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THE EFFECTIVENESS OF VIRTUAL SCIENCE TEACHING MODEL (VS-TM) TO IMPROVE STUDENT'S SCIENTIFIC CREATIVITY AND CONCEPT MASTERY ON SENIOR HIGH SCHOOL PHYSICS SUBJECT

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Abstract. *VS-TM refers to a teaching model that applies virtual media aided scientific approach. VS-TM is required to prepare students who are trained problem-solving process through scientific creative thinking opportunities and complete physics concept mastery. The aim of this research is to analyze the effectiveness of VS-TM to improve student's scientific creativity and concept mastery on Senior High School physics subject. This research involves 318 students from 3 State Senior High Schools in Jember Regency, Indonesia. Pre-test and post-test scores obtained using Sign Test and Paired Sample T-test are used to analyze VS-TM impact on student's scientific and concept mastery improvement. Such impact consistency then is observed through the calculation of n-gain achieved by each testing class using ANOVA. The research of VS-TM application on Senior High School physics subject indicates that there is a high categorized significant improvement student's scientific creativity (n-gain > 0.7) and concept mastery (n-gain > 0.8) on physics subject, before and after VS-TM application with p-value is < 0.05 and there is not any difference between 9 testing classes with p-value is > 0.05.*

Keywords: *concept mastery, scientific creativity, virtual science teaching model.*

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Introduction

Teaching in the 21st century must develop an educating vision using technology integration to creative such a creative thinking (Anderson & Krathwohl, 2001). The teaching framework in the 21st century should depict student's skill, knowledge, and ability required to reach success while entering professional zone today. The framework shall include: (1) the core subject and theme of the 21st century; (2) learning and innovative skill; (3) informational, media-related and technological skill; and (4) life skill and career (Bellanca, 2011). A successful creativity teaching process on physics subject requires such a learning environment that can encourage the students to answer with all possible answers available based on the right concept. The result of the research shows that an inspiring teaching evaluation will encourage thinking and imagination freedom. The students will not only be required to master a certain concept, but also they need to be creative in solving any problems (Park, Lee, Oliver, & Cramond, 2006). The characteristics of physics teaching have similarity with the creative process through scientific method that characterizes a scientist when trying to achieve the meaning and relevance of process, to emphasize on the product and attitude. The result of research indicates that this creative process must be supported by the involvement of creativity and student center learning (Kind & Kind, 2007; Junus, Santoso, Isal, & Utomo, 2015).

Scientific creativity refers to an intellectual character or an ability to create or potential to create a certain product that is original and has the value of both social and personal as it is designed to reach a certain goal in mind using the given information (Hu & Adey, 2002). Scientific creativity is different from free content creativity. A creative thinking must be activated during the process of investigation or process of scientific knowledge application. Scientific creativity has three dimensions consisting of products, creative

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characteristics, and processes (Park, 2013). Scientific creativity consists of two main spaces, namely the hypothesis space (looking for possible hypotheses) and the experimental space (doing experiments to get new hypotheses generated from the data). The activity that supports the improvement of scientific creativity can be held through a creative experiment, a search for scientific problem solution, and creative activity. The result of research indicates that creativity application on physics subject can be done through scientific inquiry and discovery (Oral, 2006; Hong & Kang, 2010). However, another result of research that has been performed shows that when a student is having a discussion, the student does not involve their personal experience and finally finds a creative idea as a potential solution (Akinoglu, 2008; Russell & Weaver, 2011).

Many scientific ideas owned by a student must be supported by right concept mastery, and such concept in physics teaching is interrelated with one another. Such a large number of concepts in physics subject that is systematically structured will cause the students to have a different cognitive structure from one another (Hançer & Durkan, 2008). Concept mastery refers to the ability of students to understand the meaning scientifically, both theoretical and application on daily life. Concept mastery is in the cognitive area that emphasizes on intellectual aspect, and this area has a hierarchy order (Anderson & Krathwohl, 2001). Students who master the right concept will be able to show the presented subject into a more understandable form so that they will be able to interpret and apply. Physics concept mastery is obtained from theoretical and empirical comprehension through one's knowledge of experiment, so that the student can record and transfer some information to be used in a problem solving, analyzing, and applying to a certain event. The result of research indicates that the student's concept mastery shall depend on the level of their cognitive development that encourages the involvement of performance and motivation (Bilal & Erol, 2012; Trnova, 2014). However, another result of research in that has been performed shows that the physics concepts presented by the teacher to the students tend to serve as a fact instead of natural event or phenomenon that must be observed, measured, and discussed. Thereby, the student will only memorize the concept instead of understanding it fully (Madlazim, Supriyono, & Jauhariyah, 2015).

Information and Communication Technology (ICT) utilization as teaching media gives such a quite large contribute creating attractive physics teaching. The teaching that utilizes ICT can be one of those keys to growing the student's creativity and concept mastery successfully. The utilization of ICT to gain scientific creativity can be done through (1) idea development that supports imaginative, explorative, and representative assumptions; and (2) make and create, which can be interpreted as giving a meaning according to media process, manipulation, and transformation (Jucan & Baier, 2012). Besides, ICT utilization to concept mastery of physics can also be applied to minimize human sense limitedness during the observation process and to display natural phenomena that require sophisticated or dangerous devices without having to present it live. The result of research shows that the use of computer as the device to present virtual demo and laboratory is the potential solution for abstract materials (tiny, huge, or fast), limited laboratory facilities, dangerous materials and devices, long-term teaching process (Finstein, Darrah, & Humbert, 2013; Záhorec, Hašková, & Bílek, 2014). However, another result of research that has been performed shows that less utilization of ICT during experimental activities, especially of a subject that is either complex or abstract, will only repeat and memorize the concepts as explained (Jeanpierre, 2014; Wicaksono & Pandiangan, 2015).

Data taken from Global Creativity Index (GCI) and Program for International Students Assessment (PISA) provide a contribution to the importance of improving the student's scientific creativity and concept mastery in Indonesia. The creative group of Human Resources influences how a country grows and develops (Florida, 2006). The result of CGI measurement in a country uses three aspects, those are technology, talent, and tolerance, which places Indonesia in the 81st position of 82 countries with a score of 0.037 (Institute Martin Prosperity, 2011). Besides, the research was done by PISA from 2012 – 2015 shows that the average score of Indonesian student's achievement in science is of 403 and categorized in the group of low concept mastery and is in the 64th position of 72 countries being surveyed (OECD, 2016). This indicates that it is necessary to prepare a trained generation of Human Resources to solve problems and master the concept of teaching physics creatively. In addition to the results obtained from GCI and PISA, identification and analysis of need through scientific creativity and concept mastery student's profile is held at 3 State Senior High Schools in Jember Regency, Indonesia. Those schools are State Senior High School 4 of Jember, State Senior High School 3 of Jember, and State Senior High School 1 of Pakusari. The result of such student's profile activity shows the teaching model that so far has been placing the teacher center learning. How less the chance is for the students to think creatively during experimental activities and ICT has been less used to give an interesting experience and direct them to develop scientific ideas and physics concepts instead of only memorizing (Wicaksono, Madlazim, & Wasis, 2016).

Based on the result of research that has been performed and the student's scientific creativity and concept mastery profile, the teaching model that has been developed is called Virtual Scientific Teaching Model (VS-TM). VS-TM refers to a teaching model that applies virtual media aided scientific approach developed to improve student's scientific creativity and concept mastery on Senior High School physics subject. VS-TM is also constructed according to the analysis of limited teaching model that has been applied formerly. They are 5E teaching model that gives less chance to share ideas and emphasize on concepts used during experimental activities (Bybee, Taylor, Gardner, Scotter, Powell, Westbrook, & Landes, 2006; Akcay, 2013) and creative problem-solving model that gives less feedback to the quality of idea to be followed up and relate physics concepts to give idea (Giangreco, Cloninger, Dennis, & Edelman, 2002; Laisema & Wannapiroon, 2013). VS-TM syntax that is valid of both content and constructs for student's scientific creativity and concept mastery shall consist of (1) identify the problem; (2) formulating electronic problem-solving alternatives; (3) discussing alternatives problem-solving; (4) design and apply experiments virtual; (5) elaborating experimental results; and (6) reflection. The result of research that supports these characteristics of VS-TM that is teaching to achieve student's scientific creativity and concept mastery must provide the student with an opportunity to think of how to express and apply ideas during experimental activities (Hu, Wu, Jia, Xinfa, Duan, Meyer, & Kaufman, 2013). It must encourage the student to think about the applied physics concepts deeply (Miller & Dumford, 2016). ICT utilization on VS-TM is using virtual media of Mindjet Mind Manager and virtual laboratory of PhET. The result of the research shows that Mindjet Mind Manager can accelerate idea organization as created (Brewer, 2009), while virtual laboratory of PhET gives such a high level of interactive and dynamic feedback. This enables the students to correlate between life phenomenon and the underlying physics concept (Adams, Alhadlaq, Malley, Olson, Alshaya, Alabdulkareem, & Wieman, 2012).

An evaluation of student's scientific creativity and concept mastery improvement due to the application of VS-TM teaching holds a series of activities to obtain, analyze, and interpret data in systematical and continuous ways so that the data will serve as meaningful information. Student's scientific process skill will show how many students those who have scientific creativity component are (Park, Lee, Oliver, & Cramond, 2006; Pekmez, Aktamis, & Taskin, 2009). Scientific creativity indicators those are attributed to scientific process skill are (1) unusual uses; (2) scientific imagination; (3) sensitivity to science problems; (4) creative science problem-solving; (5) creative experiment; (6) a technical product improvement; and (7) creative science product design (Hu & Adey, 2002; Pekmez, Aktamis, & Taskin, 2009). The procedure of scientific creativity refers to the criteria adapted from Torrance's Test of Creative Thinking (Torrance, 1990; Runco, Millar, Acar, & Cramond, 2010) and Scientific Structure Creativity Model compiled from Structure of the Intellect (Guilford, 1956) and creative dimension through student's fluency, flexibility, and originality of answer in the test point (Hu & Adey, 2002). Concept mastery has cognitive area indicators according to Bloom's taxonomy, as follows remembering, understanding, applying, analyzing, evaluating, and creating (Krathwohl & Anderson, 2001; Jatmiko, Widodo, Martini, Budiyanto, Wicaksono, & Pandiangan, 2016).

Problem of Research

The problem researched in this research is to analyze how the effectiveness of VS-TM to improve student's scientific creativity and concept mastery on Senior High School physics subject. VS-TM is categorized as effective when there is a statistically significant difference between the improvement of scores achieved during the pre-test and post-test of student's scientific creativity and concept mastery. The effectiveness of student's scientific creativity and concept mastery are decided from the normality gain (n-gain) scores. N-gain scores are obtained by the equation (post-test score – pre-test score)/(maximal score – pre-test score) (Hake, 1999). The calculation of n-gain scores then is converted under the following criteria: (1) if n-gain > 0.7 (high); (2) if 0.3 < n-gain < 0.7 (moderate); and (3) if n-gain < 0.3 (low).

Research Focus

This research focuses on the analysis of VS-TM impact on the student's scientific creativity and concept mastery on Senior High School physics subject. This analysis of impact shall be as follows (1) statistically, whether student's scientific creativity and concept mastery on physics subject are significantly improved before and after VS-TM application; (2) How is the category of scientific creativity and concept mastery on physics subject after VS-TM application; and (3) is there any difference in improvement student's scientific creativity and concept mastery of physics in 9 testing classes.

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Methodology of Research

General Background

Scope Research is the application of VS-TM to improve student's scientific creativity and concept mastery on Senior High School physics subject. The research was conducted in Odd Semester of Academic Year 2016/2017 for ten weeks using physics topic vibration and wave. This research is performed to analyze the effectiveness of VS-TM based on its impact on student's scientific creativity and concept mastery on Senior High School physics subject marked by n-gain scores before and after VS-TM application. Student's scientific creativity and concept mastery on Senior High School physics subject are statistically analyzed to decide whether there are different scores of pre-test and post-test. The calculation of n-gain can be used to categorize student's scientific creativity and concept mastery on Senior High School physics subject whether it is high, moderate, or low in 9 testing classes.

Sample

This research involves 318 students from 3 State Senior High Schools from a population of 1552 students at 15 State Senior High Schools in Jember Regency. Determination of the number of samples is based on Slovin's formula using error tolerance e = 5% ie [sample = population / 1 + (population × e^2)] (Sevilla, Ochave, Punsalan, Regala, & Uriarte, 1984). The sample used represents three high, moderate, and low school criteria. The criteria of Senior High School selection is based on the average scores achieved in the national exam. Those selected schools are State Senior High School 4 of Jember (high) uses 3 testing classes (37 of each class), State Senior High School 3 of Jember (moderate) uses 3 classes (35 of each class), and State Senior High School 1 of Pakusari (low) uses 3 testing classes (34 of each class). Indicators of scientific creativity and concept mastery the same were used for 9 test classes.

Instrument and Procedures

The type of this research is quasi-experimental, this research testing is done using one group pre-test and post-test design, namely $O_{pre\text{-}test}\ X_{treatment}\ O_{post\text{-}test}$ (Fraenkel & Wallen, 2009). Scientific creativity and concept mastery test use pre-test and post-test are given before the process of learning are applied to all sample students. The realization and application of VS-TM on such process of learning are using the syllabus, lesson plan, student textbook, and student worksheet. VS-TM syntax in the learning process shall consist of (1) identify the problem; (2) formulating electronic problem-solving alternatives; (3) discussing alternatives problem-solving; (4) design and apply experiments virtual; (5) elaborating experimental results; and (6) reflection.

The indicators of evaluated scientific creativity shall consist of (1) unusual uses, which is to write down as many uses of certain object as possible; (2) scientific imagination, which is to describe a certain event that will happen; (3) sensitivity to science problems, which is to sense scientific problem through scientific inquiries; (4) creative science problem solving, which is to solve scientific problems creatively; (5) creative experimental, which is to write down as many creative experiment as possible to hypothesize a scientific statement; (6) improve a technical product, which is to improve a technical product for better use; and (7) creative science product design, which is to design a certain product of science and description thereof (Hu & Adey, 2002; Pekmez, Aktamis, & Taskin, 2009). Meanwhile, concept mastery shall refer to Bloom's taxonomy evaluated to consist of remembering, understanding, applying, analyzing, evaluating, and creating (Krathwohl & Anderson, 2001; Jatmiko, Widodo, Martini, Budiyanto, Wicaksono, & Pandiangan, 2016).

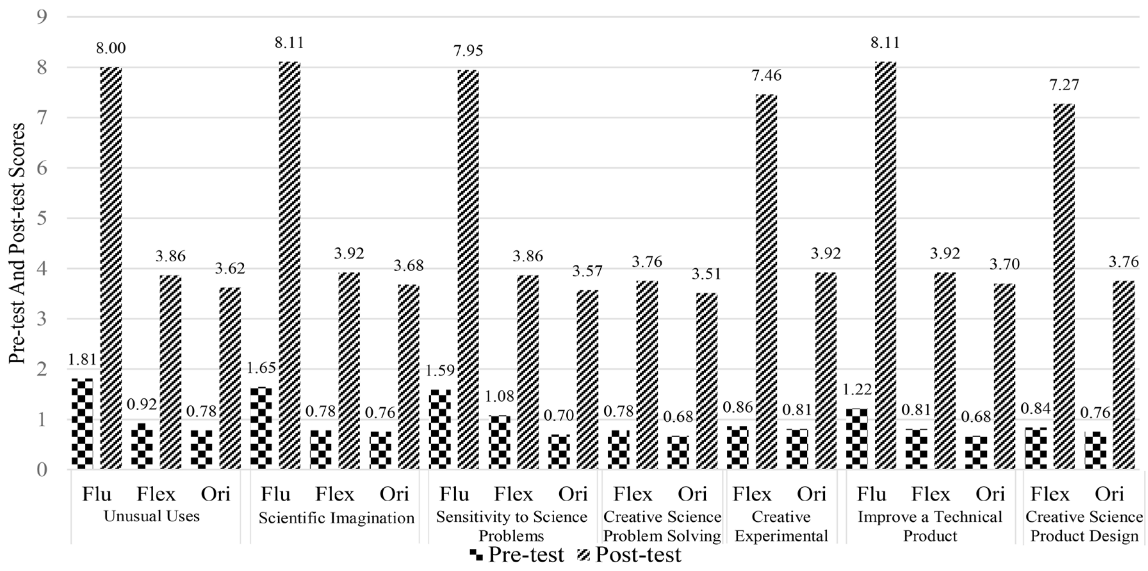
Data Analysis

The analysis of the student's answer of scientific creativity for each dimension consists of (1) fluency, which is to calculate all answers to each assignment given without taking the quality of answer into account; (2) flexibility, which is to calculate the number of approach or content used in the answer; and (3) originality, which is to calculate the probability of answer by means of frequency tabulation with the following percentage of answer: if the percentage is > 5% (2 points) if 5% < percentage < 10% (1 point), and (3) if the percentage < 10% (0 points). The answer of scientific creativity for each dimension shall be categorized as follows: (1) fluency: if total answer > 7 (high), if 3 < total answer < 7 (moderate), if total answer < 3 (low); (2) flexibility and flexibility: if the score of answer > 4 (high), if 3 < score of answer < 4 (medium), and if the score of answer < 3 (low) (CCSS ELA Aligned, 2013).

An analysis of VS-TM application impact toward the improvement student's scientific creativity and concept mastery on Senior High School physics subject is done using the scores achieved in the pre-test and post-test acquired using Paired Sample T-test if it meets data normality or non-parametric using Wilcoxon Signed Rank Test or Sign Test is applied. Furthermore, an analysis of impact consistency toward the improvement student's scientific creativity and concept mastery on Senior High School physics subject using the n-gain calculation of each testing class shall use Analysis of Variance (ANOVA). Kruskal-Wallis Test will apply when it meets data normality or non-parametric. An analysis of statistic software shall use IBM SPSS 22.

Results of Research

The average pre-test and post-test scores of each scientific creativity indicator in 9 testing classes are shown in Figure 1. Horizontal box graph indicates the scores of pre-test, while the slanting lines graph indicates the scores of post-test. The whole n-gain indicators of scientific creativity in 9 testing classes are shown in Table 1.



**Flu: fluency; Flex: flexibility; Ori: originality*

Figure 1: The average pre-test and post-test scores of each scientific creativity indicator in 9 testing classes.

Table 1. The average n-gain scores student's scientific creativity in 9 testing classes.

n-gain Scientific Creativity Indicators		State Senior High School 1 of Jember			State Senior High School 3 of Jember			State Senior High School 1 of Pakusari			Average
		C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	
Unusual uses	Fluency	0.758	0.758	0.766	0.758	0.761	0.771	0.758	0.767	0.761	0.762
	Flexibility	0.736	0.729	0.743	0.720	0.739	0.741	0.731	0.736	0.733	0.734
	Originality	0.686	0.670	0.688	0.669	0.689	0.689	0.678	0.687	0.688	0.683
Scientific imagination	Fluency	0.777	0.771	0.778	0.773	0.778	0.782	0.773	0.78	0.777	0.777
	Flexibility	0.754	0.736	0.745	0.736	0.750	0.746	0.741	0.747	0.746	0.744
	Originality	0.695	0.699	0.697	0.700	0.698	0.692	0.698	0.702	0.701	0.698
Sensitivity to Science Problems	Fluency	0.758	0.749	0.759	0.748	0.755	0.759	0.754	0.758	0.759	0.755
	Flexibility	0.727	0.720	0.731	0.722	0.730	0.725	0.719	0.726	0.728	0.725
	Originality	0.676	0.667	0.678	0.673	0.676	0.681	0.670	0.676	0.675	0.675

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n-gain Scientific Creativity Indicators		State Senior High School 1 of Jember			State Senior High School 3 of Jember			State Senior High School 1 of Pakusari			Average
		C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	
Creative science problem solving	Flexibility	0.715	0.709	0.729	0.712	0.723	0.729	0.714	0.727	0.720	0.720
	Originality	0.666	0.651	0.669	0.660	0.666	0.667	0.660	0.671	0.671	0.665
Creative experimental	Flexibility	0.816	0.808	0.826	0.805	0.816	0.831	0.806	0.830	0.821	0.818
	Originality	0.755	0.743	0.759	0.742	0.746	0.758	0.739	0.763	0.747	0.750
Improve a Technical Product	Fluency	0.786	0.785	0.787	0.786	0.784	0.787	0.789	0.791	0.787	0.787
	Flexibility	0.755	0.758	0.762	0.759	0.756	0.760	0.756	0.751	0.749	0.756
	Originality	0.705	0.701	0.707	0.709	0.697	0.716	0.707	0.707	0.701	0.706
Creative science product design	Flexibility	0.796	0.789	0.807	0.786	0.787	0.806	0.787	0.810	0.795	0.796
	Originality	0.717	0.706	0.724	0.707	0.717	0.721	0.708	0.726	0.717	0.716

**C : Testing Classes*

The average scores of concept mastery pre-test and post-test in 9 testing classes can be seen in Table 2. The whole n-gain indicators of concept mastery in 9 testing classes are shown in Table 2.

Table 2. The average scores of concept mastery pre-test, post-test, and n-gain in 9 testing classes.

Concept Mastery	State Senior High School 1 of Jember			State Senior High School 3 of Jember			State Senior High School 1 of Pakusari		
	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9
Pre-test	26.0	26.1	26.4	26.2	26.0	26.2	25.8	26.3	26.1
Post-test	89.4	88.3	88.7	88.0	89.2	88.7	87.9	88.6	88.8
n-gain	0.854	0.840	0.829	0.828	0.850	0.839	0.834	0.843	0.845

**C : Testing Classes*

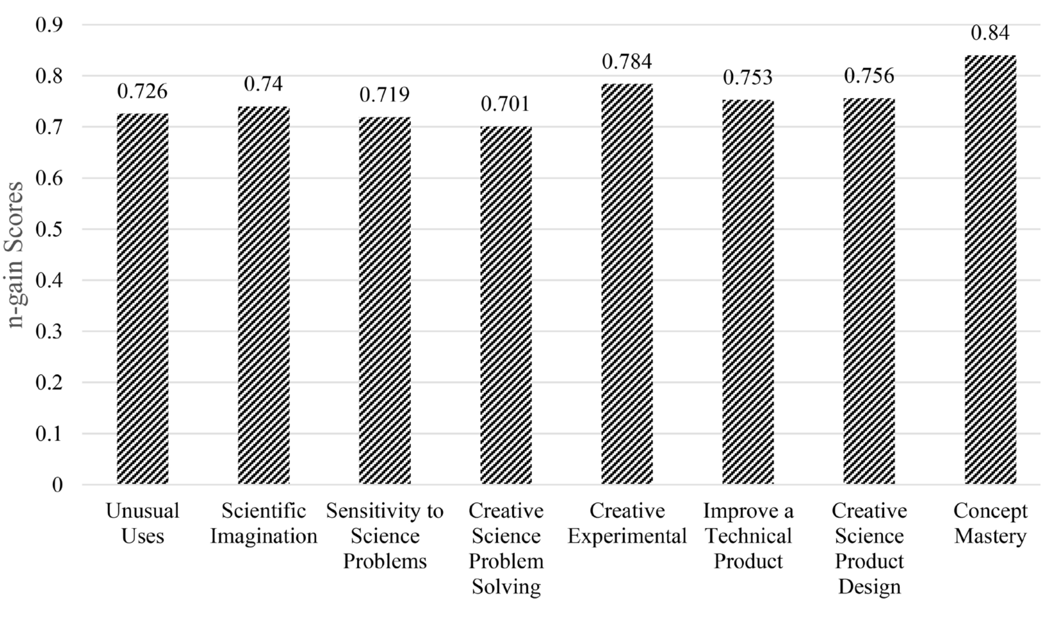

Figure 2: The average n-gain scientific creativity and concept mastery indicators in 9 testing classes.

Figure 1 shows the average pre-test and post-test scores of each scientific creativity indicator in 9 testing classes those are improved. Such improved pre-test and post-test scores of each scientific creativity indicator are reviewed from the fluency, flexibility, and originality of answer. Table 1 indicates the average scores of fluency, flexibility, and originality n-gain of each scientific creativity indicator of a student. The average scores of fluency and flexibility n-gain are categorized as high, but the originality is categorized as moderate. The average scores of concept mastery pre-test and post-test in 9 testing classes are improved as shown in Table 2. Figure 2 indicates the average n-gain of each scientific creativity and concept mastery indicator in 9 testing classes. The average n-gain of each creativity indicator of a high category is > 0.7. The average n-gain of concept mastery of high category is > 0.8.

An analysis of VS-TM application impact toward the improved student's scientific creativity shall use Sign Test statistic, while the improved student's concept mastery shall use Paired Sample T-test statistic of a normal distribution. The result of Sign Test statistic applied on pre-test and post-test of each scientific creativity indicator can be seen in Table 3. The result of statistic using Paired Sample T-test applied on pre-test and post-test of concept mastery can be seen in Table 4.

Table 3. The result of sign test statistic on each student's scientific creativity.

Scientific Creativity Indicators	Pre-test & Post-test	Testing Classes	N	Sign Test	p
1. Unusual uses 2. Scientific imagination 3. Sensitivity to science problems 4. Creative science problem solving 5. Creative experimental 6. Improve a technical product 7. Creative science product design	Fluency Flexibility Originality	C 1	37	Z = -5.918	< .0001
		C 2	37	Z = -5.918	< .0001
		C 3	37	Z = -5.918	< .0001
		C 4	35	Z = -5.747	< .0001
		C 5	35	Z = -5.747	< .0001
		C 6	35	Z = -5.747	< .0001
		C 7	34	Z = -5.659	< .0001
		C 8	34	Z = -5.659	< .0001
		C 9	34	Z = -5.659	< .0001

Table 4. The result of statistic using paired sample t-test on student's concept mastery.

Testing Classes	Paired Sample T-test (pre-test – post-test)	N	Mean	S	df	t	p
C 1	Pair 1	37	63.42	11.36	36	33.95	< .0001
C 2	Pair 2	37	62.34	10.59	36	35.79	< .0001
C 3	Pair 3	37	62.70	11.52	36	33.10	< .0001
C 4	Pair 4	35	61.81	10.70	34	34.16	< .0001
C 5	Pair 5	35	63.23	11.56	34	32.37	< .0001
C 6	Pair 6	35	62.52	11.56	34	32.00	< .0001
C 7	Pair 7	34	62.06	10.82	33	33.45	< .0001
C 8	Pair 8	34	62.40	11.60	33	31.36	< .0001
C 9	Pair 9	34	62.69	11.53	33	31.71	< .0001

The result of Sign Test on each student's scientific creativity indicator shows that Z = -5.918 in 3 testing classes at State Senior High School 4 of Jember, Z = -5.747 in 3 testing classes at State Senior High School 3 of Jember, and Z = -5.659 in 3 testing classes at State Senior High School 1 of Pakusari. Furthermore, all results of asymptotic significance 2-tailed for p-value is < 0.05. It can be concluded from the result that VS-TM does have a significant impact toward the student's scientific creativity with the significance level of 5%. The result of Paired Sample T-test on the student's concept mastery in 9 testing classes shows that asymptotic significance 2-tailed for p-value is <

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0.05. It can be concluded from the result that VS-TM does have a significant impact toward the student's concept mastery with a significance level of 5%.

A consistency analysis of VS-TM application impact toward the improved student's scientific creativity and concept mastery in 9 testing classes is done using ANOVA of a normal distribution. The result of ANOVA statistic test on the student's scientific creativity and concept mastery indicator respectively is shown in Table 5 and Table 6.

Table 5. The result of ANOVA statistic test on the student's scientific creativity indicator in 9 testing classes.

Scientific Creativity Indicator	n-gain	Sum of Squares	df	F	p
Unusual uses	Fluency	3.624	317	0.133	.943
	Flexibility	9.453		0.089	.918
	Originality	14.307		0.054	.920
Scientific imagination	Fluency	2.914		0.068	.939
	Flexibility	10.765		0.064	.976
	Originality	10.763		0.042	.998
Sensitivity to science problems	Fluency	2.613		0.076	.882
	Flexibility	10.839		0.014	.957
	Originality	14.501		0.018	.963
Creative science problem solving	Flexibility	11.218		0.074	.865
	Originality	15.619		0.021	.920
Creative experimental	Flexibility	7.524		0.181	.866
	Originality	7.806		0.987	.862
Improve a technical product	Fluency	1.923		0.039	.993
	Flexibility	8.393		0.026	.992
	Originality	10.237		0.050	.990
Creative science product design	Flexibility	11.833		0.078	.894
	Originality	10.292		0.050	.886

Table 6. The result of ANOVA statistic test on the student's concept mastery in 9 testing classes.

n-gain	Sum of Squares	df	F	p
Concept mastery	5.347	317	0.129	.873

ANOVA result of each student's scientific creativity indicator obtains asymptotic significance 2-tailed for p-value is > 0.05. It can be concluded from the result that there is not any significant difference in the application of VS-TM to the student's scientific creativity in 9 testing classes with a significance level of 5%. ANOVA result of the student's concept mastery obtains asymptotic significance 2-tailed for p-value is 0.873 > 0.05. It can be concluded from the result that there is not any significant difference in the application of VS-TM to the student's concept mastery in 9 testing classes with a significance level of 5%.

Discussion

Student Scientific Creativity

According to Figure 1, the average scores of pre-test and post-test of each student's scientific creativity indicator obtained in 9 testing classes before applying any teaching process using VS-TM is categorized as low. Such a low average scores of pre-test and post-test of each scientific creativity indicator of the student is due to the dominant role of teachers that the students are less actively involved. Fewer freedom students to develop their independence and creative thinking during the process of teaching will consequently block qualified ideas. In line with the theory of development with respect to the background of creative people and how to design an environment to meet such a creative potential, creativity will then be developed from time to time (from the potential to make achievement) as it should be mediated by an interaction between a man with his environment (Kozbelt, Beghetto, & Runco, 2010). This theory gives a contribution to the teachers and students to support such a learning environment that may support the creative effort, i.e. an environment in which exploration, imagination, and creative ideas of freedom thinking are possible. This result is supported by a student's profile scientific creativity, namely a teaching model that has been so far teacher centered learning that the students have less chance to think creatively. ICT is also less used to provide the students with interesting experiences to encourage the emergence of creative ideas (Wicaksono, Madlazim, & Wasis, 2016). Such a low scores average of each student's scientific creativity indicator highly confirms the result of GCI research of creativity as the factor of a low level of human resources quality (Institute Martin Prosperity, 2011). Besides, teachers often block the chance to think creatively and emphasize on convergent thinking that will block creative potential instead (Runco, 2007; Jeanpierre, 2014). The result of another research shows that during the process of teaching the teachers should give an opportunity to express and apply scientific ideas through experiment activities using corresponding new ways (Leonard & Penick, 2009).

However, according to Figure 1, the average pre-test and post-test scores of each student's scientific creativity indicator obtained in 9 testing classes after teaching process using VS-TM are improved of high category. The students have the freedom to think creatively about the given problem. Theoretically, it is to find a problem that explains how to apply an idea and solve the problem as creative people will be proactively involved in the process and exploration to identify the problem to be solved (Kozbelt, Beghetto, & Runco, 2010; Starko, 2010). The freedom of a search for problem-solving according to creative process theory as creative people have while identifying an interesting problem. Besides, the statistic testing of pre-test and post-test scores indicates that there is a significant impact of VS-TM toward the student's scientific creativity with a significance level of 5%. According to Table 1, fluency, flexibility, and originality n-gain average scores and Figure 2 of n-gain average scores of each student's scientific creativity indicator in 9 testing classes is slightly different as proven by statistic measurement in which there is not any significant difference of VS-TM application to the student's scientific creativity with significance level of 5%. The result of research supports this improvement, investigation and scientific inquiry in such scientific creativity shall include an interaction to understand the problem, to collect data, imagination, to make and test hypothesis, to design an experiment, to find solution, solve problem, indicate the process of evaluation, and to draw a conclusion (Hong & Kang, 2010; Usta & Akkanat, 2015).

VS-TM application gives such a consistent impact on improving each student's scientific creativity indicator. A successful VS-TM syntax application shall be according to a syllabus, lesson plan, student textbook, and student worksheet. The improvement of each student's scientific creativity indicator is made using VS-TM syntax teaching process, as follows (1) to identify a problem through a sample of event that is familiar to the student and to understand the features of important information using ICT, this stage will provide a training of unusual uses. The result of research that supports this stage is to motivate the student when student knows about the benefit of what student learned and used the information to do something about it (Kolis, Krusack, Stombaugh, Stow, & Brenner, 2011); (2) formulating electronic problem-solving alternatives through electronic brainstorming in order to formulate such alternative problem solving, so that each student has an opportunity to contribute a scientific idea to solve the problem, this stage provides a training of scientific imagination and sensitivity to science problems. The result of research that supports this stage is a learning environment in which it is possible to ask questions openly, and exercises must encourage creative thinking through an imaginative approach that various solutions are created (Park, Lee, Oliver, & Cramond, 2006), asking a question is one of creative thinking skill indicators (AlMutairi, 2015); (3) discussing alternatives problem-solving through scientific ideas database. Thereby, there will be a feedback of qualified scientific ideas to be followed up, and this stage provides a training of creative science problem-solving. The result of research that supports this stage is a hypothesis space as one of scientific creativity major space that shall consist of little temporary knowledge as a hypothesis that can explain the knowledge (Klahr, 2000); (4) design and apply experiments virtual using scientific ideas those compatible with the database to be further followed up through designing and conducting an experiment in a virtual laboratory, this stage provides a training of creative experiment. The result of research that supports this stage is that teaching physics through an experiment can be facilitated effectively by the use of both real laboratory experiment and/or virtual laboratory experiment (Başer & Durmuş, 2010); (5) elaborating experimental results by applying scientific ideas, which is a further action taken on the result of experiment in a new situation, this stage provides a training of technical product improvement and

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creative science product design. The result of research that supports this stage is that a product design is initiated by process of finding the weakness of formerly used product, which supports the evaluation of idea quality (Hu, Wu, Jia, Xinfa, Duan, Meyer, & Kaufman, 2013). In addition, the ability to use scientific knowledge to create a simple, appropriate, and original product is the success key to a valuable scientific creativity (does not have to be physical) (Siew, Chong, & Lee, 2015); (6) reflection during a virtual scientific teaching process that leads to the scientific ideas creation. The result of research that supports this stage is to do such an idea reflection to evaluate any superiorities and weaknesses so that further perfection is possible (Leung & Chiu, 2010).

Student Concept Mastery

Based on Table 2, the average scores student's concept mastery obtained in 9 testing classes before applying any teaching process using VS-TM are categorized as low. Such low average scores student's concept mastery is due to the given concept that cannot provide the students with the scientific meaning understanding and cannot encourage the student to correlate with the problems encountered in daily life. The teaching process becomes meaningful when the new subject has a systematic correlation with relevant concepts. Such teaching must create a meaningful learning activity instead of being memorizing without thinking. In line with the cognitive theory about advanced organizers, it will lead the students to the subject to be learned that helps them to remember the relevant information and finally, they can integrate the new information (Schunk, 2012). During the teaching, the teachers must encourage and direct the attention of students to the important concepts to be learned, must underline the interrelation of creative ideas, and relate the new subject with things those have been formerly known. This result is supported by the student's concept mastery profile that so far has been indicating that many students, who have learned physics, are not capable of understanding basic concepts. There are also many concepts those are wrongly understood so that physics is considered as a difficult and uninteresting science. Furthermore, the teachers should be aware of the cognitive structure of their students (Wicaksono, Madlazim, & Wasis, 2016). The result of the research shows that the students tend to memorize the theory without referring to their experience during physics teaching (Palmiero, Giacomo, & Passafiume, 2016). The result of PISA also indicates the low average scores student's concept mastery in Indonesia (OECD, 2016).

According to Table 2 of the average scores of concept mastery n-gain in each testing class and Figure 2 of the average scores of concept mastery n-gain in all testing classes after the teaching process, using VS-TM indicates that the average scores student's concept mastery in 9 testing classes is improved of high category. The essential components of teaching are the organization of information to be learned, the former knowledge that the learner has mastered, and the process that involves comprehension, understanding, saving, and regain information. The students are active seekers and information processors. According to information processing theory, an individual selects and be in the environment, changes and trains information, relates new information through formerly obtained knowledge, and controls the knowledge to be meaningful (Schunk, 2012). According to the statistic measure of pre-test and post-test scores, it indicates that there is a significant impact of VS-TM toward the student's concept mastery with a significance level of 5%. N-gain obtained in 9 testing classes is slightly different as proven by statistic measurement that there is not any significant difference of VS-TM application to the student's concept mastery with a significance level of 5%. The result of research that supports this improvement is that the cognitive development level of student can be obtained from the mastery of physics concepts perceived by the senses of a learning environment, especially using ICT. It can help the student to solve problems encountered not only during teaching at school but also in everyday life (Bilal & Erol, 2012; Sharda, Sastri, Bhardwaj, & Jha, 2016).

The consistent impact of the student concept mastery cannot be separated from the application of VS-TM. The cognitive structure of student is hierarchically organized so that the general concepts have the concepts of lower level under them. The cognitive structure of information organization and processing is a concept realized through a scheme or thinking pattern (Moreno, 2010). VS-TM syntax encourages the students to obtain meanings from the physics subject that have been learned, to be able to solve a problem scientifically based on the concept comprehension formerly obtained, and to apply it in everyday life. The VS-TM teaching process is integrated with a virtual laboratory that emphasizes on experimental activities those support the explanation of the meaning of a learned concept. This virtual laboratory has an interactive interface, so that it will not only demonstrate but also enable the students to manipulate the equipment, to do data collection and analysis, to prepare experiment reports, and to draw a conclusion based on data and graphs (Darrah, Humbert, Finstein, Simon, & Hopkins, 2014). The result of the research shows that such a right concept mastery will bring success to the student in solving a problem and grow their independence to be involved actively in obtaining knowledge (Miller, 2014; Wicaksono, Jatmiko, & Prastowo, 2015). A cognitive aspect during concept mastery will create a positive relation with deep creative and teaching processes (Miller & Dumford, 2016).

Conclusions

The effectiveness of VS-TM to improve student's scientific creativity and concept mastery on Senior High physics subject has an impact on the problem-solving process when having scientific creativity will be able to conduct investigations and processes of applying scientific knowledge. Besides, concept mastery will be able to show a matter presented into a more comprehensible form, providing interpretation and applying it. According to the result of research and discussion above, the effective improvement of the student's scientific creativity and concept mastery is as follows: there is a significant improvement of the student scientific creativity and concept mastery on physics subject before and after VS-TM application with asymptotic significance 2-tailed for p-value is < 0.05, the category of the student scientific creativity and concept mastery improvement on physics subject after VS-TM application is of high category that is > 0.7 and > 0.8, and there is not any difference of improvement between scientific creativity and concept mastery of the student on physics subject in 9 testing classes with asymptotic significance 2-tailed for p-value is > .05. Depending on the results of the study, it is considered that the application of VS-TM on physics subject requires that can encourage scientific creativity the students to answer with all possible answers available based on the right concept. It may be recommended to researchers that they conduct research to encourage students the courage to express ideas and focus during the discussions, this activity provides an opportunity to find creative ideas according to personal experience. Besides, the need for theoretical and empirical concepts mastery so that students can understand it fully.

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