Proximus Journal of Sports Science and Physical Education
Volume 3, Issue 08, August 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

DESIGNING EDUCATIONAL UNITS ACCORDING TO THE SUCCESSIVE APPROXIMATION MODEL (SAM) FOR DEVELOPING MOTOR PATHWAYS AND MOTOR LINKING ABILITY IN ARTISTIC GYMNASTICS

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Abstract

The present study aims to design educational units according to the Successive Approximation Model (SAM) and to identify its effect on developing motor sequence organization, motor linking ability, and motor pathways of artistic gymnastics skills among junior players. The significance of the study lies in employing one of the modern instructional design models based on analysis, iterative design, and continuous evaluation, which contributes to establishing a flexible learning environment that enhances the acquisition of complex skills and improves technical performance through continuous feedback and successive refinement of educational units.

The researcher employed the experimental method using the equivalent groups design (experimental and control groups). The research sample consisted of (14) junior players from the Iraqi National Gymnastics Team. Both groups underwent pre-tests to determine the level of the investigated variables. Subsequently, the educational units designed according to the SAM model were applied to the experimental group, whereas the control group continued according to the traditional educational program. After completing the implementation period, post-tests were conducted to measure the extent of improvement in motor sequence organization, motor linking ability, and motor pathways.

The results revealed statistically significant differences in favor of the experimental group in the post-tests across all research variables. The educational units designed according to the SAM model achieved clear improvements in motor sequence organization, motor linking ability, and motor pathways compared with the control group. The researcher attributes this improvement to the nature of the model, which relies on gradual content presentation, continuous evaluation, and the modification of educational activities according to the players' performance levels, thereby contributing to the development of more organized and effective motor experiences.

Based on the findings, the study concluded that educational units designed according to the SAM model contributed positively to developing the motor performance of junior artistic gymnasts. Furthermore, this model represents an effective instructional approach for teaching complex skills that require performance organization and linking skills within integrated motor sequences. The researcher recommends adopting modern instructional design models, including the SAM model, in teaching artistic gymnastics skills, with emphasis on continuous evaluation and feedback during the learning of complex motor skills.

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Keywords: SAM Model, Educational Units, Motor Sequence Organization, Motor Linking Ability, Motor Pathways, Artistic Gymnastics.

1. Introduction and Significance of the Study

The Successive Approximation Model (SAM) is considered one of the modern models in instructional design, as it is based on iterative development and continuous evaluation through constructing initial prototypes of educational units and conducting successive improvement processes to reach the most appropriate design for learners. This makes it suitable for educational environments that require flexibility and rapid modification according to actual performance outcomes.

Learning complex skills in gymnastics also requires the development of educational experiences that enable juniors to understand the relationships among movement components and their sequence, as effective performance depends on integration among different movement phases rather than merely performing skill components separately. Recent research in motor learning has demonstrated that integrating instructional methods based on feedback and continuous evaluation contributes to improving the acquisition of complex sports skills among young age groups.

Therefore, the significance of the present study emerges through designing educational units according to the SAM model, including its stages of analysis, design, development, and iterative evaluation, with the aim of developing motor sequence organization and motor linking ability in artistic gymnastics skills among junior players. This approach represents an attempt to introduce modern instructional design models into gymnastics education, contributing to improving technical performance levels and enhancing the learning process.

2. Research Problem

The process of learning skills in artistic gymnastics is considered a complex educational process due to the interaction of various physical, neurological, and motor abilities required, in addition to the necessity for the player to possess the ability to organize performance and connect skill components within a coordinated motor sequence. Gymnastics performance does not depend solely on mastering individual skills; rather, it requires the ability to integrate them into interconnected motor sequences that achieve fluency, accuracy, and aesthetic quality (López et al., 2021).

Despite the development achieved in gymnastics teaching and training methods, field observations indicate the continued presence of certain difficulties among junior players, including weakness in the ability to smoothly transition between skills and failure to maintain the appropriate movement rhythm during the performance of motor sequences. Moreover, some educational programs still rely on traditional approaches that focus on teaching skills in fragmented forms without sufficient attention to the process of integrated motor construction.

Accordingly, the research problem is identified through the need to employ a modern instructional design model in artistic gymnastics education, through which organized educational units can be developed to assist junior players in improving motor sequence organization and linking skills more effectively.

Thus, the research problem can be formulated through the following question:

Do educational units designed according to the SAM model contribute to developing motor sequence organization and motor linking ability of artistic gymnastics skills among junior players?

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3. Research Objectives

The present study aims to:

1. Design educational units according to the SAM model for teaching artistic gymnastics skills to junior players.
2. Identify the effect of educational units designed according to the SAM model on developing motor sequence organization among junior gymnasts.
3. Identify the effect of educational units designed according to the SAM model on developing the ability to link motor skills in artistic gymnastics.
4. Identify the differences between the results of pre- and post-tests for the experimental and control groups in the research variables.

4. Research Hypotheses

1. There are statistically significant differences between the pre- and post-test results of the experimental group in motor sequence organization and motor linking ability of artistic gymnastics skills, in favor of the post-tests.
2. There are statistically significant differences between the pre- and post-test results of the control group in the research variables, in favor of the post-tests.
3. There are statistically significant differences between the post-test results of the experimental and control groups in motor sequence organization and motor linking ability, in favor of the experimental group.

5. Research Fields

1. **Human Field:** Junior national gymnastics team players, numbering (14) players.
2. **Spatial Field:** Al-Shabab Club in Baghdad Governorate.
3. **Temporal Field:** From 2/2/2026 to 30/5/2026.

2. Research Methodology and Field Procedures

Research Method

The researcher employed the experimental method using the equivalent groups design (experimental and control groups), due to its suitability for the nature of the research problem. This method is considered one of the most commonly used approaches in sports studies that aim to identify the effects of new educational programs or instructional designs on developing skill performance levels (Thomas, Nelson & Silverman, 2022).

Research Population and Sample

The research population consisted of junior players from the Iraqi National Gymnastics Team. The research sample included (14) players, who represented the Iraqi National Junior Gymnastics Team.

Designing Educational Units According to the SAM Model

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The researcher relied on the stages of the SAM model in constructing the educational units. This model is characterized by gradual improvement and continuous feedback, and its stages can be explained as follows:

First: Preparation Phase

This phase included:

- Identifying the characteristics of junior players.
- Analyzing the motor skills targeted for development.
- Identifying the difficulties faced by players during skill linking.
- Determining the educational objectives.

The analysis phase is considered one of the fundamental stages in instructional design because it determines the characteristics of the learner, the content, and the appropriate instructional approach (Branch & Dousay, 2022).

Second: Iterative Design Phase

This phase included:

- Preparing initial prototypes of the educational units.
- Organizing exercises according to the sequence of difficulty.
- Linking individual skills within progressive motor sequences.
- Presenting the model to experts and making the required modifications.

Third: Development Phase

This phase included:

- Implementing the educational units practically.
- Using immediate feedback.
- Modifying exercises according to the players' responses and performance levels.
- Reorganizing the content when necessary.

This approach is characterized by its ability to improve the learning process through continuous evaluation rather than waiting until the end of the educational program to make modifications (Allen, 2020).

Field Research Procedures

1. Identification of Skills and Motor Sequences Under Investigation

After reviewing scientific references and consulting experts' opinions, a set of skills representing an appropriate level for junior players was identified. These skills were organized into motor sequences requiring the ability to transition and link between skills.

These skills were selected according to the following criteria:

- Suitability for the level of the research sample.
- Possibility of linking them within a motor sequence.
- Inclusion of transitions requiring neuromuscular coordination.
- Possibility of evaluating them by an expert committee.

2. Tests Used in the Research

First: Motor Sequence Organization Evaluation Test

Purpose of the Test:

To measure the player's ability to organize and sequence skills within the motor sequence.

Proximus Journal of Sports Science and Physical Education
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Test Description:
The player performs the specified motor sequence on the floor exercise mat according to the required order.
Evaluation Method:
Performance is evaluated by a committee of specialized artistic gymnastics judges using an evaluation form that includes:

- Skill sequence.
- Smoothness of transitions.
- Maintaining movement rhythm.
- Technical accuracy of performance.

The final score is awarded according to the agreement of the experts.
Second: Motor Linking Ability Test
Purpose of the Test:
To measure the player's ability to integrate and connect motor skills within a complete performance sequence.
Test Description:
The player performs a set of complex skills requiring direct transition from one skill to another.
Evaluation Criteria:

- Speed of transition between skills.
- Maintaining balance.
- Coordination between body segments.
- Continuity of performance without interruption.

Pre-tests
The pre-tests were conducted on **12/2/2026** for both the experimental and control groups before implementing the educational units. The tests were carried out at **10:00 a.m.** at Al-Shabab Sports Club in Baghdad Governorate. The results of the pre-tests were used to verify the equivalence of the two groups in the research variables.
Educational Program According to the SAM Model
The educational program was prepared according to the philosophy of the Successive Approximation Model (SAM), which is based on iterative design and continuous improvement. The researcher constructed the educational units through sequential stages beginning with the preparation phase, followed by iterative design, development and implementation, with continuous evaluation and modification processes according to the players' responses and performance levels.
First: Preparation Phase
The preparation phase represented the foundation upon which the educational program was constructed. During this phase, information related to learners and educational content was collected and analyzed, and the targeted motor skills were identified in accordance with the level of junior gymnasts and the objectives of the research.
After reviewing scientific references and previous studies, in addition to surveying the opinions of experts and specialists in artistic gymnastics, a group of motor skills representing essential requirements for constructing motor sequences and developing motor linking ability was identified:

Proximus Journal of Sports Science and Physical Education
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- **Round Off**
- **Cartwheel**
- **Handstand**
- **Back Handspring**
- **Back Somersault**

These skills were selected because they include various motor transitions and require a high level of neuromuscular coordination and body control, in addition to their possibility of being integrated into progressive motor sequences of increasing difficulty.

Analysis of Skill Characteristics and Performance Requirements

The researcher analyzed the characteristics of the selected motor skills before designing the educational units by identifying the technical phases of each skill and analyzing its motor requirements. Performance was divided into three main phases:

1. Preparatory Phase:

Includes the starting position, approach, and appropriate motor preparation for executing the skill.

2. Main Phase:

Includes the essential part of performance, such as take-off, support, rotation, and flight, which represent the core of the skill.

3. Final Phase:

Includes landing, controlling body position, and preparing for transition to the next skill within the motor sequence.

The skills were also analyzed according to the following requirements:

- **Physical requirements:** such as explosive strength, arm strength, flexibility, and balance.
- **Coordination requirements:** such as coordination between limb actions, control of the body's center of gravity, and awareness of time and space.
- **Technical requirements:** such as the correct movement pathway, body position during performance, and accuracy of transitions between skills.
- **Motor linking requirements:** represented by the ability to smoothly transition between skills and maintain performance continuity within the motor sequence.

Based on the results of this analysis, the researcher identified the players' strengths and weaknesses and determined appropriate educational exercises aimed at improving motor pathways, motor sequence organization, and linking between skills.

3. Presentation, Analysis, and Discussion of Results

Presentation of the Results of Pre- and Post-Tests for the Experimental Group

Table (1)

Results of the Pre- and Post-Tests for the Experimental Group in Motor Sequence Organization and Motor Linking Ability

Proximus Journal of Sports Science and Physical Education
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https://proximusjournal.com/index.php/PJSSPE
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No.	Variables	Pre-test Mean	SD	Post-test Mean	SD	Mean Difference	Calculated t-value
1	Motor Sequence Organization	5.42	0.61	8.14	0.52	2.72	9.37
2	Motor Linking Ability	5.18	0.57	8.36	0.49	3.18	10.21
3	Motor Pathway	5.36	0.63	8.22	0.55	2.86	9.84

Presentation of the Results of Pre- and Post-Tests for the Control Group

Table (2)

Results of the Pre- and Post-Tests for the Control Group in Motor Sequence Organization and Motor Linking Ability

No.	Variables	Pre-test Mean	SD	Post-test Mean	SD	Mean Difference	Calculated t-value
1	Motor Sequence Organization	5.38	0.63	6.86	0.57	1.48	5.21
2	Motor Linking Ability	5.21	0.59	7.02	0.54	1.81	5.76
3	Motor Pathway	5.33	0.61	6.94	0.56	1.61	5.48

Table (3)

Results of the Post-Tests for Both Experimental and Control Groups in Motor Sequence Organization and Motor Linking Ability

No.	Variables	Control Group Mean	SD	Experimental Group Mean	SD	Mean Difference	Calculated t-value
1	Motor Sequence Organization	6.86	0.57	8.14	0.52	1.28	4.62
2	Motor Linking Ability	7.02	0.54	8.36	0.49	1.34	5.08
3	Motor Pathway	6.94	0.56	8.22	0.55	1.28	4.71

Degree of freedom = (12)

Discussion of Post-Test Results Between the Experimental and Control Groups in Motor Sequence Organization, Motor Linking Ability, and Motor Pathway

The researcher attributes the statistically significant differences observed between the post-test results of the experimental and control groups in favor of the experimental group across all research variables (**motor sequence organization, motor linking ability, and motor pathway**) to the effectiveness of the educational units designed according to the SAM model (**Successive Approximation Model**). The nature of this model differs from traditional instructional design models through its reliance on an iterative approach based on

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analysis, experimentation, evaluation, and continuous improvement, which made the educational program more flexible and capable of responding to players' performance levels and educational needs.

The researcher believes that the superiority of the experimental group in the post-tests was not merely a result of increasing the amount of training, but rather resulted mainly from the difference in the quality of educational processing received by the experimental group. Learning according to the SAM model did not depend on presenting the skill in its final form and repeating it; instead, it relied on analyzing performance components, identifying difficulties faced by players, and reconstructing educational activities according to the actual level of achievement. This makes the learning process more effective because the learner is not merely a receiver of motor information but becomes an active participant in discovering errors, correcting them, and improving performance.

The researcher attributes the superiority of the experimental group in the variable of **motor sequence organization** to the nature of the educational units designed according to a logical sequence of movements and skills. Players were gradually moved from learning the basic components of skills to organizing them within interconnected motor sequences, which contributed to developing an integrated motor representation. The motor sequence in gymnastics does not depend on simply combining several skills randomly; rather, it requires the player to perceive the relationship between the end of one skill and the beginning of the next skill while maintaining balance, rhythm, and continuity during transitions.

This improvement is attributed to the fact that the educational program based on the SAM model provided multiple opportunities for organized practice and gradual progression in difficulty. Exercises were structured from simple to complex and from partial performance to complete performance, which helped players stabilize the fundamental components of movement before linking them together. This is consistent with Schmidt et al. (2020), who indicated that the acquisition of complex motor skills depends on organizing learning experiences progressively in a manner that allows the development of stable motor programs and improves control over performance sequencing.

Furthermore, the superiority of the experimental group in motor sequence organization can be explained by the program's continuous performance analysis, where emphasis was placed on transition timing between skills, body angles, landing positions, and support phases. These requirements directly influence the quality of the motor sequence. A player who possesses the ability to organize movement components is more capable of performing the sequence fluently and reducing unnecessary time intervals between skills.

Regarding the variable of **motor linking ability**, the researcher attributes the superiority of the experimental group to the fact that the educational units included specific exercises for motor transitions and skill linking within situations similar to competitive performance. Training was not limited to mastering individual skills; rather, it focused on how these skills are used within an integrated motor structure. Motor linking is considered one of the essential requirements in gymnastics because it reflects the player's ability to control the temporal sequence of movements and achieve coordination among different body segments during transitions from one movement position to another.

The researcher believes that the differences between the two groups in this variable resulted from the fact that the experimental group was exposed to multiple and varied learning situations that allowed them to develop broader motor experiences. Repeated performance within different sequences contributed to enhancing the

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ISSN (E): 2942-9943

nervous system's ability to organize and stabilize motor responses. Magill and Anderson (2022) emphasize that effective motor learning does not depend solely on repetition frequency, but also on the nature and organization of practice and its relationship to the situations in which performance will be applied. Purposeful practice contributes to developing the ability to integrate and control skills.

The use of continuous feedback within the experimental program also had a clear effect on developing motor linking ability, as players were able to identify errors related to timing, transitions, or balance loss and modify them immediately. In contrast, the control group relied more on general correction after performance, making error processing less accurate.

Concerning the **motor pathway variable**, the researcher attributes the superiority of the experimental group to the educational units' reliance on analyzing the pathway followed by the body during skill execution, focusing on correct movement direction, support positions, body segment angles, and transitions between different performance phases. The motor pathway represents an important indicator of performance quality in gymnastics because any deviation in movement direction or body position increases the effort exerted and reduces technical accuracy.

Furthermore, the use of visual demonstrations and continuous performance analysis helped players develop a clear mental representation of the correct motor pathway. Players became able to compare their performance with the required model, identify errors, and work on correcting them. Bouzid et al. (2025) confirmed that video-based feedback and visual analysis contribute to increasing motor awareness and improving technical accuracy in sports performance due to learners' ability to observe differences between actual and ideal performance.

The researcher confirms that the differences in favor of the experimental group in the post-tests resulted from the integration between the components of the SAM model and the fundamental principles of motor learning. The program combined preliminary skill analysis, gradual content presentation, organized practice, continuous feedback, and modification of activities according to evaluation results. These characteristics made the learning environment of the experimental group more effective than the traditional educational environment followed by the control group.

Based on the above, the researcher concludes that the SAM model contributed positively to developing the investigated variables. Its effect was not limited to improving skill performance but extended to developing the organizational and cognitive processes accompanying motor performance, represented by the ability to organize motor sequences, link skills, and control motor pathways. This confirms that instructional design based on continuous evaluation and development represents an effective approach for teaching gymnastics skills characterized by complexity and interaction among physical, neurological, and motor components.

Conclusions

Based on the research findings, the researcher reached the following conclusions:

1. Educational units designed according to the SAM model had a positive effect on developing motor sequence organization among junior artistic gymnasts.
2. The SAM model contributed to improving motor linking ability between skills through organizing the learning process in a gradual and iterative manner.

Proximus Journal of Sports Science and Physical Education
Volume 3, Issue 08, August 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

3. The experimental group that used educational units designed according to SAM outperformed the control group in the research variables.
4. The SAM model is considered one of the modern educational models that can be employed in teaching complex motor skills.

Recommendations

The researcher recommends the following:

1. Adopting modern instructional design models, including the SAM model, in teaching artistic gymnastics skills.
2. Giving attention to designing educational units that consider skill organization and linking within integrated motor sequences.
3. Using continuous evaluation and feedback during the teaching of complex skills.
4. Conducting future studies using the SAM model in other sports activities.

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