the mind map technique was more effective than the conventional method. According to the *overhand pass total success* scores of the participants of this study, a significant difference was found in favor of the experimental group, which was taught using the mind map technique. As a conclusion of the tests defined to determine the *bump pass success* levels of the students, it was found that both techniques were effective, but the increase in the scores of the experimental group was higher in comparison to that in the scores of the control group. Considering the *bump pass total success scores*, the significant difference in favor of the experimental group supported this finding.

It is considered that with the mind map technique, the students comprehended the order of skills that needed to be applied during an overhand pass or a bump pass better, the foundation of the technique was improved with the help of associations, and better recall was effective on the requirements of the technique. The results reported by McCrea and Lorenzet (2018) revealed that mind maps helped better understand topics and was more effective, especially when recalling higher-order concepts. In the study by Şen and Çoban (2018) on the effects of the mind map technique used in violin education courses on the cognitive and psychomotor skills and attitudes of students, it was determined that the mind map technique was effective in the development of cognitive and psychomotor skills, and it increased the permanence of theoretical knowledge. Abd Karim and Mustapha (2022) conducted a study on the technical and vocational education and training of students by using digital mind maps. It was found that mind maps stimulated the learning of technical skills. Awad and Hegazy (2016) conducted a study on the effects of a handball course taught using the digital mind map technique on the cognitive and psychomotor skill development of students. It was stated that the mind map technique was more effective on the students in comparison to verbal lecturing.

The tests conducted to determine the *underhand serve success* levels of the students who participated in this study revealed that both the conventional and mind map methods helped provide the students with serving skills, but there was no statistically significant difference between the two methods. The outcome of the underhand serve test may have been caused by the fact that the students had not reached sufficient skill levels to make the movement, the students in the experimental group

could have had more sports experience than those in the control group, and the PET employed at the institution might have mentioned the volleyball unit before. Ashraf and Hamouda (2017), who conducted research on the effects of mind maps on the attention and performance of archery athletes, and Fouda (2016), who studied the method among athletic walking practitioners, reported that the mind map technique increased the performance and attention of the participants.

According to the *total success score* results of the volleyball unit classes held with the mind map technique and the conventional method, it was found that the mind map technique was more effective, it allowed the students to see the concepts more clearly, kept them away from detailed and complicated information, prevented them from distraction, and visualization was effective on student success. It is believed that the mind map technique affected the cognitive and psychomotor learning processes of the students positively at the points of processing, recalling information, and using it when desired so. It has been observed that the mind map technique provides the active learning of students during a class, facilitates their observation of their preliminary and later knowledge, the presence of innovation in the classroom increases their attention and interest, stimulates multiple sensory organs, allows easier learning and remembering, helps organize information, and thus, helps academic success (Brinkman, 2005; Edwards & Cooper, 2010; Kartal & Turan, 2015; McCrea & Lorenzet, 2018; Stankovic et al., 2011; Tucker et al., 2010; Wilson et al., 2016; Yan & Rui, 2022).

It is assumed that for the experimental group, forming their mind maps, using colors, and associations, allowed the participants to have more permanent learnings by increasing their focus to making better drawings and their attention in the class. It facilitated their active participation in the process and arrangement of their maps based on their own needs. With the mind map technique, it was aimed to minimize individual differences. At the stage of forming the preliminary knowledge of the students with the mind map technique, the students not only listened to what they were told but also applied it. It is thought that the permanence of the knowledge that was learned was increased by the help of the repetition and practicing methods which are required for PE courses.

Although the results here described the mind map technique as a successful instruction tool, it has been found that it leads to time loss during classes (Bütüner, 2006; Çelik, 2016), and students experience problems while applying the technique as they are not able to express every desired concept visually (Şeyihoğlu & Kartal, 2013; Wang, 2019; Yang et al., 2022). The most liked aspects of the mind map technique were also considered difficult by some who participated in the research (Jones et al., 2012; Wheeldon, 2011; Yunus & Chien, 2016). Therefore, this technique might not be usable in every field, course, or topic. Additionally, not being able to check whether students work on their maps after school may lead to some disruptions. According to these findings, it is considered that these disadvantages should be focused on in future studies to be conducted on the mind map technique. While the mobilization of multiple sensory organs led to the materialization of information by the students, it supported their meaningful learning. In summary, it is not enough for students to understand the topic, it is needed to demonstrate it to them, do it, do it with help, do it independently, and ensure that what is being done becomes a habit. Otherwise, what is learned is forgotten fast (Kılıç, 2018).

Conclusion

This study highlighted the effects of the mind map technique on the cognitive and psychomotor development of students receiving volleyball training and investigated its effectiveness in classes in comparison to the conventional method. The cognitive and psychomotor skill levels of both groups were compared, and there was a significant difference on behalf of the experimental group in the cognitive and psychomotor domains. This is one of the few studies conducted on the mind map technique. Given the results of this study, it was concluded that the mind maps, which were applied as an in-class learning-teaching instrument, improved the cognitive and psychomotor skills of the students, and they were usable for the volleyball unit. A limitation of the study was that it was carried out at a single school and with the participation of students from two of its classrooms. This is why it is thought that a comprehensive study could be carried out by conducting research at different schools nationwide. This will be important in terms of the utilization of studies that have been and will be conducted in the field of PE. It is believed that as a student-centered technique where it is aimed to minimize the individual differences of students and ensure their active role in the process, the mind map technique made the PE course no longer a course that only includes psychomotor practices and turned it into a course that also pays importance to cognitive development.

Recommendations for Future Research

Mind maps may be utilized in frequently encountered posture disorders, for the simplification of the complexity that occurs during movements, and in the teaching of different techniques. They may also be used at the stages of understanding game rules, comprehending the series of movements between skills, introducing sports branches, and setting the foundations of theory and practice. In this study, the individual and hand-drawn mind map technique was applied. Studies may be conducted in different fields through group work or by employing computer-assisted mind map practices. This study was conducted on 6th-grade students, while future studies may be conducted with different age groups.

Statement of Responsibility

Ceren Nur Temiz; methodology, data collection, writing abstract introduction, conclusion sections and review. Ahmet Haktan Sivrikaya; methodology, analysis, and writing results section and review.

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