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# The Impact of White and Frederikson's Investigative Model on Developing Creative Thinking and Teaching Physical Exercises from Original and Derived Positions in Futsal

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## Abstract

*Traditional futsal instruction in Iraqi colleges of physical education remains teacher-centered, limiting students' ability to apply concepts during study and after graduation as teachers. As a subject teacher, the author observed persistent theoretical and practical difficulties in initiating physical exercises and in distinguishing original from derived positions. This study developed and tested an educational curriculum based on White and Frederikson's investigative model and constructed a futsal-specific creative thinking scale. An experimental pretest–posttest control-group design was used with fourth-year students at the College of Physical Education and Sports Sciences, Al-Qadisiyah University (2025–2026; N population = 120). Two intact sections were assigned to an experimental group (Section C, n = 40) and a control group (Section D, n = 40). Both groups completed a 30-item creative thinking scale (0–4 scoring, total range 0–120) and 10 rated physical-exercise tests (five original and five derived positions; 10 points each, mean of three raters) before and after the intervention. The experimental group received 10 instructional units (90 min each, once weekly) structured around the model's seven stages; the control group received traditional instruction of equal time. Both groups improved, with significantly greater posttest gains in the experimental group on creative thinking and on all 10 position tests (all  $p$ s < .01). Findings support the positive effect of the investigative curriculum on teaching original and derived exercises and on fostering creative thinking.*

**Keywords:** *White and Frederikson's model, creative thinking, original positions, derived positions, futsal, physical education*

## Introduction

### Background and Significance

The process of education has qualitatively changed to better meet the goals of education at all levels of education, in schools as well as at university, through e-learning, through learning environments and educational programs, through smart blackboards and a variety of student-centered approaches to learning that promote independent learning through ideation, inquiry and learning interaction. Physical education is not only practical but also theoretical and therefore, no physical activity should be offered without educators first explaining the objectives and benefits of said activity. Similarly, even theoretical content must be put into practice. In addition, because tasks have different levels of difficulty from lesson to lesson, teachers need to choose the best ways to present information within the given parameters.

The research model of White and Frederikson provides various channels for the implementation of knowledge and seeks a complete, integrated implementation of objectives. In this study the model was used for teaching of physical exercises from the original and derived positions in futsal with the objective of higher performance and of stimulation of creative thinking before and during the implementation.

## **Research Problem**

Field practice of the author of this paper was futsal teaching. Many sessions were taught by the author but content delivery of the sessions was heavily dependent on the author. Also it was found that students were not exposed to sufficient opportunities to teach during their study and after graduation. Specific difficulties that were found with students' delivery of futsal teaching situations were: (a) choosing a suitable location for a given futsal teaching situation, (b) starting the situation correctly (giving instructions and counting down) and (c) deciding whether a position was original or derived (with theoretical as well as practical explanations for a decision). Thus, the study was to find out whether or not an investigative-model curriculum would be effective in fostering knowledge, helping students to make decisions between alternatives and promoting critical thinking prior to application.

## **Objectives**

1. To develop a curriculum for teaching original and derived positions in futsal based on White and Frederikson's investigative model.
2. To construct and preliminarily validate a futsal-specific creative thinking scale for original and derived positions.

## **Hypothesis**

The educational curriculum based on White and Frederikson's investigative model has a positive effect on teaching physical exercises from original and derived positions in futsal and on developing creative thinking, with the experimental group outperforming the control group at posttest.

## **Delimitations**

1. Human: fourth-year students, College of Physical Education and Sports Sciences, Al-Qadisiyah University, 2025–2026.
2. Time: October 11, 2025–January 25, 2026 (pilot October 11; pretests late October; intervention November 2, 2025–January 18, 2026; posttests January 25, 2026).
3. Place: college teaching halls and indoor sports hall.

## **Method**

### **Research Design**

A quasi-experimental pretest–posttest control-group design was used, appropriate to the applied nature of the research question. The selection is considered not as a random sample of individuals, but cluster assignment of intact sections.

## Participants

There were three sections of 120 fourth-year students. Two sections were taken as its studies sample; Section C (experimental) of  $n = 40$  and Section D (control) of  $n = 40$ . The fourth year were selected because (a) futsal is taught in the fourth year, (b) access helped to implement the curriculum and supervise it, and (c) the number of students allowed for supervision in the fourth year. [AQ: report age, sex distribution if applicable, exclusion criteria, informed consent/ethics approval, and pretest equivalence statistics.]

## Instruments

**Data sources.** Arabic and international references, tests and measurements, and standardized student result forms.

**Equipment.** Two electronic stopwatches, two whistles, stationery, and one laptop computer.

**Creative thinking scale (constructed for this study).** No futsal-specific creative thinking scale was located; therefore a 30-item scale was constructed. Six domains were defined: fluency, flexibility, originality, elaboration/detail, enrichment, and solving educational problems. Items were aligned to the futsal curriculum, reviewed by experts, and scored on a 5-point Likert scale coded 0 (strongly disagree) to 4 (strongly agree); total range 0–120. This 0–4 coding is clarified here because means reported in the original file (e.g., ~19) fall below the minimum of a 1–5 coding (30) and are only interpretable under 0–4 coding.

**Physical-exercise tests (10).** Five original and five derived positions were chosen in collaboration with motor learning and futsal experts, each being related to a curriculum-based exercise. Each test included an assessment based on a 10-point scale that was allocated to pre-test, main test, and post-test stages. The mean scores of three independent assessors were calculated arithmetically.

Tests were: (1) Original: standing-arm raise/lower sideways, 2 beats; (2) derived: standing-wide stance-alternate unilateral arm raise/lower, 4 beats; (3) original: kneeling-arm raise/lower sideways, 2 beats; (4) derived: kneeling-hands on waist-trunk twist side to side, 4 beats; (5) original: lying supine-bilateral leg raise/lower, 2 beats; (6) derived: lying-hands behind head-alternate lateral leg opening/closing, 4 beats beginning right; (7) original: sitting-crossed legs-arm raise/lower, 2 beats; (8) derived: long sitting-hands on waist-alternate lateral leg opening/closing, 4 beats beginning right; (9) original: hanging-overhand grip-arm flexion/extension, 2 beats; (10) derived: hanging tuck-hip twist side to side, 4 beats. Standard verbal prompts for initiation ("Ready-Start") and termination ("Ready-Halt" on the last repetition) were employed. Performance criteria were provided in detail and taken verbatim from the source in the instruction sheets.

## Procedure

**Pilot study (October 11, 2025;  $n = 10$ , excluded from main sample).** Court suitability, instruments, supporting-team procedures, sample readiness, and test duration were checked.

**Pretests.** Creative thinking scale followed by the 12 position tests, in fixed order under pretest conditions.

**Intervention.** The experimental group engaged in ten instructional units, each lasting 90 minutes, weekly held on Tuesdays from November 2, 2025, to January 18, 2026. Every unit

included a preparatory phase (activities of general and specific warming up including various physical activities) and a main phase (instruction and learning activities) consistent with seven stages of the investigative model described by White and Frederikson: arousal, involvement, exploration, explanation, elaboration, evaluation, and expansion. The control group was subjected to conventional instruction of equal duration and content coverage but without an investigative-model component.

An example of operationalization in tables (performed during each unit with content varying between positions): arousal—provide a problem (for example, criteria for differentiating a wide stance derived from the original position); involvement—execute the position and give out the initial instruction; exploration—performing in groups, using different counts and instructions; explanation—formalize criteria in conjunction with the teacher and students; elaboration—apply the learned knowledge into another position; evaluation—evaluate peers on the 10-point scale; expansion—create a lead through for peers, thus becoming a future-teacher.

Post-tests were performed on January 25, 2026, using the same order and conditions as pre-tests.

## Statistical Analysis

Data were analyzed using SPSS program. The means and standard deviations of each variable have been provided. Paired-samples t-test has been used for within-group pre-test /post-test comparisons and independent-samples t-test has been used for post-test comparisons among groups. (An error in the original text has both the tests as the same) Level of significance is 0.05 and it is two-tailed. Exact p-values are as follows ( $p < .001$  as compared to 0.000)

## Results

Summary of Descriptive and Inferential Results is provided in Tables 1-3. Data are arranged in the same way as in the original Excel file and must be checked with the real data, especially regarding the sum of scale scores from 0 to 4.

Table 1 shows control-group pre-post means. Table 2 shows experimental-group pre-post means. Posttests comparisons of groups are given in Table 3. All the differences between pre and post were statistically significant, and higher in the experimental group on the creative thinking scale and on each of the 10 position tests.

*Table 1*

| Variable                 | Unit  | Control pre M | Control pre SD | Control post M | Control post SD | T    | p     |
|--------------------------|-------|---------------|----------------|----------------|-----------------|------|-------|
| <b>Creative thinking</b> | Score | 19.66         | 1.12           | 37.33          | 2.04            | 6.36 | .014  |
| <b>Original standing</b> | Score | 2.22          | 0.60           | 7.87           | 0.71            | 5.28 | <.001 |
| <b>Derived standing</b>  | Score | 1.65          | 0.53           | 7.56           | 0.69            | 4.94 | .006  |
| <b>Original kneeling</b> | Score | 1.89          | 0.55           | 7.32           | 0.66            | 5.12 | .001  |

|                         |       |      |      |      |      |      |       |
|-------------------------|-------|------|------|------|------|------|-------|
| <b>Derived kneeling</b> | Score | 1.12 | 0.43 | 6.92 | 0.64 | 4.76 | .002  |
| <b>Original lying</b>   | Score | 2.86 | 0.67 | 7.31 | 0.67 | 5.41 | <.001 |
| <b>Derived lying</b>    | Score | 2.09 | 0.58 | 6.55 | 0.62 | 5.06 | .001  |
| <b>Original sitting</b> | Score | 2.11 | 0.57 | 5.89 | 0.59 | 4.88 | .003  |
| <b>Derived sitting</b>  | Score | 1.98 | 0.56 | 5.72 | 0.57 | 4.81 | .004  |
| <b>Original hanging</b> | Score | 1.82 | 0.54 | 5.98 | 0.60 | 5.17 | .002  |
| <b>Derived hanging</b>  | Score | 1.13 | 0.44 | 5.78 | 0.58 | 4.79 | .004  |

*Control Group Pretest–Posttest Comparison (n = 40)*

*Note. M = mean; SD = standard deviation. Within-group paired-samples t tests, two-tailed. Verify df and effect sizes against SPSS output.*

**Table 2**

| <b>Variable</b>          | <b>Unit</b> | <b>Exper. pre M</b> | <b>Exper. pre SD</b> | <b>Exper. post M</b> | <b>Exper. post SD</b> | <b>T</b> | <b>p</b> |
|--------------------------|-------------|---------------------|----------------------|----------------------|-----------------------|----------|----------|
| <b>Creative thinking</b> | Score       | 19.62               | 1.34                 | 43.55                | 2.32                  | 10.84    | .004     |
| <b>Original standing</b> | Score       | 2.03                | 0.61                 | 9.12                 | 0.48                  | 8.91     | <.001    |
| <b>Derived standing</b>  | Score       | 2.29                | 0.58                 | 8.82                 | 0.50                  | 8.35     | .002     |
| <b>Original kneeling</b> | Score       | 1.18                | 0.44                 | 7.94                 | 0.56                  | 7.88     | <.001    |
| <b>Derived kneeling</b>  | Score       | 1.22                | 0.46                 | 8.52                 | 0.52                  | 7.46     | .001     |
| <b>Original lying</b>    | Score       | 2.21                | 0.59                 | 7.35                 | 0.60                  | 6.97     | <.001    |
| <b>Derived lying</b>     | Score       | 1.65                | 0.52                 | 7.93                 | 0.55                  | 6.62     | <.001    |
| <b>Original sitting</b>  | Score       | 1.96                | 0.56                 | 8.19                 | 0.53                  | 6.14     | .003     |
| <b>Derived sitting</b>   | Score       | 1.54                | 0.49                 | 7.83                 | 0.57                  | 5.95     | .001     |
| <b>Original hanging</b>  | Score       | 1.38                | 0.47                 | 7.62                 | 0.59                  | 6.41     | <.001    |
| <b>Derived hanging</b>   | Score       | 1.13                | 0.42                 | 7.16                 | 0.62                  | 5.82     | <.001    |

*Experimental Group Pretest–Posttest Comparison (n = 40)*

*Note. Within-group paired-samples t tests, two-tailed.*

**Table 3**

| Variable                 | Unit  | Control post M (SD) | Exper. post M (SD) | T     | p     |
|--------------------------|-------|---------------------|--------------------|-------|-------|
| <b>Creative thinking</b> | Score | 37.33 (2.04)        | 43.55 (2.32)       | 7.99  | .001  |
| <b>Original standing</b> | Score | 7.87 (0.71)         | 9.12 (0.48)        | 6.63  | <.001 |
| <b>Derived standing</b>  | Score | 7.56 (0.69)         | 8.82 (0.50)        | 6.75  | <.001 |
| <b>Original kneeling</b> | Score | 7.32 (0.66)         | 7.94 (0.56)        | 4.24  | <.001 |
| <b>Derived kneeling</b>  | Score | 6.92 (0.64)         | 8.52 (0.52)        | 9.51  | <.001 |
| <b>Original lying</b>    | Score | 7.31 (0.67)         | 7.35 (0.60)        | 4.26  | .001  |
| <b>Derived lying</b>     | Score | 6.55 (0.62)         | 7.93 (0.55)        | 7.85  | .001  |
| <b>Original sitting</b>  | Score | 5.89 (0.59)         | 8.19 (0.53)        | 15.16 | <.001 |
| <b>Derived sitting</b>   | Score | 5.72 (0.57)         | 7.83 (0.57)        | 13.51 | <.001 |
| <b>Original hanging</b>  | Score | 5.98 (0.60)         | 7.62 (0.59)        | 9.54  | <.001 |
| <b>Derived hanging</b>   | Score | 5.78 (0.58)         | 7.16 (0.62)        | 7.65  | <.001 |

*Between-Group Posttest Comparison (Control & Experimental = 40 Each)*

*Note. Independent-samples t tests (two tailed) between groups. Here, the header row of columns is mislabeled as pre/post, which was corrected here to become control-post vs. experimental-post. AQ: Confirm t-values that are very large for sitting tests to output.*

## Discussion

There was an improvement in both groups from pre to post; however, posttest performance was better in the experimental group for all measures. It resembles investigative learning with learners actively examining information, articulating ideas, accepting responsibility for the explanations, and assuming the leadership in demonstration of the exercises instead of simply receiving the content. By getting the students to focus, collect their knowledge about the lesson, present it to others, interpret it and apply the aim of the exercise to their position, it was hoped that it would make class more active and participative, and that it would benefit retention for the subsequent teaching.

Discovery and the way in which the learner thinks seems to facilitate learning and accelerate the growth of knowledge and horizons as a process of search, inquiry and questioning that results in more accurate acquisition. In this context the teacher guides students through thinking processes to discover concepts and confirm knowledge, in line with self-directed and inquiry-based learning. The fourth-year learners had enough cognitive maturity to take

in material mentally, express opinions, make inferences, and tackle problems, and they have become more self-confident, which leads to psychological security and achievement.

There is a need to explain the large gains in the control group. They can be associated with maturation, the effect of repeated testing, traditional instruction, and the motivation to succeed as motives are internal stimuli that drive efforts towards goals. A detailed description of the traditional teaching methods is not available, and therefore the specific contribution of the model, and any additional value it contributes over and above good teaching, cannot be isolated, as described below.

The large between group differences are attributed to the scientific foundation of the curriculum, which has been expertly developed with scale construction and item analysis, expert selection of most easily accessible exercises for both original and derived positions, and systematic vocal lead through, in which the student-as-future-teacher was trained to perform and direct exercises in correct form, using professional, social competence. These foundations maximized benefits for learners and activation of leadership.

The following limitations are possible: cluster assignment of intact sections without reported equivalence testing information, no reported scale  $\alpha$ , no reported test-retest ICC, no reported interrater ICC, and no details about blinding of raters, and use of general calisthenic tasks where transfer to futsal skills needs explicit justification. Future research should use randomized assignment, if possible, provide full psychometrics and effect sizes and test transfer and retention to futsal game performance and to student teaching.

## Conclusions and Recommendations

### Conclusions

1. The investigative-model curriculum benefited the experimental group; engagement across the seven stages elicited motivating, inquiry-driven participation.
2. Organizing lessons in the seven stages allowed for futsal sessions to become exciting learning experiences to create new and derived position exercises.
3. Integrating creative thinking complemented instruction: students understood the physical activity before performing it and generated original lead-throughs for peers.

### Recommendations

1. Educational specialists should analyze and test innovative teaching methods to improve curriculum content and meet learning objectives.
2. Optimize use of White and Frederikson's model and its seven stages in practical courses, given its observed efficacy and responsiveness in presenting curricular content.
3. Apply the futsal creative-thinking scale, once fully validated, in planning and evaluating practical lessons and in assessing achievement, retention, and benefit.

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