



## **Development of Game AR Integrated PjBL Syntax of Earth Structure Materials to Improve Students Creative Thinking Skills**

**Sudarmin<sup>1\*</sup>, Khamida Hikmawati<sup>1</sup>, Risa Dwita Hardianti<sup>1</sup>, Parmin<sup>1</sup>, Endang Sri Lestari<sup>2</sup>**

<sup>1</sup>Universitas Negeri Semarang, Indonesia

<sup>2</sup>SMA Negeri 1 Karanganyar, Indonesia

---

### **Keywords**

Creative Thinking,  
Learning Media,  
Game AR, PjBL

---

### **Abstract**

Creative thinking is one of the competencies that must be possessed in the 21<sup>st</sup>. However, there is a problem that students' creative thinking skills need to be improved, educational games needs to be improved due to the lack of adjustment of learning media with the condition of students. Therefore, Game AR media integrated with the PjBL syntax is needed that can improve students' creative thinking skills. This study aims to develop a valid Game AR media integrated with the PjBL syntax and analyze the significance of the influence of Game AR media integrated with the PjBL syntax on improving students' creative thinking skills. The research was carried out at SMP Negeri 1 Nusawungu. The population in this study is all class VIII and the sampling technique is carried out by means of cluster random sampling. The sample of this study is 31 students in class VIII A SMP Negeri 1 Nusawungu. This research uses the Research and Development method with a 4D model (Define, Design, Development, Disseminate). The results of the study show that the PjBL integrated Game AR is valid to be used with the N-Gain value of students in the high category. The results of the paired sample t-test showed a significance value < probability, so that it can be concluded that the Game AR media integrated with the PjBL syntax developed is valid to use and can significantly improve students' creative thinking skills.

---

\*Correspondence Address:

E-mail: hikmawatikhamida@gmail.com

p-ISSN 2528-505X

e-ISSN 2615-6377

## INTRODUCTION

The acceleration of technology, global competition, and demographic changes have created changes in all fields, including in the field of Education (Panthalookaran, 2022). This era requires all elements of Education to be able to compete globally with their creative thinking skills (Canzitu, 2022; Hasgal & Ahituv, 2017) 21st century learning emphasises the ability of students to think critically, think creatively, and be skilled in communicating and collaborating (Sumarni et al, 2021).

This research is motivated by the problem that students' creative thinking skills need to be improved Creative thinking is a mindset that is based on a way that can encourage humans to identify problems so that they can find new ideas as appropriate and original solutions (Fitriyah & Ramadani, 2021) Creative thinking is important to consider because through creative thinking skills, students can have various ways to solve problems with diverse perceptions and concepts (Ernawati et al, 2023).

The results of observations that have been carried out at SMP Negeri 1 Nusawungu show that the creative thinking skills possessed by students need to be improved The percentage of students who can answer 5 questions designed based on creative thinking indicators is 294% The percentage of students who expressed their opinions and asked questions during learning was only 625% and 156% In line with this, students in grade VIII of SMP Negeri 15 Surakarta also have creative thinking skills with a low category (Kurnia, 2021) The low creative thinking ability of students also occurs in students of SMP Negeri 5 Bima City (Hartati et al, 2021).

The results of interviews conducted with science teachers show that teachers actually have the basic ability to operate learning technology, but in reality the technology used is not optimal. Teachers usually only use power points, youtube videos, and teaching aids as tools in teaching and learning activities. In fact, the internet network at SMP Negeri 1 Nusawungu is fairly good, besides that students also have smartphones and can operate them well. The maximum use of technology can improve the quality of education, this can also support the creative thinking skills of students to further develop (Utomo & Wihartanti, 2019).

Judging from the existing problems, science learning media is needed that can overcome the problem of students' creative thinking skills that need to be improved. Learning by utilizing technology to the maximum and the right model can support students' creative thinking skills to increase (Utomo & Wihartati, 2019). Suitable and interesting learning media can be easier to learn and can encourage students' creative thinking skills (Saputra & Permata, 2018). Students' creative thinking skills can be improved through learning media that are adjusted to creative thinking indicators (Rohimah et al., 2020).

The solution that can be applied to overcome these problems is to develop PjBL integrated Game AR media. The use of Game AR in the world of education can make it easier for students to solve every problem that is difficult to understand, allowing the creation of high-level thinking intelligence, one of which is creative thinking (Estheriani & Muhid, 2020). PjBL integrated Game AR are the application of game mechanics in learning that have been integrated with the syntax of PjBL (Bilgin & Gul, 2019). The application of games in learning has various advantages. Games are considered to be able to make students more active during learning and can practice their visualization skills (Mahfi et al., 2020).

Learning that applies a project-based model (PjBL) can improve learning habits and motivate students to be able to think originally in solving problems in real life (Fitriyah & Ramadani, 2021). PjBL is considered to be able to train and improve students' creative thinking skills because students are given freedom in the learning process and are asked to learn by doing by deciding the goals and objectives that will be carried out in their research (Isabekov & Sadyrova, 2018).

PjBL makes learning more meaningful, this is because PjBL is a student-centered learning process (Tsybulsky et al., 2020) with a constructivist approach (Kokotsaki et al., 2016) in which in its implementation teachers are only tasked with guiding students in exploring their own knowledge through learning experiences (Greenier, 2020). Based on this background, the development of Game AR media integrated with PjBL syntax is an innovation in learning needed to improve students' creative thinking skills.

## METHOD

### Location and Time of Research

The research was conducted at SMP Negeri 1 Nusawungu, Cilacap, Central Java in the even semester of the 2023/2024 school year.

### Research Subject and Object

The population of this study is class VIII with a sample of 31 students of class VIII A who were selected using the cluster random sampling technique. The independent variable in this study is the PjBL integrated Game AR. The control variables in this study are the same teacher, material, and number of lesson hours.

### Research Approach

This research is research and development or research and development (R&D) with a 4D model. This 4D model has four stages, namely define, design, development, and disseminate. The schematic of the research implementation procedure is presented in Figure 1.

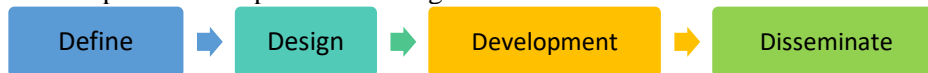


Figure 1. Schematic Procedure for Conducting Research

### Data Collection and Data Analysis Techniques

The data collection techniques in this study are in the form of documentation, interviews, questionnaires, and tests. The test instrument used was a reasoned multiple-choice question totaling 15 questions arranged based on indicators of creative thinking ability. The data analysis methods in this study are analysis of research instruments, analysis of the validity of learning media, normality test, N-gain test, and paired sample t-test. The criteria for increasing the N-Gain score range from 0 to 1. Students who obtained a score in the highest range,  $0.70 \leq N\text{-Gain} \leq 1.0$  were considered to have obtained a high improvement. The range of  $0.30 \leq N\text{-Gain} < 0.70$  indicates an increase in the medium category. An N-gain score of  $\leq 0.30$  shows an improvement in students' creative thinking skills in the low category. Meanwhile, a score of 0 indicates that there is no increase (Arikunto, 2018).

## RESULTS AND DISCUSSION

This development research aims to produce media products in the form of Game AR integrated with PjBL syntax, material on the structure of the earth and its development that is valid for use in science learning and analyze the significance of its influence on improving students' creative thinking skills. The development of Game AR media integrated with PjBL syntax is adjusted to the needs of students, learning objectives, PjBL syntax, and creative thinking indicators. Every aspect of the PjBL integrated Game AR is very considered, starting from the design, language, material content, and content that will be used to meet the indicators of students' creative thinking skills. This is done to obtain good results and suitable for use by students.

### Display Game AR Integrated with PjBL Syntax

The Game AR product design integrated with the PjBL syntax developed in this study uses the classcraft platform, assemblr studio, and scetchfab. This Game AR contains a lock feature, where each stage can only be unlocked if the challenge in the previous stage has been completed. Game AR are equipped with an interactive user guide. How to access the Game AR account used in the research is quite easy, namely by scanning the barcode, the classcraft student application, or through the following classcraft website link: [www.classcraft.com](http://www.classcraft.com). The Game AR display is presented in Figure 2.



Figure 2. Game AR Display

The results of the dashboard page display contain an overview section that contains a summary of class activities such as assignments given, experience points (XP) and health (HP) of students. In addition, the dashboard section also contains class management, quests (adventures), tools to manage and track students' positive or negative behavior, monitor the progress of student assignments, features such as timers and class management. Game AR Quest consists of six challenges or assignments that are adjusted to the syntax of PjBL. The features in the quest section contain stories, assignments, and discussion sections. At the beginning of the challenge, AR content is presented that is intended to help visualize concepts and can be used as a discussion trigger in groups to help direct conversations and brainstorm project ideas.

The AR Simulation page display will later access the camera that will be used to display 3D objects of the earth's structure and its development by pointing the mobile phone camera at the barcode that has been provided or by accessing the link provided. The simulated AR page display design is presented in Figure 3.



Figure 3. AR Page Display Design

### Results of the Validity of Game AR Integrated PjBL Syntax of Earth Structure Materials and Their Development

The validity data of the Game AR integrated with the PjBL syntax of the earth's structure material and its development were obtained from the results of the analysis of the questionnaire of the oleg validators of media experts and materials consisting of three lecturers from the Faculty of Mathematics and Natural

Sciences, State University of Semarang and two teachers of Integrated Science subjects. Validation of Game AR media aims to determine the level of validity of Game AR integrated with PjBL syntax before use. The validity test was carried out with the aiken correlation formula V (Torres et al., 2022; Wati et al., 2019). Game AR integrated with PjBL syntax are valid for use if the value of V obtained is  $>0.87$  (Aiken, 1980; Azwar, 2012). The aspects assessed in the validation of Game AR media integrated with PjBL syntax include the suitability of Game AR with PjBL syntax, the presentation or display of Game AR, and indicators of creative thinking, as well as aspects of the language used. The results of the assessment of the five validators are presented in Table 1.

**Table 1.** Results of Validation of Game AR Integrated with PjBL Syntax

No	Aspects	V Score	Follow up
1.	Compatibility of Game AR with Project Based Learning learning models and creative thinking indicators.	1,00	Valid to use
2.	Presentation or display of Game AR (including instructions for use, clarity of sound or content, and writing).	0,93	Valid for use with revision
3.	The language used in Game AR.	0,93	Valid for use with revision
	<b>Average</b>	<b>0,95</b>	Valid for use with revision

The data presented in Table 1 shows the average level of media validity of Game AR integrated with PjBL syntax in each aspect provided by the five media expert validators. The average result of the validity of Game AR integrated with PjBL syntax was 0.95 with valid criteria based on the category of calculation of the V Aiken index. Some suggestions and inputs were given by expert validators as materials to make improvements to the Game AR media integrated with PjBL syntax. Suggestions from media experts and the results of improvements are presented in Table 2.

**Table 2.** Suggestions from Media Experts and Improvement Results

No.	Suggestion	Improvement Results
1.	It is better to make the writing colors on AR more varied so that it is not monotonous.	Make the writing of material on AR content more colorful and change the font used to make it easier to read.
2.	It is recommended that the landscape video footage used in AR be adjusted to the landscape of the Banyumas, Cilacap and surrounding areas.	Adjusting landscape videos input in AR simulation with the landscapes of the Banyumas and Cilacap areas, such as videos of the Serayu River and Mount Slamet.
3.	It's a good idea to add guidance on the objects that need to be zoomed so as not to cause misconceptions.	Added a description in the form of an object guide that needs to be zoomed in the AR simulation.

Game AR integrated with the revised PjBL syntax in accordance with the suggestions and inputs provided by media experts can then be used in research that can be used as supporting data in media effectiveness trials.

### The Effect of Game AR Integrated PjBL Syntax on Improving Creative Thinking Skills

The test of the influence of Game AR integrated with PjBL syntax on improving students' creative thinking skills was obtained based on the analysis of the pretest and posttest scores of the experimental class. The improvement of creative thinking ability was analyzed using the N-gain formula while the influence test was analyzed using the paired sample t-test formula. The table of N-gain test analysis results is presented in Table 3.

**Table 3.** Results of N-gain Test Analysis

	N	Minimum	Maximum	N-gain Score	Category
N-Gain	31	0,55	0,93	0,7392	Peningkatan Tinggi

The results of the N-Gain test analysis showed an increase between the pretest and posttest scores of students after learning using the Project Based Learning model assisted by Game AR. The N-Gain value of the experimental class is 0.7392 with a high category. Furthermore, to determine the improvement of students'

creative thinking skills after the use of Game AR media integrated with PjBL syntax, a paired sample t-test was carried out. The results of the paired sample t-test analysis are presented in Table 4.

Table 4 Results of Paired Sample t-Test Analysis

Data Type	t	df	Sig. (2-tailed)
Pretest - Posttest	-22,885	30	0,000

The results of the paired sample t-test analysis on pretest and posttest values with a value of t- (calculated) = -22.885 < -2.042 with Sig. (2-tailed) = 0.000 < 0.05 showed that there was a significant influence on the students of the experimental class after learning using Game AR media integrated with PjBL syntax on creative thinking skills.

The existence of this significant influence is due to the intervention in the form of learning with Game AR media integrated with PjBL syntax which is applied before students do posttest questions which can facilitate students in improving their creative thinking skills through independent project preparation. Science learning with the concept of gamification is effective to be applied (Farhan et al., 2022). Project-based learning can encourage students to be skilled in creative thinking (Candra et al., 2019). PjBL can motivate and encourage students to create original solutions to the problems faced through their learning experiences (Ningsih et al., 2021). Game AR have currently been widely developed in the world of education (Suciliyana et al., 2020), this is because Game AR media can hone creative thinking skills through thinking activities to find and find new ideas or new thoughts by producing new works that are useful for solving problems (Estheriani & Muhid, 2020).

The AR contained in the learning gamification platform can be used to help visualize abstract concepts for the understanding and structure of an object model (Mardhiyah et al., 2021). Educational games with AR content as a form of game are designed in such a way that they have elements of educational values that can stimulate thinking, increase concentration, and train students to solve problems using a variety of strategies with creative thinking (Arisandy et al., 2021).

Game AR that integrate PjBL syntax can provide opportunities for students to apply their knowledge in the context of daily life (Fatma, 2021) and can be used to improve students' creative thinking skills through group discussion activities to solve complex challenges or problems (Sudarmin et al., 2023). This is proven by the average N-Gain score of students' creative thinking ability as a whole in the high category.

PjBL can facilitate students in expressing ideas based on their scientific knowledge to answer a number of questions smoothly (Hasnunidah & Sikumbang, 2020). Determining basic questions and participating in discussions can improve fluent and original thinking skills (Harianja, 2020). In addition, the activity of testing results in the PjBL syntax also requires students to be able to get used to answering the questions asked quickly and smoothly (Arsena et al., 2022). Project planning design activities can improve detailed and original thinking skills (Artika et al., 2023; Rosid, 2019). The activity of compiling a project schedule carried out by students can improve students' fluent thinking skills (Rohman, 2021). Monitoring activities and project developments can improve students' ability to think flexibly (Rafik et al., 2022). Kegiatan menguji hasil dan evaluasi dapat meningkatkan kemampuan berpikir kreatif peserta didik baik dalam berpikir lancar, luwes, orisinal, maupun terperinci (Rosid, 2019).

Fluent Thinking is a person's ability to produce ideas or ideas accurately (Ardiansyah et al., 2024). Students who can answer questions with fluent thinking indicators have been trained to be able to build their thinking power through the questions or problems presented (Rafik et al., 2022). Flexible thinking is a person's ability to think of various ideas or ideas to solve a problem (Qomariyah & Subekti, 2021). The achievement of the flexible thinking indicator is that students are able to provide various alternative solutions. Students who can answer questions with flexible thinking indicators solve a problem in various ways (Artika et al., 2023).

Original thinking is a person's ability to come up with innovative new ideas (Ramal et al., 2023). Students who can answer questions with original thinking indicators can think outside existing boundaries and create new and original ideas (Budiarti et al., 2023). Detailed thinking is the ability to elaborate ideas

thoroughly by paying attention to various aspects of the problem in detail (Murdiasih & Wulandari, 2022). Students can understand the complexity of the problem and elaborate in detail on things that may be ignored by others (Maysyaroh & Dwikoranto, 2021).

## CONCLUSION

The Game AR Media integrated with the PjBL syntax developed contains AR simulations and Quests (challenges in the form of project creation stages). Media development is done using Assemblr studio and Classcraft. Based on the results of the assessment of five experts, it can be concluded that the media is valid for use both in terms of the validity of the content and the construction. The Game AR Media integrated with PjBL syntax developed can significantly improve students' creative thinking skills.

## REFERENCES

- Aiken, L. R. (1980). *Content Validity and Reliability of Single Items or Questionnaires*. Educational and Psychological Measurement, 40, 955-959.
- Ardiansyah, A., Sopyan, T., & Yulisma, L. (2024). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kreatif Siswa SMA Plus Al-Falah Tasikmalaya. *J-KIP (Jurnal Keguruan dan Ilmu Pendidikan)*, 5(1), 111-123.
- Arikunto, Suharsimi. (2018). *Dasar-Dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.
- Arisandy, D., Marzal, J., & Maison, M. (2021). Pengembangan Game Edukasi Menggunakan Software Construct 2 Berbantuan Phet Simulation Berorientasi pada Kemampuan Berpikir Kreatif Siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(3), 3038-3052.
- Artika, L. Y., Uyun, M., & Isnaini, M. (2023). Kemampuan Berpikir Kreatif Melalui *Project Based Learning*. *Raudhah Proud to Be Professionals: Jurnal Tarbiyah Islamiyah*, 8(1), 299-311.
- Azwar, S. (2012). *Reliabilitas dan Validitas*. Yogyakarta: Pustaka Pelajar.
- Canzittu, D. (2022). A Framework to Think of School and Career Guidance In A VUCA World. *British Journal of Guidance & Counselling*, 50(2), 248-259.
- Ernawati, M. D. W., Sudarmin, S., Asrial, A., & Haryanto, H. (2023). The Effect of Scaffolding-Based Problem-Based Learning on Creative Thinking Skills on Hormone Materials. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(1), 129-141.
- Fitriyah, A., & Ramadani, S. D. (2021). Pengaruh Pembelajaran STEAM Berbasis PjBL (Project-Based Learning) Terhadap Kemampuan Berpikir Kreatif dan Berpikir Kreatif. *Jurnal Inspiratif Pendidikan*, 10 (1), 209-226.
- Fitriyah, A., & Ramadani, S. D. (2021). Pengaruh Pembelajaran STEAM Berbasis PjBL (Project-Based Learning) Terhadap Kemampuan Berpikir Kreatif dan Berpikir Kreatif. *Jurnal Inspiratif Pendidikan*, 10 (1), 209-226.
- Greenier, V. T. (2020). The 10Cs of Project-Based Learning TESOL Curriculum. *Innovation in Language Learning and Teaching*, 14(1), 27-36.
- Hartati, H., Fahrudin, F., & Azmin, N. (2021). Penerapan Pembelajaran Berbasis Masalah Mata Pelajaran IPA Terhadap Kemampuan Berpikir Kreatif dan Hasil Belajar Peserta didik. *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)*, 5(4).
- Hasgal, A., & Ahituv, N. (2017). The Development of Knowledge Workers in an Organization Characterized as Complex Adaptive Systems (CAS). In: E.Tsui and B. Cheung (Eds.), 14th International Conference on Intellectual Capital, Knowledge Management and Organizational Learning (ICICKM2017), *Academic Conferences and Publishing*, 97-103.
- Hasnunidah, N., & Sikumbang, D. (2020). Pengaruh Model *Project Based Learning* (PjBL) Terhadap Kemampuan Berpikir Kreatif Peserta Didik. *Jurnal Bioterdidik: Wahana Ekspresi Ilmiah*, 8(3), 11-19.
- Isabekov, A., & Sadyrova, G. (2018). *Project-based Learning to Develop Creative Abilities in Students*. Vocational Teacher Education in Central Asia: Developing Skills and Facilitating Success, 43-49.
- Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based Learning: A Review of the Literature. *Improving Schools*, 19(3), 267-277.

- Kurnia, A. (2021). Profil Kemampuan Berpikir Kreatif Peserta Didik Menggunakan Soal Tes Pilihan Ganda pada Pembelajaran Ilmu Pengetahuan Alam. *Indonesian Journal of Educational Science (IJES)*, 4(1), 27-32.
- Mahfi, K. F., Marzal, J., & Saharudin, S. (2020). Pengembangan *Game* Edutainment Berbasis Smartphone Sebagai Media Pembelajaran Berorientasi Pada Kemampuan Berpikir Kreatif. *Jurnal Pendidikan Matematika*.
- Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya Kemampuan Belajar di Abad 21 Sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Lectura: Jurnal Pendidikan*, 12(1), 29-40.
- Maysyaroh, S., & Dwikoranto, D. (2021). Kajian Pengaruh Model Project Based Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik pada Pembelajaran Fisika. *ORBITA: Jurnal Pendidikan dan Ilmu Fisika*, 7(1), 44-53.
- Ningsih, S. R., Ahman, E., & Riswanto, A. (2020). Effectiveness of Using the Project-Based Learning Model in Improving Creative-Thinking Ability. *Universal Journal of Educational Research*, 8(4), 1628-1635.
- Panthalookaran, V. (2022). Education in a VUCA-Driven World: Salient Features of an Entrepreneurial Pedagogy. *Higher Education for the Future*, 9(2), 234-249.
- Qomariyah, D. N., & Subekti, H. (2021). Analisis Kemampuan Berpikir Kreatif. *Pensa: e-jurnal pendidikan sains*, 9(2), 242-246.
- Rosid, M. (2019). Analisis Keterampilan Berpikir Kreatif dan Aktivitas Belajar Siswa Dalam Pembelajaran Kimia: Bahan Kimia dalam Kehidupan Sehari-Hari Menggunakan Model *Project Based Learning*. *Jurnal Pembelajaran Fisika*, 8(3), 195-201.
- Saputra, V. H., & Permata, P. (2018). Media Pembelajaran Interaktif Menggunakan Macromedia Flash pada Materi Bangun Ruang. *WACANA AKADEMIKA: Majalah Ilmiah Kependidikan*, 2(2), 116-125.
- Suciliyana, Y. (2020). *Augmented Reality* Sebagai Media Pendidikan Kesehatan untuk Anak Usia Sekolah. *Jurnal Surya Muda*, 2(1), 39-53.
- Sudarmin, S., Pujiastuti, R. S. E., Asyhar, R., Prasetya, A. T., Diliarosta, S., & Ariyatun, A. (2023). Chemistry Project-based Learning for Secondary Metabolite Course with Ethno-STEM Approach to Improve Students' Conservation and Entrepreneurial Character in the 21st Century. *JOTSE*, 13(1), 393-409.
- Sumarni, W., Sudarmin, S., & Kadarwati, S. (2021). Creative Skill Improvement of The Teacher Candidates in Designing Learning Programs Through A Project-Based Blended Learning. In *Journal of Physics: Conference Series*, 1918 (3)
- Torres, M. J. R., Vera-Ponce, V. J., Zuzunaga-Montoya, F. E., Talavera, J. E., La Cruz-Vargas, D., & Jhony, A. (2022). Content Validity by Expert Judgment of An Instrument to Measure Knowledge, Attitudes and Practices About Salt Consumption in The Peruvian Population. *Revista De La Facultad De Medicina Humana*, 22(2), 9.
- Tsybulsky, D., Gatenio-Kalush, M., Ganem, M. A., & Grobgeld, E. (2020). Experiences of preservice teachers exposed to project-based learning. *European Journal of Teacher Education*, 1-16.
- Utomo, S. W., & Wihartanti, L. V. (2019). Penerapan Strategi Blended Learning Untuk Meningkatkan Kemampuan Berpikir Kreatif Mahasiswa didik Pada Era Revolusi Industri 4.0. *Kwangsan: Jurnal Teknologi Pendidikan*, 7(1), 30.
- Uz Bilgin, C., & Gul, A. (2019). Investigating The Effectiveness of Gamification on Group Cohesion, Attitude, and Academic Achievement in Collaborative Learning Environments. *TechTrends*, 64(1), 124-136.