Available online at http://journal.uny.ac.id/index.php/jrpm

Jurnal Riset Pendidikan Matematika 7 (2), 2020, 178–194

Development of trigonometry learning kit with a STEM approach to improve problem-solving skills and learning achievement

Aulia Nur Arivina [1, a, *], Jailani [2, b]

[1] Masters Program in Mathematics Education, Universitas Negeri Yogyakarta
Jalan Colombo No 1, Karangmalang, Yogyakarta 55821, Indonesia
[2] Department of Mathematics Education, Universitas Negeri Yogyakarta
Jalan Colombo No 1, Karangmalang, Yogyakarta 55821, Indonesia
E-mail: [a] aulianur.2018@student.uny.ac.id, [b] jailani@uny.ac.id
* Corresponding Author

ARTICLE INFO

Article history
Received: 13 Oct. 2020
Revised: 16 Nov. 2020
Accepted: 16 Dec. 2020

Keywords
learning kit, STEM approach, learning achievement, problem-solving skill

ABSTRACT

This study aimed to produce the trigonometry learning kit for tenth-grade high school students using the STEM (Science, Technology, Engineering, and Mathematics) approach properly. This study was development research using the ADDIE model, which consisted of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. This study's subjects were tenth-grade high school students (n = 32) in Semarang, Indonesia. Data collection was carried out through questionnaires and tests. To assess the learning kit's validity, we used a questionnaire with the expert (mathematics education lecturers) as data sources. To assess the learning kit's practicality, we used the questionnaire (with teacher and student as data sources) and observation sheets. We used a test to assess the learning kit's effectiveness in terms of problem-solving skills and learning achievement. This development resulted in the trigonometry learning kit in the form of lesson plans or Rencana Pelaksanaan Pembelajaran (RPP) and worksheets or Lembar Kegiatan Peserta Didik (LKPD) using the STEM approach properly (meet the criteria of being valid, practical, and effective). The learning kit characteristics were: facilitating problem-solving skills and learning achievement, using problems related to Science, Technology, Engineering, and Mathematics, and organizing based on Engineering Design Process (EDP) steps.

How to Cite: Arivina, A. N., & Jailani, J. (2020). Development of trigonometry learning kit with a STEM approach to improve problem-solving skills and learning achievement. *Jurnal Riset Pendidikan Matematika, 7*(2), 178–194. https://doi.org/10.21831/jrpm.v7i2.35063

INTRODUCTION

The 21st-century competition requires Human Resources to be competent in science, technology, engineering design, and mathematics (Milaturrahmah et al., 2017). Trilling and Fadel (2009) state that 21st-century skills demand competent human resources in learning and innovation skills; information, media, and technology skills; and life and career skills. High school graduates should be proficient in the dimensions of science and technology (Ministry of Education and Culture, 2016a, p. 4). Hence, every individual must master not only one discipline. Learning uses the STEM approach in line with the expectations of the Curriculum 2013 regarding proficiency standards for secondary school graduates and 21st-century requirements. STEM combines some or all of the four disciplines from science, technology, engineering, and mathematics with real-world problems (Dare et al., 2018, p. 1). Torlakson (2014, p. 7) states that implementing STEM's objectives includes the need for the nation to increase the number of STEM experts to encourage innovation and keep a country competitive in the global

Table 1. The percentage of senior high school students who answer the math examination correctly in Semarang City in 2019

Test Topic	Program		
	Science	Social	Language
Algebra	56.23	46.27	43.91
Calculus	44.43	32.07	-
Geometry and Trigonometry	44.16	27.29	42.98
Statistics	45.44	46.94	44.07

economy. The research results by Syukri et al. (2013, p. 105), which integrates STEM in learning science in elementary and middle schools, show that learning can increase achievement and interest in learning.

Table 1 indicates that the geometry and trigonometry test material obtained the lowest percentage compared to other test materials (Centre for Educational Assessment, n.d.). The number of indicators algebra, calculus, geometry, trigonometry, and statistics is 14, 9, 3, 4, and 10, respectively. Three indicators on the trigonometry test material had a percentage of students who answered, correct less than 55%. Those indicators include (1) determining the value of a trigonometry ratio in various quadrants, (2) determining a graphical image of a trigonometry function, (3) solving contextual problems related to the sine and cosine rules, and (4) solving problems related to the cosine rule. Sterling (2014, p. 1) states that trigonometry forms the basis for many mathematics subjects - starting in elementary school with geometric shapes such as reading a map and continuing through calculus.

One indicator of questions on the trigonometry test material is solving contextual questions related to the sine and/or cosine rules. The problem is to determine the distance between bollards A and C if a triangular plot of land with each vertex is given boundary poles A, B, and C, the distance between the poles A and B is 300 m, $m\angle ABC = 45°$, and $m\angle BCA = 60°$. The Computer-Based National Examination problem on the trigonometry test material has used contextual problems. However, the percentage of students who answered mathematics problems correctly in the Computer-Based National Examination in the 2018/2019 academic year on geometry and trigonometry test material is still low. Based on the results of students' errors analysis in finishing a problem-solving test in trigonometry topic, students have errors in choosing what method or formula to used to solve the problem and do not understand the method or formula is chosen, students do not use all the information provided on the questions that affect the wrong result (Wahyuni & Widayanti, 2020, p. 85). Using the sine rule in the real context, students already understand the meaning of this picture. However, they cannot write it in the form of completion, so that students find it difficult to determine what trigonometry formula is used to solve the problem (Komala et al., 2020, p. 47).

Students' low competence in mastering the material shows student learning achievement, which is also low (Hijrihani & Wutsqa, 2015, pp. 2–3). Learning achievement is useful for quantifying the accomplishment and quality of learning. Dahal (2019, p. 77) states that achievement means the status of the accomplishment of all tasks or goals. According to Slameto (2010, p. 55), the level of learning achievement is influenced by two factors: internal and external. Internal factors include physical factors, psychological factors, and fatigue factors, while external factors include family factors, school factors, and community factors. External factors that come from schools are influenced by teachers' skill to deliver material, the availability of supporting facilities and infrastructure, or the use of a learning kit. One effort that needs to be considered to improve student learning achievement is through innovative learning models that align with learning objectives and the curriculum (Sidabutar, 2016, p. 10). Learning achievement assessment is needed to determine which students have good abilities or skills (Podomi & Jailani, 2015, p. 63).

According to the National Council of Teachers of Mathematics (NCTM, 2000, p. 29), students must have mathematical skill standards: problem-solving, reasoning and proof, communication, connection, and representation. One of the skills that students must master is problem-solving skill. Problem-solving skills are proficiency or potentials that students have to solve problems and apply them in everyday life (Gunantara et al., 2014, p. 5). Chabibah et al. (2019, p. 208) state that students' problem-solving skills can be trained by increasing problem-solving activities in mathematics learning. Students can practice problem-solving through the use of everyday problems in learning activities (Suryaningtyas, 2017, pp. 207–208). Nitko and Brokhart (2011, p. 186) state that problem-solving skills are not needed if the procedure to achieve a goal is well known to students.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Non-routine problem-solving strategies that arise during the learning process encourage students to think deeply about mathematical concepts related to the given problem (Wisniarti & Sugiman, 2018, p. 1). The problem-solving skill of Indonesian students is low, it is seen from the 2012 PISA results (OECD, 2014, p. 19), the difference in score per unit index of openness to problem-solving, Indonesia scored 7, while the OECD average of other countries was 31. Students' mathematical problem-solving can be trained and developed when the teacher can choose approaches, models, methods, or appropriate learning strategies and follow the material, situations, and conditions of students in learning (Siregar et al., 2018, pp. 464–465).

A learning kit is a form of preparation made by the teacher before carrying out the learning process (Tamba et al., 2019, p. 2). The key tasks involved in classroom teaching can usefully be grouped under three main headings: 'planning', 'presentation and monitoring', and 'reflection and evaluation' (Kyriacou, 2009, p. 86). Moon et al. (2002, p. 54) state that effective teachers are very systematic in preparing and implementing each lesson. The learning kit developed in this study focus on a lesson plan or RPP and worksheet or LKPD. RPP is a description of how the teacher directs student learning activities to achieve certain goals and functions as a framework to guide students to these goals (Vdovina & Gaibisso, 2013, p. 58). Ormrod et al. (2017, pp. 442–443) state that the preparation of RPP needs to consider several things from the students who will learn, namely the level of development, previous knowledge, cultural background, and other special educational needs. There are seven domains of lesson planning, namely: alignment with standards, appropriate learning objectives, opening and warming up, learning activities, closings, methods for measuring student understanding, instructional support for various students (Lim et al., 2018, p. 527). Besides RPP, students also need LKPD in the learning process. LKPD, according to Choo et al. (2011, p. 520), is a teaching kit that consists of a set of questions and information to guide the students to understand the material when they work systematically. LKPD are written materials containing explanations that guide activities that students will take in teaching any topic (İnan & Erkuş, 2017, p. 1373). Worksheets can be useful in many ways in terms of academic achievement, as a supplement to textbooks, to add information (Lee, 2014, p. 96).

Some teachers have used learning approaches or models that are tailored to the material being studied by students. However, RPP and LKPD have not been prepared to improve certain skills and have not used the STEM approach. STEM is suitable for Indonesia because STEM conforms to the Curriculum 2013 as an applicable curriculum in Indonesia (Arlinwibowo et al., 2020, p. 608). The STEM approach is an approach that combines two or more fields of science contained in STEM, namely, *Science, Technology, Engineering*, dan *Mathematics* (Khoiriyah et al., 2018, p. 54). Learning that integrates the STEM approach allows students to experience their learning process. The knowledge they can absorb and store into memory longer, the students' knowledge and understanding are more significant because the results themselves and not only receive information (Suherman et al., 2018, p. 2). Several STEM studies usually integrate the STEM approach with other learning approaches or models such as STEM through Engineering Design Process (EDP) (Winarno et al., 2020, p. 1346). An engineering design process integrates science, mathematics, and technology (Jolly, 2017, p. 25). According to Jolly, the EDP steps consist of defining the problem, research, imagine, plan, create, test and evaluate, redesign, and communicate.

Accessing STEM inspires students to think about its application in the real world (Roberts et al., 2018, p. 8). The integrated STEM approach can motivate students to pursue careers in STEM and increase their interest and performance in mathematics and science (Stohlmann et al., 2012, p. 32). The STEM-based PBL learning model's application can improve the problem-solving skills of XI Science of MA Nasruddin Dampit (Amelia et al., 2019, p.15). Research conducted by Suherman et al. (2018, p. 7) shows that students who get a STEM approach in learning have a better understanding of trigonometry concepts than students who get conventional learning. It shows that students who get a STEM approach better understand the trigonometry concept than those who receive conventional learning. Furthermore, the integration approach among STEM has a positive effect on student achievement (Becker & Park, 2011, p. 25). The STEM approach can further improve problem-solving skills with an increase in *N*-gain of 0.67 in the moderate category (Lestari, 2019, p. 108).

Research related to the use of the STEM approach in learning is mostly found in science disciplines (Acar et al., 2018, Khoiriyah et al., 2018, Lestari, 2019, Lestari et al., 2018, Sarnita et al., 2019, Syukri et al., 2013, Yaki et al., 2019). The following is research on STEM in mathematics. Previous research describes the integration of the STEM approach in quadrilateral material (Utami et al., 2018),

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

linear program material (Amelia et al., 2019), and three-dimensional material (Bakhtiar et al., 2020). Research Suherman et al. (2018) found out the increased comprehension of trigonometry concepts between the students who received STEM learning, and the who received conventional learning. Their research does not indicate that the learning kit's quality is used and not oriented to specific skills.

Based on the background, learning with the STEM approach has many theoretical benefits, especially learning achievement and problem-solving skills. Wang et al. (2011, p. 2) stated that one challenge of learning with the STEM approach is the lack of general instructions or examples for teachers to teach using the classroom's STEM approach. Therefore, the development of a learning kit is needed. The development of a learning kit with the STEM approach is a form of support for the demands of the 21st century that require competent human resources and following the expectations of the Curriculum 2013 regarding the competency standards of high school graduates. Therefore, trigonometry learning kit using the STEM approach is expected to be attractive alternative learning kits and can improve problem-solving skills and learning achievement. Therefore, this study aimed to produce a trigonometry learning kit for grade X SMA students using the STEM approach and describe the quality of the developed learning kit in terms of validity, practicality, and effectiveness.

METHOD

This research was research and development (R & D). The R & D method was a research method used to produce certain products or test their effectiveness (Sugiyono, 2015, p. 407). Meanwhile, Gay et al. (2011, pp.17–18) defined research and development as the process of researching and developing products to meet needs. There were many learning development models, but the developing learning kit in this study was referred to as the ADDIE model (Molenda & Boling, 2008, p. 110). This model consists of five phases: Analysis, Design, Development, Implementation, and Evaluation. The study's subjects were 32 students of tenth-grade in senior high school (SMA Negeri 5 Semarang), Indonesia. They consisted of 13 boys and 19 girls with heterogeneous characteristics. The research was conducted for seven meetings from April 2020 to May 2020. The first meeting was held pretest, the next five meetings were conducted with learning, and the last meeting was held posttest. In connection with the implementation of research during the COVID-19 pandemic, research activities were conducted online. The test was given using a Google Form while learning uses WhatsApp and Google Meet media.

Data were collected through questionnaires and tests. The questionnaire was a non-test instrument in the form of a set of questions, usually in written form and then given to respondents (Retnawati, 2016, p. 3). The questionnaire I was used to assessing the learning kit's validity level with expert lecturers as data sources. Questionnaire II was used to assess the practicality of the learning kit from teachers and students. The test was used to measure the effectiveness of the learning kit. We convert quantitative data into qualitative data based on Table 2 and Table 3 (Retnawati et al., 2017, pp. 127–128).

The learning kit's quality was determined based on validity, practicality, and effectiveness criteria (Nieveen, 1999, p. 127). According to Plomp and Nieveen (2010, p. 28), product quality was said to be valid if it meets needs, the components were based on up-to-date knowledge (content validity), and all components were consistent with each other (construct validity). According to Plomp and Nieveen (2010, p. 28), product quality was practical if it made it easy for teachers and students to use the product and follow the developer's intent. According to Plomp and Nieveen (2010, p. 28), the product's quality was said to be effective if the results were achieved as desired. Normalized gain (*N*-gain) as a measure of the effectiveness of a lesson (Hake, 1999) and was used to assess student performance on the initial and final tests (Bao, 2006, p .917).

The learning kit's validity was assessed using a questionnaire to choose a rating scale of 1 (not good) to 5 (very good). The assessment of the RPP instrument's validity consists of 32 items, and the assessment of the validity of the RPP instrument consists of 26 items. The assessment aspects of RPP validity were RPP identity, competence attainment indicators, learning objectives, the suitability of material, learning activities, the suitability of media, or learning resources, assessment of learning outcomes, and language use. The assessment aspects of LKPD validity were identity and guidance, indicators and learning objectives, the suitability with learning achievement, the suitability with the problem-solving skill, the suitability of content and material, layout, language conformity, the suitability of presentation component, and benefits of LKPD.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Table 2. Category of validity

Component	Interval	Category
RPP	$144 < X \leq 160$	Very good
	$128 < X \leq 144$	Good
	$112 < X \leq 128$	Fair
	$96 < X \leq 112$	Bad
	$X \leq 96$	Very bad
LKPD	$117 < X \leq 130$	Very good
	$104 < X \leq 117$	Good
	$91 < X \leq 104$	Fair
	$78 < X \leq 91$	Bad
	$X \leq 78$	Very bad

Table 3. Category of practicality

Component	Interval	Category
Teacher's response	$85,5 < X \leq 95$	Very good
	$76 < X \leq 85.5$	Good
	$66.5 < X \leq 76$	Fair
	$57 < X \leq 66.5$	Bad
	$X \leq 57$	Very bad
Students' response	$45 < X \leq 50$	Very good
	$40 < X \leq 45$	Good
	$35 < X \leq 40$	Fair
	$30 < X \leq 35$	Bad
	$X \leq 30$	Very bad

The learning kit's practicality was obtained from student assessment sheets, teacher assessment sheets, and learning implementation sheets. The teacher assessed the RPP and LKPD practicality by giving a checkmark on each statement's item to choose a rating scale of 1 (very bad) to 5 (very good). The practicality assessment of the RPP consists of ten items, and the practicality assessment of the LKPD consists of nine items. Students assessed the LKPD practicality by giving a checkmark on each statement's item to choose a rating scale from 1 (strongly disagree) to 5 (strongly agree). The LKPD practicality assessment consists of ten items. Meanwhile, learning implementation observation results were measured for each meeting, teacher activity, and student activity.

The effectiveness of the learning kit was measured using the problem-solving skills and learning achievement test. *N*-gain was used to measure a lesson's effectiveness (Hake, 1999) and assess students' performance on the initial and final tests (Bao, 2006, p.917). The level of *N*-gain (Hake, 1999) can be classified as follows, if $g \geq 0.7$, then the resulting gain was in the high category; if $0.3 \leq g < 0.7$, then the resulting gain was in the medium category; and if $g < 0.3$, then the resulting gain was in the low category. The problem-solving skill test consists of five essay questions, and the learning achievement test consists of ten multiple-choice questions. Figure 1 and 2 was one item on each test. The question was then measured for validity and reliability. Based on content validation by two Mathematics Education lecturers from Yogyakarta State University, both tests were valid. The problem-solving skill test has a reliability of 0.816 with a very high category, and the learning achievement test has a reliability of 0.622 with a high category.

The learning kit was valid if each component meets the minimum good category, practical if it meets the minimum good category, and the percentage of learning implementation at each meeting was at least 80%, and effective if the *N*-gain was obtained at least moderate category.

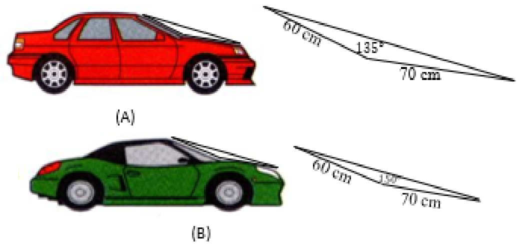
ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Test item:	**Translation:**
3. Diketahui $\sin A° = \frac{5}{13}$. Nilai dari $\cos(180° + A°)$ adalah … A. $-\frac{12}{13}$ B. $-\frac{5}{12}$ C. $-\frac{5}{13}$ D. $\frac{5}{12}$ E. $\frac{12}{13}$	Known $\sin A° = \frac{5}{13}$. The value of $\cos(180° + A°)$ is …

Figure 1. Sample of learning achievement test item

Problem:

5. Ketika mendesain sebuah mobil yang memiliki kecepatan tinggi diperlukan bentuk bagian depan yang dapat mengurangi gesekan dengan udara dan menghemat bahan bakar. Besarnya gesekan udara dipengaruhi oleh koefisien gesekan, masa jenis udara, laju relatif benda terhadap udara, dan proyeksi luas benda terhadap aliran udara. Panjang kaca mobil A dan B adalah 60 cm, dan panjang kap mobil A dan B adalah 70 cm. Sedangkan besar sudut antara kap mobil dengan kaca bagian depan pada mobil A adalah 135° dan besar sudut antara kap mobil dengan kaca bagian depan pada mobil B adalah 150°. Jika semakin kecil luas penampang maka semakin rendah gesekan udara. Mobil manakah yang mempunyai gesekan udara lebih rendah?



a. Informasi apa saja yang kamu peroleh dari masalah diatas?
   - ………………………………………………………
   - ………………………………………………………
   - ………………………………………………………

b. Buatlah permisalan untuk informasi (a)
   Panjang kaca mobil =….
   Panjang kap mobil =…

c. Berapakah luas penampang segitiga masing-masing mobil?
   Luas penampang segitiga mobil A =………………………
   =………………………
   =………………………
   Luas penampang segitiga mobil B =………………………
   =………………………
   =………………………

d. Apakah anda sudah yakin benar dengan jawaban (a), (b), dan (c)? Jika semakin kecil luas penampang maka semakin rendah gesekan udara. Mobil manakah yang mempunyai gesekan udara lebih rendah?...

Translation:

When designing a car that has a high speed, it requires a front shape that can reduce friction with the air and save fuel. The amount of air friction is influenced by the coefficient of friction, the density of the air, the relative velocity of the object to the air, and the projected area of the object to the air flow. The length of the windshields of cars A and B is 60 cm, and the hood lengths of cars A and B are 70 cm. Meanwhile, the angle between the hood and the windshield of car A is 135 ° and the angle between the hood and the windshield of car B is 150 °. If the smaller the cross-sectional area, the lower the air friction. Which car has lower air friction?

a. What information do you get about this problem?

b. Make an example for information (a)
   Car windshield length =….
   Hood length = ...

c. What is the cross-sectional area of each car?
   The cross-sectional area of the car A =
   The cross-sectional area of the car B =

d. Are you sure about answers (a), (b), and (c)? If the smaller the cross-sectional area, the lower the air friction. Which car has lower air friction? ...

Figure 2. Sample of problem-solving skill test item

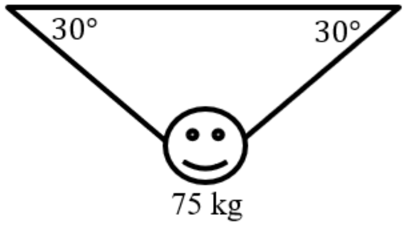
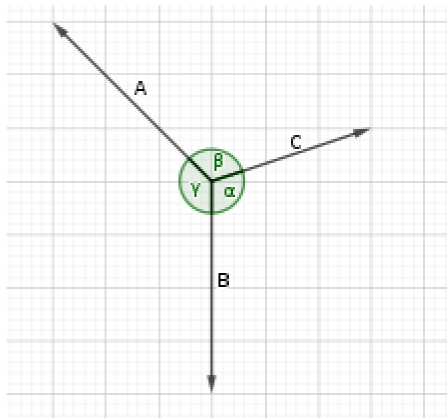
RESULTS AND DISCUSSION

Description of Learning Kit

The learning kit developed is RPP and LKPD on trigonometry material. RPP components are developed according to the Regulation of the Minister of Education and Culture Number 22/2016 (Ministry of Education and Culture, 2016b, p. 6), consisting of (1) school identity, (2) subject identity, (3) class/semester, (4) material principal, (5) allocation of time, (6) learning objectives, (7) basic competencies and competency achievement indicators, (8) learning materials, (9) learning methods, (10) learning media, (11) learning resources, (12)) learning steps; and (13) assessment of learning outcomes. The RPP is developed using the STEM approach, which theoretically can develop problem-solving skills and learning achievement. RPP has several characteristics. First, structured to improve problem-solving skills and learning achievement. It is characterized by identifying and understanding problems, exploring possible strategies, using strategies, checking and evaluating the solutions obtained. Second,

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Table 4. Examples of learning activities in the RPP (1)

No.	Teacher activities	Student activities
	Define the Problem & Research:	
18.	Ask students to discuss a problem related to the sine rule, where an archaeologist is crossing a rope tied to two cliffs *(STEM)*. (See an example of the LKPD)	Identifying the information obtained from the problem *(Identifying and understanding the problem)* The maximum rope tension is $7{,}8 \times 10^2\ N$ The mass of the archaeologist is 75 kg
	Imagine:	
19.	Ask students to sketch the archaeologist's position against the rope attached to the two cliffs if the angle θ is 30°.	Students sketch the archaeologist's position against the rope attached to the two cliffs if the angle θ is 30°. 
	Plan:	
20.	Ask students how to determine the rope tension and minimum length of rope required.	Determine rope tension using the Lamy theorem.  $\frac{A}{\sin\alpha}=\frac{B}{\sin\beta}=\frac{C}{\sin\gamma}$ Determine the length of the rope required using the sine rule, then the result is multiplied by 2. *(Exploring possible strategies)* $\frac{a}{\sin A}=\frac{b}{\sin B}=\frac{c}{\sin C}$
	Create	
21.	Ask students to determine rope tension.	Determining rope tension *(Using Strategy)*
22.	Ask students to calculate the minimum length of rope required	Determine the minimum length of rope required *(Using Strategy)*
23.	Invite students to compare the rope's condition when the rope tension angle θ is 30° with the maximum rope tension.	Answering that, what happens is the rope does not break because the tension of the rope when the angle θ is 30° is less than the maximum tension of the rope.
	Next, see Table 5.	

learning activities use problems related to Science, Technology, Engineering, and Mathematics. Examples of learning activities in the RPP can be seen in Table 4 and Table 5.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Table 5. Examples of learning activities in the RPP (2)

No.	Teacher activities	Student activities
	Test and evaluate:	
24.	Ask students about the answers obtained. Is there an answer or another way to solve the problem?	Double-check their answers and try other possible methods
	Communicate:	
26.	Ask students to determine the minimum angle so that the rope does not break	Calculate the minimum angle so that the rope does not break, which is 28.7° *(Check and evaluate the solution obtained)*
27.	The teacher conducts the confirmation of the students' responses by giving awards to each group of praise.	Make conclusions of these problems by rechecking the work that has been done. *(Check and evaluate the solution obtained)*

Examples of learning activities in the LKPD (1)

Problem:
An archaeologist is crossing a rope stretched between two cliffs by moving his hands slowly alternately. He was right in the middle of the rope, as in Figure 1, and the distance between the cliff is 500 m. If the tension on the rope exceeds $7{,}8 \times 10^2\ N$ the rope will break. The mass of the person is 75 kg. If the angle θ formed is 30°, determine the rope's tension and the minimum length of rope needed. What is the minimum angle θ so that the rope does not break?

Figure 1. An archaeologist is crossing a rope between two cliffs
Source: University Physics Book (Young et al., 2002)

Identifying and Understanding the Problem

a. What information do you get from the problems?

Exploring Possible Strategies

b. Sketch the archaeologist's position against the rope attached to the two cliffs if the angle θ is 30°.

See the next page ...

Examples of learning activities in the LKPD (2)

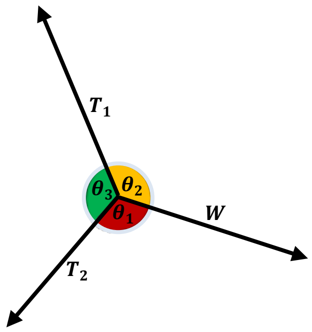


Figure 2

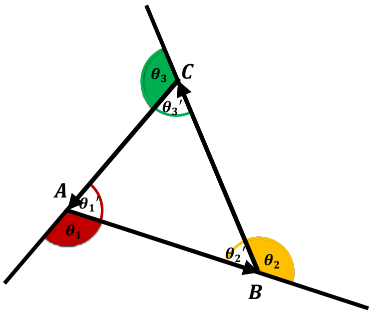


Figure 3

Description:
T : rope tension
W : weight

The three vectors $T_1, T_2, dan\ W$ in Figure 2 and Figure 3 are parallel, so that we can draw a triangle using these three vectors.
Pay attention to ΔABC
Write the sine rule that applies to ΔABC

$$\frac{\dots}{\dots} = \frac{\dots}{\dots} = \frac{\dots}{\dots} \qquad \dots. (1)$$

Use straightened corners and angular relation

$$\left.\begin{aligned} \sin\theta_1' &= \sin(180° - \cdots) = \sin \dots \\ \sin\theta_2' &= \sin(180° - \cdots) = \sin \dots \\ \sin\theta_3' &= \sin(180° - \cdots) = \sin \dots \end{aligned}\right\} (2)$$

Substitution (2) to equation (1)

$$\frac{\dots}{\dots} = \frac{\dots}{\dots} = \frac{\dots}{\dots} \qquad \dots. (3)$$

Equation (3) can be used to calculate rope tension.

c. Write down the formula that will be used to determine the rope tension and the minimum length of rope required:

Using Strategy

d. What is the minimum rope tension and length?

e. Based on the answer (d), what happened to the rope?

Checking and Evaluating the Solution Obtained

f. What is the minimum angle θ so that the rope does not break? ($2T \sin\theta = W$)

Are you sure all the answers are correct? Is there any other way to solve these problems? If there is, write down how here:

____

____

____

CONCLUSION

a. If the angle θ is 30°, the tension on the rope is … N and the minimum length of rope required is….
b. The minimum angle θ so that the rope does not break …°.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Furthermore, the LKPD developed uses the STEM approach with EDP steps: define the problem, research, imagine, plan, create, test and evaluate, redesign, and communicate. In defining the problem step, a problem is presented, which should be solved by the students. Research, students will collect information about the problem that may help them understand or resolve it. Imagine, students will use what they have learned to consider many possible solutions to this issue. Plan, students will choose a solution and plan for designing and resolving the problem. Create, student members will design the solution. In the test and evaluate step, the student will test and evaluate their answer to see if it successfully meets the criteria and accomplishes what it should. Redesign, if students find mistakes in the process, they may return to the "Plan" or "Create" communication. Students will share with one other and with the other teams during the lesson.

Eligibility of Learning Kit

The Validity of Learning Kit

The results of the RPP and LKPD assessments of each validator shown in Table 6 and Table 7. Referring to Table 2, the two validators' average number of RPP validity scores was 140 with a good category ($128 < X \leq 144$). Based on Table 6, the average score of the validity of the LKPD by the two validators was 113.5, with a good category ($104 < X \leq 117$). It can be concluded that the developed RPP and LKPD was valid.

Table 6. The validity of the RPP

No.	Validator	Total score
1.	I	150
2.	II	130
Average		140
Category		Good

Table 7. The validity of the LKPD

No.	Validator	Total score
1.	I	124
2.	II	103
Average		113.5
Category		Good

Based on Table 6 and Table 7, it can be concluded that the learning kit is ready to be tested in the field with some improvements according to input from the validator. Improvements to the RPP, such as the placement of learning syntax, do not follow the learning stages, and indicators and elements of the assessment section must be written in full. While the improvement on LKPD is adding a cover to the LKPD and improving its appearance, some problems in the LKPD do not contain questions and are only in the form of important information. Based on the results of the analysis of the validity of the RPP and LKPD, it can be concluded that the trigonometry learning kit with the STEM approach to improve learning achievement and problem-solving skills is valid. It indicates that the learning kit is feasible and ready to be used for research.

The Practicality of Learning Kit

Based on Table 8, the total score of the practicality by the teacher was 93 in the very good category ($85.5 < X \leq 95$), and the average score of the 32 students was 40.5 in the good category ($40 < X \leq 45$). Table 9 shows that the average percentage of teacher's activities during five meetings was 87.7%, and the average percentage of students' activities during five meetings was 84.8%. The teacher and students'

Table 8. The result of the teacher and students response questionnaire

No.	Subject	Component	Total score	Category
1.	Teacher	RPP LKPD	93	Very good
2.	Student	LKPD	40.5	Good

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Table 9. Percentage of learning implementation observation results

	Meeting					Average
	1	2	3	4	5	
Teacher's activity	90.9	80.9	95.7	81	90	87.7
Students' activity	86.4	80.9	95.7	81	80	84.8
Average	88.6	80.9	95.7	81	85	86.2

responses meet the minimum good category, and the average percentage of learning implementation has reached a minimum limit of 80%. Therefore, we can conclude that the trigonometry learning kit using the STEM approach was practical.

The Effectiveness of Learning Kit

Based on Table 10, it can be seen that the increase in the mean of problem-solving skill is 67.47. Before learning using the STEM approach, no students reached it completely, but after learning using the STEM approach, 31 students reached it completely. The percentage of completeness of the problem-solving skill test has increased by 96.9%. Based on Table 10, it can be seen that the increase in the mean learning achievement is 34.06. Before learning using the STEM approach, only eight students achieved completion, but after learning using the STEM approach, 26 students reached completion. The percentage of completeness of the learning achievement test has increased by 56.25%.

Table 10. Description of problem-solving skill and learning achievement test results

Description	Problem-solving skill		Learning achievement	
	Pretest	Posttest	Pretest	Posttest
Mean	14.09	81.56	40	74.06
Standard Deviation	10.30	5.37	20.64	13.41
Highest Score	33	100	70	90
Theoretical Highest Score	100	100	100	100
Lowest Score	0	69	10	40
Theoretical Lowest Score	0	0	0	0
The number of students who completed	0	31	8	26
The number of students	32	32	32	32
The percentage of completeness	0	96.9	25	81.25

The following is the calculation of the *N*-gain on the results of the learning achievement test:

$$g = \frac{\text{Percentage of posttest scores} - \text{Percentage of pretest scores}}{100\% - \text{Percentage of pretest scores}}$$

$$g = \frac{74.06 - 40}{100 - 40}$$

$$g = \frac{34.06}{60}$$

$$g = 0.567$$

The following is the calculation of the N-gain on the results of the problem-solving skill test:

$$g = \frac{81.56 - 14.09}{100 - 14.09}$$

$$g = \frac{72.7}{91.09}$$

$$g = 0.785$$

The *N*-gain calculation on the learning achievement test results shows that the increase in students' achievement after learning using the STEM approach is in the moderate category. The *N*-gain

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

calculation on the problem-solving skill test results shows that the increase in students' problem-solving skills after learning using the STEM approach is in the high category. Therefore, the learning kit developed to fulfill the effectiveness criteria is based on students' problem-solving skills and learning achievement.

Discussion

The trigonometry learning kit with the STEM approach is very valid, practical, and effective. It indicates that the trigonometry learning kit developed is feasible to improve problem-solving and learning achievement. The LKPD used contains motivation that inspires students to learn and provides an overview of the benefits of the material, and the problems used are everyday problems (related to science, technology, and engineering). Ahmad (2016, p. 271) states that motivation is an impetus that arises from within students to get high achievement, maintain their achievements, and direct the action to achieve their achievements. The use of everyday problems in learning activities allows students to continue to practice problem-solving (Suryaningtyas, 2017). One of the factors that affect students' difficulties in problem-solving is the lack of accuracy in working on questions (Novferma, 2016; Tias & Wustsqa, 2015). Before students conclude the answers obtained by the problem-solving process, in the developed LKPD some questions ask students to check their answers again. It aims to train students' accuracy.

With STEM, students can understand the concept of trigonometry because the learning process provides an opportunity to build mathematical concepts and relate them to real-world problems (Suherman et al., 2018, p. 7). One of the factors that affect this achievement is the use of the STEM approach. The learning kit arranged using the STEM approach invites students to learn from various disciplines. The questions in the LKPD are contextual problems related to Science, Technology, Engineering, and Math. Some of the STEM learning criteria are science and math content standards-based, grade-appropriate, and applied; students focus on solving real-world problems, and students are introduced to STEM careers and/or life applications (Jolly, 2017, p.25). In the teacher's experience, STEM learning makes students more exploratory toward a case so that the learning material becomes more meaningful for students (Arlinwibowo et al., 2020, p. 608). The questions contained in the LKPD may facilitate the problem-solving skill and learning achievement of students. Shernoff et al. (2017, p. 4) show that the benefits of implementing STEM are providing learning opportunities that are learner-centered, meaningful, interesting, and facilitating problem-solving skills. According to Moomaw (2013, p. 8), in STEM activities, teachers encourage students to solve their problems rather than give direct answers to build the knowledge they already have and deepen their conceptual understanding. Shernoff et al. (2017, p. 4) said that integrating STEM disciplines positively affects school responses and learning achievement.

The initial lesson plan is carried out face-to-face but must be carried out online because of the Covid-19 pandemic. Of course, this impacts several activities that cannot be carried out as planned, ineffective discussion activities, and less time allocation. One of the impacts is the second meeting activity, which requires students to measure the whiteboard's height when measured by two students with different elevation angles. The solution taken is to provide information about the height of two students and two elevation angles so that further activities can still be carried out. The development of lesson plans in this study has implemented several of these things. For example, starting learning by recalling the previous material and relating to the material to be studied (prerequisite), learning has been designed to be student-centered (the teacher becomes the facilitator), understanding student misconceptions by asking questions to check and evaluate the solutions obtained. The teacher trains students to work on problems by paying attention to problem-solving steps starting to identify and understand problems, check and evaluate the solutions obtained, and presenting the problems presented in students' worksheets related to real-world problems, especially those related to STEM. To support those activities, the teacher can apply several technologies (using calculators, use the internet to check the solutions).

CONCLUSION

This research's product is a trigonometry learning kit using the STEM approach to improve students' problem-solving skills and learning achievement. The learning kit has characteristics of containing learning activities that facilitate problem-solving skills and learning achievement, and the

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

problems found in LKPD use real-world problems to introduce STEM careers and life applications. According to the expert assessment results, the trigonometry learning kit's validity using the STEM approach is valid. The practicality assessment by the teacher is in the very good category. The practicality assessment by students is in a good category. The percentage of learning implementation was over 80%. Therefore, the learning kit is practice. The increase in students' problem-solving skills and learning achievement after learning using the STEM approach, respectively, is in the high and moderate category. It can conclude that the learning kit is effective. The suggestions for further research, namely (1) need to be a follow-up from other researchers to be tested the learning kit on a larger subject, (2) the teachers can use the learning kit as a reference to develop a learning kit with the STEM approach on other mathematics topics.

ACKNOWLEDGEMENT

The authors thank to all of the participants in this study and greatly acknowledgment the funding from Direktorat Riset dan Pengabdian Masyarakat, Deputi Bidang Penguatan Riset dan Pengembangan, Kementerian Riset dan Teknologi/Badan Riset dan Inovasi Nasional Republik Indonesia (Directorate of Research and Community Service, Deputy for Strengthening Research and Development, Ministry of Research and Technology/National Research and Innovation Agency, Indonesia).

REFERENCES

Acar, D., Tertemiz, N., & Tasdemir, A. (2018). The effects of STEM training on the academic achievement of 4th graders in science and mathematics and their views on STEM training teachers. *International Electronic Journal of Elementary Education, 10*(4), 505–513. https://www.iejee.com/index.php/IEJEE/article/view/465

Ahmad, S. (2016). Pengaruh math phobia, self-efficacy, adversity quotient dan motivasi berprestasi terhadap prestasi belajar matematika siswa SMP [The effect of math phobia, self-efficacy, adversity quotient and achievement motivation on mathematics learning achievement of junior high school students]. *Jurnal Riset Pendidikan Matematika*, *3*(2), 259–272. http://doi.org/10.21831/jrpm.v3i2.6138

Amelia, A., Abidin, Z., & Faradiba, S. S. (2019). Penerapan model pembelajaran problem based learning berbasis *STEM* (Science, Technology, Engineering and Mathematics) untuk meningkatkan kemampuan pemecahan masalah matematika materi program linear siswa kelas XI IPA MA Nasruddin Dampit tahun akademik 2018/2019 [Application learning model of problem-based learning based STEM (Science, Technology, Engineering and Mathematics) to improve mathematical problem-solving skills of students of class XI IPA MA Nasruddin Dampit in the academic year 2018/2019]. *Jurnal Penelitian, Pendidikan, dan Pembelajaran*, *14*(2), 10–16. http://riset.unisma.ac.id/index.php/jp3/article/view/2497

Arlinwibowo, J., Retnawati, H., & Kartowagiran, B. (2020). The types of STEM education implementation in Indonesia. *Journal of Xi'an University of Architecture & Technology*, *12*(8), 606–613. https://doi.org/10.37896/JXAT12.08/2664

Bakhtiar, I., Kurniati, L., & Nayazik, A. (2020). Effectiveness of STEM (Science, Technology, Engineering, Mathematics) approach towards mathematics learning achievement on point, line and field material in three dimensions. *Jurnal Hipotenusa, 2*(1), 1–5. https://doi.org/10.18326/hipotenusa.v2i1.1-5

Bao, L. (2006). Theoretical comparisons of average normalized gain calculations. *American Journal of Physics*, *74*(10), 917–922. https://doi.org/10.1119/1.2213632

Becker, K. H., & Park, K. (2011). Effects of integrative approaches among Science, Technology, Engineering, and Mathematics (STEM) subjects on students' learning: a preliminary meta analysis. *Journal of STEM Education*, *12*(5), 23–37. https://www.jstem.org/jstem/index.php/JSTEM/article/view/1509

Centre for Educational Assessment. (n.d.). *Laporan hasil ujian nasional* [*National exam results report]* Ministry of Education and Culture. https://hasilun.puspendik.kemdikbud.go.id/

Chabibah, L. N., Siswanah, E., & Tsani, D. F. (2019). Analisis kemampuan pemecahan masalah siswa dalam menyelesaikan soal cerita barisan ditinjau dari adversity quotient [Analysis of students' problem-

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

solving skills in solving sequence story questions in terms of adversity quotient]. *Pythagoras: Jurnal Pendidikan Matematika*, *14*(2), 199–210. https://doi.org/10.21831/pg.v14i2.29024

Choo, S. S. Y., Rotgans, J. I., Yew, E. H. J., & Schmidt, H. G. (2011). Effect of worksheet scaffolds on student learning in problem-based learning. *Advances in Health Sciences Education*, *16*(4), 517–528. https://doi.org/10.1007/s10459-011-9288-1

Dahal, B. (2019). Formative assessment and achievement of mathematics students in community schools of Nepal. *Social Inquiry: Journal of Social Science Research*, *1*(1), 75–93. https://doi.org/10.3126/sijssr.v1i1.26918

Dare, E. A., Ellis, J. A., & Roehrig, G. H. (2018). Understanding science teachers' implementations of integrated STEM curricular units through a phenomenological multiple case study. *International Journal of STEM Education*, *5*(1), 1–19. https://doi.org/10.1186/s40594-018-0101-z

Gay, I. R., Geoffrey, E. M., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and application*. Pearson.

Gunantara, G., Suarjana, M., & Riastini, P. N. (2014). Penerapan model pembelajaran problem based learning untuk meningkatkan kemampuan pemecahan masalah matematika siswa kelas V [Application of problem-based learning models to improve the mathematics problem solving skills of fifth-grade students]. *Jurnal Mimbar PGSD Universitas Pendidikan Ganesha, 2*(1), 1–10. http://doi.org/10.23887/jjpgsd.v2i1.2058

Hake, R. R. (1999). Analyzing change/gain scores. https://www1.physics.indiana.edu/~sdi/AnalyzingChange-Gain.pdf

Hijrihani, C., & Wutsqa, D. (2015). Keefektifan cooperative learning tipe jigsaw dan STAD ditinjau dari prestasi belajar dan kepercayaan diri siswa [The effectiveness of cooperative learning types jigsaw and STAD in terms of learning achievement and student self-confidence]. *Pythagoras: Jurnal Pendidikan Matematika*, *10*(1), 1–14. https://doi.org/10.21831/pg.v10i1.9091

İnan, C., & Erkuş, S. (2017). The effect of mathematical worksheets based on multiple intelligences theory on the academic achievement of the students in the 4th grade primary school. *Universal Journal of Educational Research*, *5*(8), 1372–1377. https://doi.org/10.13189/ujer.2017.050810

Jolly, A. (2017). *STEM by design: Strategies and activities for grades 4–8*. Routledge.

Khoiriyah, N., Abdurrahman, A., & Wahyudi, I. (2018). Implementasi pendekatan pembelajaran STEM untuk meningkatkan kemampuan berpikir kritis siswa SMA pada materi gelombang bunyi [Implementation of the STEM learning approach to improve high school students' critical thinking skills in sound wave material]. *Jurnal Riset dan Kajian Pendidikan Fisika*, *5*(2), 53–62. https://doi.org/10.12928/jrkpf.v5i2.9977

Komala, E., Suryadi, D., & Dasari, D. (2020). Learning obstacle related to the ability of high school student representation to the trigonometry concept. *Proceeding books: The 2nd international conference and innovation exhibition global education (ICEGE),* pp. 43–49. https://doi.org/10.22236/ie.v1i1.107

Kyriacou, C. (2009). *Effective teaching in schools: Theory and practice*. Stanley Thornes.

Lee, C. (2014). Worksheet usage, reading achievement, classes' lack of readiness, and science achievement: A cross-country comparison. *International Journal of Education in Mathematics, Science and Technology*, *2*(2), 96–106. https://doi.org/10.18404/ijemst.38331

Lestari, D. A. B., Astuti, B., & Darsono, T. (2018). Implementasi LKS dengan pendekatan STEM (Science, Technology, Engineering, and Mathematics) untuk meningkatkan kemampuan berpikir kritis siswa [Implementation of worksheets with a STEM (Science, Technology, Engineering, and Mathematics) approach to improve students' critical thinking skills]. *Jurnal Pendidikan Fisika dan Teknologi, 4*(2), 202–207. http://doi.org/10.29303/jpft.v4i2.809

Lestari, I. F. (2019). Pendekatan Science, Technology, Engineering, and Mathematics (STEM) untuk meningkatkan kemampuan pemecahan masalah fisika siswa pada konsep tekanan hidrostatis

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

[Science, Technology, Engineering, and Mathematics (STEM) approach to improve students' physics problem solving skills on the concept of hydrostatic pressure]. *Jurnal Pendidikan Universitas Garut*, *13*(1), 103–109. https://journal.uniga.ac.id/index.php/JP/article/view/831

Lim, W., Son, J. & Kim, D. (2018). Understanding preservice teacher skills to construct lesson plans. *International Journal of Science and Mathematics Education, 16*(3), 519–538. https://doi.org/10.1007/s10763-016-9783

Milaturrahmah, N., Mardiyana, M., & Pramudya, I. (2017). Mathematics learning process with Science, Technology, Engineering, Mathematics (STEM) approach in Indonesia. *Journal of Physics: Conference Series*, *895*, 012030. https://doi.org/10.1088/1742-6596/895/1/012030

Ministry of Education and Culture. (2016a). *Lampiran Peraturan Menteri Pendidikan dan Kebudayaan Nomor 20 Tahun 2016 tentang Standar Kompetensi Lulusan Pendidikan Dasar dan Menengah. [Attachment Regulation of the Minister of Education and Culture No. 20 of 2016 on Graduate Competency Standards for Primary and Secondary Education].* Ministry of Education and Culture

Ministry of Education and Culture. (2016b). *Lampiran Peraturan Menteri Pendidikan dan Kebudayaan Nomor 22 Tahun 2016 tentang Standar Proses Pendidikan Dasar dan Menengah [Attachment Regulation of the Minister of Education and Culture No. 22 of 2016 on Standards Process for Primary and Secondary Education].* Ministry of Education and Culture

Molenda, M., & Boling, E. (2008). *Creating*. In A. Januszewski & M. Molenda (Eds.). *Educational technology: A definition with commentary*. Taylor & Francis. https://doi.org/10.4324/9780203054000

Moomaw, S. (2013). *Teaching STEM in the early years: Activities for integrating science, technology, engineering, and mathematics*. Redleaf Press

Moon, B., Mayes, A. S., & Hutchinson, S. (2002). *Teaching, learning, and the curriculum in secondary schools: A reader*. Routledge.

NCTM. (2000). *Principles and standards for school mathematics*. Author.

Nieveen, N. (1999). *Prototyping to reach product quality.* In J. Van den Akker, R. M. Branch, K. Gustafson, N. Nieveen, T. Plomp (Eds.) *Design approaches and tools in education and training* (pp. 125–136). ICO Cluwer Academic Publisher.

Nitko, A. J., & Brookhart, S. M. (2011). *Educational assessment of students*. Pearson.

Novferma, N. (2016). Analisis kesulitan dan self-efficacy siswa SMP dalam pemecahan masalah matematika berbentuk soal cerita [Analysis of the difficulties and self-efficacy of junior high school students in solving math problems in the form of story questions]. *Jurnal Riset Pendidikan Matematika*, *3*(1), 76–87. https://doi.org/10.21831/jrpm.v3i1.10403

OECD. (2014). *PISA 2012 result in focus.* OECD Publishing. https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf

Ormrod. J. E., Anderman, E. M., & Anderman, L. (2017). *Educational Psychology: Developing learners* (9th ed.). Pearson.

Plomp, T., & Nieveen, N. (2010). *An introduction to educational design research*. SLO-Netherlands Institute for Curriculum Development

Podomi, P. A., & Jailani, J. (2015). Pengaruh pendekatan analogi personal terhadap prestasi, penalaran dan kemandirian siswa materi dimensi dua di SMK [The influence of the personal analogy approach on student achievement, reasoning and independence in two-dimensional material at vocational school]. *Pythagoras: Jurnal Pendidikan Matematika, 10*(1), 61–70. https://doi.org/10.21831/pg.v10i1.9110

Retnawati, H. (2016). *Analisis kuantitatif instrumen penelitian: Panduan peneliti, mahasiswa, dan psikometrian) [Quantitative analysis of research instruments: Researcher, student, and psychometric Guidelines)].* Parama.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Retnawati, H., Hadi, S., Nugraha, A. C., Ramadhan, M. T., Apino, E., Djidu, H., Wulandari, N. F., & Sulistyaningsih, E. (2017). *Menyusun laporan hasil asesmen pendidikan di sekolah [Prepare reports on the results of the assessment of education in schools]*. UNY Press.

Roberts, T., Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Cavalcanti, M., D. Schroeder, C., Delaney, A., Putnam, L., & Cremeans, C. (2018). Students' perceptions of STEM learning after participating in a summer informal learning experience. *International Journal of STEM Education*, *5*(1), 1–14. https://doi.org/10.1186/s40594-018-0133-4

Sarnita, F., Fitriani, A., & Widia, W. (2019). Pengembangan perangkat pembelajaran model PBL berbasis STEM untuk melatih keterampilan berfikir kreatif siswa tuna netra [Development of STEM-based PBL learning kit to practice creative thinking skills of visually impaired students]. *Jurnal Pendidikan MIPA*, *9*(1), 38–44. https://doi.org/10.37630/jpm.v9i1.180

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *International Journal of STEM Education*, *4*(13), 1–16. https://doi.org/10.1186/s40594-017-0068-1

Sidabutar, R. (2016). The efforts to improve mathematics learning achievement results of high school students as required by competency-based curriculum and lesson level-based curriculum. *Journal of Education and Practice*, *7*(15), 10–15. https://www.iiste.org/Journals/index.php/JEP/article/view/30805

Siregar, N., Asmin, D., & Fauzi, K. M. A. (2018). The effect of problem based learning model on problem solving ability student. *Proceedings of the 3rd Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2018)*. https://doi.org/10.2991/aisteel-18.2018.100

Slameto, S. (2010). *Belajar dan faktor-faktor yang mempengaruhinya [Learning and the factors that influence it]*. Rineka Cipta

Sterling, M. J. (2014). *Trigonometry for dummies*. John Wiley & Sons.

Stohlmann, M., Moore, T., & Roehrig, G. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research*, *2*(1), 28–34. https://doi.org/10.5703/1288284314653

Sugiyono, S. (2015). *Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R & D [Educational research methods: Quantitative, qualitative, and R & D approaches]*. Alfabeta.

Suherman, S., Komarudin, K., Rosyid, A., Aryanita, S., Asriyanto, D., Putra, T. A., & Anggoro, T. (2018). Improving trigonometry concept through STEM (Science, Technology, Engineering, and Mathematics) learning. *International Conference on Multidisciplinary Academic (ICMA) 2018*. https://doi.org/10.2139/ssrn.3248139

Suryaningtyas, C. P. (2017). Pengembangan perangkat pembelajaran matematika dengan PMRI untuk meningkatkan kemampuan pemecahan masalah dan komunikasi matematika [Development of mathematics learning kit with PMRI to improve problem solving skills and mathematics communication]. *Pythagoras: Jurnal Pendidikan Matematika, 12*(2), 200–209. https://doi.org/10.21831/pg.v12i2.14876

Syukri, M., Halim, L., & Meerah, T. S. M. (2013). Pendidikan STEM dalam entrepreneurial science thinking "ESciT", satu perkongsian pengalam dari UKM untuk Aceh [STEM education in entrepreneurial science thinking "ESciT", sharing experiences of UKM for Aceh]. Aceh Development International Conference 2013.

Tamba, E. F., Syafari, S., Siagian, P., & Sihotang, M. L. (2019). Development of realistic mathematics education-based learning devices to improve mathematical problem solving skills of SMP Negeri 1 Medan students. *American Journal of Educational Research*, *7*(1), 1–5. https://doi.org/10.12691/education-7-1-1

Tias, A. A. W., & Wustsqa, D. U. (2015). Analisis kesulitan siswa SMA dalam pemecahan masalah matematika kelas XII IPA di Kota Yogyakarta [Difficulty analysis of high school students in mathematical problem solving class XII science in Yogyakarta]. *Jurnal Riset Pendidikan Matematika*, *2*(1), 28–39. https://doi.org/10.21831/jrpm.v2i1.7148

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Torlakson, T. (2014). *Innovate: A blueprint for science, technology, engineering, and mathematics in California public education*. State Superintendent of Public Instruction.

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. John Wiley & Sons.

Utami, T. N., Jatmiko, A., & Suherman, S. (2018). Pengembangan modul matematika dengan pendekatan Science, Technology, Engineering, and Mathematics (STEM) pada materi segiempat [Development of a mathematics module with the Science, Technology, Engineering, and Mathematics (STEM) approach on quadrilateral material]. *Desimal: Jurnal Matematika*, *1*(2), 165–172. https://doi.org/10.24042/djm.v1i2.2388

Vdovina, E., & Gaibisso, L. C. (2013). Developing critical thinking in the english language classroom: A lesson plan. *ELTA Journal*, *1*(1), 54–68. https://eltajournal.org.rs/elta-journal-volume-1-no-1-dec-2013-2/

Wahyuni, N. S., & Widayanti, E. (2020). Students' errors analysis in finishing a problem solving test based on newman procedures in trigonometry materials. *IndoMath: Indonesia Mathematics Education*, *3*(2), 78–86. https://doi.org/10.30738/indomath.v3i2.7213

Wang, H., Moore, T. J., Roehrig, G. H., & Park, M. S. (2011). *STEM* integration: Teacher perceptions and practice. *Journal of Pre-College Engineering Education Research*, *1*(2), 1–13. https://doi.org/10.5703/1288284314636

Winarno, N., Rusdiana, D., Samsudin, A., Susilowati, E., Ahmad, N. J., & Afifah, R. M. A. (2020). The steps of the engineering design process (EDP) in science education: A systematic literature review. *Journal for the Education of Gifted Young Scientists, 8*(4), 1345–1360. http://doi.org/10.17478/jegys.766201

Wisniarti, W., & Sugiman, S. (2018). A student's cognitive dissonance in solving non-routine perimeter problems. *Journal of Physics: Conference Series*, *1097*, 012099. https://doi.org/10.1088/1742-6596/1097/1/012099

Yaki, A. A., Saat, R. M., Sathasivam, R. V., & Zulnaidi, H. (2019). Enhancing science achievement utilizing an integrated STEM approach. *Malaysian Journal of Learning and Instruction*, *16*(1), 181–205. https://doi.org/10.32890/mjli2019.16.1.6

Young, H. D., Freedman, R. A., Sandin, T. R. & Ford, A. L. (2002). *Fisika universitas edisi 10* [*University physics tenth edition]* (E. Juliastuti, Trans.). Erlangga. Original work published 2000.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)