*­­DEVELOPMENT OF PHYSICS COMICS BASED ON LOCAL WISDOM (PAK PAK DOR AND SULAMANDA) ASSISTED BY ANDROID TO IMPROVE MATHEMATICAL REPRESENTATION ABILITY, HOTS, AND CREATIVE THINKING*

Kuswanto, Heru   
Physics Education, Graduate Program  
Universitas Negeri YogyakartaDI Yogyakarta, Indonesia  
[herukus61@uny.ac.id](mailto:herukus61@uny.ac.id)

Sari, Fita Permata  
Physics Education, Graduate Program  
Universitas Negeri YogyakartaDI Yogyakarta, Indonesia  
[fitapermata@gmail.com](mailto:fitapermata@gmail.com)

Wardani, Ratna   
Electrinic Engineering and Informatic Education   
Universitas Negeri YogyakartaYogyakarta, Indonesia  
ratna@uny.ac.id

Nikmah, Syafridatun  
Physics Education, Graduate Program  
Universitas Negeri YogyakartaDI Yogyakarta, Indonesia  
syafridatunnikmah@gmail.com

*Abstract*— The development of technology has an effect on smartphone addiction. Students become smartphone users who are compulsive and vulnerable to negative consequences. Books used by students are less interesting to read, other than that students are more interested in reading comics than academic books. Comics have systematic stories that make it easy for readers to follow their contents. The shift in the value of knowledge shows that the value of local knowledge or local wisdom is forgotten. Physics learning can balance physics knowledge with the cultivation of scientific attitudes, as well as national character values based on local wisdom (the game Pak-pak dor and Sulamanda). Students make mistakes in the problem solving stage when using mathematical representations. The low mathematical ability of students and the lack of teacher understanding of HOTS. Creative thinking has many limitations because creative thinking is a multifaced phenomenon. Even if used properly, smartphones, comics, and local wisdom can be used in the learning process. The process can improve the mathematical representation ability, HOTS, and creative thinking of students.This study aims to produce physics media based on local wisdom comics (game Pak-pak dor and Sulamanda) assisted by android to improve the ability of mathematical representation, HOTS, and creative thinking. This research was a development research with reference to 10 R&D cycles consisting of 10 stages namely; 1. introduction which contains information gathering (literature review and observation survey of learning); 2. designing research (research objectives, estimated costs and time, and work procedures in research); 3. initial product development (analyzing physical aspects of local wisdom, designing comics according to KI, KD, and Indicators); 4. preliminary field test; 5. major product revisions; 6. Main field test; 7. major field test revisions; 8. operational field test (operational field test); 9. revision of the final product; 10. product disseminator.The data of this study were assessments and suggestions for improving the learning tools of the validator, mathematical representation ability, HOTS, and students' creative thinking. Research data were captured through questionnaires, written tests, and observations. Data analysis used were qualitative and quantitative analysis to revise and determine the quality of the learning tools developed.

*Keywords - Mobile Learning; Physics Comics, Mathematical Representations; Local Wisdom, Pak Dor; Sulamanda*

# Introduction

Technological developments affect smartphone addiction. Low academic achievement has a negative influence on school life [1]. Smartphones are now a mandatory item for everyone [2]. Students view smartphones as an entertainment tool with time of use becoming a habit [3]. Trends in the development of technology and information can be utilized in education as a means of learning outside and inside the classroom [4].

The development of life shows animation, comics, and games have a big influence on the entertainment market [5]. The 9th century comic carries an important legacy in creating its own narrative code [6]. Comics include media that are often used in daily life as entertainment facilities. Comics are not only functioned as an entertainment tool, but are also used in education [7]. Language in comics can change rigid science into simple science that can be understood by students [8].

Multiple representatation in solving problems, including verbal, diagram / picture, mathematics / symbolic, and graphics. Performance on math problems is worse than other formats despite students' preferences for calculation questions [9]. Students make mistakes in problem solving when using physics diagrams and mathematical representations [10]. Students are shown the importance of numerical understanding for the development of mathematical skills. The discovery of mathematical representation can predict students' mathematical achievement [11].

Indonesian local wisdom has the role of building the nation's character and has the potential to be mixed in the 2013 curriculum due to its regional characteristics in many aspects, such as technology, economy, culture, information and communication, ecology, and others [12]. Local wisdom based education teaches students to be close to the environment around the place of learning. Physics learning is able to develop thinking creativity and national character based on local wisdom. Physics learning can balance physics knowledge with the cultivation of scientific attitudes, as well as national character based on local wisdom [13-14].

Based on the description that has been explained, it is necessary to have research with the title "Development of Physics Comics Based on Local Wisdom (Pak-Pak Dor and Sulamanda) Assisted by Android to Improve the Capability of Mathematical Representation, HOTS, and Creative Thinking".

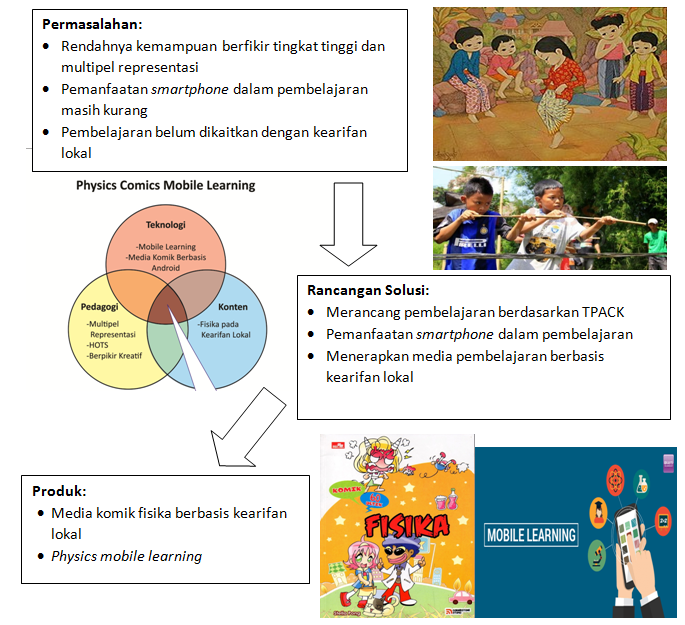


Figure 1. Problem Solving Framework

# LITERATURE REVIEW

## TPACK

The key to the success of learning physics is shown in the educational technology that is used, because physics is a subject that contributes greatly to the scientific and technological development of society [15-16].

Learning needs to be integrated by utilizing technology. A theoretical framework has emerged recently to guide research in the use of ICT is Technological, Pedagogical, Content Knowledge (TPACK) [17]. The technology pedagogical knowledge framework (TPACK) has the potential to provide a strong foundation for future technology integration research and provide theoretical guidance on how teacher education programs can approach training candidates who can use technology in content-specific and general ways [18].

TPACK is an emerging form of knowledge that transcends the three core components (content, pedagogy, and technology). The importance of the development of TPACK by teachers to understand and overcome the contextual factors of the use of tablet computers in education for effective teaching with technology [19-20].

Students' mathematical skills are needed for physics problems and explain how equations are used, because physics lessons contain concepts that can be represented in several forms of representation [9], [21].

The ability of mathematical representation is the ability to modify and combine mathematical functions or equations [22]. Mathematical representation, namely: (1) representing real objects in pictures, diagrams or mathematical models, (2) describing ideas, situations, and mathematical relationships in writing in the form of tables, diagrams, pictures or graphs, (3) describing daily events days in language or mathematical symbols, and (4) changing the form of mathematical representation to other forms of mathematical representation [23].

Effective learning by developing High Order Thinking Skills (HOTS), including identifying, integrating, analyzing, evaluating, and creating, can significantly improve learning performance [24-27]. HOTS includes the ability to analyze (C4), evaluate (C5), and make (C6) [26].

Creativity such as fluency, flexibility, originality, elaboration is the ability to solve problems from knowledge and are identified as strategies in developing creative thinking skills to create an environment that supports education [28-30].

## Local Wisdom

Local wisdom is the cultural values of the community as a product of local knowledge that provides a local context in the development of science [31-33]. The use of local wisdom in learning science changes the exclusive view of science, becoming science for daily living, science for the future, and science for all [34]. Integrating the values of local wisdom in the 2013 curriculum because its regional characteristics in many aspects become important as one of cultural wealth, nation formation, and maintaining the nation's cultural values [35], [12]. Science domain based learning that integrates local wisdom can improve students' science process skills and scientific attitude [36].

Traditional Sulamanda or Engklek games contain problem solving values that consist of finding and understanding problems, developing good problem solving strategies, and exploring solutions [37].

Pak Pak game is a shooting game made of long bamboo blades, with paper bullets. The sound in the packages bam occurs because of a change in pressure. When a push is applied to a paper bullet, it will produce a compression of space in the bamboo tube, causing the pressure inside to rise, and as the volume continues to be pushed smaller, this pressure forces the bullet to come out and produce a sound.

Physics concept of pak-pak dor local wisdom is shown in Table 1

Table 1. Physics Concept of Pak-pak Dor Local Wisdom

|  |  |
| --- | --- |
| **Activities** | **Theory** |
| **Kinetic Theory of Gases** | |
| When the bullet starts to be pushed, the volume inside the bamboo tube shrinks, the pressure rises | Ideal Gas Equation and Ideal Gas Pressure (P)      For isothermic conditions, a comparison is used: |
| **Parabolic Motion** | |
| When *pak-pak dor* are fired at certain angles, the bullets come out of the bamboo and form a parabolic motion | Parabolic trajectories can be illustrated as shown below.    **Figure 1. Parabolic Motion Track**   * Initial velocity      * Velocity      * Distance / Height      * Maximum Height / Distance |
| **Sound Wave** | |
| When the bullet comes out of the bamboo it makes a sound | Sound waves are included in longitudinal waves that occur due to stretching and sealing in liquid, solid, or gas mediums.  Sound velocity in solids  Sound velocity in liquid  Sound velocity in gases |

Physics concept of sulamanda local wisdom is shown in Table 1

Table 2. Physics Concept of Sulamanda Local Wisdom

|  |  |
| --- | --- |
| **Activities** | **Theory** |
| **When the engine is in a state of silence or movement** | 1. **Momentum**   When the gaco has mass m in stationary condition () or moves (). Gaco has momentum that indicates the state of motion of the engine. Momentum is a measure of difficulty in stopping the motion of an object. Momentum is influenced by mass and speed, these equations can be written like Equation 1.  (i) |
| **When the spurs come into contact with other gaco or *Sulamanda* traditional game plots within a certain interval of time** | 1. **Impulses**   Force when the gaco touch each other with another gaco or *Sulamanda* traditional game plot in a short period of time. Players give an average impulsive force to another gaco or game plot in a short interval of time. So that the impulse can be written like Equation 2.  (ii)  Impulses are proportional to the impulsive force - average and time interval, the greater the impulsive force - the greater the impulse. Impulse is also a change of momentum, can be seen from changes in the velocity of the motion. The formula can be written like Equation 3.    (iii) |
| **When there is a gaco pounding another gaco or about another player.** | 1. **Collision**   When the gaco hits another gaco, there will be a collision process between the gaco. In any collision process, momentum is always eternal as long as there is no external force acting (total zero external force). So as written in Equation 4.  (iv)  Here we consider the gaco to experience collisions each does not change. In the collision process, in addition to speed, the mass of each object before and after the impact can change. For example, after the collision, the two gaco join, or after the collision there is a broken gaco  The collision process is divided into 3 types, namely:   1. perfectly resilient collision , 2. partial resilient collisions, and 3. collisions are not resilient at all .   Where, e is the value of the restitution coefficient obtained from Equation 5.  (v) |

[38]

## Comic

Comics are one of the superior educational media compared to other media, both for increasing knowledge [7], [39-40].

Comics have humor and narrative features, allowing multiple perspectives, visually and verbally, are considered as potential innovative media for science communication and can convey life messages [8], [41-43]. Unlike textbooks, stories and comics allow many perspectives, visually and verbally, and apply the beginning, end, climax moments, and focal points, as well as the complexity of complex stories, textbooks, virtual reality simulations [41].

Learning to use comics that includes illustrations and written content is an effective intervention to increase knowledge. Comic learning is an innovative communication media that can be used to achieve goals [43].

## Mobile / Android based learning

Mobile learning (m-learning) uses Android by combining strategies to provide broader opportunities in mobile technology, improve student learning abilities, higher-order thinking skills, motivation, and enable student-centered learning processes [27], [44-45]. The use of Physics Mobile Learning (PML) media products assisted by Android can improve students' divergent thinking abilities and HOTS physics [46].

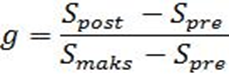
# METHODOLOGY

The final product of the research was the physics learning comics media based on local wisdom on sound material and contextual impulses and momentum to improve mathematical representation, HOTS, and students' creativity. The research model used was the development of R & D education (Educational Research and Development) referring to the 10 R&D cycles which consist of 10 stages, namely: (1) Introduction which includes information gathering (literature review and survey of learning observations); (2) Designing research (research objectives, estimated costs and time, and work procedures in research); (3) initial product development (analyzing physical aspects of local wisdom, designing comics according to KI, KD, and Indicators); (4) Preliminary field test; (5) Major product revisions; (6) Main field test; (7) Major field test revisions; (8) Operational field test; (9) Revision of the final product; (10) Product disseminator.

The type of data to be obtained was qualitative and quantitative data. Qualitative data were in the form of survey data, while quantitative data were obtained from product feasibility assessments, scores on mathematical representation abilities and cognitive abilities of students, such as high order thinking skills and creative thinking skills.

Retrieval of data in this study used two instruments, the non-test instrument and the test instrument. Non-test instruments were in the form of questionnaires and survey observation sheets, product evaluation questionnaires and sheets, attitude observation sheets, self-assessment questionnaires, student questionnaire responses, and peer-to-peer evaluation questionnaires. The test instruments used in this study were short answer questions and descriptions to assess students' mathematical and cognitive abilities, such as high order thinking skills and creative thinking skills.

A qualitative data analysis technique was used to analyze the results of the survey need assessment. While quantitative analysis conducted quantitatively was used to determine product viability, an increase in mathematical representation abilities and cognitive abilities of students, such as high order thinking skills and creative thinking skills. Analysis of this data was done by calculating the normalized-gain (N-gain) pretest and posttest after the application of learning, which was formulated as follows [45].



Information:

Spre = Pre-test score

Spost = Post-test score

Smaks = Maximum score

Classification of the normalized gain (g) was as follows: height g> 0.7; moderate 0,3 ≤ g ≤ 0,7; low g <0.3 [48]. Besides the descriptive increase in gain was described by normalized gain, inferentially done by multivariate analysis with the help of the SPSS computer program.

The study was conducted in two places namely in Brebes Regency which had local wisdom Pak-pak dor to improve mathematical representation ability and HOTS, and Cilacap District which had local wisdom Sulamanda to improve mathematical representation ability and creative thinking.

# RESULT AND DISCUSSION

The results obtained were known differences in learning outcomes using the media and without using media. These results could be known from the results of several analyzes that had been conducted. Product trials produced test results in mathematical representation ability, HOTS, and creative thinking of high school students. The results of the research in the two districts with local wisdom Sulamanda and Pak-pak dor were presented and analyzed respectively.

The results of the study using physics comics based on local wisdom Pak-pak dor to improve mathematical representation and HOTS were presented in Table 3 and Table 4.

Table 3. Results of Mathematical Representation Ability

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Class** | **Number of Student** | **Average Representation Ability** | | **Average Gain Value** | **Category** |
| *Pretest* | *Posttest* |
| 1 | Experiment | 36 | 18,63 | 82,75 | 0,79 | High |
| 2 | Control | 35 | 19,40 | 77,61 | 0,72 | High |

Table 3 shows the gain value of the mathematical representation ability of each experimental and control class is 0.79 and 0.72 which is included in the high category.

Table 4. Results of High Order Thinking Skills (HOTS)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Class** | **Number of Student** | **Average High Order Thinking Skills** | | **Average Gain Value** | **Category** |
| *Pretest* | *Posttest* |
| 1 | Experiment | 36 | 19,44 | 80,78 | 0,75 | High |
| 2 | Control | 35 | 24,76 | 71,90 | 0,61 | Medium |

Table 4 shows the gain value of the HOTS ability of each experimental and control class is 0.75 and 0.61 which is included in the high and medium category.

The results of the study using physics comics based on local wisdom Sulamanda to improve mathematical representation and creative thinking skills were presented in Table 5 and Table 6.

Table 5. Results of Mathematical Representation Ability

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Class** | **Number of Student** | **Average Representation Ability** | | **Average Gain Value** | **Category** |
| *Pretest* | *Posttest* |
| 1 | Experiment | 30 | 29,50 | 83,50 | 0,77 | High |
| 2 | Control | 31,17 | 75,50 | 0,64 | Medium |

Table 5 shows the gain value of the mathematical representation ability of each experimental and control class is 0.77 and 0.64 which is included in the high and medium category.

Table 6. Results of Creative Thinking Skills

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Class** | **Number of Student** | **Average Creative Thinking Skills** | | **Average Gain Value** | **Category** |
| *Pretest* | *Posttest* |
| 1 | Experiment | 30 | 23,83 | 85,17 | 0,80 | High |
| 2 | Control | 18,00 | 74,00 | 0,68 | Medium |

Table 6 shows the gain value of the creative thinking skills of each experimental and control class is 0.80 and 0.68 which is included in the high and medium category.

The statistical test used was multivariate analysis (MANOVA) to determine the influence of local wisdom physics comic media: the game of Sulamanda and Pak-pak dor assisted android on the ability of mathematical representation, HOTS, and creative thinking of high school students. Nine prerequisite test steps performed:

1) Dependent variable consisted of three namely mathematical representation, High Order Thingking Skill, and creative thinking in the form of continuous data.

2) The independent variable consisted of two categories, namely local wisdom based comic media Sulamanda games or Pak-Pak dor games which were tested in the experimental class and learning media which were usually applied in the control class.

3) Observation of each class was different from the previous trial class.

4) Samples of each control and experiment class each amounted to more than 25 samples.

5) There were no univariate and multivariate outliers.

6) Multivariate Normality Test

Analysis of normality in the Shapiro-Wilk test obtained sig. more than 0.05. That meant the data of the two experimental and control class groups were normally distributed.

7) Linearity Test

8) Homogeneity test of variance-covariance matrices

Homogeneity test results using Box’s Test obtained sig values. more than 0.05 showed the value of the ability of mathematical representation and creative thinking that had relatively the same variance.

9) Correlation Test (No multicollinearity)

Pearson Correlation results obtained r values in the range of 0.20 to 0.80, and included in the weak category so that there was a correlation between the ability of mathematical representation and creative thinking in the experimental class and the control class, and there was a correlation between the ability of mathematical representation and HOTS in the class experiment and control class.

The results of the MANOVA analysis showed that the significance value indicated the value of 0,000 <0.05. The conclusion that could be drawn from this multivariate test was that there were differences in the ability of mathematical representation, HOTS, and students' creative thinking between learning using comics media Local wisdom physics: the game Pak-pak dor and Sulamanda assisted by android with learning using textbooks and the usual media provided school. The results of effective contributions given to each variable in each class were different, meaning that there were differences in effectiveness for each class.

The results of effective contributions in the trial using physics comics based on local wisdom Pak-Pak Dor to improve mathematical representation and HOTS included:

a. The effective contribution of the experimental and control class was 96.5% and 95.5% to the increase in mathematical representation ability and HOTS.

b. The effective contribution of the experimental and control class was 95.7% and 94.7% for the improvement of mathematical representation ability.

c. The effective contribution of the experimental and control class was 89.5% and 83.2% to the increase in HOTS.

The results of effective contributions in the trial using physics comics based on local wisdom Sulamanda to improve mathematical representation and creative thinking skills included:

a. The effective contribution of the experimental and control class was 94.3% and 92.3% to the increase in mathematical representation ability and creative thinking skills.

b. The effective contribution of the experimental and control class was 91.4% and 87.7% for the improvement of mathematical representation ability.

c. The effective contribution of the experimental and control class was 91.6% and 89.4% to the increase in creative thinking skills.

The comic physics products based on local wisdom of the Sulamanda game produced were presented in Figure 2 (a), (b), (c), and (d). Whereas physics comic products based on local wisdom produced by Pak-pak dor were presented in Figure 2 (e), (f), (g), and (h).

|  |  |
| --- | --- |
|  |  |
| (a) | (b) |
|  |  |
| (c) | (d) |
| revisi media 1a | komik 19 |
| (e) | (f) |
| komik 12a | komik 3 |
| (g) | (h) |

Figure 2. (a) Comic Cover (b) Impulse and Momentum Chapter (c) Examples of Questions in Comics, (d) Examples of Sulamanda games (e) Comic Cover (f) Sound Wave Chapter (g) Examples of Questions in Comics (h) Example of the game Pak-Pak Dor.

# CONCLUSION

The results show that the comics media Physics of local wisdom; the game Pak-pak dor and Sulamanda assisted by android to improve the ability of mathematical representation, HOTS, and creative thinking of high school students contained a complete explanation of the material associated with local wisdom, learning videos, discussion sheets, sheets experiments, examples and practice questions. The product could be operated using a smartphone with the EPUB Reader application or a computer with an internet browser.

Pak-pak dor based physics comic products were categorized as suitable for use in the physics learning process based on an assessment of 3,26 from a scale of 1-4 with a good category. The average result of the gain standard of mathematical representation ability of the experimental class was 0.79 and the control class was 0.72 with the high categories. While the average result of the standard gain of creative thinking ability of the experimental class was 0.76 and the control class was 0.62 with a high and medium category.

Sulamanda-based physics comic products were categorized as suitable for use in the physics learning process based on an assessment of 4.07 from a scale of 1-5 with a good category. The average result of the gain standard of mathematical representation ability of the experimental class was 0.77 and the control class was 0.64 with the high and medium categories. While the average result of the standard gain of creative thinking ability of the experimental class was 0.80 and the control class was 0.68 with a high and medium category.

There was a difference between the experimental class and the control class with a significance level <0.05. This shows that the local wisdom Physics comic media: the game Pak-Pak Dor and Sulamanda assisted by Android to improve the mathematical representation ability, HOTS, and creative thinking of high school students..

##### Acknowledgment

This research was supported by Universitas Negeri Yogyakarta and Ristekdikti. We thank Dr. Heru Kuswanto for comments that greatly improved the manuscript. We thank our colleagues from SMA 1 Brebes, SMA 2 Brebes, and SMA 1 Majenang that greatly assisted the research.

##### References

1. Lee, C., & Lee, S. J. (2017). Prevalence and predictors of smartphone addiction proneness among Korean adolescents. Children and Youth Services Review, 77, 10–17. <https://doi.org/10.1016/j.childyouth.2017.04.002>
2. Timbowo, D. (2016). Manfaat Penggunaan Smartphone Sebagai Media Komunikasi. E-Journal “Acta Diurna,” V(2).
3. Aljomaa, S. S., Mohammad, M. F., Albursan, I. S., Bakhiet, S. F., & Abduljabbar, A. S. (2016). Smartphone addiction among university students in the light of some variables. Computers in Human Behavior, 61, 155–164. <https://doi.org/10.1016/j.chb.2016.03.041>
4. Irwandani, & Juariah, S. (2016). PENGEMBANGAN MEDIA PEMBELAJARAN BERUPA KOMIK FISIKA BERBANTUAN SOSIAL MEDIA INSTAGRAM SEBAGAI. Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 05(April), 33–42. <https://doi.org/10.24042/jpifalbiruni.v5i1.103>
5. Sheu, J. J., & Chu, K. T. (2017). Mining association rules between positive word-of-mouth on social network sites and consumer acceptance: A study for derivative product of animations, comics, and games. Telematics and Informatics, 34(4), 22–33. <https://doi.org/10.1016/j.tele.2016.12.010>
6. Guérin, C., Rigaud, C., Bertet, K., & Revel, A. (2017). An ontology-based framework for the automated analysis and interpretation of comic books’ images. Information Sciences, 378, 109–130. <https://doi.org/10.1016/j.ins.2016.10.032>
7. Widyastuti, P. D., Mardiyana, M., & Saputro, D. R. S. (2017). An Instructional Media using Comics on the Systems of Linear Equation An Instructional Media Using Comics on the Systems of Linear Equation. <https://doi.org/10.1088/1742-6596/895/1/012039>
8. Lin, S.-F., Lin, H., Lee, L., & Yore, L. D. (2015). Are Science Comics a Good Medium for Science Communication? The Case for Public Learning of Nanotechnology. International Journal of Science Education, Part B, 5(3), 276–294. <https://doi.org/10.1080/21548455.2014.941040>
9. Docktor, J. L., & Mestre, J. P. (2014). Synthesis of discipline-based education research in physics, 020119, 1–58. <https://doi.org/10.1103/PhysRevSTPER.10.020119>
10. Leigh, Gregor. (2004). Developing Multi-representational Problem Solving Skills in Large, Mixed-ability Physics Classes. (University of Cape Town Department of Physics: Thesis)
11. Wong, T. T. Y. (2017). The unique and shared contributions of arithmetic operation understanding and numerical magnitude representation to children’s mathematics achievement. Journal of Experimental Child Psychology, 164, 68–86. <https://doi.org/10.1016/j.jecp.2017.07.007>
12. Subali, B., Sopyan, A., & Ellianawati, E. (2015). Developing local wisdom based science learning design to establish positive character in elementary school. Jurnal Pendidikan Fisika Indonesia, 11(1), 1–7. <https://doi.org/10.15294/jpfi.v11i1.3998>
13. Sholakhudin, M. N., Sutarto, & Subiki. (2016). Paket Sumber Belajar ( Psb ) Dengan Analisis Foto Kejadian Fisika ( AFKF ) Berbasis Kearifan Lokal Pada Pembelajaran Fisika di SMK ( Kajian Pengembangan pada Pokok Bahasan Fluida untuk SMK Jurusan Perikanan dan Kelautan ). Jurnal Pembelajaran Fisika, 5(3), 253–260.
14. Suastra, I. W., & Yasmini, L. P. B. (2013). Model Pembelajaran Fisika Untuk Mengembangkan. Jurnal Pendidikan Indonesia, 2(2), 221–235.
15. Aytekin, P., & Sakarya, I. (2007). How Technology Is Integrated Into Science Education in a Developing Country : North Cyprus Case, 6(3), 54–61.
16. Eraikhuemen, L., & Ogumogu, A. (2014). An assessment of secondary school physics teachers conceptual understanding of force and motion in Edo, 5(1), 253–262.
17. Ahmed, A., & Qasem, A. (2016). Blended Learning Approach to Develop the Teachers’ TPACK. Contemporary Educational Technology, 7(3), 264–276.
18. Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). Computers and Education, 57(3), 1953–1960. <https://doi.org/10.1016/j.compedu.2011.04.010>
19. Koehler, M. J., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)? Contemporary Issues in Technology and Teacher Education, 9(1), 60–70. <https://doi.org/10.1016/j.compedu.2010.07.009>
20. Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2016). The influence of TPACK contextual factors on early childhood educators’ tablet computer use. Computers and Education, 98, 57–69. <https://doi.org/10.1016/j.compedu.2016.02.010>
21. Rizky, G., Tomo, D., & Tms, H. (2014). Kemampuan multirepresentasi siswa sma dalam menyelesaikan soal-soal hukum newton, 1–10.
22. Jaccard, J., & Jacoby, J. (2010). Theory Contruction and Model Building Skills. New York: Guilfrord Press.
23. Ramdani, Y. (2012). Pengembangan Instrumen dan Bahan Ajar untuk Meningkatkan Kemampuan Komunikasi, Penalaran, dan Koneksi Matematis dalam Konsep Integral. Jurnal Penelitian Pendidikan, 13(1), 44–52.
24. Resurreccion, R. D., & Ph, D. (2014). The Effects of Using Videos on Teaching Selected Topics in Physics Towards the Development of Higher-Order Thinking Skills, 2(5), 38–45.
25. Bagarukayo, E., & College, M. (2012). The impact of learning driven constructs on the perceived higher order cognitive skills improvement : Multimedia vs . text Theo Weide Victor Mbarika and Min Kim, 8(2), 120–130.
26. Kusuma, M. D., Rosidin, U., & Suyatna, A. (2017). The Development of Higher Order Thinking Skill ( Hots ) Instrument Assessment In Physics Study, 7(1), 26–32. <https://doi.org/10.9790/7388-0701052632>
27. Sulisworo, D. (2017). Mobile Learning Application Development Fostering High Order Thinking Skills on Physics Learning, 102–107.
28. Fitriani, N., Gunawan, & Sutrio. (2017). BERPIKIR KREATIF DALAM FISIKA DENGAN PEMBELAJARAN CONCEPTUAL UNDERSTANDING PROCEDURES ( CUPs ) BERBANTUAN LKPD Nurul Fitriani , Gunawan , Sutrio Program Studi Pendidikan Fisika Universitas Mataram. Jurnal Pendidikan Fisika Dan Teknologi, III(1), 24–33.
29. Munandar, Utami. 2012. Pengembangan Kreativitas Anak Berbakat. Jakarta: Rineka Cipta
30. Lin, Y.-S. (2011). Fostering Creativity through Education – A Conceptual Framework of Creative Pedagogy. Creative Education, 02(03), 149–155. <https://doi.org/10.4236/ce.2011.23021>
31. Fajarini, U. (2014). Peranan Kearifan Lokal Dalam Pendidikan Karakter. SOSIO DIDAKTIKA: Social Science Education Journal, 1(2). <https://doi.org/10.15408/sd.v1i2.1225>
32. Anwari, A., Nahdi, M. S., & Sulistyowati, E. (2016). Biological science learning model based on Turgo’s local wisdom on managing biodiversity. AIP Conference Proceedings, 1708. <https://doi.org/10.1063/1.4941146>
33. Parmin, Sajidan, Ashadi, Sutikno, & maretta, Y. (2016). Preparing prospective teachers in integrating science and local wisdom through practicing open inquiry. Journal of Turkish Science Education, 13(2), 3–14. <https://doi.org/10.12973/tused.10163a>
34. Pramadi, I. P. W. Y., Suastra, I. W., & Candiasa, I. M. (2013). Pengaruh penggunaan komik berorientasi kearifan lokal bali terhadap motivasi belajar dan pemahaman konsep fisika. E-Journal Program Pascasarjana Universitas Pendidikan Ganesha, 3.
35. Dewi, I. N., Poedjiastoeti, S., Prahani, K., & Professor, S. P. (2017). Elsii Learning Model Based Local Wisdom To Improve Students’ Problem Solving Skills and Scientific Communication. International Journal of Education and Research, 5(1), 107–118.
36. Dwianto, A., & Kun, P. Z. (2015). Science domain based learning integrated local wisdom to improve student’s science process skills and scientific attitudes. Proceeding of International Seminar on Science Education.
37. Iswinarti. (2017). Nilai-nilai Problem Solving Permainan Tradisional Engklek. Seminar Nasional Dan Gelar Produk, 1–9.
38. Abdullah, M. (2016). Fisika dasar 1. Bandung: Institut Teknologi Bandung.
39. Mendelson, A., Rabinowicz, N., Reis, Y., Amarilyo, G., Harel, L., Hashkes, P. J., & Uziel, Y. (2017). Comics as an educational tool for children with juvenile idiopathic arthritis. Pediatric Rheumatology, 15(1). <https://doi.org/10.1186/s12969-017-0198-5>
40. Kim, J., Chung, M. S., Jang, H. G., & Chung, B. S. (2017). The use of educational comics in learning anatomy among multiple student groups. Anatomical Sciences Education, 10(1), 79–86. <https://doi.org/10.1002/ase.1619>
41. Babaian, C. S., & Chalian, A. A. (2014). “The thyroidectomy story”: Comic books, graphic novels, and the novel approach to teaching head and neck surgery through the genre of the comic book. Journal of Surgical Education. <https://doi.org/10.1016/j.jsurg.2013.11.008>
42. Tekle-Haimanot, R., Pierre-Marie, P., Daniel, G., Worku, D. K., Belay, H. D., & Gebrewold, M. A. (2016). Impact of an educational comic book on epilepsy-related knowledge, awareness, and attitudes among school children in Ethiopia. Epilepsy & Behavior, 61, 218–223. <https://doi.org/10.1016/j.yebeh.2016.05.002>
43. Hanson, A., Drendel, A. L., Ashwal, G., & Thomas, A. (2017). The Feasibility of Utilizing a Comic for Education in the Emergency Department Setting. Health Communication. <https://doi.org/10.1080/10410236.2016.1211076>
44. Han, I., & Shin, W. S. (2016). The use of a mobile learning management system and academic achievement of online students. Computers and Education, 102, 79–89. <https://doi.org/10.1016/j.compedu.2016.07.003>
45. Kuswanto, H. (2017). Android Used in The Learning Innovation Atwood Machines on Lagrange Mechanics Methods, 2(1), 338–345. <https://doi.org/10.20961/ijsascs.v2i1.16740>
46. Mardiana, N., & Kuswanto, H. (2017). Android-assisted physics mobile learning to improve senior high school students’ divergent thinking skills and physics HOTS. AIP Conference Proceedings, 1868. <https://doi.org/10.1063/1.4995181>
47. Meltzer, David E. (2002). The Relationship between mathematics preparation and conceptual learning gain in physics: ‘hidden variable’ in diagnostic pretest scrores. American Journal of Physics, 70, (12), 1260
48. Hake, Richard R. (1998). Interactive-Engagement Versus Traditional Methode: ASix-Thousand-Student Survey of Mechanics Test Data for IntroductoryPhysics Course. American Journal of Physics.