Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989 – 9572

DOI: 10.47750/jett.2023.14.01.062

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Journal for Educators,Teachers and Trainers, Vol. 14 (1)

https://jett.labosfor.com/

Date of reception:12 Nov 2022

Date of revision: 15 Jan 2023

Date of acceptance: 26 Feb 2023

Nuri Uslu, İbrahim Dalbudak, Melih Balyan (2023). Multidisciplinary Approach in Physical Education and Sports: Mathematics Lesson Example.*Journal for Educators, Teachers and Trainers,*Vol. 14(1). 664-674

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Multidisciplinary Approach in Physical Education and Sports: Mathematics Lesson Example

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ABSTRACT
In this study, the effects of physical education and sports lessons organized in game form with the understanding of interdisciplinary teaching on some mathematics achievements and attitudes of students towards physical education and mathematics lesson were examined.
The sample of the study consists of 5th grade students at the secondary school of the state school in Izmir. 97 of these students constitute the control group (51 females - 69 males) and 120 of them constitute the study group (44 females - 53 males).
"Physical education lesson attitude scale", "Mathematics Attitude Scale" and mathematics lesson outcome test were applied to the participants, respectively.
In the study, quasi-experimental model with pretest-posttest control group, one of the quantitative research methods, was used. Firstly, pre-tests were applied to all students (control-study group). After the tests were applied, the research application was carried out during the first lesson hours of physical education and sports lessons for 8 weeks. In accordance with the physical education curriculum, applications were made to the students in the control group in a game form. On the other hand, game forms specially adapted for the mathematics achievements of similar games were applied to the students in the study group. Post-tests were applied to all students (control-study group) at the end of 8 weeks. The data were analyzed by using IBM SPSS Statistic 20 program. There was an improvement in the mathematics achievements of the control group (t = -2.60, p0.011 *) and the study group (t = -6.17, p0.000***). On the other hand, as a result of the effect sizes examined, it was found that the mathematics achievements in the study group (effect size d = 0.66) were higher than the control group (effect size d = 0.24). As a result of our research, it was concluded that physical education lessons and mathematics lessons conducted with a multidisciplinary approach increase students' mathematics achievements. It is recommended to add the studies carried out with the interdisciplinary teaching model to the education and training programs.

Keywords: Interdisciplinary teaching, middle school, achievement, attitude, games

INTRODUCTİON

Today, rapidly changing technology and science, the constantly changing needs of individuals and societies and the changes in teaching and learning strategies have made it necessary to change and renew education programs. The renewed education programs should aim to train people who produce information rather than take it readily and can transfer this knowledge to different areas of life, solve problems, are entrepreneurs and have high communication skills (WEF, The Future of Jobs Report , 2018). With this change, the educational processes in the formal structures in which we spend a long period of our lives must also change. One of the changes in this process is the interdisciplinary teaching approach.
The multi-disciplinary approach is a model that enriches the student's perspective and way of thinking about problems. "Interdisciplinarity includes collaborative problem solving, complex research problems, borrowing tools and methodologies, and cross-seeding between disciplines and concepts." (Yıldırım, 1996; Gür, 2003). Interdisciplinary teaching also helps to make the educational environment more enjoyable (Hatch & Smith, 2004). With the interdisciplinary teaching approach, more meaningful and permanent learning can be achieved by addressing common concepts in different fields together with different perspectives in different discipline teaching.

The interdisciplinary teaching approach is also referred in the literature with different concepts such as multidisciplinary approach and aggregation approach in teaching. In the literature, the interdisciplinary approach model is a subject of research in many areas (Jacops, 1989; Dervişoğlu and Soran, 2003; Delier, 2005; İşler, 2007; Ürey et al., 2015; Ürey and Çeppi; 2014,, Kanatlı and Şık; 2013. ; Sağdıç and Demirkaya, 2014; Marijke et al., 2016; Lattuca et al., 2017; Kızılateş; 2018 ;; Chrysostomou, 2004;). However, it can be said that the number of researches (Arslantaş; 2007; Koşar , 2007; Hartman, 2003; Vazou & Skrade, 2017; Marijke et al., 2018; Hraste et al., 2018) on physical education and sports lessons is insufficient.

Many different definitions have been made regarding the interdisciplinary approach. The common points that stand out in general in these definitions are as follows. In an interdisciplinary approach, a link should be established between subjects and lesson plans. The content of the course should be enriched with different resources, not relying on textbooks. Concepts must be associated. Programs should be flexible and able to be shaped by teachers.

Concerning the connection of physical education and sports discipline with other disciplines, Cone et al. (1998) presented 3 different interdisciplinary teaching models as simple to complex, shared and collaborative.

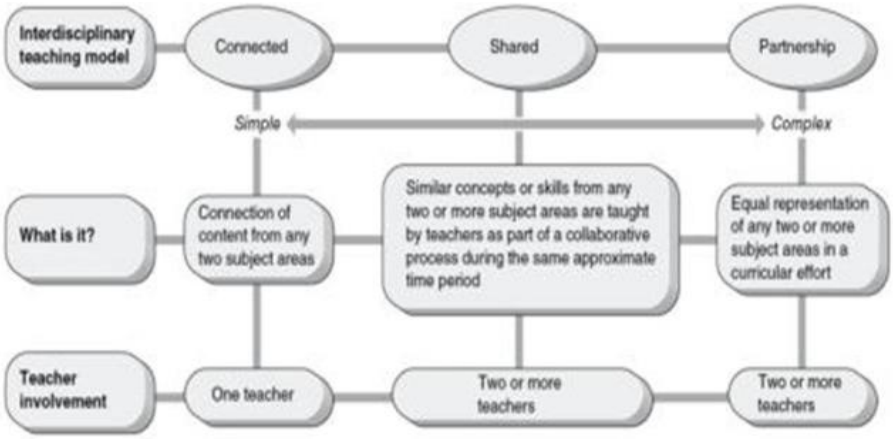


Figure 1:Interdisciplinary Teaching Models (Cone et al., 1998)

Connected Model

In this model, only the subjects and achievements of a lesson are at the center of learning. The contents of the lesson to be associated are used to increase the achievements of the other lesson (Cone et al., 1998).

Shared Model

Teaching the concepts and achievements of more than one lesson by associating them. The model requires collaboration among teachers in the skill, subject concept or teaching period. Applications should be done simultaneously or recently (Cone et al., 1998).

Partnership Model

In this model, lessons are taught by representing more than one field at the same level. Learning takes place at the same time in all disciplines. Teachers transfer their achievements in their own discipline to students together with other colleagues in the same class. The result provides a content that will enable students to better understand the interconnection of all fields (Cone et al., 1998).

When we examine the programs of physical education and sports lessons in our country, we see that the curriculum is mostly oriented towards achievements that support the psychomotor skills of the students. Physical education and sports lessons, which are based solely on the psychomotor behavior of the students, turn into a one-dimensional and ordinary education with such classical practices. However, physical education and sports lessons can appeal to students with different types of intelligence with interdisciplinary partnerships. Lessons to be taught with this and similar approach models can target the development of students as a whole with psychomotor, cognitive and affective motifs. The following hypotheses will be investigated in our study that we have carried out for this purpose;

Physical education and sports lessons, which are taught in game form with an interdisciplinary approach, enable students to get some mathematics achievements more easily.

Physical education and sports lessons, which are taught in game form with an interdisciplinary approach, develop students' positive attitude towards mathematics lesson.

Physical education and sports lessons, which are taught in game form with an interdisciplinary approach, develop students' positive attitude towards physical education lesson.

METHOD

Research Design

In this study, a quasi-experimental model with pretest-posttest control group, one of the quantitative research methods, was used. "This research design is one of the most widely used patterns in educational research and in settings where it is not possible to equate the participants. In this design, the study and control groups are randomly selected, all groups are pre-tested and post-tested. However, the experimental process is only applied to study groups. (Cohen, Manion & Morrison, 2007).

The approval of the ethics committee of the study was obtained from Ege University Social and Human Sciences Research and Publication Ethics Commission (protocol number- 157-2018)

Sample (study group)

The research application was carried out in the secondary school with 230 students studying at the fifth grade in the central district of Izmir in the 2018-2019 academic year. Of these students, a total of 13 students were excluded from the study, including 5 students who took the first test but did not participate in the final test, 6 students who did not attend at least 25 percent of the practice lessons by more than 2 absences during the applications, and 2 students who dropped out of the school through transfer, and a total of 217 students were evaluated. 97 of the students constitute the control group and 120 of them constitute the study group. Gender difference was not taken into consideration in forming the sample group. Control and study groups were formed by random selection method from among the branches. It can be said that the distribution of the control group (male (n:53) female (n:44)) and the study group (male (n:51) female (n:69)) is close to each other by gender.

Table 1:Examination of the pre-test results of control and study group students in mathematics achievement test

Groups	Achievement Test Scores	Art. Mean	n	SD	T test for independent groups
Control	Pretest	2.98	97	2.22.	1.14
Study	Pretest	2.66	120	1.93	

While the arithmetic mean of the control group was 2.98 and the standard deviation was 2.22, the arithmetic mean of the study group was 2.66 and the standard deviation was 1.93. As a result of the independent t test performed for the pre-test scores of the control and study groups, no statistically significant difference was found between the groups (t=1.14, p0.26). This finding shows that before the application, the control and study groups were at a similar level in terms of the mathematics achievements desired to be given in the study.

Data Collection Tools

In the research, a scale consisting of 3 parts and a mathematics achievement test were applied. In the first part of the scale, a personal information form was used and in the second part, to determine students' attitudes towards physical education and sports lessons, "Physical education lesson attitude scale" developed by Güllü, Güçlü, & Arslan (2009) was used. In the third part, to determine students' attitudes towards mathematics lesson, "Mathematics Attitude Scale" developed by Önal (2013) was used. In addition to these scales, the "Mathematics Lesson Outcome Test" prepared by teachers who are experts in their field was conducted to the students.

Mathematics Attitude Scale

Attitude Scale Towards Mathematics was developed by Nezih Ünal in 2013. "It consists of 4 factors: interest, anxiety, work and necessity". There are a total of 22 items in the questionnaire. The scale is 5-point Likert type. It was found that "internal consistency coefficient of the whole scale was .90, and internal consistency coefficient of the sub-factors was 0.89 for "Interest" (number of items 10), 0.74 for "Anxiety" (number of items 5), 0.69 for "Study" (number of items 4), and 0.70 for "Necessity" (number of items 3). It was confirmed by confirmatory factor analysis that the scale constitutes a four-factor structure " Önal (2013).

Physical Education Lesson Attitude Scale

"Physical Education Lesson Attitude Scale" was developed by Güllü, Güçlü and Arslan in 2009 to determine students' attitudes towards physical education lesson. "The scale consisting of 35 items (11 negative, 24 positive) is one-dimensional, and the variance explained by the single factor is 36.19% and the first eigenvalue is 12.67. According to the test-retest method, the reliability coefficient was found to be 0.80 and the consistency coefficient to be 0.94. The results show that the scale has provided validity and reliability" Güllü, Güçlü, & Arslan (2009).

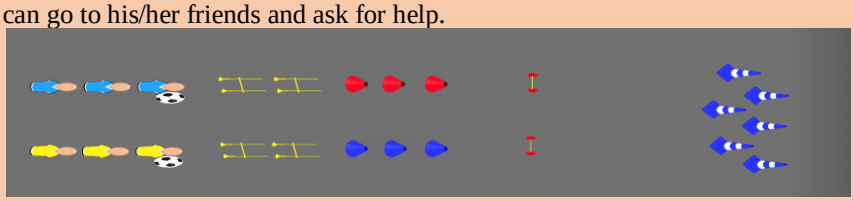
Mathematics Lesson Achievement Test

In the study, a 10-question mathematics achievement test was prepared by expert teachers (3 teacher) in order to measure the mathematics achievements desired to be taught to students. A pool of 40 questions was created about the strategies of mental operations of the mathematics lesson, multiplying by 5 from the mind, dividing by 5 from the mind and multiplying by multiples of 2, and then a 10-question achievement test was prepared that includes these 3 achievements. Mathematics achievement test is about whether children use easy mental processing strategies or not, and it was prepared to understand whether students use these strategies taught while solving mathematical problems.

Procedure

During the pre-test and post-tests of the research, the 3-part scale and mathematics achievement test were applied to the students. After the pre-tests were applied to the students, a research application was made to the study group at the first hour of physical education and sports lessons for 8 weeks. In the lessons taught in game format, intergroup course competitions, target hitting, group dynamics games and games where students can both compete and get help from each other were played. In the control group, these games were played only considering the achievements of physical education and sports lessons, while in the study group, the same games were played in different formats by reforming in order to provide achievements of mental processing strategies in mathematics. Multiplication by 5, division by 5 and multiplication by multiples of 2, which are the sub-achievements of the study group, were added to the games, and the students were allowed to apply these strategies to make fast operations.

Table 2: Daily lesson schedule example of physical education and sports lessons carried out with a multidisciplinary approach

Lesson	Physical Education
GRADE And DURATION	5th GRADE - 40 MINUTES
Learning Area	A. Movement Competence
Sub-Learning Area	Movement Skills
Basic Skills	Problem Solving Skills, Communication Skills, Decision-Making Skills, Entrepreneurship Skills, Observation Skills, Space Perception Skills
Achievements	A.5.3. S/He Performs Balancing, Object Control And Displacement Movements. A.5.8 S/He Shows Combined Movement Skills In A Variety Of Games And Activities. A.5.14. S/He Understands The Importance Of Cooperation In Games And Activities.
Math Lesson Achievement	S/He Uses The Appropriate Strategy For Mentally Multiplying And Dividing With Natural Numbers.
Teaching Methods	Lecture, Command, Exercise. Problem Solving
Tools And Equipments	Sportswear, Ball, Funnel, Vest, Etc.
Lesson Area:	Schoolyard
Learning And Teaching Process	
• Warm-up and explanation of the lesson objectives (10 minutes)	Students are prepared for physical activity with general or special warm-up movements. Students are informed about the objectives of the lesson. (The use of mathematical mental multiplication strategies to the study group is explained)
• Practice Game (25 mins.)	After the students make the jump and slalom movement, they shoot from a certain distance and try to hit the target funnels with the ball. Students who hit the target in this game played in the control group earn 1 point. The study group also plays the same game, but questions are put under the target funnel, where students will waste time when trying to do it in normal ways such as 120 x 5, 260 x5, 420 x5 to use mental trading strategy. The student who hits the target gets 1 point, while the student who answers the question correctly gains 2 additional points. In this way, students' motivation to solve the problem is increased and the student is enabled to use mental multiplication strategies to avoid wasting time. An ask their friend lifeline is given to each group to provide cooperation. When the student cannot know the answer, s/he can go to his/her friends and ask for help.
• Ending the Lesson (5 mins.)	 Feedback is given about the illegal or positive actions of the students observed during the games. By asking questions about the goals of the lesson, it is ensured that they are aware of the achievements.

Data Analysis

The data obtained from the pre-test and post-test results were analyzed in IBM SPSS Statistic 20 program. The frequency, arithmetic mean and standart deviation values of the data were determined. In the analysis process, independent t test and paired t test were used to determine whether the pre-test and post-test scores of the students from the attitude scales and mathematics test differ in terms of the control and study groups. Significant results were calculated with cohen's d effect size formula and the sizes of significant differences were reached.

Findings

Table 3:Paired t Test Results of Mathematics Achievement Test Pre Test-Post Test Data of Control and Study Group Students

Groups	Achievement Test	Art. Mean	n	Sd	Paired t Test	Effect Size
Control	Pre-test	2.98	97	2.22	-2.60*	.24
	Post-test	3.56	97	2.43		
Study	Pretest	2.66	120	1.93	-6.17***	.66
	Posttest	4.18	120	2.64		

*p<0.05; **p<0.01; ***p<0.001Effect Size: low = 0.2 medium = 0.5 high = 0.8

Paired t test was applied to measure the difference between the mathematics achievements pretest and posttest scores of the control and study groups. A significant difference was found in favor of post-tests in terms of pre-test and post-test scores of the control group (t=-2.60, p0.011*) and the study group (t=-6.17, p0.000***). After Cohen's d effect size analysis conducted in line with these data, the effect size (d = 0.24) between the pre-test and post-test data of the control group was found to be low, while the effect size between the data of the study group (d = 0.66) was found to be medium. These findings reveal that the students in the study group improved more in terms of mathematics achievement than the students in the control group.

Table 4:Comparison of Student Attitudes towards Mathematics, Physical Education and Sports Lessons in Terms of Study and Control Groups

Attitudes		Groups	n	Art.Mean	SD	T test for independent groups
Mathematics Attitude Scale Lesson	Interest pretest	Control	97	2.14	.86	.36
		Study	120	2.10	.70	
	Anxiety pretest	Control	97	2.97	1.19	1.41
		Study	120	2.76	1.06	
	Study pretest	Control	97	1.66	.60	-.75
		Study	120	1.73	.70	
	Necessity pretest	Control	97	1.65	.83	-.64
		Study	120	1.73	.95	
Physical education lesson attitude scale pre-test		Control	97	4.11	.75	.21
		Study	120	4.08	.86	
Mathematics Attitude Scale Lesson	Interest posttest	Control	97	2.18	.90	.50
		Study	120	2.18	.87	
	Anxiety posttest	Control	97	2.97	1.19	1.41
		Study	120	2.76	1.06	
	Study posttest	Control	97	1.81	.77	.81
		Study	120	1.73	.77	
	Necessity posttest	Control	97	1.58	.76	-.53
		Study	120	1.64	.90	
Physical education lesson		Control	97	4.17	.75	-.71

attitude scale posttest	Study	120	4.24	.73	

In terms of students' attitudes towards mathematics and physical education and sports lessons, no significant finding was found as a result of independent t-test analysis of the pre-test and post-test scores according to the variables of the control and study groups (p>0.05).

Table 5:Paired T Test Results of Control and Study Group Students' Attitudes towards Mathematics and Physical Education and Sports Lesson

Groups		Attitudes	n	Art. Mean	SD	Paired t Test	Effect Size
Control Group	Mathematics Attitude Scale Lesson	Interest pretest	97	2.14	.86	-.70	
		Interest posttest	97	2.18	.90		
		anxiety pretest	97	2.68	1.12	-3.28***	.25
		anxiety posttest	97	2.97	1.19		
		Study pretest	97	1.66	.60	-2.01*	.21
		Study posttest	97	1.81	.77		
		Necessity pre-test	97	1.65	.83	.94	
		Necessity posttest	97	1.58	.76		
	Physical Education and Sports Attitude Scale pretest		97	4.11	.75	-.80	
	Physical Education and Sports Attitude Scale posttest		97	4.17	.75		
Study Group	Mathematics Attitude Scale Lesson	Interest pretest	120	2.10	.70	-1.13.	
		Interest posttest	120	2.18	.87		
		anxiety pretest	120	3.00	.98	2.54*	.24
		anxiety posttest	120	2.76	1.06		
		Study pretest	120	1.73	.70	.00	
		Study posttest	120	1.73	.77		
		Necessity pre-test	120	1.73	.95	.88	
		Necessity posttest	120	1.64	.90		
	Physical Education and Sports Attitude Scale pretest		120	4.09	.86	-2.35*	.19
	Physical Education and Sports Attitude Scale posttest		120	4.24	.73		

*p<0.05; **p<0.01; ***p<0.001Effect Size: low = 0.2 medium = 0.5 high = 0.8

The pre-test and post-test paired t-test analyzes of each of the sub-dimensions of physical education and sports lesson and math lesson attitudes of the control and study groups were performed. As a result of the analysis, a significant difference was found in the anxiety (t=-3.28; p0.001***) and study (t= -2.01; p0.047*) dimensions of the mathematics attitude scale in the control group. In the study group, there was a statistically significant difference in the anxiety (t=-2.54; p0.012*) dimension, which is one of the sub-dimensions of the mathematics attitude scale. There is no statistically significant difference in attitudes in terms of other sub-dimensions. The effect sizes of the data that were found to be significant were calculated and it was seen that all of them were low (d = 0.20 - 0.26). While there was an increase in the post-test data in the dimension of anxiety towards mathematics in the control group, it was observed that the students in the study group experienced less anxiety towards mathematics than their pre-test scores in the post-test. When the physical education and sports lesson attitude scores were examined, there was no significant difference in terms of the control group, but a small significant difference was found when the pre-test post-test scores of the study group were compared (t = -2.35; p0.02*, d =.19).

DİSCUSSİON

In this study, the effect of interdisciplinary practices in which physical education and sports and mathematics lessons are synthesized and presented on students' mathematics achievements and physical education and sports and mathematics lessons were examined with a quasi-experimental model.

In the results of our research; as a result of the findings on students' mathematics achievements, there was no difference in mathematics achievement in terms of the two groups before the application (Table 1), while the

mathematics achievements of both groups were improved as a result of the applications carried out for 8 weeks (Table 3). On the other hand, as a result of the effect sizes examined, it was concluded that the mathematics achievements in the study group were at a higher level compared to the control group.

Arslantas (2007), in his work conducted with 4th grade primary education students, he aimed to teach the physical education lesson, which he organized in a multidisciplinary way, with mathematics and social studies lesson and reported that he found improvements in students' skills and cognitive levels.

Koşar (2007), in his study, examined the effects of the physical education lesson, which was applied according to the "interdisciplinary education" approach by using volleyball and basketball units in the primary school 4th grade physical education lesson, on the achievements of the science lesson that was linked in addition to the cognitive and psychomotor development. As a result, a significant difference in favor of the study group was found.

In our study, it can be said that the results of the control group related to the developmental processes of mathematics achievement originated from the lives of the students. At the same time, students realize the achievements that are desired to be gained in the research in the teaching process in the content of the mathematics lesson, and accordingly, improvement in both groups can be interpreted as a natural result. Another finding supporting this can be that although the pre-test scores of the students in the study group were lower than the control group, they were above the average scores at the end of the application compared to the control group. The results obtained in our research supports the studies of Hatch and Smith (2004), Donnelly and Lambourne (2011), Dwyer et al. (2001), Grissom (2005), Castelli et al. (2007) and Vazou and Skrade (2017).

It can be said that the fact that the mathematics lesson achievements increased in the study group as a result of the study shows that the physical education lessons taught with an interdisciplinary approach not only increase the ability of students to move, but also contribute to their cognitive processes. Vazou and Skrade (2017), in their study integrating physical activity with mathematics, compared interdisciplinary teaching with classical teaching method and obtained results about students' performance in mathematics and their perception of their own mathematical competencies at the end of the 8-week term. In the results of this study, while improvement was observed in both the control and study groups, they reported that more improvement was observed in the study group in which mathematics lessons integrated with physical activity were taught. Marijke et al., in their study published in 2016, used physical activity for mathematics teaching and the development of speaking skills, and as a result of the applications performed with 499 students with an average age of 8.1 from 12 different schools and lasting for 2 years, medium significant differences in the math speed test, general math test and speaking test for the study group have been found. This means 4 months more learning achievement compared to the control group. Our results support the results of these studies.

In our study, no significant findings were found as a result of pre-test and post-test independent t-test analysis of their attitudes towards mathematics, physical education and sports lesson for the control and study groups. In line with these findings, it can be said that the control and study groups displayed similar attitudes towards mathematics and physical education lessons at the beginning and at the end of the study (Table 4).

Paired t test analysis was conducted to explain the pre-test and post-test differences of the mathematics, and it was concluded that physical education lesson attitudes of the control and study groups, and the anxiety level of the control group towards mathematics increased in the post-tests, on the contrary, the anxiety level of the students in the study group was lower in the post-test compared to the first test (Table 5). The teaching of the lessons with this approach mode can change students' prejudices about the lessons and enable them to express themselves more easily. This result supports McCan's (2017) study in which mathematics and physical activity exercises were synthesized and he reported that students' physical activity levels increased, and that their self-confidence related to mathematics developed.

Hraste et al. (2018) found results that match with our study in the study in which they examined the effect of motor activities integrated with the cognitive approach in geometry teaching. In the light of these results, it is said that by synchronizing children's bodies with their minds, their motor skills, coordination, memory, reading, speaking, language and math skills can be developed in a balanced way and thus hyperactivity, anxiety and stress can be reduced. It was concluded that the integration of geometry lessons with physical education is much more efficient and effective compared to teaching with traditional methods.

Another finding in our study is that while the attitude levels towards physical education and sports lesson did not change in the control group, there was a significant difference in the post-test attitude towards physical education and sports lesson in the study group (Table 5). According to these results, it can be said that in physical education lessons that are taught through an interdisciplinary approach, students' doing different activities other than the usual lessons increases their attitudes towards the lesson. Interdisciplinary teaching helps to make it more enjoyable with diversified and non-monotonous physical activities in the educational environment. Hatch and Smith (2004) stated in their study that students' views were generally that they enjoyed the interdisciplinary classroom environment when presenting a subject in relation to other fields through the interdisciplinary curriculum.

CONCLUSİON AND RECOMMENDATİONS

As a result of our study, it was concluded that physical education and sports lessons combined with the multidisciplinary approach method and mathematics lessons especially increase the mathematics achievements. In addition, it can be said that this teaching model can increase student attitudes towards mathematics and physical education and sports lessons.

At this point, we can list our suggestions as follows:

- The effects can be examined by applying the study in different age groups, different grade levels and durations.
- The common effects of integrating physical education and sports lessons with lessons in different fields can be examined.
- Curriculum development studies in accordance with the interdisciplinary teaching model should be carried out and interdisciplinary studies should be added to the education curriculum.
- Information seminars on this subject can be held in teacher training and in-service training. Interdisciplinary teaching can be mentioned in the guide books, and case studies that integrate different lessons that teachers can benefit from when necessary can be added to these books.
- In studies to be carried out on this subject, different studies can be considered by taking different fields into the center, except for physical education and sports lessons.
- In our study, the connected model, which is one of the interdisciplinary teaching models, was used. New studies can be considered for the shared and collaborative model, which is one of the interdisciplinary teaching models.

Note:This article was produced from the master's thesis of nuri uslu.(Ege University,2019).

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