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USING THE STEM APPROACH-BASED LEARNING MODEL IN ELEMENTARY SCHOOLS TO BOOST TEACHER CREATIVITY

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Abstrak

Teachers in elementary schools were given creativity questionnaires as part of a quantitative study to see how the STEM approach to learning affected teachers'n creativity. In this work, both the experimental and pre-experimental approaches were applied. The STEM method can boost teachers' creativity in elementary classrooms, according to research findings. This article offers recommendations on how to develop environments that foster and promote teachers' creativity.

INTRODUCTION

The education sector must be better equipped to handle the difficulties of fostering teacher innovation in the instructional process in order to succeed in the future 21st century. This has to be done first in order to raise educational standards. The rise in teacher creativity unquestionably plays a significant role in the contemporary development of education.

The indicators of teacher creativity must be adjusted for educational progress. With regard to learning, Abat 21 skills place a priority on practical activities and encourage experimentation. The term "creative" refers to the process of mentally formulating plans for novel approaches, theories, concepts, expressions, or goods. mostly due to the wide range of this subject. Because of the many ways that creativity can appear, it is quite challenging to quantify.

The human brain's right hand side is where creative processes take place. People use this part of the brain the least. This differs from left hemispheric process thinking, which is processed by logic and sequence. More creative abilities are still being underutilized.

Until we attempt, most expectations are unpredictable. Everyone has the capacity for creativity, and everyone has a creative aspect to their brain. Due to the demands of modern life and the demand for specialists, many of us never have the time or chance to discover our hidden abilities and reach our full potential.

Approach STEM

The aim of the STEM approach to education is to prepare students for careers in their chosen disciplines by making them competitive and job-ready. The primary objective of STEM education is to teach comprehensive knowledge about all STEM subjects, according to research done by the Hannover Research Institute in 2011.

Rapid globalization and technical advancement are two characteristics of the twenty-first century. Today's innovations in information and communication technologies make it simple to dissolve geographical boundaries. Right now, it's not difficult to find and amass varied facts and knowledge.

Due to this, a new economic era centered on information and technology emerged. A person will be able to handle a variety of issues in a global society if they have the ability to acquire, process, and comprehend this diverse information and knowledge. This implies the significance of the necessary learning concepts.

STEM-based learning, which takes an interdisciplinary approach to education, is one method of addressing this issue in the classroom (Reeve, 2013). STEM-based learning integrates science, technology, engineering, and mathematics in real-world contexts that are connected to classrooms, the workplace, and the rest of the world to help students build STEM literacy that will help them compete in the 21st century.

We can see that STEM-based education is crucial by looking at the following:

- Shifts in the STEM education process that blur the lines between science, mathematics, technology, and engineering as well as connect what students learn to real-world issues and generate original solutions. (Santrock, 2002).
- Development of scientific comprehension skills: By connecting various scientific concepts to actual problems, STEM education can help students develop their understanding of science. It's crucial to comprehend this content in order to impart concepts through student responses (Hergenhahn and Olson, 2017).
- Human resource development: In the twenty-first century, it is important to include expectations for abilities like the capacity to collaborate, communicate, think critically, and be creative in hiring criteria. STEM-based education develops a range of problem-solving abilities. In 2013, Capraro et al.
- Engineering prowess is the secret to the creation of technology, according to the technological challenge. Students are pushed to use their understanding of engineering design to develop technical fixes for issues in STEM education. DeCoito (2014) asserts.
- Students develop problem-solving abilities, which are crucial to the development and creativity of STEM education. According to Suwarna et al. (2015), this capability will lead to various technological advances as well as increased learning motivation in students.
- Vital to wellbeing: Numerous technical advancements have been created to simplify our lives and increase the value of knowledge (Trianto, 2007).
- In order for STEM learning to be successful and for instructors to become more creative, Roehrig (2012) identified four factors that educators should take into account. The following figure shows the four elements.

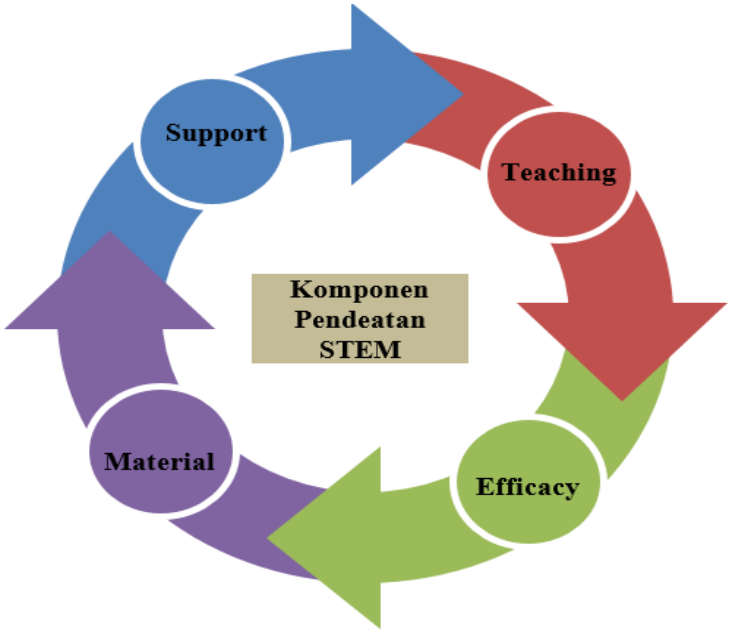


Figure 1: Components that Support STEM Learning

Teachers can incorporate STEM learning in their classrooms by doing a variety of things, including going to appropriate training sessions, collaborating with other organizations or schools, and working with other teachers in the same school. Focus is placed on planning and carrying out in-class learning in the instructional or learning component. Teacher confidence in delivering STEM education is a key component of success. The degree of the teacher's understanding of the subject matter and teaching techniques, as well as their dedication to the execution of learning, might have an impact on this level of self-assurance. Materials pertaining to learning facilities' readiness.

Design, systems, and the use of technology are all elements of integrated STEM-based science education, which teaches science concepts in a practical way. So it is envisaged that STEM-based learning can improve Indonesia's competitiveness. The ability to think critically and comprehend text and information thoroughly, among other STEM learning outcomes, have been found to benefit by speaking in small groups, according to growing research (Murphy et al., 2018).

Steps in the STEM Approach

During the STEMRA learning processes, a number of requirements must be met.

- Observation (observation), in which students make observations on issues and phenomena relevant to the STEM concept that arise in daily life and that will be provided in accordance with the material (Weil, 1980).
- New Ideas (new ideas), wherein students are tasked with gathering more data regarding challenges, problems, and occurrences in nature or the environment. Additionally, instructors direct pupils to conduct analysis at the moment (Piaget, 1984).
- Design or planning tasks students with creating a problem that needs to be solved in order to address a problem, issue, or occurrence related to nature or the environment. They then demonstrate solutions with proper planning

- Communication, or communication, assists pupils in problem-solving and encourages the application of original thought. Additionally, it boosts their self-assurance in their skills (Jolly, 2017).
- According to Santrock (2002), creativity (creation) and society (values) are two subjects where students can express the concepts they have created in the form of plans to address issues.
- Society, where pupils are given the chance to advance their knowledge based on the ideas they have studied. Students create items to practice problem-solving.

Teacher Innovation

Creativity is key to European education strategy. The development of creative and innovative skills for the workplace and life after school has been acknowledged to be dependent on school and early education. The opportunity for general educators to develop and encourage each student's creativity is exceptional. The study of teacher creativity and its characterization has grown in importance as a field of study within the behavioral sciences. The concepts of creative teaching and teaching for creativity are regularly brought up in discussions of education today. Creative teaching, according to Cremin (2009), "engages teachers in making learning more interesting and effective and using imaginative approaches in the classroom." Teachers' individual originality, as well as how they express it in daily practice, are all part of creative teaching. Creativity can be increased by combining activities and instruction (Kim, Roh, & Cho, 2016).

According to Halper (Oga: 2013), "creative thinking is frequently referred to as divergent thinking, which means that it provides various possible answers to the same question." There are three categories of information that are stored or remembered in the brain, according to Langrehr: What is believed about diverse symbols, numbers, words, sentences, facts, rules, procedures, and so forth constitutes content (content); feelings regarding the information; "Piaget's (1983)

> “The main objective of education is to produce men who are innovative, creative, and discoverers—men who can develop new things rather than just copying what previous generations have done.”

Gallagher's (2010) statement that

> "Creativity is a mental process by which an individual creates new ideas or products, or combines existing ideas and products, in a fashion that is novel to him or her" supports Piaget's theory.”

As a mental process used by a person to develop new concepts and products, or to mix the two, which will finally stick to himself, creativity is the capacity to create, create, and create something. The expression and actualization of one's identity in relation to oneself and others are aided by experiences associated to creativity.

Motode

The use of generic learning techniques can increase instructor creativity during the instructional process. A class for controls and a class for experiments make up this form of experimental research's pre-experimental design. Fraenkel and Wallen (2009) defined experiment as trying, looking for, and confirming. According to Gordon L. Patzer (1996), a causal relationship or cause and effect is the cornerstone of

experimental research. In this instance, the dependent variable's value will change if the independent variable's value changes.

According to Creawll (2012), experimental research methods are utilized to determine the relationship between independent and dependent variables' causal effects. This means that, with the exception of the independent variable, or treatment, the researcher must account for all factors that influence the findings. Researchers will look into 21 instructors to learn more about their creativity in adopting STEM concepts in elementary classrooms. Data was gathered by dispersing traditional learning tools and STEM learning tools using a Likert scale Djaali (2008). A typical research equipment for a conventional method is depicted in Table 1.

Table 1: Conventional Method Instruments

Assessment indicators	Assessment criteria				
	1	2	3	4	5
The learning process begins with preparing the class (Suryabrata, 2009)					
Teachers use the conventional method Sudjana (2016)					
Teachers explain the lessons based on the lecture method (Sanjaya, 2006)					
Teachers do not use media in the learning process. Sanjaya (2006)					
Students are not given the opportunity to ask Winkel (1991)					
Teachers often give instructions to students Fleming and Mills (1992)					
Students only listen to what the teacher explains Fleming and Mills (1992)					
Students in the learning process are cool with their respective activities. Sanjaya (2006)					
Students just wait for orders from the teacher Fleming and Mills (1992)					

Information:

Very good : 5

Good : 4

Neutral : 3

Not good : 2

Not very good : 1

The sorting assessment method can be modified for each category in order to examine creativity, and the evaluation can be guided by Sitinggins' (1994) findings. The researchers will apply the fundamental selection criteria, namely, to evaluate instructor creativity.

- Knowledge and outcomes demonstrate that teachers have a substantial command of the subject matter;
- Reasoning and outcomes demonstrate that teachers act in accordance with their abilities;
- Skills and outcomes demonstrate skills based on an understanding of the subject matter;
- Product and outcomes demonstrate mastery of materials that can produce products;
- Affective and outcomes demonstrate application of knowledge possessed in attitude.

The indicator table for teacher creativity in table 2 is shown below.

Table 2: Indicator of Teacher Creativity

Kreativitas Guru	Kriteria penilaian					%
	1	2	3	4	5	
Knowledge & Outcomes						
Teachers are knowledgeable about the subject matter in their field.	21	-	-	-	-	100%
Teachers can modify assignments to fit students' skill levels	21	-	-	-	-	
Skill & Oucames						
Teachers can design educational resources.	21	-	-	-	-	100%
Teachers employ a range of media	21	-	-	-	-	
Product & Oucames						
The environment is a resource used by teachers.	18	2	1	-	-	86%
Teachers operating home businesses on school property	18	2	1	-	-	
Affective & Outcomes						
Used items are used by educators as learning resources.	18	2	1	-	-	86%
Teachers make use of the classroom setting	18	2	1	-	-	

Information:

Very good : 5
Good : 4
Neutral : 3
Not good : 2
Not very good : 1

According to Lee and Lee (2018), creativity meeting competence refers to the capacity to identify and address issues in a variety of problem settings utilizing original, analytical, and logical reasoning based on knowledge from a variety of academic disciplines. Individual creativity and collaborative thinking abilities are combined to form Kim and Han's (2019) definition of creativity meeting competence. the indicator of a teacher's success in fostering creativity through the STEM method. The Ministry of Education and Culture's suggested methods are shown in table 3 for measuring student learning outcomes.

Table 3: Assessment Criteria Techniques

Predicate	Success Category
A	Very good
B	Good
C	Netutral
D	Not good
E	Not very good

Djaali. 2008

RESULTS

The study's findings demonstrate that incorporating the STEM approach into instruction increases teacher creativity and makes learning more enjoyable for students. The data obtained are shown in Table 4.

Table 4: STEM-based Creativity Data

Predicate	Category	Frequency	%
A	Very good	18	86
B	Good	2	9,4
C	Netutral	1	4,6
D	Not good	0	0
E	Not very good	0	0

Djaali. 2008

According to the research, 18 out of 21 teachers have attempted to boost their creativity with some degree of success. This demonstrates how the STEM method may foster teachers' inventiveness. Of course, one can also observe the results of pupil learning. Working through ten-item questions has been used to assess students' performance levels. Figure 2 provides a clearer explanation of the evaluation outcomes for students.

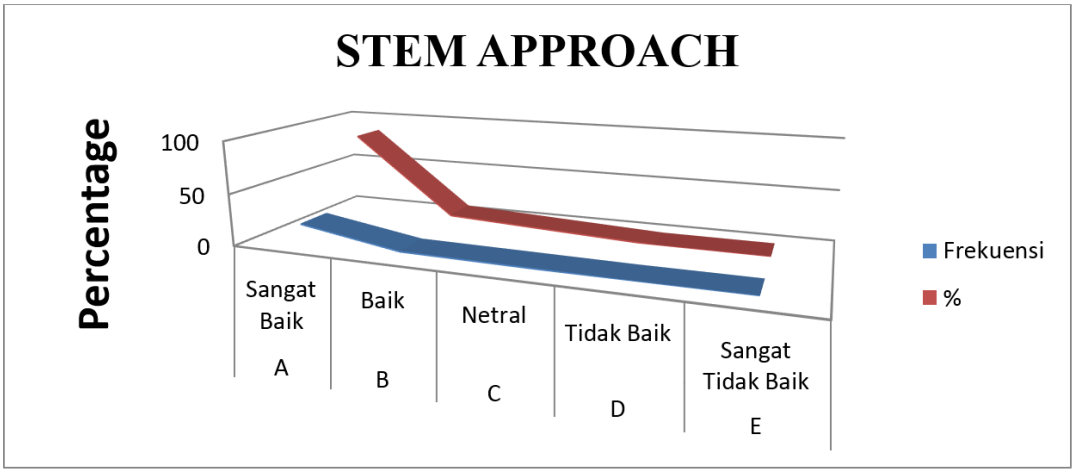


Figure 2: Teacher Creativity with the STEM Approach

To see the learning process using conventional methods can be seen data in table 5.

Table 5: Conventional Method

Predicate	Category	Frequency	%
A	Very good	0	0
B	Good	1	5
C	Netutral	12	57
D	Not good	8	38
E	Not very good	0	0

Djaali. 2008

The employment of traditional methods could not affect teacher creativity, according to data from 21 teachers, including 12 teachers who satisfied the "Neutral" criteria with a percentage of 57% and teachers who qualified the "Not Good" criteria with a percentage of 38%. The results gathered are more clearly displayed in Figure 3.

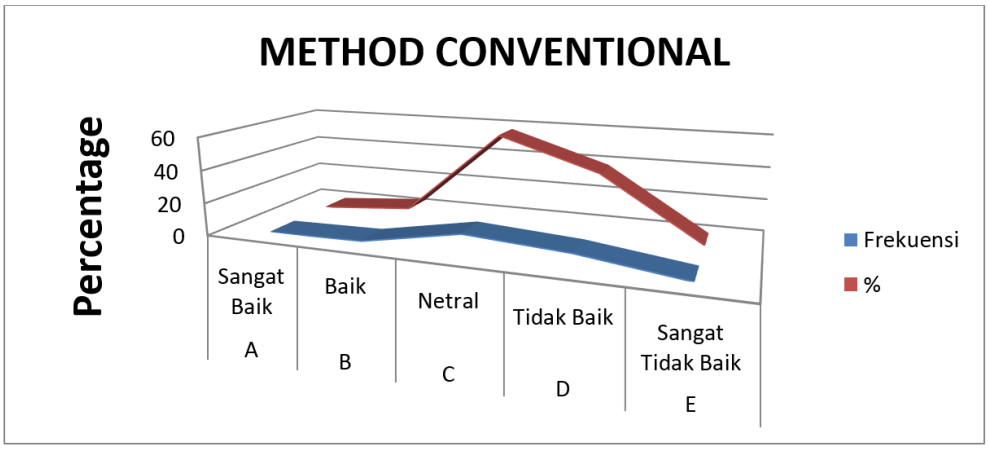


Figure 3: Conventional Method

More graphs are displayed in the centre of the image, where the threshold for the "Neutral" criterion is 57% and the position for the "Not Good" criterion is 38%. Using traditional methods demonstrates that the teacher lacks imagination, is more interested in giving directions, and that the students are required to wait more. An evaluation was conducted with two classes, each with 29 students, to determine the effectiveness of the method used. The evaluation findings are shown in table 6.

Table 6: Student Evaluation Results

Student Initials	Value *Conventional* Method	Student Initials	Value *STEM approach*
AS	60	AA	85
AD	60	AS	98
BS	60	AR	90
BS	60	BG	90
EG	60	BR	100
FI	60	EH	85
GF	80	FJ	100
GW	80	GI	100
IH	60	GH	100
IP	60	IK	80
MM	60	IP	90
MK	60	MO	98
ML	60	MS	98
MO	60	MR	100
OK	60	MV	100
OI	60	NU	98
RI	60	NI	95
RS	60	RE	100
RY	60	RO	100
RK	60	RT	100
SI	60	SE	90
SA	60	SH	90
SG	60	SI	95
SN	60	SK	90
SM	60	VH	98
SS	60	YH	98
YD	60	YI	100
YF	60	YR	100
YH	60	YZ	100

The information in the table above displays the outcomes of the students' evaluations. Table 7 illustrates the stark contrast between the traditional model and the STEM approach.

Table 7: Conventional Data and STEM Approach

Predicate	Category Very good	*Conventional* Method		*STEM approach*	
		Frequency	%	Frequency	%
A	Very good	0	0	20	69
B	Good	0	0	8	28
C	Netutral	2	7	1	3
D	Not good	27	93	0	0
E	Not very good	0	0	0	0

Djaali. 2008

It is abundantly obvious from the aforementioned evidence that children do better on experiments carried out by teachers who adopt a STEM approach. The percentage and frequency between the two teacher-conducted experiments varied significantly. The evaluation results demonstrate an increase in instructor innovation; the success rates of students in the "Very High" and "High" categories, respectively, were 69% and 28%, with a frequency of 20 students in each category.

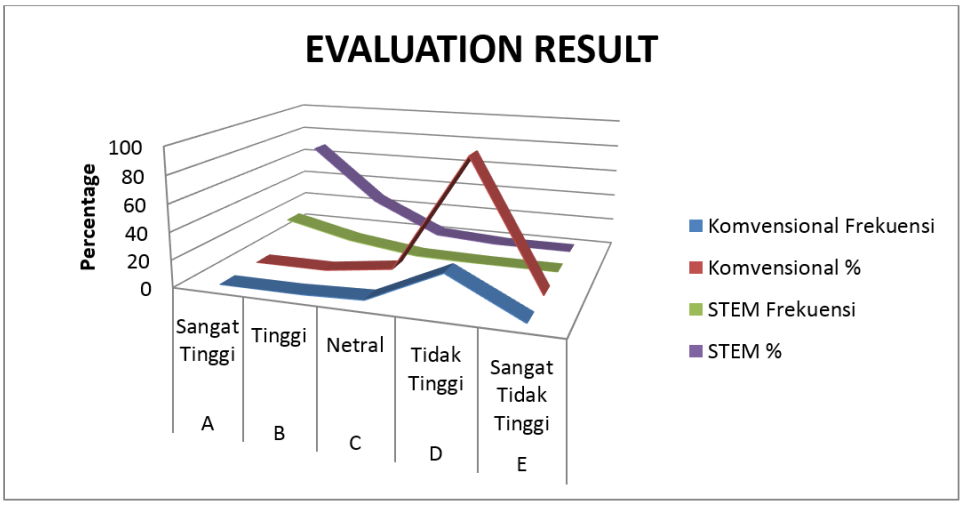


Figure 4: Evaluation Results

The picture above shows a significant difference in the results of student assessment of the learning process designed by the teacher. The results show that teachers who use the STEM approach model provide opportunities for students to develop their potential. The STEM approach makes teachers more prepared and have more creative ideas.

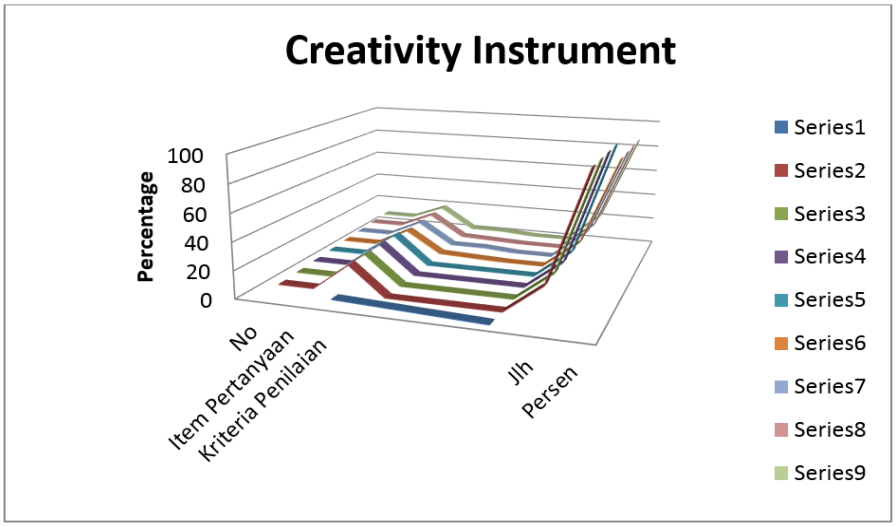
DISCUSSION

The study's findings demonstrate that the STEM method can foster teachers' creativity. The findings indicate that teachers are more equipped to meet students' equipment and need as well as their capacity and motivation to implement change. Sitingging claims that Knowledge & Outcomes is an early attempt to boost creativity. Confidence in your ability to master the subject will give you the guts to convey it well.

Confidence in your talents will lead to Skills & Oucames, great ideas for creating learning scenarios, and best attempts to make learning enjoyable. Teachers make an effort to provide supplemental materials, choose methods, and design unique learning curricula. If a teacher is capable of implementing learning innovations and has confidence in their skills, the innovations will undoubtedly provide the desired outcomes. Additionally, whether the innovations used give pupils a deep knowledge will be demonstrated by the teacher's expectations for the final product and output. The teacher's expectations for students are based on the process used, including how they can be Affective & Outcomes, so that they can be productive in the classroom. The effectiveness of the creative tool is seen in Figure 8.

Table 8: Creativity Instruments

Question Items	Assessment criteria					Amount	Percentage
	5	4	3	2	1		
1	21	0	0	0	0	21	100
2	21	0	0	0	0	21	100
3	21	0	0	0	0	21	100
4	21	0	0	0	0	21	100
5	18	2	1	0	0	21	86
6	18	2	2	0	0	22	86
7	18	2	1	0	0	21	86
8	18	2	2	0	0	22	86



CONCLUSION

According to the findings of the experimental research, the STEM approach fosters instructors' creativity, improves their readiness, and develops engaging learning scenarios with innovative and creative ideas.

Bibliography

1) Ansyar, Mohamad. 2015. (in press). *Kurikulum: Hakekat, Fondasi, Disain dan Pengembangan.* Jakarta, Prenadamedya Group

2) Breiner, J., Harkness, S., Johnson, C., & Koehler, C. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112(1), p. 3-11.*

3) *Bybee, R. W., & Landes, N. M. (1988) What research says about new science curriculums (BSCS) Science and Children, 25, 35-39*

4) Chen, M. (2001). A potential limitation of embedded-teaching for formal learning. In J. Moore & K. Stenning (Eds.), *Proceedings of the Twenty-Third Annual Conference of the Cognitive Science Society (pp. 194-199).* Edinburgh, Scotland: Lawrence Erlbaum Associates, Inc.

5) Carter, Philip. IQ dan Uji Kepribadian. London dan Philadelphia: Library of Congress Katalogisasi-dalam-Data Publikasi

6) Desmita. 2006. Psikologi Dahlan Djawad. 2000. Psikologi Perkembangan Anak dan Remaja. Bandung : PT Remaja Rosdakary

7) Djaali. 2008. Skala Likert. Jakarta: Pustaka Utama

8) Dugger, W. (2010). *Evolution of STEM in the U.S*. 6th Biennial International Conference on Technology Education Research. [Avaliable online: http://citeseerx.ist.psu.edu]

9) Frey, Nancy and Fisher, Douglas. 1959 The Formative Assessment Actio. Library of Congress Cataloging-in-Publication Data

10) Gredler, E. Margaret. 2011. *Learning and Instruction*. Jakarta:Kencana Prenada Media Group

11) Harry Firman. (2016). Pendidikan STEM sebagai Kerangka Inovasi Pembelajaran Kimia untuk Meningkatkan Daya Saing Bangsa dalam Era Masyarakat Ekonomi Asean. *Prosiding Seminar Nasional Kimia dan Pembelajarannya, ISBN : 978-602-0951-12-6.*

12) Hanover Research (2011). K-12 STEM education overview

13) Hurlock, B. Elizabeth. 1980. Pisikologi Perkembangan Suatu Pendekatan Sepanjang Rentang Kehiduoan. Jakrata: Eralangga

14) *Johnson, D. W., Johnson, R. T., & Smith, K. (1991). Active learning: Cooperation in the college classroom. Edina, MN: Interaction Book.*

15) *Karplus, R., & Their, H. D. (1967). A new look at elementary school science. Chicago, IL: Rand McNally.*

16) Latipah Eva. 2012. Pengantar Psikologi Guruan. Pedagogia: Yogyakarta

17) Morrison, J. (2006). *STEM education monograph series: Attributes of STEM education*. Teaching Institute for Essential Science. Baltimore, MD.

18) Monkis, dan Knoers. 2004. Pisikologi Perkembangan Pengantar dalam Berbagai Bagian. Belanda : Gajah Mada Universitas Press

19) Munandar Utami, Perkembangan Bakat. Jakarta : Kemdikbud

20) National Academy of Sciences (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. The National Academic Press: Washington DC.

21) Rahmad, Aceng, dkk. Filsafat Ilmu Lanjutan. Kakarta : Kencana Perdana Media Group

22) *Resnick, L. B. (1999). Making America smarter. Education Week Century Series. 18 (40), 38-40. Retrieved from http://www.edweek.org/ew/vol-18/40resnick.h18*

23) Roberts, A. (2012). A justification for STEM education. *Technology and Engineering Teacher, 74(8), 1-5.*

24) Roberts, A. & Cantu, D. (2012). Applying STEM instructional strategies to design and technology curriculum. *Technology Education in the 21st Century, (73), 111-118.*

25) Santrock, W.J. 2007. Perkembangan Anak. Jakarta : Eralangga

26) Wang, H., Moore, T., Roehrig, G., & Park, M. (2011). STEM integration: Teacher perceptions and practice. *Journal of Pre-College Engineering Education Research, 1(2), 1-13.*

27) Yusuf, Syamsu. 2000. Pisikologi Perkembangan Anak & Remaja. Bandung:PT. Remaja Rosdakarya

28) Zais, S. Robert. 1976. *Curriculum: Principles and foundations*. N.Y.: Harper & Row Publishers