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Developing human anatomy learning for physical education students using the Pirogov Anatomy Model and Anchored Instruction approach

Ratno Susanto[1], **Erwin S. Neolaka**[1]

[1] Physical Education Health and Recreation, Faculty of Teacher Training and Education, Nusa Cendana of University, Kupang City, Indonesia
*Corresponding Author. Email: ratno.susanto@staf.undana.ac.id

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Abstract: *This study aims to develop the Pirogov Anatomy Model with an Anchored Instruction approach as an innovation in human anatomy learning for Physical Education students. The background of this research arises from the need for an anatomy learning model that not only emphasizes memorization of body structures but also provides contextual, interactive, and applicable learning experiences relevant to the professional demands in the field of physical education. The Pirogov Anatomy Model utilizes three-dimensional representations of the human body combined with Anchored Instruction, in which learning is guided through contextual scenarios based on real-life problems. Thus, students are encouraged to understand the relationship between anatomical structures, physical activity, sports performance, and health in a more comprehensive way. The research method employed was Research and Development (R&D), consisting of several stages: needs analysis, model design, expert validation, limited trials, and effectiveness testing. The research subjects were Physical Education students enrolled in the Human Anatomy course. Data collection instruments included needs analysis questionnaires, expert validation sheets, and learning outcome tests. The findings indicate that the developed model is valid, practical, and effective in improving students' conceptual understanding of anatomy. Findings demonstrate a substantial improvement in students' conceptual understanding. The average pretest score was 62, increasing to 82 on the posttest, resulting in a gain score of 0.53, indicating a moderate to high level of learning effectiveness. Expert evaluations rated the learning design as highly feasible in terms of content accuracy, instructional relevance, and user experience. Students reported improved clarity in identifying anatomical structures and stronger engagement when solving contextual movement-related problems. Overall, the integration of a 3D anatomical visualization tool and anchored, scenario-based learning effectively enhances comprehension of human anatomy in Physical Education contexts and offers a promising model for technology-supported anatomy instruction. Students demonstrated better ability to link anatomical structures with body functions and their application in sports and movement. In conclusion, the Pirogov Anatomy Model with Anchored Instruction offers an innovative alternative learning model that enriches anatomy teaching strategies in higher education, particularly in Physical Education study programs. This model has the potential to improve learning outcomes, critical thinking skills, and the relevance of anatomy knowledge to students' professional practice.*
Keywords: *Pirogov Anatomy Model, Anchored Instruction, anatomy learning, Physical Education, student learning outcomes.*

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INTRODUCTION

One of the most important introductory courses in the Physical Education curriculum is learning human anatomy. Students' mastery of sports science, health, and practical skills in teaching physical activities will be largely based on their comprehension of the anatomy and physiology of the human body(Koney et al., 2024). But in reality, learning anatomy still faces a number of challenges, such as theoretical teaching approaches, a focus on memorization, a dearth of interactive learning resources, and a failure to relate the theoretical content to real-world situations in sports and physical activity. As a result, students struggle to integrate anatomical principles in professional practice and have a limited comprehension of them.

Understanding anatomical structures and their functional relationships is essential for Physical Education students, as it forms the conceptual basis for analyzing movement, preventing injuries, and designing instructional strategies in sports contexts. However, conventional anatomy instruction dominated by lectures, textbook diagrams, and limited physical models often results in superficial understanding because students struggle to visualize three-dimensional structures and connect them to real-life movement scenarios

The study of the human body's intricate structure, including its bones, muscles, organs, and other systems, is known as anatomy. Anatomical knowledge is essential for understanding movement, biomechanics, preventing injuries, and organizing safe and productive physical activities in the framework of physical education. The National Standards for Higher Education state that learning anatomy should place an emphasis on connecting ideas with sports and health practices in addition to memorization of body structures(Bogomolova et al., 2020). However, a number of studies have revealed that because there is a dearth of contextual learning materials, physical education students still find it difficult to relate anatomical theory to its application in physical activities.

Recent technological developments in visualization-based learning have provided new opportunities to strengthen anatomy comprehension through more immersive and interactive representations. One of the influential foundations for modern anatomical visualization is the work of Nikolay Ivanovich Pirogov, whose frozen section method pioneered precise anatomical cross-section mapping. This historical contribution inspired the development of the Pirogov Anatomy Model, a contemporary 3D visualization framework designed to help learners explore anatomical layers with greater spatial clarity.

To enhance not only visualization but also contextual application, this study integrates the Pirogov Anatomy Model with the principles of Anchored Instruction. From the outset, this integration is designed to create an innovative learning environment where students engage with 3D anatomical structures while solving realistic movement-related problems situated in authentic physical activity scenarios. The combined model allows students to anchor conceptual understanding within meaningful contexts, thereby reinforcing the transfer of anatomical knowledge to practical decision-making in sports and exercise settings

A three dimensional depiction of human anatomy based on body portions is the Pirogov Anatomy model. The work of Russian anatomist Nikolay Ivanovich Pirogov, who is credited with developing the frozen section method for researching the human body, served as the model's inspiration. This model's advantage is that it can realistically depict body architecture, giving pupils a firsthand look at how organs relate to one another(Barmaki et al., 2024). The Pirogov Anatomy model is thought to enhance students' spatial comprehension of human body form and lessen the importance of memory in the learning process.

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to connect anatomical ideas to practical issues. For instance, a real-life example of a rotator cuff injury in volleyball players is used to teach students about shoulder anatomy(Abel & Ziman, 2024).

Relevance to Today: Despite being developed in the 19th century, the ideas of Pirogov Anatomy are still applicable today since they complement new advancements in cross-sectional anatomical visualization (CT, MRI, AR/VR). This model serves as a link between traditional anatomical theory and the real-world requirements of contemporary sports in physical education(Tanweer & Galton, 2018).

Previous research has demonstrated that 3D visualization tools improve spatial understanding, while anchored or problem-based learning strengthens critical thinking and situational reasoning. However, studies that intentionally merge advanced anatomical visualization with contextual scenario-based learning for Physical Education students remain limited. Therefore, this study addresses this gap by developing and evaluating an integrated learning design that incorporates the Pirogov Anatomy Model and Anchored Instruction to enhance comprehension, engagement, and application of human anatomy concepts.

Learning models that may offer a more relevant, applicable, and engaging learning experience are required in tandem with the advancement of technology and contemporary pedagogical approaches. The Pirogov Anatomy Model, a three-dimensional depiction of human anatomy that enables pupils to view and comprehend bodily structures more realistically, is one pertinent invention(Bogomolova et al., 2021). The Anchored Instruction strategy, which use scenarios or contextual problems as "anchors" to promote comprehension and problem-solving, is combined with this concept. In addition to mastering the cognitive components, it is desired that students would be able to relate their understanding of anatomy to sports, physical activities, and the demands of the physical education profession(Pettersson et al., 2023).

The Cognition and Technology Group at Vanderbilt (CTGV) created the problem-based learning strategy known as Anchored Instruction. Presenting information as contextual scenarios or "anchors" that inspire students to investigate, evaluate, and solve problems is its fundamental tenet(Ritchie et al., 2023). This method has been shown to be successful in enhancing conceptual comprehension, critical thinking abilities, and the capacity to apply knowledge to practical contexts. The application of Anchored Instruction in anatomy education can involve movement analysis, case studies of sports injuries, or creating workout regimens that incorporate anatomical features.

Anchored instruction's core tenets are: Contextualization: Real-world scenarios are used to frame the subject matter. Problem-based learning: Rather than just memorizing facts, students are urged to tackle challenging questions(Susanto & Lestari, 2021). Multiple viewpoints: In order to become more critical and reflective, students are taught to consider issues from a variety of angles. Collaborative: To allow students to share ideas and tactics, the learning process is conducted in groups. Knowledge transfer: Acquired knowledge can be used outside of the official educational setting, particularly in practical settings(Pickering & Swinnerton, 2019).

Application in the Study of Anatomy for Anchored Instruction is applied in this study by showcasing actual sports cases, such as hamstring strains in soccer players, shoulder dislocations in volleyball players, or ankle sprains in runners(Achmad Afandi, 2019). In order to comprehend the structure of the muscles, joints, and tissues involved, students are instructed to study the case using the Pirogov Anatomy Model. Based on an understanding of anatomy, group discussions are held to identify methods for treating and preventing injuries. The speaker does more than merely provide knowledge; they also serve as a guide and facilitator(Triepels et al., 2020).

The benefits of this method for physical education students include more relevant learning: In addition to knowing the names of muscles and bones, students also comprehend how anatomy functions in athletic motions(Ratno Susanto, 2019). Enhanced motivation for learning: Since real-life examples align with students' interests and fields of study, they pique their attention. Foster critical thinking abilities: Students are asked to relate anatomy to sports physiology and biomechanics. Practical relevance: Sports injury prevention, physical education in schools, and coaching activities can all benefit from anatomical understanding(Javaid et al., 2020).

There is a great chance to provide more engaging, relevant, and useful anatomy education by combining the Anchored Instruction method with the Pirogov Anatomy Model. In addition to learning about the human body in three dimensions, students also apply this knowledge to real-world issues in physical education and sports. Therefore, it is anticipated that the creation of this model will enhance

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professional competence, critical thinking abilities, and student learning outcomes(Bhandari et al., 2016).

For instance, the instructor uses a basketball player's anterior cruciate ligament (ACL) injury as an example when talking about knee anatomy. Using the Pirogov Anatomy Model, students examine the structure of the knee before talking about the causes, processes of injury, and ways to avoid it. In this way, anatomy is taught as an analytical tool for the real world of athletics rather than as a subject to be memorized(Eid et al., 2017).

The purpose of this study was to create and evaluate the Pirogov Anatomy Model's ability to enhance student learning outcomes when used in conjunction with an Anchored Instruction strategy. In order to address the demands of physical education in higher education, it is anticipated that this research will aid in the creation of more creative, efficient, and pertinent anatomy learning methodologies.

METHODS

In order to create and evaluate the Pirogov Anatomy Model using an Anchored Instruction strategy for teaching physical education students about human anatomy, this study employs a Research and Development (R&D) methodology(Drapkin et al., 2015). The phases of Borg & Gall are condensed into a few key stages by the development model that is being employed. These are: (1) needs analysis; (2) model design; (3) expert validation; (4) limited trials; (5) product revision; and (6) field trials to test effectiveness(Susanto & Lestari, 2021).

This study employed a Research and Development (R&D) approach using a simplified modification of the Borg and Gall model. The original ten-step Borg and Gall cycle was adapted into six integrated stages to fit the scope and time frame of instructional product development. The simplified stages consisted of:

1. Preliminary Research and Needs Analysis (integrating steps 1–2: research and planning),
2. Design of Product Prototype (step 3: initial product development),
3. Expert Validation and Revision (steps 4–5 merged: preliminary field testing and revision),
4. Limited Trial Implementation (step 6: main field testing),
5. Product Revision and Enhancement, and
6. Field Implementation and Final Evaluation (integrating steps 7–10 into a combined summative evaluation phase).

This modification retains the developmental rigor of the Borg and Gall model while streamlining stages to ensure feasibility within the academic research timeline.

Students in the Human Anatomy course in the odd semester of the 2025–2026 school year who were enrolled in the Physical Education Study Program served as the research subjects. Additionally, lecturers with expertise in anatomy, physical education, and learning media made up the team of specialists participated in the model validation. From this population, research sampling aligned with the development cycle:

- Needs analysis stage: 60 students (drawn proportionally from all four classes).
- Limited trial phase: 15 students voluntarily participating from one class.
- Field trial phase: 40 students selected from two classes to evaluate product effectiveness.

This distribution ensured that both early formative feedback and later summative evaluation represented the actual learning environment.

A student needs analysis questionnaire was one of the tools used to determine the issues with anatomy education. An expert validation sheet to evaluate the viability of the design, content, and incorporation of the Pirogov Anatomy model into the Anchored Instruction technique. A learning outcome exam that assesses comprehension of anatomical concepts using both objective and descriptive questions. a survey with student responses to gauge the model's degree of acceptability and usefulness(Salame & Kabir, 2022).

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Table 1. Validation sheet of the Pirogov Anatomy model into the Anchored Instruction technique

Variable	Conceptual Definition	Operational Definition	Indicators	Instruments	Scale	Analysis Technique
Learning Effectiveness	The extent to which the integrated Pirogov Anatomy Model and Anchored Instruction improve students' conceptual understanding of human anatomy.	Measured through pretest–posttest score improvement and calculated gain score.	- Pretest score - Posttest score - Gain score - Achievement of learning objectives	Learning achievement test (MCQ & descriptive)	Interval	Paired t-test, N-Gain analysis
Product Feasibility	The quality and appropriateness of the developed learning product based on content validity, instructional design, and technical quality.	Measured through expert validation ratings on content accuracy, design suitability, and usability.	- Content validity - Accuracy of anatomy concepts - 3D visualization quality - Anchored scenario appropriateness	Expert validation sheets	Likert	Expert validity index, Aiken's V
Student Engagement	The degree of student involvement, attention, and motivation when interacting with the learning product.	Measured through student perception surveys after implementation.	- Interest in 3D visualization - Engagement in problem-solving - Learning motivation - Ease of media use	Student response survey	Likert	Descriptive statistics (mean, SD)
Learning Needs (Needs Analysis)	The gap between current anatomy learning conditions and students' needs for visual and contextual learning tools.	Measured during preliminary research to determine students' learning difficulties and media preferences.	- Difficulty visualizing 3D structures - Need for realistic representation - Preference for contextual learning	Needs analysis questionnaire	Likert	Descriptive analysis

The research process involved distributing questionnaires and doing a needs analysis through lectures on anatomy. Using Pirogov Anatomy material, an Anchored Instruction-based learning scenario was created as part of the model design. Prior to testing, expert validation was done to guarantee the model's quality. A small sample of students participated in a restricted trial, and the outcomes were examined for potential revisions. The model's ability to enhance learning outcomes was tested in a field trial with an entire class.

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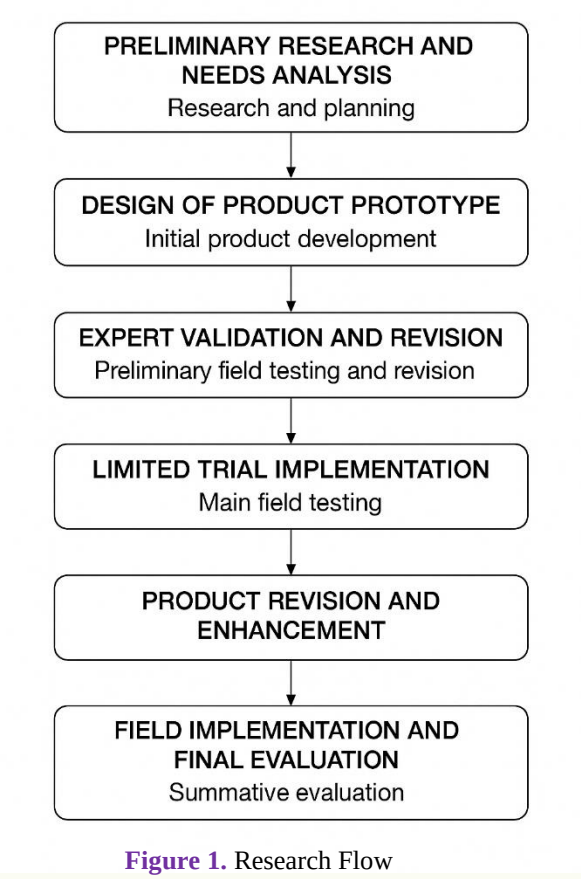

Figure 1. Research Flow

The flowchart illustrates the methodical steps involved in creating a learning model, from determining needs to creating a finished product that is reliable, useful, and efficient for teaching anatomy to students in physical education.

Four instruments were employed to collect data throughout the development and testing phases is

Needs Analysis Questionnaire

Used to determine students' initial difficulties in understanding anatomical structures and their preferences for visualization-based learning. The questionnaire consisted of Likert-scale items and short open-ended responses.

Expert Validation Sheets

Two experts one in human anatomy education and one in learning media development evaluated the prototype product in terms of content accuracy, pedagogical suitability, technical quality, and usability. Validation sheets employed structured rating scales and qualitative comment sections.

Learning Achievement Test

A combination of objective items (multiple-choice) and descriptive problem-based items designed to measure conceptual understanding and ability to apply anatomy concepts to physical movement scenarios. This test was administered as both pretest (baseline) and posttest, and later used to calculate the gain score reported in the results.

Student Response Survey

Distributed after the implementation stages to assess user experience, engagement, perceived clarity of anatomical visualization, and the usefulness of contextual Anchored Instruction scenarios.

All instruments were validated before use to ensure content relevance and measurement reliability.

The project started with a requirements analysis to uncover issues with anatomy learning, as the flowchart above shows. The analysis's findings were then used as the foundation for creating a learning model that blends the Anchored Instruction methodology with Pirogov Anatomy. The model design then underwent an expert validation phase to evaluate the approach's applicability, substance, and design. Following validation, a restricted number of students participated in a trial of the model to get

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real-world input. A better model was produced by using the trial's input during the product revision phase. The usefulness of the updated model in enhancing learning outcomes was then evaluated during a field trial phase. Creating a Final Pirogov Anatomy Model using the Anchored Instruction approach that was reliable, useful, and efficient for use in teaching anatomy to physical education students was the last step.

RESULT AND DISCUSSION

Results

With an Anchored Instruction strategy, this development research yielded a novel learning model called the Pirogov Anatomy Model. The following is a description of the research findings.

Needs Analysis

According to the results of the requirements analysis questionnaire, most students (82%) found the anatomy content difficult to understand since it was very theoretical and centered on memorizing. Students also indicated that they needed more interactive visual aids and instruction that connected to sports practice.

Table 2. Analysis of Student Needs in Anatomy Learning

No	Observed Aspects	Percentage of Students (%)
1	Difficulty understanding anatomical structures	78%
2	Learning is too theoretical	82%
3	Dominance of memorization in lectures	80%
4	Lack of interactive visual media	85%
5	Lack of connection to sports practice	88%

Description:

It is evident from Table 2 that most students have difficulties when learning anatomy. The two areas with the largest percentages are the absence of interactive visual media (85%) and the lack of connection to sports practice (88%). This highlights the necessity of a more practical, visual-based learning methodology in order to help students better comprehend the human body's structure and connect it to the context of physical exercise.

Model Design

Based on these results, researchers created a model that combines learning situations from Anchored Instruction with Pirogov Anatomy media, which is based on three-dimensional anatomical representations. In order to help students relate bodily form to movement function, the situations are set up as real-life examples, such as examining muscle injuries sustained during exercise.

Expert Validation

The model received an average score of 89%, indicating that it was deemed "very appropriate" by three experts in the fields of anatomy, physical education, and learning media. Content, manner, media design, and integrated approach were among the elements evaluated.

Table 3. Expert Validation Results of the Pirogov Anatomy Model with the Anchored Instruction Approach

No	Rated aspect	Average Score (%)	Category
1	Suitability of anatomical content	90%	Very Worthy
2	Suitability of the Anchored Instruction approach	88%	Very Worthy
3	Media design and model display	87%	Very Worthy
4	Integration of content with sports practice	89%	Very Worthy
5	Clarity of learning instructions	91%	Very Worthy
	Average	**89%**	**Very Worthy**

According to validation results from a group of experts (including specialists in anatomy, physical education, and learning media), this model received an average score of 89%, which is classified as "Very Appropriate." This suggests that the Anchored Instruction strategy in conjunction with the

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Pirogov Anatomy Model satisfies the requirements for media quality, method suitability, topic appropriateness, and integration with the sports learning context.

Limited Trial

Fifteen pupils participated in a restricted trial. Students showed high levels of interest, were more engaged in conversations, and had an easier time grasping anatomical ideas, according to observations. 91% of students responded to the model, ranking it as "very positive."

Field Trial

One class of forty pupils participated in the field trial. Pretest and posttest results were compared in order to determine learning outcomes. The mean score on the pretest was 62, while the mean score on the posttest rose to 82. Calculations of gain scores revealed a rise in the "moderate to high" category, demonstrating how well the model improved anatomical comprehension.

Table 4. Student Learning Outcomes (Pretest–Posttest)

No	Indicator	Average Value	Categor y
1	Pretest (before using the model)	62	Enough
2	Posttest (after using the model)	82	Good
3	Gain Score	0,53	Medium–High

Based on Table 4, the average student score during the pretest was 62, categorized as sufficient. After implementing the Pirogov Anatomy Model with the Anchored Instruction approach, the average student score on the posttest increased to 82, categorized as good. The gain score calculation of 0.53 indicates an increase in learning outcomes in the moderate to high category. This confirms that the developed learning model is effective in improving the anatomical understanding of Physical Education students.

Final Model

Based on all phases, an Anchored Instruction technique was used to produce the final Pirogov Anatomy Model, which has been shown to be reliable, useful, and efficient. This strategy can improve conceptual and applied comprehension, boost student engagement, and relate anatomical theory to the practical setting of physical exercise.

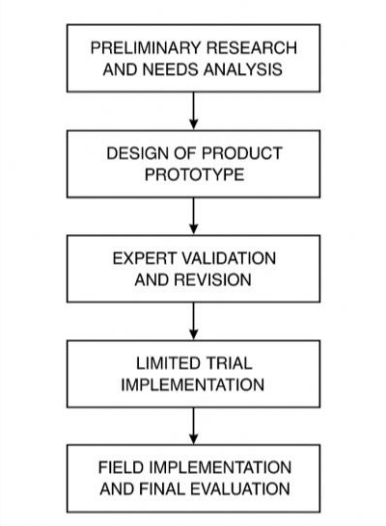

Figure 2. Pirogov Anatomy Model Flowchart with Anchored Instruction Approach

Comparison Chart of Student Learning Outcomes

- X-axis (horizontal): Test Stage (Pretest, Posttest)
- Y-axis (vertical): Average Student Grade (0–100)
- Bar 1 (Pretest): 62
- Bar 2 (Posttest): 82
- Add value labels above the bars to make them more informative.

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The efficiency of the learning paradigm is demonstrated by the graphic results, which show an improvement in student scores from 62 (adequate) on the pretest to 82 (excellent) on the posttest.

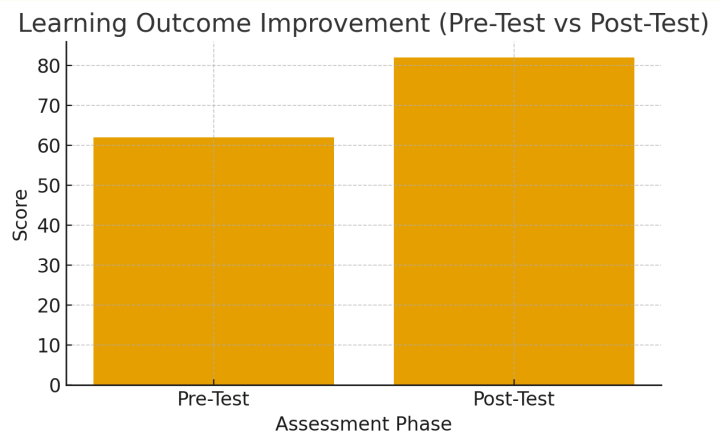

Figure 3. Pretest and Posttest Date

Graph Interpretation:

Pretest and posttest scores significantly increase, according to the student learning outcomes comparison graph. The average student score on the pretest was just 62, falling into the adequate range. The average student score rose to 82, which falls into the good category, following the use of the Anchored Instruction technique in conjunction with the Pirogov Anatomy Model. This rise indicates that students' comprehension of anatomy can be considerably enhanced by the created learning model.

Figure 4. results of the application of anatomical pirogov

Additionally, the model's ability to effectively encourage students to comprehend the connection between body form and movement function is demonstrated by the gain score calculation of 0.53, which shows a rise in the moderate to high category. Thus, this graph supports the conclusion that students' learning outcomes in Physical Education are improved when the Pirogov Anatomy model and the Anchored Instruction approach are combined.

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Figure 5. Application of anatomical Pirogrov

Figure 4 and 5 Developed Learning Product: Pirogov Anatomy Model with Anchored Instruction Approach

The developed product is a visual–instructional learning model named the Pirogov Anatomy Model with Anchored Instruction, designed specifically for Human Anatomy courses for Physical Education students. The product is presented in the form of a structured instructional flowchart that guides lecturers and students through contextual, problem-based anatomy learning.

The model consists of six interconnected learning stages, visually represented in a professional diagram using sequential arrows and anatomy-related icons:

Anchor / Real-World Problem

Learning begins with an authentic, sport-related problem (e.g., muscle injury, joint movement limitations, or posture disorders). This stage serves as a cognitive anchor to stimulate students' curiosity and relevance to physical education contexts.

Exploration of Anatomical Concepts

Students explore relevant anatomical structures such as bones, muscles, joints, and body systems using visual aids, anatomical models, or digital media. This stage emphasizes conceptual understanding.

Problem Analysis and Concept Mapping

Students analyze the given problem by mapping anatomical structures and their functions, identifying cause–effect relationships between anatomy and physical movement.

Application / Practical Solution

Students apply anatomical knowledge to propose practical solutions, such as designing movement corrections, injury prevention exercises, or training programs based on anatomical principles.

Reflection and Evaluation

Students reflect on learning outcomes through discussion, presentations, and formative assessments. Lecturers evaluate students' conceptual understanding and problem-solving abilities.

Concept Reinforcement

Key anatomical concepts are reinforced through summaries, diagrams, and structured feedback to strengthen long-term understanding.

Visually, the product is displayed as a vertical flowchart with:

- Clear stage labels,
- Directional arrows indicating learning progression,
- Anatomy-related icons (skeletal system, brain, muscles),
- Consistent color coding to distinguish each learning phase.

This developed product functions as a practical instructional guide, a learning design framework, and a visual teaching aid that lecturers can directly implement in anatomy learning for Physical Education students.

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Discussion

The results of the study indicate that the development of the Pirogov Anatomy Model using the Anchored Instruction approach proved valid, practical, and effective in improving anatomy learning outcomes for Physical Education students. The increase in average scores from a pretest of 62 to a posttest of 82, with a gain score of 0.53, indicates that this model is able to provide a more meaningful learning experience.

The Anchored Instruction approach, which stresses context-based learning to promote in-depth comprehension and problem-solving abilities, is consistent with this development. Students now apply their memorization of bodily structures to real-world scenarios, such motion analysis or sports injuries. This confirms the findings of the Cognition and Technology Group at Vanderbilt (CTGV), which found that Anchored Instruction successfully improves knowledge transfer and critical thinking abilities(Susanto & Riyanto, 2020).

Additionally, students' spatial learning is facilitated by the usage of the Pirogov Anatomy Model in three-dimensional representation. It was previously challenging to assist students comprehend the relationships between organs and body systems using traditional approaches based on text or two-dimensional graphics, but more realistic visualizations make this easier. This result is consistent with earlier studies that indicate interactive visual learning materials can enhance student engagement and retention of anatomical knowledge(Korre & Sherlock, 2023).

This model satisfies the requirements for appropriateness of content, methodology, media design, and integration with sports practice, according to the expert validation results, which had an average score of 89% and were classified as extremely practical. Positive student feedback further demonstrates that this technique can boost learning motivation in addition to being advantageous academically(Stull et al., 2009).

How My Research Differs from Other Research?

1. Use of the Pirogov Anatomy Model: Digital, VR, or AR-based 3D anatomical visualization for medical and health sciences has been the subject of numerous prior studies (Triepels et al., 2020). By creating a Pirogov Anatomy Model based on a real-world depiction (3D human anatomy from a physical and sports perspective), my research is unique in that it is more relevant to students studying physical education than only medical students(Bogomolova et al., 2021).
2. The Anchored Instruction Approach: The majority of earlier anatomy research still places a strong emphasis on practicing dissection or multimedia-based learning. By combining Anchored Instruction with real-world sports scenarios (such as muscle injuries, joint mobility, and biomechanics), my study helps students not only learn anatomical principles but also connect them to their careers as coaches or physical educators(Sheehy et al., 2014).
3. The subjects of my research are Students studying medicine, physiotherapy, or nursing were typically involved in earlier studies. Physical education students, whose learning demands differ because they emphasize movement function and body performance in sports rather than only clinical features, are the target audience for my research.
4. Development Goal: Enhancing visual and spatial comprehension of anatomy is the main focus of other studies. My study contributes to the creation of a learning model that is approved by professionals and evaluated for efficacy using pretests and posttests, producing a cutting-edge anatomy learning tool that is prepared for use in higher education.
5. Novelty: In the context of physical education, my research combines visual aids for Pirogov Anatomy with an Anchored Instruction approach. This technique has not been extensively researched in Indonesia or abroad. For non-medical students, this research helps create a more relevant, interactive, and contextual anatomy learning paradigm.

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Table 5. Comparison of Previous Research with This Research

Aspect	Previous Research	This research
Media/Model	Software for anatomy, virtual reality, augmented reality, or 3D digital visualization (Triepels et al., 2020) (Bogomolova et al., 2020)	A true depiction of human anatomy serves as the foundation for the Pirogov Anatomy Model.
Approach	Dissection, demonstration, or multimedia-based	Connecting anatomy to actual sports situations through anchored instruction
Research Subjects	Students studying medicine, nursing, and physical therapy	Physical Education Student
Focus Goal	Boost spatial comprehension and anatomical memory retention	Creating models of contextual learning for sports and physical education
Evaluation Method	Digital media trial and limited experiment	Pretest–posttest design, expert validation, and limited and field trials
Novelty	Innovation in medical media based on technology	Combining Anchored Instruction with Pirogov Anatomy, especially for physical
Contribution	Adding diversity to medical students' anatomy education	Offering non-medical students a contextual anatomy learning approach

My research has the following strengths: Combining Anchored Instruction with the Pirogov Anatomy Model. Prior studies have focused on digital visual media (3D, VR, and AR), but they haven't integrated it with a contextual learning strategy. Additionally, this study combines Anchored Instruction with a genuine visual model (Pirogov Anatomy) so that students can immediately relate anatomical elements to actual sporting situations in addition to seeing them(Chheang et al., 2024).

In the context of physical education, medical or health students are the target audience for the majority of anatomical research. Students in physical education, who have distinct demands since they concentrate more on movement function, biomechanics, and sports injuries than just clinical elements, are the specific objective of this study(Stieff, 2007).

A new learning model that has been validated by professionals, tested, and shown to enhance student learning outcomes is the result of this research, which is a comprehensive learning model that goes beyond simply assessing the efficacy of media. Because it may be immediately incorporated into the curriculum, this increases the research's applicability(Losco et al., 2017).

The pretest-posttest findings demonstrated a considerable rise (from 62 to 82 with a gain score of 0.53), demonstrating the usefulness of the test as demonstrated by empirical research. This suggests that in addition to being theoretically possible, the approach works well for enhancing students' knowledge and abilities.

This study supports the shift in anatomy instruction toward interactive, contextual, and meaningful learning, which fosters innovation in higher education. Because of its high caliber, the research is pertinent to the Merdeka Belajar-Kampus Merdeka (MBKM) policy, which promotes creativity and the practical application of higher education.

The significance of innovation in anatomy education, especially in physical education, is thus reaffirmed by this study. It has been demonstrated that combining a contextual approach with three-dimensional visual media helps students learn anatomy in a way that is more applicable to and relevant to their future careers.

CONCLUSION

According to the study's findings, physical education students' learning results for anatomy can be enhanced by using the Pirogov Anatomy Model in conjunction with an Anchored Instruction strategy. By connecting anatomical ideas to actual physical activity situations, this model fosters critical thinking abilities in addition to providing students with a clearer understanding of bodily parts through three-dimensional representation. This model is appropriate for application as an innovation in anatomy

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learning in higher education, as evidenced by the rise in pretest to posttest results. This study creates a valid, useful, and efficient Pirogov Anatomy Model with an Anchored Instruction technique for use in teaching physical education students about human anatomy. The needs analysis's findings show that students continue to struggle with anatomy since the subject matter is overly theoretical, heavily relies on memorization, doesn't make use of visual aids, and has no bearing on actual athletic practice. A model that satisfies the requirements for appropriateness of content, design, methodology, and relevance to the setting of physical education was produced through phases of creation, expert validation, and limited and field testing. The model's ability to improve students' conceptual and applied understanding is demonstrated by the increase in student learning outcomes, which went from an average score of 62 on the pretest to 82 on the posttest, with a gain score of 0.53. All things considered, this model offers a different approach to teaching anatomy in higher education, especially in study programs for physical education. This methodology enhances learning outcomes, fosters critical thinking abilities, fortifies spatial comprehension, and gives learning greater context and significance. The study concludes that integrating the Pirogov Anatomy Model with the Anchored Instruction approach effectively enhances students' understanding of human anatomy by providing learning experiences that are contextual, realistic, and relevant to physical education practice. The increase from a pretest mean score of 62 to a posttest mean score of 82, along with a gain score of 0.53, demonstrates the model's substantial contribution to improving conceptual mastery. The learning design not only supports cognitive development but also provides meaningful links between anatomical structures and their functional implications in sports and movement contexts. In light of these findings, educational institutions in physical education are encouraged to consider adopting this integrated model as part of their anatomy curriculum, particularly to strengthen student engagement and contextual problem-solving. Furthermore, future research may examine the model's impact on motor-skill performance or its effectiveness in supporting knowledge transfer to practical simulation scenarios, thereby expanding the evidence base for its broader instructional applicability.

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