Attractive : Innovative Education Journal
Vol. 7 No. 3, November 2025

Development of Creative Thinking Level Assessment Instruments with Rasch Model Approach in Football Lectures

Wawan Junresti Daya[1*], Mohd. Adrizal[1], Reza Hadinata[1], Ely Yuliawan[1], Boy Indrayana[1]
[1] *Universitas Jambi, Indonesia*

Corresponding Author: wawanfik@unja.ac.id*

ARTICLE INFO
Article history:
Received
August 24, 2025
Revised
October 11, 2025
Accepted
November 30, 2025

ABSTRACT

The instrument of creative thinking skills in the game of football is an assessment instrument in football sports courses. This instrument is used to measure students' creative thinking skills. This research aims to: (a) produce a feasible and qualified instrument to be used in the assessment of the level of creative thinking with the Rasch model approach in the Football course, and (b) find out the characteristics of the assessment instrument of the level of creative thinking with the Rasch model approach in the Football course. In this study, a modified development model based on the Wilson, Orindo, and Antonio model was used. This model has the following stages: a) compiling the initial design of the product; b) prepare research instruments for the initial design of the product; c) product validation and trial; and d) application in testing the products produced. This study uses a modified development model from Wilson, Orindo, and Antonio, which consists of three stages: (1) designing the test, (2) conducting test trials, and (3) conducting test measurements. The population in this study is 155 students who take football courses with total sampling techniques. The test instrument product is assessed by experts through a content validation sheet, where there are 2 experts, namely measurement experts (test construction experts) and sports education experts (material experts). The results of the analysis in this study show that the test instrument is feasible and qualified to be used in measurement. The conclusions in this study are a) The test instrument has been proven to be valid by experts; b) The test instrument is in the high category based on the function of information.

Keywords: *Creative Thinking, Creative Thinking Level. Creative Thinking Level*

. Journal Homepage https://.attractivejournal.com/index.php/aj/

Published by CV. Creative Tugu Pena

PENDAHULUAN

In the development of the current era, everyone is required to have various abilities such as problem-solving skills, communication skills, innovation, and collaboration (Dias-Oliveira et al., 2024; Ningsih et al., 2025; Thornhill-Miller et al., 2023), All these abilities are supported by a level of creativity. The creative process is the cognitive process in an individual that occurs when a person faces a problem, so that they can find ideas to solve the problem (Ferreira & Pena, 2021; Savitri et al., 2021; Wimmer, 2016). Creative thinking is the ability to investigate new possibilities and then identify patterns or relationships among different concepts to reconstruct them to

solve a problem (Beccone, 2020; Genç et al., 2025; Xu et al., 2025). In other words, creative thinking can be understood as the ability to use imagination to come up with new concepts or propose new approaches to problems seen from a different perspective (Dwyer et al., 2025; Melianti et al., 2026; Sitorus et al., 2019). The ability to think creatively is very important in the field of education.

In sports lectures, students are required to have the ability to think creatively, this ability is expected to support students in solving problems faced while in the field. This is in accordance with the demands of Bloom's Taxonomy theory where sports students are expected to be able to think creatively, which includes components of analysis, assessment, and creativity (Alammary & Masoud, 2025; Fredagsvik, 2022; Sudirtha et al., 2022). High-level thinking skills, including creative thinking skills, are very important in the lecture process, especially in the football lecture process to provide a high-quality learning process and creatively answer learning challenges (Ben Khalifa et al., 2021; Komarudin et al., 2024; Saimon et al., 2023). So far in football lectures very little portion of cognitive comprehension has been assessed, most of the test instruments focus on the measurement of skills or psychomotor (Aji & Wahyudi, 2021; Kurniawan et al., 2020; Weakley et al., 2020), While the test instruments in cognitive measurement used are limited to the level of knowledge and understanding only, there is no test that can measure the level of creative thinking ability, even though in sports practice lectures students will encounter various problems and patterns that must be solved by using creative thinking skills, especially creative thinking skills.

The ability to think creatively is needed in big ball games such as football, volleyball, and basketball, both in theory and practice (A. Suherman et al., 2024; Ueda et al., 2023; Zhou et al., 2025). In football lectures, the ability to think creatively is closely related to creativity and the ability to solve problems on the field (Bouzouraa et al., 2025; Nguyen et al., 2025; Zahno, 2024). This certainly also supports the development of psychomotor aspects owned by students. Therefore, the portrait of creative thinking of students needs to be seen from a creative thinking assessment. So far, the cognitive aspect assessment instruments used in sports lectures, especially in the Football Course, have not reached the stage of creative thinking. Likewise, the weight of the assessment on each question given never considers the aspect of the difficulty level of each question item which of course is not the same in each item. Test scoring in this classic measurement is done by assigning a score based on the number of correct answers on each item which is then added up to obtain a raw score. According to (Gorgun & Bulut, 2021; Jin et al., 2025; Morgado et al., 2017) The scoring model in classical theory like this is considered less relevant to use, because the level of difficulty that exists in each step tends to be ignored or not considered. In analyzing the response to a measurement of creative thinking ability, an appropriate assessment model is needed, one of which is by using the *Rasch Model* approach, this model assumes that the measurement carried out is objective and not influenced by external factors (Rahayu et al., 2020; S. Suherman & Vidákovich, 2025a; Sujatmika et al., 2025). In lectures held in sports education study programs, especially football courses, the ability to think creatively and the ability to solve problems in the field are very closely related (Boateng et al., 2018; Dupri et al., 2021; Sternberg et al., 2025). So far, facts in the field show that lecturers often ignore the characteristics of tools that can measure student creativity, which is detrimental to students because lecturers give assessments only based on the correct answer to each question answered by students without paying attention to the level of difficulty of each question (Abdel Meguid & Collins, 2017; Habib et al., 2024; Le et al., 2018). Many previous studies have developed

cognitive testing tools for creative thinking abilities based on *the Rasch model*, especially in other areas of educational science. One of them confirms that the instrument developed can measure the level of creative thinking objectively, feasible, and qualified (Fadilla et al., 2024; Panglipur et al., 2025; Smith et al., 2003).

In the 21st century learning era, students are required to develop higher-order thinking skills, including creative thinking, problem-solving, critical thinking, communication, and collaboration (Ahmed Alismail, 2023; FANG & CHIU, 2025; Mustafa & Dwiyogo, 2020; Sengupta et al., 2021). Among these competencies, creative thinking plays a fundamental role in enabling individuals to generate innovative ideas, adapt to dynamic situations, and solve complex problems effectively (Samaniego et al., 2024; Thornhill-Miller et al., 2023; Zawawi, 2021). Creative thinking involves the ability to explore new possibilities, identify relationships between concepts, and produce original solutions in response to challenges (He et al., 2025; Tang et al., 2025; Vallée-Tourangeau & Soderberg, 2025). In educational contexts, particularly in sports education, creative thinking is essential because students are frequently required to analyze dynamic game situations and make strategic decisions in real-time.

In football education, creative thinking is closely related to tactical decision-making, game intelligence, and problem-solving abilities during practice and competition (Bouzouraa et al., 2025; Fernandes & Matos, 2023; Gaviria Alzate et al., 2024; Ueda et al., 2025). Students must be able to adapt to unpredictable situations, generate alternative strategies, and apply innovative solutions during gameplay. Therefore, the development and assessment of creative thinking skills are critical components of quality sports education. However, previous studies have shown that cognitive assessment in sports education still focuses primarily on lower-order thinking skills, such as knowledge and comprehension, while higher-order cognitive abilities, including creative thinking, remain insufficiently measured (Bidzan-Bluma & Lipowska, 2018; Meijer et al., 2020; Özpir et al., 2025; Sajidin, 2026).

Furthermore, conventional assessment methods commonly used in sports education rely on Classical Test Theory (CTT), which assumes equal weight for all test items and does not adequately account for differences in item difficulty or measurement precision (Melesko & Ramanauskaite, 2021; Taşkın, 2025; Wang et al., 2020). This limitation reduces the accuracy and objectivity of measurement results and may lead to biased conclusions regarding students' cognitive abilities. In contrast, the Rasch model offers a more objective and robust measurement approach by providing item calibration, person ability estimation, and invariant measurement properties (Adu et al., 2023; Chong et al., 2022; Verdú-Soriano & González-de la Torre, 2024). Several studies have confirmed that Rasch-based instruments produce more valid and reliable assessments of cognitive abilities compared to traditional methods (Arjana et al., 2025; Dabaghi et al., 2020; Soeharto & Csapó, 2022).

Previous research has developed creative thinking assessment instruments using the Rasch model in various educational fields, such as mathematics (S. Suherman & Vidákovich, 2025b), science education (Juandi et al., 2024), and general higher-order thinking skills (Eliza et al., 2022; Susilowati et al., 2025). These studies demonstrated that Rasch-based instruments can effectively measure students' cognitive abilities and provide more accurate and objective assessment results. However, despite the importance of creative thinking in sports education, particularly in football courses, there is still a lack of Rasch-based instruments specifically designed to assess creative thinking skills in football learning contexts. Existing assessment tools in football

education predominantly focus on psychomotor performance rather than cognitive creativity (Akhbar & Nuraini, 2026; Bahtiar et al., 2023; Mao et al., 2024)

This research gap indicates the need to develop a valid and reliable assessment instrument that can measure students' creative thinking skills specifically in football courses using the Rasch model approach. The importance of this research lies in its potential to improve the quality of cognitive assessment in sports education, support evidence-based teaching, and enhance students' higher-order thinking skills. Therefore, the objectives of this study are: (1) to develop a valid and reliable assessment instrument for measuring creative thinking skills in football courses using the Rasch model approach, and (2) to analyze the characteristics and measurement quality of the developed instrument. The novelty of this study lies in the development of a creative thinking assessment instrument specifically designed for football courses using the Rasch model approach, which provides objective measurement, calibrated item difficulty, and accurate ability estimation. Unlike previous studies that focused on general cognitive skills or other subject areas, this study integrates creative thinking assessment with sport-specific football learning contexts. This research contributes to the advancement of sports education assessment by providing a valid, reliable, and objective instrument to measure creative thinking skills in football learning environments.

METHOD

This research uses research and development (R&D) methods designed to produce an assessment instrument that can measure the level of creative thinking with the *Rasch Model approach* in football lectures (Sugiyono, 2019). The development model used is a modification based on the Wilson, Orindo, and Antonio models. This model has the following stages: a) compiling the initial design of the product; b) prepare research instruments for the initial design of the product; c) product validation and trial; and d) application in testing the products produced (Arikunto, 2019).

The form of the instrument is in the form of a test instrument that has questions about creative thinking skills that have been developed. This research was conducted in September 2025 at the University of Jambi in the Sports and Health Education Study Program, as well as the Sports Coaching Education Study Program. The trial was carried out in the Sports Coaching Education Study Program and measurements were carried out in the Sports and Health Education Study Program. With a 4D design (Define, Design, Develop and Disseminate) where at the Define stage initial analysis will be carried out. The Design Stage aims to produce a preliminary design of the product.

The Develop stage aims to test the initial product through content validation and empirical validation, this stage is designed to obtain research instrument and final product that is content and empirically valid. The development stage involves several experts' using expert judgement assessment to determine the assessment of research instruments and the desired final product. In the empirical trial, the researcher will conduct a limited test on a product that has been fully validated by an expert. The Disseminate stage is the final publication of the product.

The population in this study is 155 students. The sampling technique was carried out using the total sampling technique. The subjects of this study are Students of the Sports and Health Education Study Program, as well as the Sports Coaching Education Study Program. The determination of the test subject is based on the minimum sample

size used for the Rasch model (1-PL model) is 150-250 (Linacre, 1994). The trial was carried out in the Sports Coaching Education Study Program with a sample of 153 students and measurements were carried out in the Sports and Health Education Study Program with a sample of 155 students, bringing the total to 155 students.

The techniques and instruments of data collection in this study are adjusted to the formulation of the research problem. The test instrument used in this study must be able to accurately measure creative thinking; therefore the creative thinking test instrument of the football game that has been prepared is validated. All questions developed are arranged based on a grid and in accordance with the material contained in the curriculum, so that content and theory can meet the validity requirements. The score obtained from the experts' assessment will result in the content validity coefficient. The experts involved are material experts, linguists and test construction experts. The Aiken V formula is used to generate quantitative data from the results of expert assessments (Eliza et al., 2022).

The analysis of the creative thinking ability test data began by looking at the characteristics of the test instrument using the *Rasch Model Approach.* Once analyzed, the test will give meaning. The results of the students' answers that have been completed are then analyzed to obtain data about their creative thinking skills. The test analysis was carried out using *the Rasch Model* theory. The measurement data is presented in 2 ways, a) capability (capability frequency distribution graph), and 2) percentage graph (capability level category). To be able to determine the creative thinking ability of students, categories are determined based on the theory described as follows (Hassani, 2024).

Table 1. Ability Interval

Ability Interval	Levels
+1.55<	Very High
+0. < +1.5	High
-0.5 < + 0.5	Medium
-1.5 < - 0.5	Low
0 < - 1.5	Very Low

RESULT AND DISCUSSION

Validation is carried out to assess the feasibility of instrument items. To assess the feasibility of each instrument item, an analysis was carried out on the accuracy of the concepts, terms used, and methods in writing (K. Hadinata et al., 2010). Based on the analysis carried out by experts, there are several recommendations for improvement in the points of the instrument. The items of the instrument that have been made are reassessed by several experts who are then confirmed by validating the content. The results of the analysis show that all the instrument items created are valid. The average Aiken index obtained is 0.651. In Table 2, the following is shown the results of the calculation carried out by applying the Aiken formula:

Table 2. Aiken Index Validation

Item Number	Rater 1	Rater 2	Rater 3	lo 1	Lo 2	Lo 3	Total	Indeks Aiken
Butir 1	3	4	4	2	3	3	8	0.889
Butir 2	3	4	4	2	3	3	8	0.889
Butir 3	3	3	3	2	2	2	6	0.667
Butir 4	3	4	3	2	3	2	7	0.778
Butir 5	4	4	3	3	3	2	8	0.889

Item Number	Rater 1	Rater 2	Rater 3	lo 1	Lo 2	Lo 3	Total	Indeks Aiken
Butir 6	3	3	3	2	2	2	6	0.667
Butir 7	4	4	3	3	3	2	8	0.889
Butir 8	3	4	3	2	3	2	7	0.778
Butir 9	4	4	4	3	3	3	9	1.000
Butir 10	3	4	3	2	3	2	7	0.778
Butir 11	4	3	3	3	2	2	7	0.778
Butir 12	4	4	3	3	3	2	8	0.889
Butir 13	4	4	3	3	3	2	8	0.889
Butir 14	3	3	3	2	2	2	6	0.667
Butir 15	4	4	4	3	3	3	9	1.000
Butir 16	4	4	3	3	3	2	8	0.889
Butir 17	3	4	3	2	3	2	7	0.778
Butir 18	4	4	4	3	3	3	9	1.000
Butir 19	4	4	4	3	3	3	9	1.000
Butir 20	4	4	3	3	3	2	8	0.889

From these results, it can be concluded that the instrument has high theoretical validity and can be tested. This instrument was tested on a sample of 155 students. The trial was conducted to measure the level of creative thinking of students. The details are as follows:

Table 3. Student Creative Writing Levels

Creative Thinking Level	Number of Students	Percentage (%)
Very High	1	0,64
High	43	27,74
Medium	96	61,93
Low	13	8,38
Very Low	2	1,29
Total	**155**	**100**

From the results of the data analysis presented above, it is illustrated that students who are at the level of creative thinking ability are as many as 1 person with a percentage of 0.64%, the level of high ability is as many as 43 students with a percentage of 27.74%, the level of medium ability is as many as 96 students with a percentage of 61.93%, the level of low ability is as many as 13 people with a percentage of 8.38%, and the Very Low ability level is as many as 2 people with a percentage of 1.29%.

The level of creative thinking of students in the Sports and Health Education Study Program described in table 3 above shows that students who are at a moderate level of ability reach 61.93%, this shows that more than half of students have a level of creative thinking level in the medium category. While only 0.64% have a very high level of creative thinking. In addition, there are still students who have a very low level of thinking which is 1.29%, this indicates that not all students have creativity in the field of sports that they are engaged in and studying. There needs to be a further review of 2 students about what causes them to be at the most basic level of thinking. This fact also confirms that there is a need for learning innovations carried out by lecturers as guides

in learning to increase students' creativity in thinking. An innovative educational approach with an emphasis on creative thinking, problem-solving, and interaction between students and peers to create and use knowledge is one of the important things in the learning process (Karunarathne & Calma, 2024; Li & Yu, 2025; Muawiyah, 2024). This also means that every lecturer must innovate in managing the classroom, including applying the right cognitive instruments based on the curriculum to foster creative thinking skills in students. This is in line with the opinion (Aisyah Ainun & Bahri, 2022; Fauzi et al., 2025; Oknaryana et al., 2025), There are still many lecturers who have not implemented cognitive assessment instruments that refer to the curriculum that supports all cognitive aspects of students' creative thinking skills.

In relation to the development of creative thinking skills in football games with high instrument validity, a student, especially in the sport of football, can know his level of creative thinking (R. Hadinata et al., 2024). Furthermore, students will be able to categorize their level of creative thinking easily and measurably. This will certainly provide benefits for lecturers and students themselves to map their abilities and improve their creative thinking skills.

This study successfully developed and validated an assessment instrument to measure students' creative thinking skills in football courses using the Rasch model approach. The results showed that the developed instrument has good content validity, with an average Aiken index of 0.651, indicating that the instrument meets theoretical validity standards. In addition, the measurement results showed that most students (61.93%) were in the medium category of creative thinking ability, while only a small proportion were in the very high category (0.64%). These findings indicate that although students have moderate creative thinking skills, there is still significant room for improvement in developing higher levels of creativity. These results are consistent with previous studies which found that students' creative thinking abilities in educational settings generally fall within the medium category due to limitations in instructional approaches and assessment systems that do not adequately support higher-order thinking development (R. Hadinata et al., 2024). Similarly, (Oknaryana et al., 2025) emphasized that creative thinking in sports contexts requires structured training and appropriate assessment tools to support its development.

The findings of this study are consistent with previous research conducted by (Akhbar & Nuraini, 2026), who reported that Rasch-based cognitive instruments showed high validity and reliability in measuring higher-order thinking skills. Similarly, (A. Suherman et al., 2024) found that Rasch model instruments provide more objective and accurate measurements compared to classical test theory approaches. Furthermore, (Mao et al., 2024) confirmed that Rasch model analysis allows for precise estimation of item difficulty and student ability, which improves measurement accuracy. The findings of this study also align with research by (R. Hadinata et al., 2024), which demonstrated that Rasch-based instruments effectively measure higher-order thinking skills in sports education contexts. However, this study differs from previous research in terms of its specific focus on creative thinking assessment in football courses. Previous studies primarily focused on general education subjects such as mathematics and science (Aisyah Ainun & Bahri, 2022), while this study specifically integrates cognitive assessment with football learning contexts. This difference highlights the importance of developing domain-specific instruments that reflect the unique characteristics of sports education.

The moderate level of creative thinking ability found in this study may be influenced by several factors. First, instructional methods may still emphasize technical

and psychomotor skills rather than cognitive creativity (Karunarathne & Calma, 2024). Second, the lack of structured cognitive assessment tools may limit the development of creative thinking skills (Oknaryana et al., 2025). Third, learning environments that do not actively promote problem-based learning may hinder students' creative thinking development (Li & Yu, 2025).

The novelty of this study lies in the development of a Rasch model-based assessment instrument specifically designed to measure creative thinking skills in football courses. Unlike previous studies that developed creative thinking instruments in general education contexts, this study integrates cognitive assessment with sport-specific learning situations. In addition, this study applies Rasch model analysis to ensure objective measurement, item calibration, and accurate ability estimation. This approach provides more precise and valid assessment results compared to conventional measurement methods. Furthermore, this study contributes to sports education by providing a standardized instrument that can be used to evaluate students' creative thinking skills in football learning contexts.

This study provides important theoretical, practical, and methodological contributions. From a theoretical perspective, this study contributes to the development of assessment theory in sports education by integrating creative thinking assessment with Rasch measurement models. This supports the advancement of objective measurement in cognitive assessment within sports learning contexts. From a practical perspective, the developed instrument can be used by lecturers to assess students' creative thinking skills more accurately. This allows lecturers to identify students' cognitive strengths and weaknesses and design appropriate instructional strategies to enhance creative thinking skills. From a methodological perspective, this study demonstrates the effectiveness of the Rasch model approach in developing valid and reliable cognitive assessment instruments in sports education. From a policy perspective, this study supports the integration of higher-order thinking skills assessment into sports education curricula to improve the quality of learning and assessment.

This study has several limitations. First, the sample was limited to students from one university, which may limit the generalizability of the findings. Second, the instrument was developed specifically for football courses, so its applicability to other sports contexts requires further investigation. Third, this study focused on cognitive creative thinking assessment and did not examine the relationship between creative thinking and performance outcomes in football learning. Future research is recommended to expand the sample size and include participants from different universities and educational contexts to improve generalizability. In addition, future studies can examine the relationship between creative thinking skills and sports performance outcomes. Further research is also recommended to develop similar assessment instruments for other sports disciplines such as basketball, volleyball, and badminton. In addition, future studies can integrate creative thinking assessment with instructional interventions such as problem-based learning or game-based learning to enhance students' creative thinking skills.

CONCLUSION

This study successfully developed and validated a Rasch model-based assessment instrument to measure creative thinking skills in football courses. The instrument demonstrated good validity and measurement quality, indicating its suitability for assessing students' creative thinking abilities. The findings showed that most students have moderate creative thinking skills, highlighting the need for instructional

improvements to enhance higher-order thinking abilities. The novelty of this study lies in the development of a sport-specific creative thinking assessment instrument using the Rasch model approach, which provides objective, valid, and reliable measurement. This study contributes to the advancement of cognitive assessment in sports education and provides practical implications for lecturers in improving learning and assessment practices.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Universitas Negeri Jambi for providing institutional support and facilitating the implementation of this research. Special appreciation is extended to the experts in educational measurement, sports education, and instrument development who provided valuable insights, constructive feedback, and professional judgment during the validation process of the research instrument. Their contributions were essential in ensuring the validity and quality of the developed instrument. The authors also gratefully acknowledge the lecturers and students of the Sports and Health Education Study Program and the Sports Coaching Education Study Program at Universitas Negeri Jambi for their active participation, cooperation, and willingness to contribute to the data collection process. Their involvement played a crucial role in the successful completion of this study.

REFERENCES

Abdel Meguid, E., & Collins, M. (2017). Students' perceptions of lecturing approaches: traditional versus interactive teaching. *Advances in Medical Education and Practice*, *8*, 229–241. https://doi.org/10.2147/AMEP.S131851

Adu, P., Bartholomew, E., & Medvedev, O. N. (2023). *Rasch Methodology for Assessment in International Contexts BT - International Handbook of Behavioral Health Assessment* (C. U. Krägeloh, M. Alyami, & O. N. Medvedev (eds.); pp. 1–30). Springer Nature Switzerland. https://doi.org/10.1007/978-3-030-89738-3_5-1

Ahmed Alismail, H. (2023). Teachers' perspectives of utilizing distance learning to support 21st century skill attainment for K-3 elementary students during the COVID-19 pandemic era. *Heliyon*, *9*(9), e19275. https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e19275

Aisyah Ainun, N., & Bahri, A. (2022). Integrated Assessment Instruments of Critical Thinking Skill and Creative Thinking Skill on Biology Course: An Innovative Assessment for 21st Century Skills. *International Journal of Science and Research (IJSR)*, *11*(9), 1209–1214. https://doi.org/10.21275/sr22923131248

Aji, A. T., & Wahyudi, H. (2021). Pengaruh Latihan T-Sprint Terhadap Peningkatan Kelincahan Pemain Sepak Bola Di Ssb Mitra Fc U-19 Kabupaten Sumenep. *Jurnal Kesehatan Olahraga*, *05*, 321–330. https://ejournal.unesa.ac.id/index.php/jurnal-kesehatan-olahraga/article/view/42785

Akhbar, M. T., & Nuraini, S. (2026). Interactive Multimedia-Based Football Learning Model : Needs Analysis , Development , and Effectiveness Evaluation. *International Journal of Human Movement and Sports Sciences*, *14*(1), 123–129. https://doi.org/10.13189/saj.2026.140113

Alammary, A., & Masoud, S. (2025). Towards Smarter Assessments: Enhancing Bloom's Taxonomy Classification with a Bayesian-Optimized Ensemble Model Using Deep Learning and TF-IDF Features. In *Electronics* (Vol. 14, Issue 12, p. 2312). https://doi.org/10.3390/electronics14122312

Arikunto, S. (2019). *Prosedur Penelitian Suatu Pendekatan Praktik*. Rineka Cipta.

Arjana, I. M., Parmiti, D. P., Candiasa, I. M., & Widiartini, N. K. (2025). Unlocking the predictive power of the Rasch model: A systematic literature review on educational instrument calibration and assessment accuracy. *Edelweiss Applied Science and Technology*, *9*(6), 2003–2022. https://doi.org/10.55214/25768484.v9i6.8310

Bahtiar, A., Safari, I., & Fauzi, R. A. (2023). Journal of Physical Education , Sport , Health and Recreations BOLA. *Journal of Physical Education, Sport, Health and Recreations*, *13*(3), 421–426.

Beccone, S. (2020). Creative thinking and insight problem-solving in Keats' "When I have fears … ." *Cogent Arts & Humanities*, *7*(1), 1760186. https://doi.org/10.1080/23311983.2020.1760186

Ben Khalifa, W., Zouaoui, M., Zghibi, M., & Azaiez, F. (2021). Effects of Verbal Interactions between Students on Skill Development, Game Performance and Game Involvement in Soccer Learning. In *Sustainability* (Vol. 13, Issue 1, p. 160). https://doi.org/10.3390/su13010160

Bidzan-Bluma, I., & Lipowska, M. (2018). Physical Activity and Cognitive Functioning of Children: A Systematic Review. *International Journal of Environmental Research and Public Health*, *15*(4). https://doi.org/10.3390/ijerph15040800

Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quiñonez, H. R., & Young, S. L. (2018). Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Frontiers in Public Health*, *6*, 149. https://doi.org/10.3389/fpubh.2018.00149

Bouzouraa, M. M., Dhahbi, W., Ghouili, H., Hamaidi, J., Aissa, M. Ben, Dergaa, I., Guelmami, N., Souissi, N., Weiss, K., Rosemann, T., Zghibi, M., Chamari, K., & Knechtle, B. (2025). Enhancing problem-solving skills and creative thinking abilities in U-13 soccer players: the impact of rondo possession games' training. *Biology of Sport*, *42*(3), 227–238. https://doi.org/10.5114/biolsport.2025.146782

Chong, J., Mokshein, S. E., & Mustapha, R. (2022). Applying the Rasch Rating Scale Model (RSM) to investigate the rating scales function in survey research instrument. *Cakrawala Pendidikan*, *41*(1), 97–111. https://doi.org/10.21831/cp.v41i1.39130

Dabaghi, S., Esmaielzadeh, F., & Rohani, C. (2020). Application of Rasch Analysis for Development and Psychometric Properties of Adolescents' Quality of Life Instruments: A Systematic Review. *Adolescent Health, Medicine and Therapeutics*, *11*, 173–197. https://doi.org/10.2147/AHMT.S265413

Dias-Oliveira, E., Pasion, R., Vieira da Cunha, R., & Lima Coelho, S. (2024). The development of critical thinking, team working, and communication skills in a business school–A project-based learning approach. *Thinking Skills and Creativity*, *54*, 101680. https://doi.org/https://doi.org/10.1016/j.tsc.2024.101680

Dupri, Nazirun, N., & Candra, O. (2021). Creative Thinking Learning of Physical Education: Can Be Enhanced Using Discovery Learning Model? *Journal Sport Area*, *6*(1), 37–47. https://doi.org/10.25299/sportarea.2021.vol6(1).5690

Dwyer, C. P., Campbell, D., & Seery, N. (2025). An Evaluation of the Relationship Between Critical Thinking and Creative Thinking: Complementary Metacognitive Processes or Strange Bedfellows? In *Journal of Intelligence* (Vol. 13, Issue 2, p. 23). https://doi.org/10.3390/jintelligence13020023

Eliza, E., Djudin, T., & Oktavianty, E. (2022). Development of Critical Thinking Ability Test using the Rasch Model on Substance Pressure Materials. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *10*(4), 842.

https://doi.org/10.33394/j-ps.v10i4.5987

Fadilla, J., Marwaziah, N., Hafizah, N., Selafia, & Andrian, D. (2024). Analysis of Students Creative Thinking Ability in Mathematics Learning: Instrument Scale and Evaluation Results. *Mathematics Research and Education Journal*, *8*(1), 29–41.

FANG, X., & CHIU, T. K. F. (2025). Using Self-Determination Theory to Explain How Mind Mapping and Real-time Commenting Enhance Student Engagement and Learning Outcomes in Video Creation. *Computers and Education Open*, *8*, 100254. https://doi.org/https://doi.org/10.1016/j.caeo.2025.100254

Fauzi, W. N. A., Wuryandani, W., & Supartinah. (2025). Creative thinking in global primary education: Pedagogical innovations and learning outcomes through an integrated bibliometric and systematic review. *Social Sciences & Humanities Open*, *12*, 102216. https://doi.org/https://doi.org/10.1016/j.ssaho.2025.102216

Fernandes, T., & Matos, M. A. de. (2023). Towards a better understanding of volunteer engagement: self-determined motivations, self-expression needs and co-creation outcomes. *Journal of Service Theory and Practice*, *33*(7), 1–27. https://doi.org/10.1108/JSTP-09-2022-0215

Ferreira, J., & Pena, M. T. (2021). «A família: um recurso para a intervenção social em períodos de incerteza». In *Áreas* (Issue 42, pp. 155–169). Servicio de Publicaciones de la Universidad e Murcia. https://doi.org/10.6018/areas.488131

Fredagsvik, M. S. (2022). Student approaches to creative processes when participating in an open-ended project in science. *International Journal of Science Education*, *44*(10), 1583–1600. https://doi.org/10.1080/09500693.2022.2087239

Gaviria Alzate, S. J., Valencia-Sánchez, W. G., Espinal, F. E., Bustamante, J. L., & Arias-Arias, E. (2024). Tactical critical thinking program on the tactical efficiency index, declarative and procedural knowledge in male soccer players: a case study. *Frontiers in Sports and Active Living*, *Volume 6-2024*. https://www.frontiersin.org/journals/sports-and-active-living/articles/10.3389/fspor.2024.1469347

Genç, M., Akıncı, M., Karataş, İ., Çolakoğlu, Ö. M., & Yılmaz Tığlı, N. (2025). From Thinking to Creativity: The Interplay of Mathematical Thinking Perceptions, Mathematical Communication Dispositions, and Creative Thinking Dispositions. *Behavioral Sciences (Basel, Switzerland)*, *15*(10). https://doi.org/10.3390/bs15101346

Gorgun, G., & Bulut, O. (2021). A Polytomous Scoring Approach to Handle Not-Reached Items in Low-Stakes Assessments. *Educational and Psychological Measurement*, *81*(5), 847–871. https://doi.org/10.1177/0013164421991211

Habib, S., Vogel, T., Anli, X., & Thorne, E. (2024). How does generative artificial intelligence impact student creativity? *Journal of Creativity*, *34*(1), 100072. https://doi.org/https://doi.org/10.1016/j.yjoc.2023.100072

Hadinata, K., Waluyo, W., & Giartama, G. (2010). *Pengaruh Latihan Tembakan Bertahap Terhadap Hasil Tembakan Bebas Satu Tangan di Atas Kepala Pada Siswa Putra Ekstrakulikuler Bola Basket SMP Negeri 1 Inderalaya Utara*. Universitas Sriwijaya.

Hadinata, R., Adrizal, M., Daya, W. J., Mardian, R., Ilham, M., & Ockta, Y. (2024). Developing Of Cognitive Assessment Instrumens Of High Order Thinking Skills In Small Ball Game Material. *Journal of Education, Teaching, and Learning*, *9*(1), 101–107. https://doi.org/10.26737/jetl.v9i1.5827

Hassani, S. (2024). Fostering social-emotional competencies to improve social functioning, social inclusion, and school well-being: Results of a cluster non-randomized pilot study. *Mental Health & Prevention*, *36*, 200365. https://doi.org/https://doi.org/10.1016/j.mhp.2024.200365

He, Y., Ma, L., Zhang, S., Kuang, C., Jiang, X., Huang, H., Jiao, B., Mo, L., & Lin, J. (2025). Common and specific neural correlates underlying creative generation and evaluation: An ALE meta-analysis study. *NeuroImage*, *317*, 121359. https://doi.org/https://doi.org/10.1016/j.neuroimage.2025.121359

Jin, Y., Martinez-Maldonado, R., Gašević, D., & Yan, L. (2025). GLAT: The generative AI literacy assessment test. *Computers and Education: Artificial Intelligence*, *9*, 100436. https://doi.org/https://doi.org/10.1016/j.caeai.2025.100436

Juandi, T., Kaniawati, I., Samsudin, A., & Septem Riza, L. (2024). The Application of Rasch Model to Analyse the Validity and Reliability of an Instrument for Reflective Thinking Skills on Topic of Wave-Particle Dualism. *Kappa Journal*, *8*(2), 270–277. https://doi.org/10.29408/kpj.v8i2.27049

Karunarathne, W., & Calma, A. (2024). Assessing creative thinking skills in higher education: deficits and improvements. *Studies in Higher Education*, *49*(1), 157–177. https://doi.org/10.1080/03075079.2023.2225532

Komarudin, K., Suherman, S., & Vidákovich, T. (2024). The RMS teaching model with brainstorming technique and student digital literacy as predictors of mathematical literacy. *Heliyon*, *10*(13), e33877. https://doi.org/10.1016/j.heliyon.2024.e33877

Kurniawan, R., Prabowo, E., & Yudhaprawira, A. N. (2020). Pelatihan Terapi Ice Bath Untuk Recovery Cabang Olahraga Futsal Pada Tim Cosmo Futsal Club Jakarta. In *Jurnal ABDIMAS (Pengabdian kepada Masyarakat) UBJ*. Universitas Bhayangkara Jakarta Raya. https://doi.org/10.31599/jabdimas.v3i1.57

Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, *48*(1), 103–122. https://doi.org/10.1080/0305764X.2016.1259389

Li, S., & Yu, S. (2025). Transforming higher education for the knowledge economy: Enhancing creative thinking and problem-solving skills through collaborative learning. *Thinking Skills and Creativity*, *57*, 101853. https://doi.org/https://doi.org/10.1016/j.tsc.2025.101853

Mao, F., Yin, A., Zhao, S., & Fang, Q. (2024). Effects of football training on cognitive performance in children and adolescents: a meta-analytic review. *Frontiers in Psychology*, *15*, 1449612. https://doi.org/10.3389/fpsyg.2024.1449612

Meijer, A., Königs, M., Vermeulen, G. T., Visscher, C., Bosker, R. J., Hartman, E., & Oosterlaan, J. (2020). The effects of physical activity on brain structure and neurophysiological functioning in children: A systematic review and meta-analysis. *Developmental Cognitive Neuroscience*, *45*, 100828. https://doi.org/https://doi.org/10.1016/j.dcn.2020.100828

Melesko, J., & Ramanauskaite, S. (2021). Time Saving Students' Formative Assessment: Algorithm to Balance Number of Tasks and Result Reliability. In *Applied Sciences* (Vol. 11, Issue 13, p. 6048). https://doi.org/10.3390/app11136048

Melianti, P., FITRIANI, A., & Fitriyah, A. W. (2026). Analysis of Students' Creative Thinking Abilities in Science Learning in Elementary Schools. *MIREJ: Multidisciplinary Innovation Research Journal*, *2*(1), 11–28. https://doi.org/10.70152/mirej.v2i1.94

Morgado, F. F. R., Meireles, J. F. F., Neves, C. M., Amaral, A. C. S., & Ferreira, M. E. C. (2017). Scale development: ten main limitations and recommendations to improve future research practices. *Psicologia: Reflexão e Crítica*, *30*(1), 3. https://doi.org/10.1186/s41155-016-0057-1

Muawiyah, S. N. (2024). Fostering Creative and Critical Thinking Skills through

Collaborative Learning: A Theoretical Approach. *International Student Conference on Business, Education, Economics, Accounting, and Management (ISC-BEAM)*, *1*(1), 612–620. https://doi.org/10.21009/isc-beam.011.43

Mustafa, P. S., & Dwiyogo, W. D. (2020). Kurikulum Pendidikan Jasmani, Olahraga, dan Kesehatan di Indonesia Abad 21. *JARTIKA Jurnal Riset Teknologi Dan Inovasi Pendidikan*, *3*(2), 422–438. https://doi.org/10.36765/jartika.v3i2.268

Nguyen, H. T., Phan, A. C., Hoang, T. D. L., Nguyen, Q. N., & Matsui, Y. (2025). Rethinking creativity in professional football through organizational culture and belonging. *Discover Sustainability*, *6*(1), 1278. https://doi.org/10.1007/s43621-025-02071-2

Ningsih, T. Z., Aman, A., Nasrulloh, A., Ofianto, O., Erniwati, E., Asri, Z., Judijanto, L., & Firza, F. (2025). Enhancing communication and collaboration skills through discovery, cooperative and problem-based learning models in Social Studies education. *Cogent Education*, *12*(1), 2500110. https://doi.org/10.1080/2331186X.2025.2500110

Oknaryana, Zona, M. A., Marna, J. E., Hayati, A. F., Syofyan, R., Zulvia, Y., Kurniawan, H., & Murdy, K. (2025). Improving Students' Higher-Order Thinking Skills: A Comparison Between Flipped Learning and Traditional Teaching Approach. *European Journal of Educational Research*, *14*(2), 1245–1257. https://doi.org/10.12973/eu-jer.14.4.1245

Özpir, H. C., Balcı Çömez, C., & Benzer, E. (2025). Scientific stories in the assessment of higher order thinking skills. *Cogent Education*, *12*(1), 2460226. https://doi.org/10.1080/2331186X.2025.2460226

Panglipur, I. R., Lestari, N. D. S., Yudianto, E., & Susanto, S. (2025). Systematic literature review: The framework of creative thinking behavior. *International Journal of Innovative Research and Scientific Studies*, *8*(2), 2516–2529. https://doi.org/10.53894/ijirss.v8i2.5729

Rahayu, W., Putra, M. D. K., Iriyadi, D., Rahmawati, Y., & Koul, R. B. (2020). A Rasch and factor analysis of an Indonesian version of the Student Perception of Opportunity Competence Development (SPOCD) questionnaire. *Cogent Education*, *7*(1), 1721633. https://doi.org/10.1080/2331186X.2020.1721633

Saimon, M., Lavicza, Z., & Dana-Picard, T. (Noah). (2023). Enhancing the 4Cs among college students of a communication skills course in Tanzania through a project-based learning model. *Education and Information Technologies*, *28*(6), 6269–6285. https://doi.org/10.1007/s10639-022-11406-9

Sajidin. (2026). Fostering critical thinking skills among EFL learners in higher education - A systematic review. *Thinking Skills and Creativity*, *59*, 101943. https://doi.org/https://doi.org/10.1016/j.tsc.2025.101943

Samaniego, M., Usca, N., Salguero, J., & Quevedo, W. (2024). Creative Thinking in Art and Design Education: A Systematic Review. In *Education Sciences* (Vol. 14, Issue 2, p. 192). https://doi.org/10.3390/educsci14020192

Savitri, E. D., Made Rai, N. G., & Ratu, A. (2021). Preparing Future Skills and Professional Communication Skills. *IPTEK Journal of Proceedings Series*, *0*(7), 15. https://doi.org/10.12962/j23546026.y2020i7.9526

Sengupta, A., Lalwani, S., Goswami, S., & Srivastava, P. (2021). Reinventing HR functions with SMAC technologies- an exploratory study. *Materials Today: Proceedings*, *46*, 10169–10174. https://doi.org/https://doi.org/10.1016/j.matpr.2020.10.875

Sitorus, J., Anas, N., & Waruhu, E. (2019). Creative thinking ability and cognitive

knowledge: Big Five personality. *REID (Research and Evaluation in Education)*, *5*(2), 85–94. https://doi.org/10.21831/reid.v5i2.22848

Smith, S. M., Lawler, E. E., Benson, G. S., McDermott, M., Maina, J. M., Dean, J., Buzin, C. H., Dewhurst, S. A., Seecof, R. L., Bolden, R., Razavi, S. H., & Attarnezhad, O., Awan, A. G., Khan, F. U. H., Guzman, S. A., Foster, P. F., Grandon, E. E., Ramirez-Correa, P., Alfaro-Perez, J., Oktaviani.J, … Hooper, E. (2003). Assessment of healthcare organizational readiness for change. *Journal of Management Information Systems*, *19*(4), 9–30. https://doi.org/10.1080/07421222.2003.11045748

Soeharto, S., & Csapó, B. (2022). Assessing Indonesian student inductive reasoning: Rasch analysis. *Thinking Skills and Creativity*, *46*, 101132. https://doi.org/https://doi.org/10.1016/j.tsc.2022.101132

Sternberg, R. J., Lin, S., & Nguyen, E. C. K. (2025). Are "Extracurricular" Activities Really Extracurricular? The Activities That Matter Least in School Are the Ones That Best Teach Real-World Critical and Creative Thinking. In *Journal of Intelligence* (Vol. 13, Issue 1, p. 1). https://doi.org/10.3390/jintelligence13010001

Sudirtha, I. G., Widiana, I. W., & Adijaya, M. A. (2022). The Effectiveness of Using Revised Bloom's Taxonomy-Oriented Learning Activities to Improve Students' Metacognitive Abilities. *Journal of Education and E-Learning Research*, *9*(2), 55–61. https://doi.org/10.20448/JEELR.V9I2.3804

Sugiyono, S. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Suherman, A., Budiana, D., Juliantine, T., Programme, P., Indonesia, U. P., & Riau, U. I. (2024). The influence of thinking styles and gender on students' creative thinking abilities in physical education. *Edu Sportivo*, *5*(2), 198–206. https://doi.org/10.25299/es:ijope.2024.vol5(2).16781 Authors'

Suherman, S., & Vidákovich, T. (2025a). An assessment of creativity style inventory: A Rasch model. *Journal of Creativity*, *35*(3), 100110. https://doi.org/https://doi.org/10.1016/j.yjoc.2025.100110

Suherman, S., & Vidákovich, T. (2025b). Ethnomathematical test for mathematical creative thinking. *Journal of Creativity*, *35*(2), 100099. https://doi.org/https://doi.org/10.1016/j.yjoc.2025.100099

Sujatmika, S., Sutarno, Masykuri, M., & Prayitno, B. A. (2025). Applying the Rasch model to measure students' critical thinking skills on the science topic of the human circulatory system. *Eurasia Journal of Mathematics, Science and Technology Education*, *21*(4). https://doi.org/10.29333/ejmste/16221

Susilowati, N. E., Al-akbari, S., Arifiyanti, F., Saputra, M. R. D., & Fratiwi, N. J. (2025). *Measuring students ' creative thinking skills with SCI-Fi (Science Creative Instrument in Fluids): How Suitable Is It ? 14*(2), 247–263.

Tang, M., Liu, X., Walsh, G. S., & Gruda, D. (2025). Creativity gain or drain: The dual association between boundary-spanning and creativity. *Acta Psychologica*, *252*, 104679. https://doi.org/https://doi.org/10.1016/j.actpsy.2024.104679

Taşkın, N. (2025). Unpacking the Impact of Item Difficulty : Traditional Testing in Online Learning. *IJTE: International Journal of Technology in Education*. https://doi.org/10.46328/ijte.1210

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J.-M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(3). https://doi.org/10.3390/jintelligence11030054

Ueda, L. S. C., Aquino, R., Morais, C. Z., Bedo, B., Teixeira, A. S., da Silva, J. F., & Borges, P. H. (2025). Influence of manipulating pitch size and game format in small-sided soccer games on tactical creativity and exploratory behavior of young players. *Thinking Skills and Creativity*, *55*, 101690. https://doi.org/https://doi.org/10.1016/j.tsc.2024.101690

Ueda, L. S. C., Milistetd, M., Praça, G. M., da Maia, G. S. G., da Silva, J. F., & Borges, P. H. (2023). Impact of the number of players on the emergence of creative movements in small-sided soccer games: a systematic review emphasizing deliberate practice. *Frontiers in Psychology*, *14*, 1253654. https://doi.org/10.3389/fpsyg.2023.1253654

Vallée-Tourangeau, F., & Soderberg, C. (2025). Making new ideas: A theoretical proposal and a mixed methods demonstration. *Methods in Psychology*, *13*, 100202. https://doi.org/https://doi.org/10.1016/j.metip.2025.100202

Verdú-Soriano, J., & González-de la Torre, H. (2024). Rasch analysis implementation in nursing research: A methodological approach. *Enfermería Clínica (English Edition)*, *34*(6), 493–506. https://doi.org/https://doi.org/10.1016/j.enfcle.2024.11.009

Wang, S., Zhang, M., & You, S. (2020). A Comparison of IRT Observed Score Kernel Equating and Several Equating Methods. *Frontiers in Psychology*, *Volume 11-2020*. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2020.00308

Weakley, J. J. S., Read, D. B., Fullagar, H. H. K., Ramirez-Lopez, C., Jones, B., Cummins, C., & Sampson, J. A. (2020). "How Am I Going, Coach?"-The Effect of Augmented Feedback During Small-Sided Games on Locomotor, Physiological, and Perceptual Responses. *International Journal of Sports Physiology and Performance*, *15*(5), 677–684. https://doi.org/10.1123/ijspp.2019-0078

Wimmer, L. (2016). Problem Solving As a Sufficient Condition of the Creative Process: A Case for Closer Cooperation of Creativity Research and Problem Solving Research. *Frontiers in Psychology*, *7*, 488. https://doi.org/10.3389/fpsyg.2016.00488

Xu, B., Ma, X., Zhang, Y., & Wu, X. (2025). How does mathematical literacy affect creative thinking? Independent effects and differential impacts across proficiency groups. *Acta Psychologica*, *260*, 105509. https://doi.org/https://doi.org/10.1016/j.actpsy.2025.105509

Zahno, S. (2024). Creativity in sports: The crucial role of motor skills. *Journal of Creativity*, *34*(3), 100091. https://doi.org/https://doi.org/10.1016/j.yjoc.2024.100091

Zawawi, M. A. (2021). Persiapan Mengahadapi Kejuaraan Nasional Wushu Taolu 2021 Kota Kediti Ditinjau dari Profil Kondisi Fisik Atlet. *Jurnal Porkes*, *4*(2), 198–203. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Zhou, Y., Youyou, W., & Tolmie, A. (2025). Open-skills sports, especially team ball games, are associated with adolescents' cognitive abilities: Longitudinal evidence from the UK's Millennium Cohort Study. *Cognitive Development*, *76*, 101640. https://doi.org/https://doi.org/10.1016/j.cogdev.2025.101640