EFFECT OF POLYA'S STRATEGY USING METHODS OF HOMOGENEOUS AND HETEROGENEOUS SMALL GROUPS ON LEARNING SOME BASIC VOLLEYBALL SKILLS

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ABSTRACT

Background. The development of effective learning strategies is essential in physical education, particularly in team sports such as volleyball, where acquiring fundamental skills requires structured instruction and active participation. Traditional teaching approaches often focus on repetition, which may not fully engage students or cater to their diverse learning needs. Therefore, it becomes important to explore innovative strategies that combine cognitive problem-solving with collaborative learning. **Objectives.** This study aimed to investigate the effect of Polya's strategy, applied through homogeneous and heterogeneous small group methods, on learning some basic volleyball skills among intermediate school students. **Method.** The research employed an experimental method due to its appropriateness for the nature of the problem. The sample consisted of 54 students from the second intermediate grade at Al-Suwaira Intermediate School for Boys, divided into three classes of 18 students each. Two groups were taught using Polya's strategy with different small-group structures—homogeneous and heterogeneous—while the third group served as a control. Data were analyzed using appropriate statistical procedures to determine the effectiveness of the applied methods. **Results.** The results showed that students who learned through Polya's strategy in both homogeneous and heterogeneous groups significantly outperformed the control group in acquiring basic volleyball skills. The positive effect was attributed to the structured steps of Polya's strategy, which encouraged systematic thinking, problem-solving, and active collaboration. Moreover, grouping methods provided opportunities for peer interaction and learning based on students' styles and abilities. **Conclusion.** Polya's strategy proved to be an effective instructional approach for enhancing skill acquisition in volleyball. This research contributes to the field of physical education by demonstrating the value of integrating cognitive strategies with group-based learning methods, offering practical implications for sports educators seeking to improve teaching effectiveness and student outcomes.

Keywords; polya's strategy, homogeneous small groups, heterogeneous small groups, basic volleyball skills.

A. INTRODUCTION

In contemporary education, there has been a paradigm shift from traditional teacher-centered approaches toward more student-centered learning models (Agrahari, 2016). Numerous educational studies emphasize that treating all students in the same manner is no longer effective, as learners possess diverse characteristics, needs, and potentials (Landrum & McDuffie, 2010; Subban, 2006). Students should not be viewed as one uniform group but rather as individuals who require differentiated instruction. Consequently, the development of teaching strategies that address these differences has become essential for creating effective learning environments and achieving the intended educational goals.

One of the strategies considered suitable for this purpose is Polya's Strategy, which originates from systematic problem-solving approaches. This strategy consists of four fundamental steps: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) reviewing and extending the solution (Barrera et al., 2019). Through these steps, students are not only guided toward the correct solution but also encouraged to develop critical, logical, and structured thinking skills. Moreover, Polya's Strategy actively involves learners in the educational process, fosters self-confidence, and enhances cooperation among peers (Canto López et al., 2022; Nguyen et al., 2023).

The effectiveness of Polya's Strategy can be further optimized through small-group learning methods (Hensberry & Jacobbe, 2012). Homogeneous groups allow students with similar abilities to learn at a balanced pace, reducing obstacles during the learning process. In contrast, heterogeneous groups bring together students of varying achievement levels, enabling high-achieving students to support their peers who face learning difficulties. This method not only facilitates mastery of subject matter but also promotes essential social skills such as communication, teamwork, and empathy (Nguyen et al., 2023).

In the field of physical education, particularly volleyball, such approaches are of great importance. Volleyball is a competitive team sport that requires solid fundamental motor skills, quick concentration, and the ability to adapt to rapidly changing situations. Basic skills such as overhead passing and underhand passing are essential for effective participation in the game (Damrah et al., 2020; Rajidin et al., 2022). However, field observations reveal that many intermediate-level students struggle to master these skills.

Drawing on the researcher's experience as a player, coach, and educator, it was found that current instructional practices often remain teacher-centered, fail to consider individual learning differences, and are challenged by the large number of students in each class. As a result, students' motivation decreases, boredom arises, and the learning objectives are not fully achieved (Wang et al., 2010).

This study seeks to address these challenges by integrating Polya's Strategy with homogeneous and heterogeneous small-group methods in teaching basic volleyball skills. The novelty of this research lies in applying a cognitive problem-solving strategy to the psychomotor domain, an area rarely explored in previous studies. While most existing research on Polya's Strategy focuses on academic subjects such as mathematics and science, the present study extends its application to physical education. Thus, this research aims to make both theoretical and practical contributions: theoretically by broadening the scope of Polya's Strategy across learning domains, and practically by providing physical education teachers with innovative methods to enhance the effectiveness of sports skill instruction in schools.

B. METHOD

Participant

The research population consisted of second intermediate grade students at Al-Suwayrah Intermediate School for Boys in Wasit Governorate for the academic year (2023–2024), with a total of (152) students divided into four classes (A – B – C – D), representing the original population.

The research sample consisted of (54) students representing three classes, with (18) students in each class. They were randomly selected from among the second intermediate classes after excluding (60) students. Afterwards, the teaching methods were randomly distributed among the selected research groups. Table (1) represents the homogeneity of the research sample, while Table (2) represents the equivalence of the research sample.

Table 1. represents the homogeneity of the research sample

Variables	Unit of Measurement	Arithmetic Mean	Median	Standard Deviation	Skewness Coefficient
Age	Years	13.13	13.00	0.65	0.635
Weight	Kg	42.55	43.00	3.15	-0.418
Height	Cm	152.22	154.00	2.67	-1.981

Table 2. represents the equivalence of the research sample.

Skills	Source of Variance	Sum of Squares	Degrees of Freedom	Mean Squares	(F) Calculated	(F) Tabular	Significance
Overhead Pass	Between Groups	0.108	2	0.052	0.106	3.178	Not Significant
	Within Groups	25.885	51	0.505			
Underhand Pass	Between Groups	0.700	2	0.349	0.010	3.178	Not Significant
	Within Groups	1494.276	51	29.297			

Research Design

This study employed an experimental research design to examine the effect of Polya's Strategy, implemented through homogeneous and heterogeneous small-group methods, on learning basic volleyball skills. The design included two experimental groups and one control group, with all participants drawn from the second intermediate grade at Al-Suwaira Intermediate School for Boys. A total of 54 students participated, divided into three classes of 18 students each.

The first experimental group received instruction through Polya's Strategy using the homogeneous small-group method, in which students were grouped according to similar levels of skill performance determined by pre-test results. The second experimental group received instruction through Polya's Strategy using the heterogeneous small-group method, where students of different skill levels were combined within the same groups. The control group, in contrast, was taught through the conventional method typically employed by the physical education teacher, without systematic grouping based on ability or structured use of Polya's Strategy.

The independent variable in this design was the teaching method (Polya's Strategy with homogeneous groups, Polya's Strategy with heterogeneous groups, or conventional teaching), while the dependent variables were the levels of student performance in the selected volleyball skills (overhead passing and underhand passing). Pre-tests and post-tests were administered to all groups to measure learning progress and determine the effect of the instructional methods.

Field Research Procedures

After reviewing relevant scientific sources on volleyball, analyzing the prescribed curriculum for second intermediate students, and conducting interviews with the subject teacher regarding the instructional methods typically employed in physical education, an educational program was designed for the selected volleyball skills. The program was structured in accordance with Polya's Strategy and implemented through the methods of homogeneous and heterogeneous small groups. It consisted of eight instructional units for each teaching method, equally divided between two fundamental volleyball skills: overhead passing from the front and underhand passing. Each unit lasted 45 minutes. To ensure effective implementation, the assisting team participated in a preparatory workshop, and students in the research sample were given two introductory sessions. These sessions served to familiarize learners with the basic skills and volleyball test procedures before administering the pre-tests, as well as to minimize errors during the subsequent application of the program.

The first experimental group received the proposed curriculum using Polya's Strategy through the homogeneous small group method over eight instructional units. Students were divided into groups where members shared similar skill levels, as determined by pre-test results. Within each group, a student leader was appointed to oversee group activities, with leadership rotating across the units. Groups worked independently, while students actively participated with the teacher in the evaluation process. The teacher provided supervision, signals for starting and ending exercises, and ensured a supportive learning environment. Throughout each unit, students followed Polya's four sequential steps to guide their learning and reinforce skill acquisition.

The second experimental group received the same curriculum using Polya's Strategy through the heterogeneous small group method. In this arrangement, students of varying skill levels were grouped together based on pre-test results. Apart from the grouping structure, all other procedures were consistent with those applied to the first experimental group.

The control group, in contrast, received instruction through the conventional teaching method typically employed by the subject teacher. This method was also conducted over eight instructional units, with students divided randomly into small groups without

reference to pre-test results. In this approach, the teacher directed the entire instructional process, made all decisions regarding implementation and evaluation, and required students to respond directly to instructions without discussion or peer collaboration.

Instrument

The first test used in this study was the Overhead Passing Test for Distance, designed to measure students' ability to pass the ball for the farthest possible distance using the overhead pass. The required instruments included a volleyball court, five volleyballs, and a measuring tape. The court was prepared by dividing it into transverse lines, each separated by one meter, with the corresponding distance clearly marked next to each line, measured vertically from the tester's standing point. During the test, the participant stood inside a square measuring 1 × 1 meter, positioned in the second half of the court on the 3-meter line. From this designated area, the student executed the overhead pass, and the distance of the ball trajectory was recorded as the test result (see Figure 1).

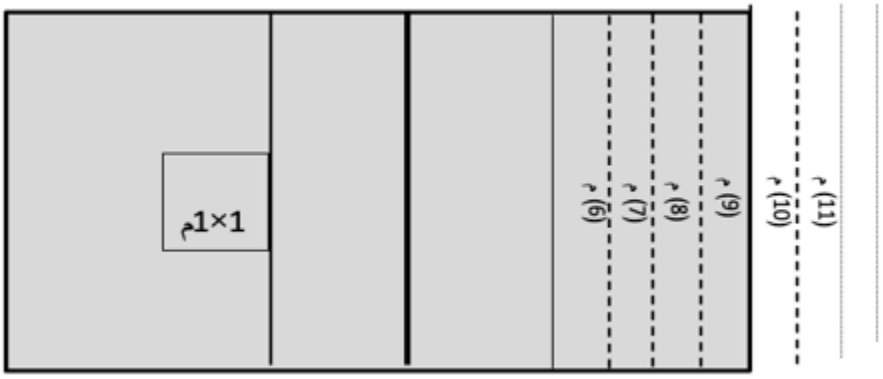

Figure 1. Overhead Passing Test

The second test was the Accuracy of Reception from Thrown Balls Test, which aimed to measure students' accuracy in receiving and directing the ball. The instruments used included a volleyball court, a vaulting box topped with a mat placed at a height of 180 cm, and a volleyball. The setup required the mat to be positioned at point (3) on the court, while the tester stood at point (6). An assisting player, positioned at point (6) on the opposite half of the court, threw the ball toward the tester. The tester was then required to receive and pass the ball so that it landed on the mat. Each participant was given 10 attempts to complete the task, as illustrated in Figure (2). The scoring system awarded four points if the ball landed

inside the box or on the mat, three points if the ball touched the boundaries of the mat, and two points if the ball landed within the 3-meter area. The cumulative score from the 10 attempts was used as the student's final performance measure in this test.

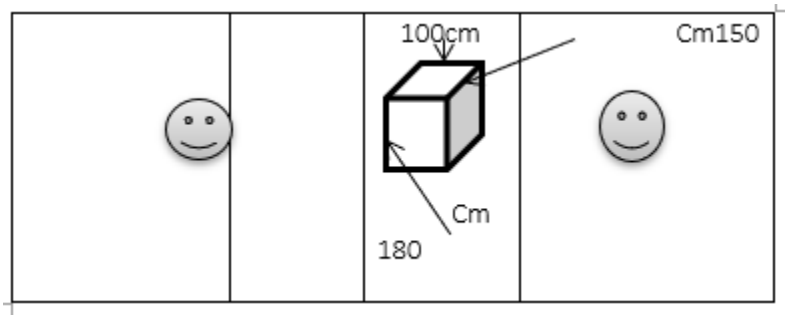

Figure 2. Thrown Balls Test

Data Analysis

To analyze the collected data, both descriptive and inferential statistical techniques were employed. Descriptive statistics, including the mean, standard deviation, and percentage values, were calculated to provide an overview of student performance in the pre-tests and post-tests. These measures helped identify the distribution of scores and the degree of variation within each group.

For inferential analysis, appropriate statistical tests were applied to determine whether the observed differences between groups were significant. Comparative tests were conducted between the pre-test and post-test results within each group to measure the progress achieved as a result of the instructional interventions. In addition, comparisons across the three groups were carried out to assess the relative effectiveness of Polya's Strategy in homogeneous and heterogeneous group settings compared to the conventional method. The level of statistical significance was set at ($p \leq 0.05$) to ensure the reliability of the findings.

C. RESULTS AND DISCUSSION

Results

Table (3) presents the pre-test and post-test results for the control group in the volleyball skills under investigation. The findings show that the control group achieved some improvement after the teaching intervention. For the overhead pass, the mean score

increased from 6.74 (±0.77) in the pre-test to 8.34 (±0.93) in the post-test, with a calculated *t*-value of 5.806, which is greater than the tabulated *t*-value of 2.11 at the 0.05 level, indicating statistical significance. Similarly, for the underhand pass, the mean improved from 14.20 (±6.10) to 18.30 (±4.57), with a calculated *t*-value of 2.40, also statistically significant. These results suggest that even the conventional method employed by the subject teacher led to measurable progress in skill acquisition, though the degree of improvement was modest.

Table 3. Results of the Control Group

num	test	Measurement Unit	Pre-test		Post-test		Calculated t-value	Statistical Significance
			M	± SD	M	± SD		
3	Overhead Pass	Score	6.74	0.77	8.34	0.93	5.806	Significant
4	Underhand Pass	Score	14.2	6.10	18.30	4.57	2.40	Significant

Table (4) displays the results for the first experimental group, which was taught using Polya's Strategy through the homogeneous small-group method. Substantial improvements were observed in both skills. The overhead pass mean score increased from 6.63 (±0.618) in the pre-test to 11.47 (±1.455) in the post-test, yielding a calculated *t*-value of 13.01, which far exceeds the tabulated *t*-value, confirming a highly significant difference. For the underhand pass, the mean improved from 13.85 (±5.371) to 25.56 (±3.546), with a calculated *t*-value of 5.230, also statistically significant. These findings indicate that the use of Polya's Strategy in homogeneous small groups had a strong and positive effect on students' performance in both volleyball skills.

Table 4. Results of the First Experimental Group

num	test	Measurement Unit	Pre-test		Post-test		Calculated t-value	Statistical Significance
			M	± SD	M	± SD		
3	Overhead Pass	Score	6.63	0.618	11.47	1.455	13.01	Significant
4	Underhand Pass	Score	13.85	5.371	25.56	3.546	5.230	Significant

Table (5) reports the outcomes for the second experimental group, which was taught using Polya's Strategy through the heterogeneous small-group method. Notable improvements were also recorded. For the overhead pass, the mean increased from 6.69 (±0.737) in the pre-test to 9.24 (±1.235) in the post-test, with a calculated *t*-value of 7.539,

indicating statistical significance. For the underhand pass, the mean rose from 14.13 (±4.719) to 21.13 (±4.556), with a calculated *t*-value of 4.532, which is also statistically significant. These results confirm the effectiveness of applying Polya's Strategy in heterogeneous small groups, though the degree of improvement was somewhat less than that observed in the homogeneous group.

Table 5. Results of the Second Experimental Group

num	test	Measurement Unit	Pre-test		Post-test		Calculated t-value	Statistical Significance
			M	± SD	M	± SD		
3	Overhead Pass	Score	6.69	0.737	9.24	1.235	7.539	Significant
4	Underhand Pass	Score	14.13	4.719	21.13	4.556	4.532	Significant

Table (6) presents the results of the analysis of variance (ANOVA) for the post-test scores of the three groups. For the overhead pass, the calculated *F*-value was 32.97, exceeding the tabulated value of 3.178 at the 0.05 significance level, indicating significant differences between groups. Similarly, for the underhand pass, the calculated *F*-value of 10.232 was also greater than the tabulated value, confirming significant group differences. These findings suggest that the instructional method had a significant effect on student outcomes across the groups.

Table 6. Results of the Analysis of Variance

Skills	Source of Variance	Sum of Squares	df	Mean Squares	Calculated F	Tabulated F	Significance
Overhead Pass	Between	92.44	2	46.22	32.97	3.178	Significant
	Within	73.56	51	1.44			
Underhand Pass	Between	484.482	2	242.241	10.232	3.178	Significant
	Within	1207.448	51	23.675			

Table 7. Results of the Least Significant Difference

Tests	Groups	Difference between Means	Difference	L.S.D Value	Significance
Overhead Pass	Control Group – First Experimental Group	8.34 – 11.47	3.13	0.597	Significant
	Control Group – Second Experimental Group	8.34 – 9.24	0.90		Significant
	First Experimental Group – Second Experimental Group	9.24 – 11.47	2.23		Significant
Underhand Pass	Control Group – First Experimental Group	18.30 – 25.56	7.26	2.097	Significant
	Control Group – Second Experimental Group	18.30 – 21.11	2.81		Significant
	First Experimental Group – Second Experimental Group	21.11 – 25.56	4.45		Significant

To identify where the significant differences lay, the Least Significant Difference (L.S.D) test was conducted, as shown in Table (7). For the overhead pass, the differences favored

both experimental groups over the control group: the first experimental group (M = 11.47) significantly outperformed the control group (M = 8.34), with a mean difference of 3.13. The second experimental group (M = 9.24) also outperformed the control group, though with a smaller mean difference of 0.90. Additionally, the first experimental group performed significantly better than the second experimental group, with a mean difference of 2.23. For the underhand pass, similar patterns emerged. The first experimental group (M = 25.56) outperformed both the control group (M = 18.30) and the second experimental group (M = 21.11), with mean differences of 7.26 and 4.45, respectively. The second experimental group also significantly outperformed the control group, with a mean difference of 2.81.

Discussion

The results presented in Tables (3, 4, and 5) indicate statistically significant differences between the pre- and post-tests for all three groups in the acquisition of basic volleyball skills (overhead pass and underhand pass). These improvements reflect the positive effect of the instructional programs, whether through the conventional method applied in the control group or Polya's Strategy applied in the two experimental groups. The consistent presence of significant gains across all groups aligns with the argument by (Cho et al., 2012; Wang et al., 2010), who suggest that repeated practice combined with structured feedback typically leads to measurable skill development in physical education settings.

The findings also show that Polya's Strategy, applied in both homogeneous and heterogeneous small groups, had a greater impact than the traditional method. This is consistent with research by (Johnson et al., 1984), which highlighted the value of cooperative learning structures in enhancing motivation, student engagement, and performance in motor skill acquisition. The structured stages of Polya's Strategy—understanding the problem, devising a plan, carrying out the plan, and reviewing—encouraged deeper learning and retention, supporting earlier claims by (Barnett & Jung, 2020; Kshetree, 2019) regarding the effectiveness of problem-solving strategies in education.

Discussion of the post-test results for the two experimental groups Tables (6 and 7) demonstrate that the first experimental group, which applied Polya's Strategy in homogeneous small groups, outperformed both the control group and the heterogeneous small-group experimental group. This suggests that grouping students by

similar skill levels provides a more conducive environment for targeted practice, peer competition, and skill mastery. These findings are in line with Schullery & Schullery, 2006), observation that when learners of similar levels are grouped together, they are more likely to challenge one another, leading to accelerated progress. The success of homogeneous grouping can also be explained by increased opportunities for equitable participation. In this setting, students felt less overshadowed by higher-performing peers, which likely enhanced motivation and confidence. This resonates with the findings of (Murphy et al., 2017; Zamani, 2016), who noted that homogeneous groups can foster a sense of fairness and balance in cooperative learning contexts.

On the other hand, the heterogeneous small-group method also produced significant improvement, albeit to a lesser extent. This supports Schullery & Schullery, (2006), argument that heterogeneous grouping promotes peer teaching and social interaction, which can enrich the learning process. In such groups, stronger students reinforce their knowledge by teaching peers, while less experienced students benefit from personalized support. However, the current study suggests that in the context of volleyball skills, this method may not be as effective as homogeneous grouping, possibly due to the physical and technical demands of the sport, which require practice at a similar pace and intensity.

It should be noted that not all research supports the superiority of homogeneous groups. For example, Mashud et al., (2023); Saputra et al., (2023) reported that heterogeneous groups often outperform homogeneous groups in academic tasks, as mixed abilities create opportunities for peer scaffolding. In contrast, the present study found greater benefits in homogeneous grouping for motor skill learning (Rubiyatno et al., 2023; Suryadi et al., 2024). This contradiction suggests that the effectiveness of grouping strategies may depend on the nature of the task: while cognitive tasks may benefit from mixed abilities, psychomotor tasks such as volleyball may require more uniform practice conditions.

Despite the encouraging results, this study has several limitations. First, the sample size (n = 54) was relatively small and limited to a single educational context, which restricts the generalizability of the findings. Second, the intervention period was relatively short (eight instructional units), which may not fully capture long-term skill retention or performance stability. Third, the study focused only on two volleyball skills—overhead passing and

underhand passing—leaving out other critical aspects such as serving, spiking, and tactical play. Additionally, while Polya's Strategy emphasizes problem-solving, its application in physical education required adaptation, and the study did not assess whether students transferred problem-solving strategies beyond volleyball. Finally, the reliance on teacher-led signals and evaluation may have introduced bias in performance assessment.

In summary, the study confirms that Polya's Strategy, particularly when applied with homogeneous small groups, is highly effective in improving students' volleyball skills compared to conventional teaching methods. At the same time, heterogeneous grouping under Polya's Strategy also offered benefits, especially in promoting peer collaboration, though its effectiveness was slightly lower. These findings contribute to the growing body of evidence supporting student-centered, strategy-based learning in physical education, while also highlighting the nuanced effects of group composition on motor skill development.

D. CONCLUSION

The results of the study demonstrated that both experimental groups, which applied Polya's Strategy using homogeneous and heterogeneous small-group methods, outperformed the control group in learning the basic volleyball skills. Among these, the best-performing group was the one that used Polya's Strategy with homogeneous small groups, followed by the group that applied the heterogeneous small-group method, while the control group showed the lowest improvement. Based on these findings, the researcher recommends the wider use of Polya's Strategy in teaching various sports skills, including the overhead pass and underhand pass in volleyball. Furthermore, it is necessary to apply Polya's Strategy with both homogeneous and heterogeneous small-group methods in physical education lessons at other educational stages, as these approaches have proven effective in enhancing student engagement, motivation, and skill acquisition.

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F. AUTHOR CONTRIBUTION STATEMENT

This study was conceived, designed, and conducted solely by Ali Abdul-Hussein Hammoud Saleh, who was responsible for formulating the research problem, designing the methodology, collecting and analyzing the data, interpreting the results, and preparing the manuscript for publication.

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