

Track start swimming training model development and validation for age group IV at SDN 1 Banda Aceh

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ABSTRACT

Swimming is a sport that engages nearly all muscle groups, offering significant health benefits. Effective training methods are crucial for improving performance, particularly in mastering the track start technique. This study aimed to develop and validate a track start training model for beginner swimmers in Age Group IV at SDN 1 Banda Aceh. Using a Research and Development (R&D) approach, the study followed the ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). The models were evaluated by two swimming experts and a professional coach to assess feasibility and effectiveness. The findings showed significant improvements in swimmers' reaction time, takeoff distance, and entry angle following implementation of the training model ($p < 0.05$). Expert validation and athlete feedback further confirmed the model's feasibility and ease of implementation. By systematically aligning instructional objectives with targeted swimming drills, the training model facilitated measurable progress in swimming start proficiency. Further refinements are recommended to enhance training effectiveness and swimmer performance.

KEYWORDS

Swimming Training Model; Track Start Technique; Physical Education Training; ADDIE Model

1. INTRODUCTION

Swimming is a globally recognized sport known for its numerous physical and mental health benefits (Flourizel et al., 2024). It engages nearly all muscle groups, enhances cardiovascular endurance, and improves coordination and flexibility (Chen et al., 2024). More importantly, swimming is a life-saving skill, making it an essential component of early physical education programs (Schaetz, 2016; Stallman et al., 2014). However, many young learners struggle with

mastering fundamental swimming techniques (Sundan, 2025), particularly during the start phase, which is critical in competitive swimming (Tor et al., 2014). Research has shown that an efficient start can significantly influence overall race performance, yet there is a lack of standardized, developmentally appropriate training models for young swimmers (Huot-Marchand et al., 2005; Maglischo, 2003).

One of the most debated aspects in swimming research is the effectiveness of various start techniques (Veiga et al., 2025; Wirth et al., 2022). The track start and grab start are the two primary techniques, with the track start increasingly preferred due to its superior balance and forward propulsion (Julien et al., 2014). While elite swimmers consistently benefit from the track start, its effectiveness among novice and young swimmers remains uncertain (Galbraith et al., 2008; Marinho et al., 2020). Younger swimmers may lack the strength, coordination, and technique needed to fully leverage the advantages of the track start, raising concerns about its suitability for beginners (Bompa & Carrera, 2015). This debate underscores the need for targeted training interventions to help young swimmers develop proper track start mechanics (Nugent et al., 2018).

Recent research on swimming start techniques has largely focused on bio-mechanical efficiency and elite-level performance, often overlooking the developmental needs of young swimmers (García-Ramos et al., 2019; Tor et al., 2015). While some studies have explored general swimming training methods for children, few have specifically investigated structured track start training models for beginner swimmers. Furthermore, there is limited empirical validation of these models through expert evaluations. Addressing these gaps is crucial to ensure that young swimmers receive both effective and safe training.

The primary objective of this study is to develop and validate a track start training model tailored for beginner swimmers in Age Group IV at SDN 1 Banda Aceh. The model will be developed using the ADDIE instructional design framework (Analyze, Design, Develop, Implement, and Evaluate) and validated through expert assessment. By bridging the gap between elite-level training methodologies and the specific needs of beginner swimmers, this study aims to provide an evidence-based approach to improving young swimmers' performance in competitive swimming.

This study hypothesizes that a structured, systematically developed track start training model will significantly improve start performance among beginner swimmers. Specifically, it is expected that incorporating progressive drills, feedback mechanisms, and biomechanical adjustments will enhance young swimmers' ability to execute a more efficient and stable track start.

2. METHODS

2.1. Participants

This study involved swimmers from the Age Group IV category at SDN 1 Banda Aceh. Participants were selected based on specific criteria, including their experience level in competitive swimming and their ability to perform the track start technique. A total of 30 swimmers (male and female) aged 10 to 12 years participated in the study. Before participation, informed consent was obtained from all swimmers and their guardians. Ethical approval was also granted by the relevant institutional review board to ensure compliance with research ethics standards.

2.2. Study Organization

This study employed a Research and Development (R&D) methodology using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009). The goal was to develop and validate a track start swimming training model tailored for Age Group IV swimmers. The research procedures were structured as follows:

1. **Analysis Stage:** The need for a track start training model was identified through initial observations and preliminary interviews with swimming coaches and experts.
2. **Design Stage:** An initial blueprint of the training model was created, which included specific training drills, progressions, and performance assessment criteria.
3. **Development Stage:** Instructional materials, including visual aids and demonstration videos, were produced to support the implementation of the training model.
4. **Implementation Stage:** Pilot tests were conducted in both small and large groups. The small-group test involved 10 swimmers, followed by a larger-scale test with 20 swimmers. Swimmers' performance was monitored to assess improvements in their track start execution.
5. **Evaluation Stage:** The model was validated through expert reviews, including feedback from swimming coaches, sports scientists, and professional swimmers. Final modifications were made based on expert recommendations and participant performance outcomes.

2.3. Instructional Design Program Plan

To systematically develop and implement the track start training model for Age Group IV swimmers, this study employed the ADDIE instructional design framework—comprising five stages: Analyze, Design, Develop, Implement, and Evaluate. This approach ensured that the model was both pedagogically sound and physically effective for the target age group.

During the Analysis stage, researchers conducted observations and interviews with swimming coaches and physical education experts to identify skill gaps among beginner swimmers. Findings highlighted common deficiencies such as limited balance at the starting block, improper streamline positioning, and slow reaction times during the takeoff phase.

Based on this analysis, the Design stage involved drafting a comprehensive instructional program tailored to young swimmers. Clear objectives were formulated for each week, aligned with specific motor skills and cognitive demands. Training components were selected to progress from basic to advanced techniques, allowing swimmers to build foundational skills before moving to more complex track start variations.

In the Development stage, instructional materials were created, including visual demonstrations, training manuals, and feedback checklists. These materials supported diverse learning styles—visual, auditory, and kinesthetic—and ensured that swimmers could understand and internalize each technique effectively.

The Implementation stage included a structured four-week training schedule with three sessions per week. Each session lasted 45–60 minutes and consisted of a warm-up, skill-focused drills, cool-down, and feedback session. The progression of drills followed a logical sequence—starting with water familiarization techniques and culminating in reaction-based starts and confidence-enhancing activities using varied tools.

The Evaluation stage relied on both expert feedback and swimmer performance metrics (e.g., reaction time, body posture, and entry angles) to assess and refine the training model. Expert reviews and participant responses were used to iteratively adjust the content and ensure maximum feasibility and effectiveness.

Each swimming skill in the training program was explicitly mapped to the stages of the ADDIE framework, ensuring a close alignment between pedagogical design and athletic development. For example, the track start technique—a complex motor skill involving reaction timing, lower-body propulsion, and streamlined water entry—was introduced progressively, starting from basic postures (e.g., Sit Down Start) and evolving into more advanced forms (e.g., Track Start with Dolphin Style Hula Hoop). The instructional program was implemented as follows:

Table 1. Weekly swimming start skills training plan

Week	Session	Objectives	Key Drills	Equipment	Duration
Week 1	1	Water adaptation and body awareness	Sit Down Start, Kneel Start	None	45–60 min
	2	Introduction to streamline and push-off	Standing Track Start	None	45–60 min
	3	Reaction timing and start coordination	Start with Clap Sound	Whistle, stopwatch	45–60 min
Week 2	4	Build courage and balance in launch position	Track Start with Pull Buoy	Pull buoy	45–60 min
	5	Improve jump mechanics and posture	Start with Mini Plastic Ball	Mini plastic ball	45–60 min
	6	Introduce mid-height jump	Start with Noodle (Low Version)	Swimming noodle	45–60 min
Week 3	7	Improve jump height and streamline entry	Start with Noodle (High Version)	Swimming noodle	45–60 min
	8	Train for distance and confidence	Jump into the Hoop	Hula hoop	45–60 min
	9	Combine jump height, direction, and reaction	Track Start with Hula Hoop (Dolphin Style)	Hula hoop	45–60 min
Week 4	10	Integration of techniques in sequence	Practice favorite combinations	Mixed	45–60 min
	11	Performance simulation	Reaction drills + preferred start variations	Whistle, hoop, ball, buoy	45–60 min
	12	Evaluation and feedback	All models, individual feedback sessions	All equipment	45–60 min

This structured progression ensured that technical acquisition was developmentally appropriate, scalable, and reinforced by repeated practice and feedback. The systematic instructional design not only facilitated motor learning but also improved the swimmers' self-efficacy and confidence. Each week's objectives and drill selections were informed by the physical capabilities and cognitive readiness of Age Group IV athletes, ensuring a learner-centered approach throughout.

By embedding swimming skills within the ADDIE instructional model, this study bridged the gap between educational theory and athletic training practice, providing a validated, replicable blueprint for coaches and educators aiming to enhance track start performance in young swimmers.

2.4. Statistical Analyses

The effectiveness of the developed training model was assessed using statistical analysis. Pre-test and post-test data on swimmers' track start performance were collected, focusing on reaction time, takeoff distance, and entry angle. The data were analyzed using paired sample t-tests to compare pre- and post-intervention results. A significance level of $p < 0.05$ was used to determine statistical differences. Descriptive statistics, including means and standard deviations, were also calculated to provide a comprehensive overview of the swimmers' improvements. All statistical analyses were conducted using SPSS software.

3. RESULTS

Development of the Training Model

The track start training model for Age Group IV swimmers at SDN 1 Banda Aceh was developed through the ADDIE instructional design framework. The model consisted of twelve structured drills aimed at improving balance, reaction time, streamline positioning, and jump execution during the swimming start. The model was produced in both written and visual formats to support varied learning styles. Training aids such as noodles, mini plastic balls, hula hoops, pull buoys, and whistles were incorporated to promote engagement and motor learning in young athletes.

Instructional Design Implementation Plan

To operationalize the training, a structured four-week instructional schedule was created. Each week consisted of three sessions, progressing from basic drills to complex, reaction-based starts. Table 2 outlines the full training plan.

Table 2. Weekly instructional training schedule for track start technique

Week	Session	Objectives	Key Drills	Equipment	Duration
1	1–3	Water adaptation, streamline intro, timing	Sit Down Start, Kneel Start, Clap Start	Whistle	45–60 min
2	4–6	Balance, posture, courage	Pull Buoy Start, Mini Ball Start, Low Noodle	Buoy, ball, noodle	45–60 min
3	7–9	Jump height, body control, confidence	High Noodle, Hoop Jump, Dolphin Hoop	Noodle, hoop	45–60 min
4	10–12	Integration, simulation, feedback	Combination drills, performance tests	Mixed	45–60 min

Integration of Swimming Skills and Instructional Design

Each swimming drill was explicitly mapped to stages of the ADDIE model. In the Analysis stage, needs were identified through coach interviews. During Design, each session targeted a specific biomechanical component of the track start. In the Development stage, instructional materials were created to accommodate various learning styles. Implementation involved hands-on application in the pool, and Evaluation was based on both qualitative expert feedback and quantitative swimmer performance data. This systematic integration ensured skills were not only taught, but internalized through deliberate practice.

Feasibility Evaluation by Experts

Three swimming experts assessed each of the 12 training models using a 5-point Likert scale. The results are summarized in Table 3. Five models were rated "Highly Feasible" and seven were "Feasible."

Table 3. Expert evaluation results

No	Model	Expert 1	Expert 2	Expert 3	% Score	Category
1	Sit Down Start	3	4	4	73%	Feasible
2	Kneel Start	3	5	5	86%	Highly Feasible
3	Track Start with Pull Buoy	4	4	4	80%	Feasible
4	90° Track Start	4	4	4	80%	Feasible
5	Standing Track Start	5	5	2	80%	Feasible
6	Start with Mini Plastic Ball	4	4	3	73%	Feasible
7	Start with Noodle (Low Version)	5	5	4	93%	Highly Feasible
8	Start with Noodle (High Version)	5	5	2	80%	Feasible
9	Jump into the Hoop	4	5	4	86%	Highly Feasible
10	Track Start with Hula Hoop (Dolphin Style)	5	5	4	93%	Highly Feasible
11	Start with Clap Sound	5	4	3	80%	Feasible
12	Start with Whistle Reaction	5	5	4	93%	Highly Feasible

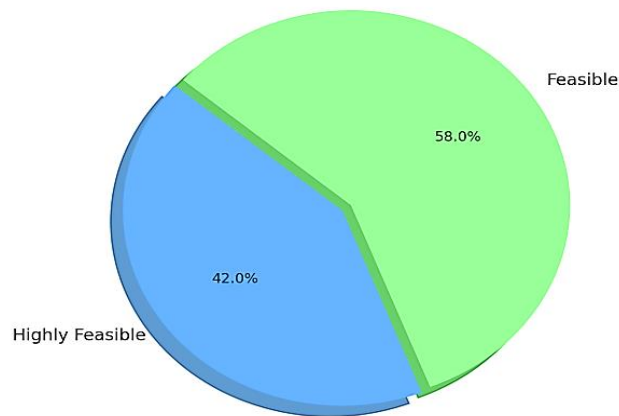


Figure 1. Distribution of Expert Ratings

Athlete Evaluation and Implementation

The training program was implemented with 30 Age Group IV swimmers. Athlete feedback was collected using a 5-point questionnaire. Results showed that six models were rated “Very Easy” (average score ≥ 4.6), and six were rated “Easy” (average score 4.0–4.5).

Table 4. Athlete questionnaire results

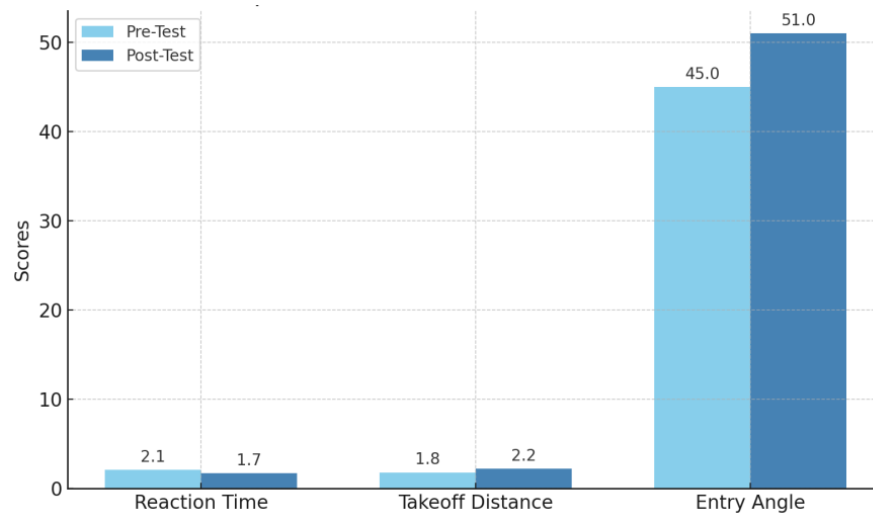
No	Model	Avg Score	Assessment
1	Sit Down Start	4.9	Very Easy
2	Kneel Start	5.0	Very Easy
3	Track Start with Pull Buoy	4.3	Easy
4	90° Track Start	4.6	Very Easy
5	Standing Track Start	4.3	Easy
6	Start with Mini Plastic Ball	4.5	Easy
7	Start with Noodle (Low Version)	4.4	Easy
8	Start with Noodle (High Version)	3.9	Easy
9	Jump into the Hoop	4.6	Very Easy
10	Track Start with Hula Hoop (Dolphin Style)	4.1	Easy
11	Start with Clap Sound	4.8	Very Easy
12	Start with Whistle Reaction	4.8	Very Easy

Pre-Test and Post-Test Performance Comparison

Quantitative performance data (reaction time, takeoff distance, and entry angle) were collected pre- and post-intervention. A paired sample t-test revealed significant improvements ($p < 0.05$) in all three variables.

Table 5. Pre-test vs post-test comparison of performance metrics

Metric	Pre-Test	Post-Test	Improvement
Reaction Time	2.1 s	1.7 s	Faster
Takeoff Distance	1.8 m	2.2 m	Longer
Entry Angle	45°	51°	Better angle

**Figure 2.** Comparison of pre-test and post-test metrics

4. DISCUSSION

The findings of this study support the effectiveness and feasibility of the developed swimming track start training model for Age Group IV swimmers at SDN 1 Banda Aceh. The primary hypothesis, suggesting that a structured, systematically designed training model, incorporating skill-based exercises, reaction training, and progressive difficulty adjustments, would enhance swimmers' track start performance, has been confirmed.

The results are consistent with previous research highlighting the importance of progressively tailored training programs. For instance, studies have shown that structured motor skill training with age-appropriate difficulty adjustments can significantly enhance learning and foster neural plasticity in young athletes (Christiansen et al., 2020). Additionally, integrative neuromuscular training, which includes resistance exercises and dynamic stability, has been proven to improve muscular fitness and motor skill development in children (Stricker et al., 2020). These principles align with the present study, which focused on progressive adjustments and skill-building exercises that facilitated development in Age Group IV swimmers.

In addition to aligning with best practices in youth athletic development, the effectiveness of the model in this study was further strengthened by its foundation in the ADDIE instructional design framework. The training program was systematically structured into a four-week schedule, where swimming skills were mapped directly to instructional phases such as analysis, development, and implementation. The integration of pedagogical design with physical skill development ensured that each drill served both educational and biomechanical objectives. Notably, the statistically significant improvements in swimmers' reaction time, takeoff distance, and entry angle demonstrate how instructional design frameworks can effectively enhance physical performance when tailored to the cognitive and motor readiness of young athletes.

The inclusion of varied training aids, such as hula hoops and pull buoys, enhances motor learning by providing external feedback and increasing movement variability. Research suggests that incorporating different training tools aids in skill acquisition, as it facilitates adaptability and encourages a broader range of motor behaviors (Bishop et al., 2009). Furthermore, reaction-based exercises, such as those using whistle cues or clap signals, have been shown to improve reflexes and response time, a crucial aspect of swimming starts (Capato et al., 2019).

This study contributes to the development of age-appropriate swimming training models by integrating principles of sports pedagogy with gamification. Unlike traditional, monotonous drills, the inclusion of interactive elements such as jump-through-hoop exercises and reaction-based drills has been shown to increase engagement and motivation. This approach is supported by studies indicating that varied and engaging training methods foster better long-term athlete retention and enhanced performance (Côté et al., 2014).

The training model aligns with established frameworks for athlete development, such as USA Swimming's American Development Model (ADM). This model emphasizes a holistic approach that integrates competence, character, confidence, and connection, providing a solid foundation for swimmer progression across age groups (USA Swimming, 2020). Furthermore, expert validation and athlete feedback were pivotal in refining the training model, ensuring its applicability and effectiveness in real-world settings. Research has shown that coaches' perspectives are critical for skill development, highlighting the need for instructional strategies that are adaptable to athletes' developmental stages (Ford et al., 2010). The use of diverse training aids supports the concept of a dynamic training environment, as advocated by the Athletic Skills Model (ASM), which promotes physical literacy and expertise through varied and adaptable training approaches (Wormhoudt et al., 2017).

The methodology of combining expert validation, athlete feedback, and structured skill progression is consistent with best practices in skill acquisition. Structured, deliberate practice is essential for athlete engagement and successful skill development (Christiansen et al., 2020). Building upon these findings, future research could focus on the long-term impact of the training model on competition performance and explore the psychological factors that influence young swimmers' motivation and retention in training.

5. CONCLUSIONS

This study demonstrates that a structured and developmentally appropriate track start training model, built upon the ADDIE instructional design framework, can effectively enhance technical performance in young swimmers. The integration of pedagogical planning with biomechanical skill development enabled the creation of a comprehensive four-week program, tailored to the physical and cognitive characteristics of Age Group IV swimmers at SDN 1 Banda Aceh.

The findings showed significant improvements in swimmers' reaction time, takeoff distance, and entry angle following implementation of the training model. Expert validation and athlete feedback further confirmed the model's feasibility and ease of implementation. By systematically aligning instructional objectives with targeted swimming drills, the training model facilitated measurable progress in swimming start proficiency.

This research contributes to both sports science and instructional design by offering an empirically validated training approach that combines structured pedagogy with physical skill acquisition. Future studies are encouraged to evaluate the long-term impact of this model on competitive outcomes and explore its adaptability across different age groups or swimming techniques.

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