Android-based GymAp application to improve handstand skills in gymnastics learning among high school students

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ABSTRACT

This study aimed to develop a valid, practical, and effective gymnastics instruction media to improve students' handstand skills in gymnastics education. The development process followed the Plomp model. The study involved 60 students from the Faculty of Sports Sciences of Universitas Negeri Padang, Indonesia. Data were collected through tests, interviews, questionnaires, and observations and assessed quantitatively through the use of a t-test. The findings indicated that the Android-based gymnastics educational media demonstrated very high validity across material, media, and language assessments, as well as in handstand skill evaluation tools. The media was also rated as very practical and very effective. The average initial handstand skill scores across three schools were 83.65, 84.65, and 73.45, with average improvement scores of 0.61, 0.65, and 0.64, respectively. These results indicate that the android-based gymnastics learning media is valid, practical, and effective in enhancing students' handstand skills. It is anticipated that this media will serve as an alternative resource for improving the quality of gymnastics education and other related academic disciplines.

1. INTRODUCTION

As professional educators, teachers must possess a comprehensive and in-depth understanding of their subject matter and demonstrate mastery of the content. They should also effectively demonstrate and teach the correct progression of handstand techniques in gymnastics (Handayani et al., 2023; Khataybeh et al., 2024; Kojima et al., 2021). Handstand skills are essential for prospective physical education teachers tasked with enhancing their professional skills to effectively guide students in acquiring proficiency in gymnastics (Morsalfard et al., 2023). The forward roll is a gymnastic maneuver performed on the floor that involves propelling the body forward over the cervical, thoracic, lumbar, and pelvic regions, beginning from a squatting position and transitioning into a standing posture position (Kojima et al., 2021; Makadada et al., 2024). A handstand is a forward inverted body movement with the legs spread apart in a V-shape or straddled position (Malíř et al., 2023; Mizutori et al., 2021). Future physical education teachers, need this gymnastic skill, as it is a key component of the academic framework. Thus, it is essential for sports teachers to fully understanding the necessary steps in performing correct handstand skills. The rapid advancement of technology has significantly contributed to the development of educational media, including Android-based learning media. This operating system, used on tablets and smartphones, offers an accessible platform for developers to innovate applications (Alghazzawi et al., 2021). This media is a problem-solving tool utilizing data processing techniques to achieve the desired computation or data processing outcomes (Hidayat et al., 2024). Media encompassing information or messages within the educational domain are designed to communicate these messages from the sender to the recipient throughout learning (Dennis, 2008; Djordjevic & Cotton, 2011). Media can motivate learners to actively engage in pedagogical activities. Educational media can be physical tools, materials, or techniques. Android-based learning media can present content effectively, efficiently, and engagingly, helping students achieve optimal learning outcomes (Hakiki et al., 2024). Therefore, learning media encompass everything used to stimulate students' minds, attention, feelings, and will, ultimately encouraging a productive and streamlined learning process.

Various researchers have shown generally favorable outcomes in developing Android-based multimedia for floor gymnastics learning (Handayani et al., 2023; Handayani et al., 2023; Sriwahyuniati et al., 2022). However, these media are insufficient for developing students' forward roll (straddle) skills. While effective in enhancing learning outcomes, they have not fully supported the development of forward roll skills. On the other hand, with Android-based learning, students can access the applications anytime and from any location using smartphones, tablets, laptops, and other

devices. These applications can also function offline, which is particularly beneficial in areas with unstable internet connections. Several studies have indicated that most secondary school students own smartphones (Aloteibi et al., 2024; Buabbas et al., 2021; Warzecha & Pawlak, 2017). However, the use of smartphones as a learning medium for gymnastics, particularly for handstand materials, remains suboptimal. This suggests that the integration of technology and media into gymnastics education, especially in Physical Education, is still lagging. To enhance students' handstand skills, creating Android-based learning media that allows offline access through students' devices could offer an innovative solution. This approach is novel, as no android-driven acrogym instructional platform specifically focused on developing handstand skills material has been developed at the middle school level.

In various regions, measurements of middle school students' handstanding skills indicate moderate abilities that require improvement. For example, students showed higher scores in the initial phase (comprising several indicators). In comparison, their scores were generally lower in the main and final phases, which involved more complex indicators. This suggests that handstanding skills need improvement at each stage. One contributing factor was the limited availability of learning media. Preliminary studies also indicate that current handstand learning media are incomplete and inaccessible offline. Many middle schools currently use e-learning platforms; however, their implementation and evaluation are considered insufficient due to their limited capacity for presenting materials and video-based evaluations. Furthermore, existing e-learning media are typically restricted to online use and always require a stable internet connection. Observations also show that many teachers still rely on conventional methods for teaching gymnastics, are inconsistent in applying video-based learning media, and have yet to utilize Android-based media. Meanwhile, many students face network issues when accessing e-learning, indicating that gymnastics learning is not running as effectively as it should be. This situation has encouraged researchers to develop Android-based learning media to facilitate more efficient gymnastics instruction in middle schools. The researcher was motivated to develop an Android-based learning application containing teaching materials with images and videos demonstrating movements, as well as evaluations for each learning module. This application will also feature attendance tracking for each session and facilitate interaction between students and teachers. The objective pertaining to this research was to create gymnastics education with Android technology medium to improve students' handstand proficiency. It is expected that this learning medium will not only enhance the quality of gymnastics education but

also provide a learning experience that meets students' current needs. Additionally, this study is likely to offer an alternate reference for improving other countries' educational quality disciplines.

2. METHODS

2.1. Design and Participants

This study used a Research and Development (R&D) approach, focusing on creating a valid, practical, and effective gymnastics educational platform. The development process followed the Plomp model (Plomp & Nieveen, 2013). During the foundational investigative interval, a thorough analysis was carried out, including a needs and context evaluation, a review of relevant literature, and the formulation of an abstract schema for an Android-driven gymnasium instructional apparatus. The needs and context analyses involved examining gymnastics instruction, student characteristics, curriculum content, and relevant learning materials.

The initial phase of the study involved analyzing the current state of Android-based gymnastics learning media. This investigation helped identify gaps and led to the development of a conceptual framework for the design of the instructional media. The prototyping phase focused on creating the Android application, which included several key features such as media usage instructions, syllabi, instructional guides, course content attendance tracking, practice videos, and student evaluation instruments. Regarding participants, the study involved 60 students from the Faculty of Sports Sciences of Universitas Negeri Padang, Indonesia.

2.2. Validation Process

Once the product prototype was developed, it was subjected to validation. Various tools were used to assess its quality, including validation metrics, formative diagnostic instruments, and pragmatic gauges. These tools were analyzed using a Likert rating system, and the final validation scores were calculated using Aiken's V formula (Azwar, 2014). The products validity level was determined based on the validity criteria presented in Table 1.

Table 1. Validity criteria

Correlation	Description
0.801 – 1.00	Very high validity
0.601 – 0.800	High validity
0.401 – 0.600	Moderate validity
0.001 – 0.400	Low validity
≤ 0.00	Not valid

2.3. Field Testing

After validation, the product underwent field testing. The field test was conducted across three schools: Junior High School (JHS) 7, JHS 5, and JHS 14, each selected based on their initial gymnastics test scores (categorized as high, medium, or low). This stage allowed for further evaluation of the media's effectiveness in real-world settings, assessing its ability to improve handstand skills among students.

2.4. Practicality Analysis

In the final phase, practicality was evaluated based on feedback from both teachers and students. Practicality indicators included the ease of use, contribution to gymnastics instruction, and long-term applicability of the application in teaching gymnastics. A Likert-type scale was used for the analysis of the practicality data, which helped determine how effectively the media could be used in a teaching environment.. Practicality data analysis was derived from the questionnaire feedback provided by teachers and students on the Android-based gymnastics teaching tools. Practicality indicators include the ease of using the teaching media, its contribution to gymnastics instruction, and the applicability of the application in gymnastics teaching over time. The practicality analysis was conducted using a Likert-type scale. The final data calculation of the practicality results is analyzed on a scale of 0–100 using the following formula. The discernment of pragmatic appraisals was done through the ensuing evaluative benchmarks presented in Table 2.

Table 2. Practicality criteria

Percentage	Description
0 – 20%	Not practical
21 – 40%	Less practical
41 – 60%	Fairly practical
61 – 80%	Practical
81 – 100%	Very practical

The effectiveness examination of the Android gymnastics learning media was carried out using an evaluation instrument designed to assess handstand performance, which covers the preparatory, execution, and concluding phases. Handstand skills in each sub-evaluation were evaluated using the following formula: the effectiveness of the product was analyzed as a percentage (achievement score/maximum score $\times$ 100). The handstand competency appraisal was stratified according to the parameters in Table 3.

Table 3. Handstand skill classification

Interval	Criteria
0 - 29	Poor
30 - 64	Fairly Poor
65 - 79	Quite Good
80 - 89	Good
90 - 100	Very Good

To measure the development of Student Handstand Skills using gain analysis, improvements in student handstand skills were appraised according to the parameters mentioned in the table 4.

Table 4. Improvement criteria

Interval	Criteria
$g > 0.7$	High
$0.3 < g < 0.7$	Medium
$g < 0.3$	Low

3. RESULTS

3.1. Design and Expert Validation of the Prototype

The development of an Android-driven acrogym pedagogical platform began with an analysis of handstand skills among students in the Department of Sports Education. This analysis identified the necessary content for the platform to effectively support students in mastering handstand techniques. Table 5 details the scope of handstand materials within the department.

Table 5. Handstand learning material coverage in the Department of Sports Education

Competence	Indicator
Handstand skills	Stand with both hands positioned next to your ears.
	Position both hands on the mat, spaced at shoulder width.
	Keep both legs straight, bend your elbows, and fold your head forward until your chin touches your chest.
	Lean forward, shifting the weight onto both palms.
	Begin rolling moving forward, with a landing first on the back of your neck. Open both legs with the knees remaining straight, forming a V shape or straddling position.
	Release your hands from the mat and move them forward between your legs. Push with your hands to assist in rising back up.
	Return to a standing position with your feet close together.
	Ready for the next movement.

The resulting product is an Android application designed for gymnastics instruction that is accessible on Android devices. This learning media includes a user guide, syllabus, semester learning

plan, teaching materials, attendance tracking features, practice videos, and evaluation tools to facilitate handstand skill improvement. Mobile gymnastics learning media for improving handstand skills, designed for Android material, features a logo with the word "GymAp" as shown in Figure 1. This Android-integrated gymnastics educational media offers seven main menu options: user guide, syllabus and semester learning plans, lecture materials, practice videos, attendance, assignments, and discussion forums. The homepage presents an introductory video from the Faculty of Sports Science, presenting the course vision and identity (Figure 2).

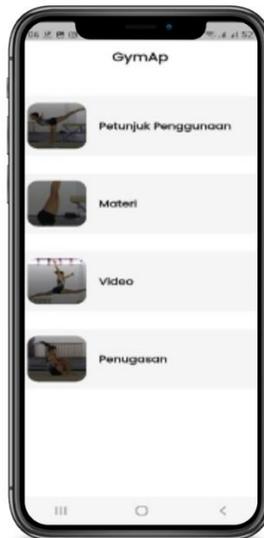**Figure 1.** Interface Application

Figure 2. Main Menu Application

The User Guide explains application usage in both online and offline modes. The learning Materials menu provides weekly course content for the semester, from (weeks 1–16), in PDF format. The Attendance menu is integrated into the teacher's portal for direct student attendance tracking. The Syllabus and Semester Learning Plan menu outline the semester's subjects and competencies, offering students clear learning objectives. The Video and Practice menu includes instructional videos demonstrating each movement phase (preliminary, main, and final phase). This menu also features basic exercise videos to build the physical strength for handstands, such as sit-ups for abdominal muscle strength, push-ups for arm strength, hand-supported bodyweight exercises for arm endurance, press exercises for transitioning to a standing position after rolling, and other weight-bearing hand exercises essential for achieving a stable handstand.

3.2. The Validity of Android-Based Gymnastics Educational Media

The assessments evaluated content feasibility, constructs, and language. Three experts validated the product through written evaluations and iterations until consensus was achieved, confirming the validity of the developed Android learning tools. The evidence from the validation is presented in Table 6.

Table 6. Findings from the Product Development Validation Process

Indicator	Element	Validity	
		Score (V)	Information
Application	Construct	0.89	Very High
	Content	0.86	Very High
	Language	0.85	Very High
Material	Construct	0.86	Very High
	Content:	0.85	Very High
	Language	0.87	Very High
Language	Construct	0.90	Very High
	Content	0.89	Very High
	Language	0.89	Very High

3.3. Practical Application Android-Based Gymnastics Educational Media

The functional practicality of the developed intervention was assessed based on its friendliness (Plomp & Nieveen, 2013). The typology consistency of the Android Gymnastics Learning Media demonstrates its practical application in meeting real-world learning environment expectations and assessments, aligning anticipated and actual implementation. Expert analysis evaluations established the learning media's practicality, confirming its applicability. Real-world evidence supports its effective implementation. During the validation stage, validators implemented

the usage instructions and language of the Android Gymnastics Media, resulting in average V-scores of 0.82, 0.78, and 0.84, respectively. Subsequent comparisons were made with teacher and student responses regarding the applied Android gymnastics learning tool implemented through the gymnastics learning application. Practicality-related outcome assessments from the teachers' perspective are illustrated in Table 7.

Table 7. Findings from the practicality evaluation from the teachers

Assessment Aspects	JHS 7	JHS 5	JHS 14
Teacher app			
Ease of application of teacher applications in exercise learning.	3.61	3.70	4
The benefits of teacher applications in gymnastics learning.	3.65	4	3.65
The applicability of teacher applications in gymnastics learning	4	3.76	3.81
Installment-installment (%)	93.18	95.45	95.45
Mean Percentage		94.70	
Category		Very Practical	
Student Implementation			
The user-friendliness of the student gymnastics app.	4	3.66	4
Usefulness of the Student application in gymnastics learning.	3.80	4	3.76
Application applicability in gymnastics learning.	3.63	4	3.83
Time allocation for application in gymnastics learning.	4	4	3.70
Installment-installment (%)	95.31	98.43	95.3
Mean Percentage		96.35	
Category		Very Practical	

The android-based gymnastics learning medium implemented through an application used by both teachers and students, is practical for use and aids teachers in delivering forward straddle roll content (Table 7). The mean percentage of application usage by both teachers and students fell within the 80–100 interval, categorizing it as "highly practical". Respondents reported that the Android-based gymnastics learning media made learning more accessible and efficient for both teachers and students. Table 8 summarizes the students' feedback reflecting its practicality.

Table 8. Students' practicality assessment results

Evaluation Aspects	JHS 7	JHS 5	JHS 14
App-facilitated learning simplicity gymnastics.	3.25	3.08	3.32
The advantages of the application for pupils in education gymnastics	3.47	3.37	3.39
Application for students in gymnastics learning	3.48	3.45	3.45
Time allocation for application implementation for students in gymnastics learning	3.60	3.52	3.47
Installment-installment (%)	86.71	84.46	85.47
Mean Percentage		85.55	
Category		Very Practical	

The table demonstrates the Android gymnastics educational media., accessed through the student application, aids and facilitates their gymnastics learning experience. The mean assessment rate fell within the 80–100 interval, categorizing it as "highly practical". Participants noted that the Android-based gymnastics learning media enhanced the learning experience by making it more student-friendly.

4.4. Effectiveness of the Mobile Gymnastics Learning Tools on Android Platform

The developed product effectively measured the achievement of learning goals. In this context, Android gymnastics learning tools are considered effective if they improve handstanding skills. Field test results showed student improvement in each session across three schools. Skill levels and improvement analysis are detailed in Table 9 and Table 10, respectively.

Table 9. Handstand Skills Assessment Results

JHS 7					
Aspects observed	**The meeting**				
	Pre-Treatment	**1**	**2.**	**3**	**4**
Early Phase	57.54	59.60	67.55	74.76	83.56
Main Phases	43.60	52.30	65.78	72.92	83.20
Final Phase	69.35	72.35	80.35	84.24	86.89
Average	53.74	61.41	71.22	77.30	84.55
Criterion	Fairly Poor	Fairly Poor	Quite Good	Quite Good	Good
JHS 5					
Aspects observed	**The meeting**				
	Pre-Treatment	**1**	**2**	**3**	**4**
Early Phase	52.87	64.67	72.34	82.35	87.76
Main Phases	46.52	60.54	66.67	75.76	78.89

Final Phase	69.98	74.26	80.34	84.98	89.35
Average	56.45	66.48	73.11	81.03	85.33
Criterion	Fairly Poor	Quite Good	Quite Good	Good	Good

JHS 14					
Aspects observed	**The meeting**				
	Pre-Treatment	**1**	**2**.	**3**	**4**
Early Phase	52.23	64.59	70.46	78.69	83.90
Main Phases	46.54	55.72	69.83	73.74	77.69
Final Phase	70.25	70.15	74.82	82.91	89.74
Average	56.34	63.48	71.70	78.44	83.77
Criterion	Fairly Poor	Fairly Poor	Quite Good	Quite Good	Good

Table 10. Handstand Skill N-Gain Score

School	Score N-Gain			Average
	Early Phase	**Main Phases**	**Final Phase**	
JHS 7	0.63	0.60	0.65	0.62
JHS 5	0.73	0.56	0.66	0.65
JHS 14	0.70	0.61	0.64	0.65
Average			0.64	
Category			**Medium**	

4. DISCUSSION

The first session showed mean handstand scores of 61.41, 66.48, and 63.48 for JHS 7, 5, and 14, respectively. The execution of the main phase of the handstand remained in the lower category. While JHS 7 (64.67) and JHS 5 (64.56) reached the "quite good" category, JHS 14 (59.60) remained "poor". This suggests that the initial learning media lacked effectiveness, particularly in strengthening and facilitating body push during the main handstand movement phase. Learning activities encompass various modalitiesvisual, auditory, verbal, written, drawing, metric, cognitive, and emotional (Alam & Mohanty, 2023; Horváth, 2021). However, the researcher focused only on six types of learning activities: visual, auditory, verbal, cognitive, quantitative, and emotional. Following the introduction of the Android-based learning media, the central tendency handstand skill scores of students were 71.22 (JHS 7), 73.11 (JHS 5), and 71.70 (JHS 14). All sub-evaluations reached the "quite good" category. This improvement indicates students became more familiar with the Android-designed media, which offered a balanced level of complexity—challenging enough to stimulate learning, yet simple enough to remain user-friendly for students–which also had a positive effect on this improvement. This media proved to be an effective and relevant educational tool for

physical education, especially in floor gymnastics (Sriwahyuniati et al., 2022). Initially, handstand skills were "poor" in the first session; but improved to "quite good" in the same session.

This indicates that the issues observed in previous sessions with conventional teaching methods could be addressed effectively. Android media enhances gymnastics learning and increases students' motivation for active participation. Leveraging gadgets can intrinsically motivate students to learn actively, individually, or collaboratively (Razzaq et al., 2018). In the second session, the sub-evaluation representing the final phase entered the high category. This achievement was seen in JHS 7 and JHS 5, with scores of 80.35 and 80.34, respectively. However, JHS 14 remained in the good category with a score of 74.82. This result was attributed to the structure of the Android-based gymnastics instructional materials, which provided positive stimuli for students, such as independently performing hand weight exercises and practicing standing after a straddle roll. These exercises demonstrate the strengths of the Android learning media, which are accessible at any time and from any location, both online and offline. Furthermore, in the third and fourth sessions, the average handstand skill scores of students at JHS 7, 5, and 14 in Sijunjung improved. In the third session, the scores were 77.30, 81.03, and 78.44, respectively; in the fourth session, the results were 84.55, 85.33, and 83.77, placing all three institutions in the highest category overall. However, regarding the three sub-evaluations, the handstand skills of students from JHS 5 and JHS 14 still fell into the good category, with average scores of 83.25 and 78.89%, respectively. Analysis based on handstand sub-evaluation indicators showed that the main phase consistently had the lowest scores, contrasting with other factors influencing the overall average of students' handstand skills. This phase is crucial for developing students' motor skills. Nevertheless, the significant improvement, particularly at JHS 7, highlights the positive impact of Android-compatible gymnastics learning resources on enhancing students' handstand skills.

Data collected over four sessions at the three schools showed no notable anomalies in the primary phase sub-evaluation, especially in performing a straight-knee roll and sustaining the handstand position for 2 seconds. This is because all features in the Android-driven gymnastics learning aids accommodated the execution of these movements. Collectively, the results of the three sub-evaluations for handstand skills revealed a notable enhancement, with all schools reporting elevation indices surpassing 0.50. The mean uplift quotient for students from JHS 14, JHS 7, and JHS 5 in Sijunjung was 0.63, 0.73, and 0.70, respectively, all falling into the "medium" category. These findings indicate that the Android-based gymnastics learning application contributes to the

improvement of students' handstanding abilities and thus meets the criteria for an effective educational medium outlined in the third phase of the intervention

5. CONCLUSIONS

The study concluded that the Android-based acrogym instructional interface demonstrated high quality in terms of validity, practicality, and pedagogical effectiveness. Validation results for language, content, media, and handstand skill assessment instruments were all classified as very high, indicating strong relevance and consistency across the material, media, and linguistic aspects. For both instructors and students, the Android-based gymnastics learning media met the benchmarks for operational simplicity, instrumental worth, and contextual suitability. Regarding instructional potency, the media significantly improved students' handstand skills, with mean N-gain metrics across institutions registering at 0.61, 0.60, and 0.63. The android-fueled instructional platform had a markedly positive influence on the advancement of students' handstand skills. Hence, the Android application for gymnastics instruction may effectively serve gymnastics teachers or other educational fields as an alternative to improve learning quality and enhance students' handstand performance.

6. REFERENCES

1. Alam, A., & Mohanty, A. (2023). Implications of virtual reality (VR) for school teachers and instructional designers: An empirical investigation. *Cogent Education, 10*(2), 1-22. https://doi.org/10.1080/2331186X.2023.2260676
2. Alghazzawi, D. M., Hasan, S. H., Aldabbagh, G., Alhaddad, M., Malibari, A., Asghar, M. Z., & Aljuaid, H. (2021). Development of platform independent mobile learning tool in Saudi universities. *Sustainability, 13*(10), 1-22. https://doi.org/10.3390/su13105691
3. Aloteibi, S., Ratanasiripong, P., & Priede, A. (2024). Teachers' Perspectives Toward Smartphone Usage by Students and Resulting Classroom Policies. *Journal of School Administration Research and Development, 9*(2), 66–75. https://doi.org/10.32674/E9DRQN92
4. Azwar, S. (2014). *Metode Penelitian*. Pustaka Pelajar.
5. Buabbas, A. J., Hasan, H., & Buabbas, M. A. (2021). The associations between smart device use and psychological distress among secondary and high school students in Kuwait. *PLoS ONE, 16,* 1–14. https://doi.org/10.1371/journal.pone.0251479
6. Dennis, A. R., Fuller, R. M., & Valacich, J. S. (2008). Media, task, and communication processes: a theory of media synchronicity. *MIS Quarterly, 32*(3), 575–600.
7. Djordjevic, A., & Cotton, D. R. E. (2011). Communicating the sustainability message in higher education institutions. *International Journal of Sustainability in Higher Education, 12*(4), 381–394. https://doi.org/10.1108/14676371111168296
8. Hakiki, M., Surjono, H. D., Wagiran, Fadli, R., Samala, A. D., Eliza, F., Fricticarani, A., Suryaningsih, A., & Hidayah, Y. (2024). Effectiveness of Android-Based Mobile Learning in Graphic Design Course for Digital Learning: The Development Research Study. *International Journal of Information and Education Technology, 14*(4), 602–611. https://doi.org/10.18178/ijiet.2024.14.4.2083

9. Handayani, S. G., Myori, D. E., Yulifri, Komaini, A., & Mario, D. T. (2023). Android-based gymnastics learning media to improve handstand skills in junior high school students. *Journal of Human Sport and Exercise, 18*(3), 690–700. https://doi.org/10.14198/jhse.2023.183.15

10. Handayani, S. G., Myori, D. E., Yulifri, Zakaria, J. Bin, Hasbullah, N. A., Fitri, M., Oktaviani, R., Edwarsyah, & Mariati, S. (2023). The influence of Android-based gymnastics learning media on cartwheel skills. *Journal of Physical Education and Sport, 23*(12), 3495–3499. https://doi.org/10.7752/jpes.2023.12401

11. Hidayat, H., Zulhendra, Z., Efrizon, E., Delianti, V. I., Dewi, F. K., Isa, M. R. M., Harmanto, D., & Tanucan, J. C. M. (2024). Computational Thinking Skills in Engineering Education: Enhancing Academic Achievement Through Innovations, Challenges, and Opportunities. *TEM Journal, 13*(4), 3454–3467. https://doi.org/10.18421/TEM134-78

12. Horváth, I. (2021). An Analysis of Personalized Learning Opportunities in 3D VR. *Frontiers in Computer Science, 3,* 1–12. https://doi.org/10.3389/fcomp.2021.673826

13. Khataybeh, A., Al-Shadiedh, M., & Khasawneh, G. (2024). The effectiveness of cooperative learning strategy for mastery in enhancing the skill performance of some gymnastics floor movements. *Pedagogy of Physical Culture and Sports, 28*(4), 292–300. https://doi.org/10.15561/26649837.2024.0406

14. Kojima, M., Kinomura, Y., & Kuzuhara, K. (2021). Development of observational indicators for evaluating handstand posture in the mat exercise in physical education class: Validity and reliability. *Journal of Physical Education and Sport, 21*(3), 2087–2096. https://doi.org/10.7752/jpes.2021.s3266

15. Makadada, F. A., Hadjarati, H., Berhimpong, M. W., Piri, N., Baan, A. B., Mangolo, E. W., Perdana, G. S., Ndayisenga, J., & Ilham. (2024). The effects of game-based passive, static stretching, and trunk flexibility on the execution of forward roll in floor exercise: A factorial experimental design. *Journal of Physical Education and Sport, 24*(4), 872–885. https://doi.org/10.7752/jpes.2024.04100

16. Malíř, R., Chrudimský, J., Šteffl, M., & Stastny, P. (2023). A Systematic Review of Dynamic, Kinematic, and Muscle Activity during Gymnastic Still Rings Elements. *Sports, 11*(3), 1-21. https://doi.org/10.3390/sports11030050

17. Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. *PLoS ONE, 16*, 1–15. https://doi.org/10.1371/journal.pone.0253951

18. Morsalfard, S. N., Nasermeli, M. H., & Namin, B. G. (2023). Comparison of the Traditional Training Method To Teach Handstand and Training Through a Researcher-Made Device and Their Impact on the Handstand Duration, Pain and Quality of Performance in 8-10-Year-Old Beginner Gymnast Girls. *Science of Gymnastics Journal, 15*(3), 395–407. https://doi.org/10.52165/sgj.15.3.395-407

19. Plomp, T., & Nieveen, N. (2013). *Educational Design Research: An Intorduction.* SLO.

20. Razzaq, A., Samiha, Y. T., & Anshari, M. (2018). Smartphone Habits and Behaviors in Supporting Students Self-Efficacy. *International Journal of Emerging Technologies in Learning, 13*(02), 94–109.

21. Sriwahyuniati, C. F., Nuritasari, N. N., Budiarti, R., & Sukamti, E. R. (2022). Android Application-Based Basic Elements Model of Rhythmic Gymnastics. *International Journal of Human Movement and Sports Sciences, 10*(1), 90–97. https://doi.org/10.13189/saj.2022.100113

22. Warzecha, K., & Pawlak, A. (2017). Pathological use of mobile phones by secondary school students. *Archives of Psychiatry and Psychotherapy, 19*(1), 27–36. https://doi.org/10.12740/APP/67931

ACKNOWLEDGMENTS

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

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