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iji@ogu.edu.tr Dec 28, 2019, 5:42 AM
to me, yusnaidary, epinur.fkip, muhaimin_73, akhmad.habibi, tjohor25

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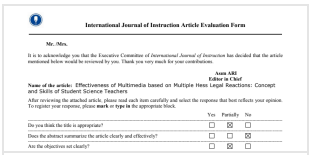
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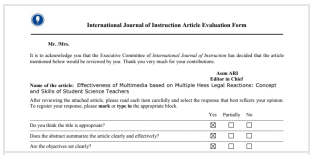
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Asım ARI
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Name of the article: Effectiveness of Multimedia based on Multiple Hess Legal Reactions: Concept and Skills of Student Science Teachers

After reviewing the attached article, please read each item carefully and select the response that best reflects your opinion. To register your response, please **mark** or **type in** the appropriate block.

	Yes	Partially	No
Do you think the title is appropriate?	☒	☐	☐
Does the abstract summarize the article clearly and effectively?	☐	☒	☐
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Evaluation:

☐ The article can be published as it is.
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☐ The article cannot be published.

Would you like to see the revised article if you have suggested any revisions? ☒ Yes ☐ No

Please write your report either on this paper or on a spare paper.

REPORT

Section of the Manuscript	Comments and Notes
Title- Abstract-Summary	The title is adequate
Introduction and Literature Review	The authors should provide an expositroy review of literature on Hess Law/Hess Law Reaction
Research Methods	The research instruments, validity and reliability of instruments, and how the data was analysed should be provided, even though it is a part of a larger study.
Research Findings	Frequency counts, percentages, means are inadequate to answer the questions regarding this topic 'Effectiveness of Multimedia based on Multiple Hess Legal Reactions: Concept

	and Skills of Student Science Teachers'. ANCOVA, Estimated Marginal Means, and line graphs are preferable since the study used pretest, treatment, and posttest. The authors should note that t test is inadequate to analyse the data on learning outcomes.
Discussion	The research questions discussed in the manuscript were not stated.
Conclusion and Suggestions	The conclusion should be presented after the research questions/hypotheses are stated, and the data is re-analysed.
References and Citation	Adequate
Language	Minor Language editing is necessary
Other issues	The research questions should be stated, while the data should be analysed using ANCOVA and Estimated Marginal Means aspect of ANCOVA.

Effectiveness of Multimedia based on Multiple Hess Legal Reactions: Concept and Skills of Student Science Teachers

In ideal conditions, learning is centered on students with learning media that are not only sourced from reading books or texts, but there are also multimedia-based multiple representations (macroscopic, microscopic, and symbolic) so that learning becomes more interesting. The purpose of this study was to determine: 1) the attitudes and motivations of students in learning Hess Law Reaction using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess Law Reaction; 2) the learning outcomes of the participated students after experiencing the learning through the multimedia, and 3) the effectiveness of the multimedia in improving the mastery of students' science processes and concepts about Hess Law Reaction. The method used in study is quasi-experimental; pre-test and post-test were addressed through a questionnaire and test. Data analysis was performed through multimedia quality data based on the multiple representations (macroscopic, microscopic and symbolic) and t test. The results showed that students could learn Hess's Law Reaction material more easily, faster, more actively, more independently, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess's Law Reaction. The results of the t-test for the difference before and after treatment was significant (p <.005).

Keywords: multimedia, multiple representations, Hess Law Reaction, effectiveness, learning outcomes.

INTRODUCTION

Physical Chemistry is one of the sciences that give rise to abstract phenomena. Much of the material in chemistry learning is difficult to illustrate in real form and two-dimensional images. In the process of learning Physics Chemistry, students are often faced with abstract material that is outside their daily experience so that the material is difficult to teach and difficult to understand. This phenomenon is known as multiple representations of chemistry.

Representations are categorized into two groups, namely internal and external representations. Internal representations are defined as individual cognitive configurations that are thought to originate from behaviors that describe several aspects of physical processes and problem solving, while external representations. ~~They can be described as~~ structured physical situations that ~~can be seen~~ ~~as~~ the embodiment of physical ideas (Bayraka & Bayramb, 2010; Chandrasegaran, Treagust, & Mocerino, 2007). Johnstone as cited in Chittleborough and Treagust (2007) divides chemical phenomena into three levels, namely: (1) Macroscopic level that is obtained through real phenomena that may directly or indirectly be part of daily student experience, which can be seen or perceived by the five senses . For example changes in color, temperature, pH of the solution, formation of gases

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and deposits that can be observed when a chemical reaction takes place. (2) Sub-microscopic level consists of real chemical phenomena, which indicate a particular level so that it cannot be seen. The sub microscopic representation is very closely related to the theoretical model underlying the particle level explanation. The representation model at this level is expressed symbolically starting from simple action to using computer technology, namely with words, two-dimensional images, and three-dimensional images, both still and moving animation or simulation. (3) Symbolic level consists of kinds of representation images, algebra and computerized forms (Chittleborough & Treagust, 2008).

Hess Law Reaction is a material in the Physics Chemistry course which is incorporated in the scientific and skills subjects group. The existence of this Hess Law Reaction material is very important, but many students are less enthusiastic and interested in learning it, which is marked by the low learning outcomes. So far, the learning in the Chemical Education of an Indonesian state university has been only done with lectures and discussions. Even though this lecture material requires more active student involvement, it is deemed necessary to use multiple multimedia-based representing the Hess Law Reaction which can help students understand the Hess Law Reaction material. Through multimedia based on multiple representations on the Hess Law Reaction, the gap between ideal conditions and existing real conditions is expected to be overcome. Real conditions is conventional that learning resources are usually only in the form of reading books / texts and learning. In this way the learning process is expected to be effective and efficient and the level of mastery of the concepts and science process skills of students towards the Hess Law Reaction material will be better. This study ~~is~~ therefore ~~aimed at determining~~ the attitudes and motivations of students in learning Hess Law Reaction using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess Law Reaction, the learning outcomes of the participated students after experiencing the learning through the multimedia, and the effectiveness of the multimedia in improving the mastery of students' science processes and concepts about Hess Law Reaction

REVIEW OF LITERATURE

These three levels are interconnected and contribute to students to be able to understand the abstract material of Chemistry Physics. This is supported by the statement of Tasker, Roy, and Dalton (2006), that chemistry involves processes of change that can be observed in terms of (e.g. changes in colors, odors, and bubbles) in macroscopic or laboratory dimensions, but in terms of changes that cannot be observed with eyes, such as changes in structure or processes at the sub micro or imaginary molecular level can only be done through modeling. These changes at the molecular level are then depicted at the abstract symbolic level in two ways, namely qualitatively using special notation, language, diagrams, and symbolically and quantitatively using mathematics (equations and graphs).

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Based on the characteristics of Physical Chemistry, the modes of representation of Physical Chemistry are classified in terms of levels of representation, namely macroscopic representation, submicroscopic representation and symbolic representation (Chandrasegaran et al., 2007). Macroscopic representation is a chemical representation obtained through tangible observation of a phenomenon that can be seen and perceived by the sensory level or can be in the daily experience of the learner. Subcompact microscopic representations are chemical representations that explain the structure and processes at the particle level (atoms or molecules) against the macroscopic phenomena observed.

Sub-microscopic representation is closely related to the theoretical model underlying it, so students can explore the dynamics that occur at the particle level. The mode of representation at this level can be expressed starting from simple to using computer technology, which uses words, two-dimensional images, three-dimensional images, both still and moving (animated) or simulation. Symbolic representations are chemical representations qualitatively and quantitatively, namely chemical formulas, diagrams, drawings, reaction equations, stoichiometry and mathematical calculations (Acree, Cormae, Fulbright, Weaver, & Krantzman, 1995; Domagk, Schwartz, & Plass, 2010; Treagust, Chittleborough, & Mamiala 2003).

Although macroscopic observations of chemical phenomena are chemical bases, the explanation of these phenomena is actually based on the representation of submicroscopic and symbolic levels. Consequently, an important aspect to reduce explanation depends on the ability of students to understand the role of each level of representation and the ability to transfer one level to another. Acquisition of knowledge without a clear understanding will cause students to experience confusion, because at the same time they have to deal with macroscopic, submicroscopic and symbolic levels. There are two categories of learners' understanding related to the depth of understanding and the ability to apply knowledge, namely; instrumental understanding (knowing how) and relational understanding (knowing why). The level of instrumental understanding reflects learning.

RESEARCH METHODS

The population of this study is all Chemistry Study Program students in Indonesian universities that attended Physical Chemistry courses I. We applied a sample random sampling for this study. Two tests were conducted; small-group test and field test. The sample for the small group test consisted of twelve students and the sample for the field test consisted of twenty-four students attending a Chemistry Study Program of a university that is ~~located~~ in Jambi provincial in southern part of Sumatra, Indonesia. The report of this study is a part of research and development study using ADDIE model that was fully funded by the 2018 Higher Education Applied Research Grants. It takes 2 years to finish all projects.

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~~As an~~ independent variable was a learning system using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess Law Reaction and the dependent variable is student learning outcomes on the Hess Law Reaction material, this study uses quasi-experimental research methods. The study design can be seen in Table 1.

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The data in this study were obtained from students in the form of multimedia quality data, motivation and benefit data, and student learning outcomes. Multimedia quality data, motivational data and benefits obtained through questionnaires, student learning outcomes data obtained through learning outcomes tests, learning outcomes tests used for the Hess Law Reaction material are objective questions.

Tabel 1
Research design

Sampel	Pre-test	Treatment	Post-test
A	Y_1	X	Y_2

Data analysis of learning outcomes is done by t-test. The significant level (α) used in this study is 5% with a probability (1 - α) dk = (n1 + n2 - 2), if -table <t count <table, then Ho is accepted which means there is no average difference significant between the pre-test results and the post-test results, and Ho is rejected for other t values (Sudjana, 2001).

RESULTS AND DISCUSSION

Analysis of Multiple Small Group Multimedia Trial Based Data Analysis (macroscopic, microscopic and symbolic) Hess Law Reaction

Analysis of multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in small group trials for aspects of learning, content / material, and media can be seen in Tables 2 and 3.

Table 2
Frequency distribution Assessment of aspects of learning, content / media, and media in a small group multimedia test based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	7	58,3	6	50	4	33,3
Good	5	41,7	6	50	8	66,7
Sufficient	0	0	0	0	0	0
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	12	100	12	100	12	100

Table 2 shows the distribution of assessments in the multimedia small group test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in a small group test in terms of learning or pedagogy, content / material, and media are included in the criteria either.

Table 3
Quality of multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction results of small group trials

Assessment	Mean	Criterion
Pedagogy	4,21	Good
Content	4,17	Good
Media	3,77	Good
Total mean	12,15	Good
Mean average	4,05	

Analysis of Data Field Trials based on multiple multimedia representations (macroscopic, microscopic and symbolic) Hess Law Reaction

In this part we report the Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction, Motivation and benefits aspects, and Learning outcomes.

Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Analysis of multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in field trials for aspects of learning, content / material, and media can be seen in Tables 4 and 5.

Table 4
Frequency distribution Assessment of aspects of learning, content / media, and media in the pilot multimedia field based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	14	58,3	13	54,2	10	41,7
Good	9	37,5	9	37,5	13	54,1
Sufficient	1	4,2	2	8,3	1	4,2
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	24	100	24	100	24	100

Table 4 shows that the distribution of assessments in the multimedia field test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in the field test in terms of learning, content/material, and media are included in good criteria.

Table 5
Quality of multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction results of field trials

Assessment	Mean	Criterion
Pedagogy	4,17	Good
Content	4,13	Good
Technology	4,18	Good
Average	12,48	Good
Rerata keseluruan	4,16	

Motivation and benefits aspects

In general, students stated that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction can foster motivation and provide meaningful benefits in the learning process of voltaic cells. More detailed data analysis can be seen in Table 5.

Table 5
Analysis of data on motivational aspects and benefits in multimedia field trials based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

No	Indicator	Yes (%)	No (%)
1.	The material for Hess's Law Reaction was easy for me to learn through multimedia	100	0
2.	The concept presented is easy for me to understand	91,7	8,3
3.	The Hess Law Reaction material presented challenged me to study better	95,8	4,2
4.	I want to learn a lot through multimedia based on multiple representations (macroscopic, microscopic and symbolic)	100	0
5.	Through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction gives me the opportunity to learn at my own pace	100	0
6.	multimedia based on multiple representations (macroscopic, microscopic and symbolic) Legal Reaction Hes this lesson helped me in learning Hess's Law Reaction	100	0
7.	Working on evaluations helped me understand Hess's Law Reaction material	100	0
8.	Hess Law Reaction material presented through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction made me learn faster	79,2	20,8
9.	I enjoy using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction for learning	100	0

10.	I want to learn by using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction learning (multimedia), on other courses	91,7	8,3
11.	Without being accompanied by a lecturer, I experienced confusion and lack of confidence	25	75
12.	Presentation of interesting material because with a variety of media (text, images, and videos)	100	0
13.	The instructions that make me confused	16,7	83,3
14.	I study the material coherently	100	0

All students (100%) who were respondents in the field trial stated: The material presented in multimedia is based on multiple representations (macroscopic, microscopic and symbolic). Hess's Law Reaction is easy to learn; Respondents want to learn a lot through multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hesss Law Reaction, meaning they are motivated to learn as much material as possible; By using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction respondents can learn according to their abilities; Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction helps respondents in learning the material of Hess Law Reaction; Respondents can measure their understanding by working on evaluation questions that exist in multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction; Respondents feel happy to learn through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Reaction of Hess's Law, meaning multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction is not boring and interesting; Presentation of material with a variety of interesting media (text, pictures, videos), this becomes a motivator for students in learning; Respondents study the material coherently.

Some respondents (91.7%) stated that the concepts presented in multimedia are based on multiple representations (macroscopic, microscopic and symbolic). The Hess Law Reaction is easy to learn. Some respondents (95.8%) stated that they felt challenged to learn better because the material was relatively easy to learn and they were actively involved in the learning process. Some respondents (79.2%) stated that they could more quickly learn the material of the Hess Law Reaction. Some respondents (91.7%) stated that they wanted to learn with multimedia in other subjects. Only a small proportion of respondents (25%) stated that they were confused and were not confident if they were not accompanied by a lecturer, meaning that 75% of respondents were able to study independently with the Hess Law Reaction. Only a small proportion of respondents (16.7%) stated that the instructions provided made them confused, meaning 83.3% of respondents found it easy when using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction in learning so that the learning process went smoothly .

In general it can be concluded that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction provides benefits for students who learn to use multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction. Students also become more motivated in learning the material presented. It can be said that multimedia is based on multiple representations (macroscopic, microscopic and symbolic). The Hess Law Reaction contributes positively to the learning process of the Hess Law Reaction.

2.3 Learning outcomes

To find out the effectiveness of multimedia based on multiple representations (macroscopic, microscopic and symbolic), the Hess Law Reaction in the field trial carried out pre-test and post-test data analysis at the end of learning. Data analysis was performed by means of the different statistic test using the t test for paired samples. multimedia based on multiple representations (macroscopic, microscopic and symbolic) The Hess Law Reaction is said to be effective if there is a significant increase in scores between pre-test and post-test scores. Statistical testing was carried out with the help of the SPPS program

Pre-test and post-test data were normally distributed, then t tests were performed.

It is necessary to formulate a hypothesis to make a decision whether the pre-test and post-test mean scores differ significantly or not with the following formula:

H0: The two mean test scores are identical (pre-test and post-test scores are not significantly different), H1: The two mean test scores are not identical (pre-test and post-test scores are significantly different). Decision making is based on probability values, namely: 1) H0 is accepted if probability> 0.05, 2) H1 is accepted if probability <0.05

From the paired samples test table (Appendix 2) the Sig. (2-tailed) or the probability is 0,000 less than 0.05. So it can be concluded that H0 is rejected which means the pre-test and post-test scores differ significantly. It can be said that there was a significant increase from the test scores before using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction to test scores after using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction. Based on the results of statistical analysis it can be concluded that multimedia b multimedia-based multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction is effectively used in the learning process of voltaic cells.

CONCLUSION

Multimedia quality criteria based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction from the aspects of learning, content / material, and media are included in both criteria with an average score of 4.05 for small group trials and

4.16 for trials field. Students can learn Hess's Law Reaction material more easily, faster, more active, not boring, more independent, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction. The results of the t-test mean pre-test and post-test scores showed that the mean pre-test and post-test scores differed significantly with a probability value of 0,000 small than 0.05. Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction is effectively used in the learning process of Hess Law Reaction.

Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction can be utilized in the learning process of Hess Law Reaction so that learning is more effective and efficient and student motivation and independence can be improved.

Acknowledgment

Thank you to the Republic of Indonesia Ministry of Research, Technology and Higher Education for funding this Research through the 2018 Higher Education Applied Research Grants.

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After reviewing the attached article, please read each item carefully and select the response that best reflects your opinion. To register your response, please **mark** or **type in** the appropriate block.

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Do you think the title is appropriate?	☒	☐	☐
Does the abstract summarize the article clearly and effectively?	☒	☐	☐
Are the objectives set clearly?	☒	☐	☐
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Is the presentation of the findings adequate and consistent?	☒	☐	☐
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Are the conclusions and generalizations based on the findings?	☒	☒	☐
Are the suggestions meaningful, valid, and based on the findings?	☐	☐	☒
Are the references adequate?	☒	☐	☐
Is the language clear and understandable?	☒	☐	☐
Is cohesion achieved throughout the article?	☒	☐	☐
Is the work contributing to the field?	☒	☐	☐

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- ☒ The article can be published after some revision.
- ☐ The article must undergo a major revision before it can be resubmitted to the journal.
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Would you like to see the revised article if you have suggested any revisions? ☒ Yes ☐ No

Please write your report either on this paper or on a spare paper.

REPORT

Section of the Manuscript	Comments and Notes
Title- Abstract-Summary	Both the title and the abstract are appropriate.
Introduction and Literature Review	You might want to introduce your location/ university system prior to para. three, where you begin to discuss the Indonesian State University. Since this is an international journal, it might benefit readers to know a little more about your location.
Research Methods	It might aid to clarity to add more about your population

Research Findings	Under 2.3, there is a typo: SPPS should be SPSS
Discussion	
Conclusion and Suggestions	Could you add some suggestions to the piece?
References and Citation	Needs hanging indentations
Language	Well-done. This piece is very well, written.
Other issues	

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Is cohesion achieved throughout the article?	☐	☒	☐
Is the work contributing to the field?	☐	☒	☐

Evaluation:

☐ The article can be published as it is.
☐ The article can be published after some revision.
☐ The article must undergo a major revision before it can be resubmitted to the journal.
☒ The article cannot be published.

Would you like to see the revised article if you have suggested any revisions? ☒ Yes ☐ No

Please write your report either on this paper or on a spare paper.

REPORT

Section of the Manuscript	Comments and Notes
Title- Abstract-Summary	1. What do you mean by Student Science Teachers? It's unclear 2. Be consistent with your tenses and prepositions. Please improve your written English and look back to your draft. Here I only provide some examples. Eg. The method used in study is (was) quasi-experimental; pre-test and post-test were addressed through a questionnaire and test. effectiveness of the multimedia in (on) improving 3. It's not necessary to repeat words that you already mentioned before. Eg. multiple representations (macroscopic, microscopic and symbolic), you mentioned this

	three times. 4. You spent a lot to express an introduction: In ideal conditions, learning is centered on students with learning media that are not only sourced from reading books or texts, but there are also multimedia-based multiple representations (macroscopic, microscopic, and symbolic) so that learning becomes more interesting. You may revise it and make it concise. Instead, you may present more about your findings and implications.
Introduction and Literature Review	1. In academic writing, I suggest you using : active sentences instead of passive ones, academic English words, and logic structures. You used a lot, such as "can be seen... I marked them by coloring red, please kindly check in your draft. 2. Arrange your running citation logically according to the publishing year, not alphabetic. (Bayraka & Bayramb, 2010; Chandrasegaran, Treagust, & Mocerino, 2007). Please provide some current references. 3. Instead of using "namely", you may use "such as"; "use", you may use "apply, implement...." 4. You may abbreviate Hess Law Reaction as HLR. 5. Please kindly improve your introduction by providing some current researches regarding HLR and multimedia-based multiple representations, and how important your research is
Research Methods	1. Please kindly present your sampling technique, because it doesn't make sense with your sample size compare to your population size (all Chemistry Study Program students in Indonesian universities that attended Physical Chemistry courses I) 2. To consider using academic writing: 58,3 must be 58.3. Revise all please!
Research Findings	1. Arrange your tables well, please! 2. Please present the findings logically and well.
Discussion	I did not see any discussion in this draft. Please kindly provide.
Conclusion and Suggestions	Please kindly provide the implication or suggestions in your draft based on the conclusions.
References and Citation	Please kindly provide more current references and present them by using APA style, mendeley or any other references tools.
Language	You must improve your academic writing. Probably you can send your draft to the English language center to improve it.
Other issues	The research topic is interesting enough, but the author (s) has/have to improve it a lot to present the findings and implications well.

Effectiveness of Multimedia based on Multiple Hess Legal Reactions: Concept and Skills of Student Science Teachers

In ideal conditions, learning is centered on students with learning media that are not only sourced from reading books or texts, but there are also multimedia-based multiple representations (macroscopic, microscopic, and symbolic) so that learning becomes more interesting. The purpose of this study was to determine: 1) the attitudes and motivations of students in learning Hess Law Reaction using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess Law Reaction; 2) the learning outcomes of the participated students after experiencing the learning through the multimedia, and 3) the effectiveness of the multimedia in improving the mastery of students' science processes and concepts about Hess Law Reaction. The method used in study is quasi-experimental; pre-test and post-test were addressed through a questionnaire and test. Data analysis was performed through multimedia quality data based on the multiple representations (macroscopic, microscopic and symbolic) and t test. The results showed that students could learn Hess's Law Reaction material more easily, faster, more actively, more independently, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess's Law Reaction. The results of the t-test for the difference before and after treatment was significant ($p < .005$).

Keywords: multimedia, multiple representations, Hess Law Reaction, effectiveness, learning outcomes.

INTRODUCTION

Physical Chemistry is one of the sciences that give rise to abstract phenomena. Much of the material in chemistry learning is difficult to illustrate in real form and two-dimensional images. In the process of learning Physics Chemistry, students are often faced with abstract material that is outside their daily experience so that the material is difficult to teach and difficult to understand. This phenomenon is known as multiple representations of chemistry.

Representations are categorized into two groups, namely internal and external representations. Internal representations are defined as individual cognitive configurations that are thought to originate from behaviors that describe several aspects of physical processes and problem solving, while external representations. They can be described as structured physical situations that can be seen as the embodiment of physical ideas (Bayraka & Bayramb, 2010; Chandrasegaran, Treagust, & Mocerino, 2007). Johnstone as cited in Chittleborough and Treagust (2007) divides chemical phenomena into three levels, namely: (1) Macroscopic level that is obtained through real phenomena that may directly or indirectly be part of daily student experience, which can be seen or perceived by the five senses . For example changes in color, temperature, pH of the solution, formation of gases

and deposits that can be observed when a chemical reaction takes place. (2) Sub-microscopic level consists of real chemical phenomena, which indicate a particular level so that it cannot be seen. The sub microscopic representation is very closely related to the theoretical model underlying the particle level explanation. The representation model at this level is expressed symbolically starting from simple action to using computer technology, namely with words, two-dimensional images, and three-dimensional images, both still and moving animation or simulation. (3) Symbolic level consists of kinds of representation images, algebra and computerized forms (Chittleborough & Treagust, 2008).

Hess Law Reaction is a material in the Physics Chemistry course which is incorporated in the scientific and skills subjects group. The existence of this Hess Law Reaction material is very important, but many students are less enthusiastic and interested in learning it, which is marked by the low learning outcomes. So far, the learning in the Chemical Education of an Indonesian state university has been only done with lectures and discussions. Even though this lecture material requires more active student involvement, it is deemed necessary to use multiple multimedia-based representing the Hess Law Reaction which can help students understand the Hess Law Reaction material. Through multimedia based on multiple representations on the Hess Law Reaction, the gap between ideal conditions and existing real conditions is expected to be overcome. Real conditions is conventional that learning resources are usually only in the form of reading books / texts and learning. In this way the learning process is expected to be effective and efficient and the level of mastery of the concepts and science process skills of students towards the Hess Law Reaction material will be better. This study is therefore aimed at determining the attitudes and motivations of students in learning Hess Law Reaction using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess Law Reaction, the learning outcomes of the participated students after experiencing the learning through the multimedia, and the effectiveness of the multimedia in improving the mastery of students' science processes and concepts about Hess Law Reaction

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These three levels are interconnected and contribute to students to be able to understand the abstract material of Chemistry Physics. This is supported by the statement of Tasker, Roy, and Dalton (2006), that chemistry involves processes of change that can be observed in terms of (e.g. changes in colors, odors, and bubbles) in macroscopic or laboratory dimensions, but in terms of changes that cannot be observed with eyes, such as changes in structure or processes at the sub micro or imaginary molecular level can only be done through modeling. These changes at the molecular level are then depicted at the abstract symbolic level in two ways, namely qualitatively using special notation, language, diagrams, and symbolically and quantitatively using mathematics (equations and graphs).

Based on the characteristics of Physical Chemistry, the modes of representation of Physical Chemistry are classified in terms of levels of representation, namely macroscopic representation, submicroscopic representation and symbolic representation (Chandrasegaran et al., 2007). Macroscopic representation is a chemical representation obtained through tangible observation of a phenomenon that can be seen and perceived by the sensory level or can be in the daily experience of the learner. Subcompact microscopic representations are chemical representations that explain the structure and processes at the particle level (atoms or molecules) against the macroscopic phenomena observed.

Sub-microscopic representation is closely related to the theoretical model underlying it, so students can explore the dynamics that occur at the particle level. The mode of representation at this level can be expressed starting from simple to using computer technology, which uses words, two-dimensional images, three-dimensional images, both still and moving (animated) or simulation. Symbolic representations are chemical representations qualitatively and quantitatively, namely chemical formulas, diagrams, drawings, reaction equations, stoichiometry and mathematical calculations (Acree, Cormae, Fulbright, Weaver, & Krantzman, 1995; Domagk, Schwartz, & Plass, 2010; Treagust, Chittleborough, & Mamiala 2003).

Although macroscopic observations of chemical phenomena are chemical bases, the explanation of these phenomena is actually based on the representation of submicroscopic and symbolic levels. Consequently, an important aspect to reduce explanation depends on the ability of students to understand the role of each level of representation and the ability to transfer one level to another. Acquisition of knowledge without a clear understanding will cause students to experience confusion, because at the same time they have to deal with macroscopic, submicroscopic and symbolic levels. There are two categories of learners' understanding related to the depth of understanding and the ability to apply knowledge, namely; instrumental understanding (knowing how) and relational understanding (knowing why). The level of instrumental understanding reflects learning.

RESEARCH METHODS

The population of this study is all Chemistry Study Program students in Indonesian universities that attended Physical Chemistry courses I. We applied a sample random sampling for this study. Two tests were conducted; small-group test and field test. The sample for the small group test consisted of twelve students and the sample for the field test consisted of twenty-four students attending a Chemistry Study Program of a university that is located in Jambi provincial in southern part of Sumatra, Indonesia. The report of this study is a part of research and development study using ADDIE model that was fully funded by the 2018 Higher Education Applied Research Grants. It takes 2 years to finish all projects.

As an independent variable was a learning system using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess Law Reaction and the dependent variable is student learning outcomes on the Hess Law Reaction material, this study uses quasi-experimental research methods. The study design can be seen in Table 1.

The data in this study were obtained from students in the form of multimedia quality data, motivation and benefit data, and student learning outcomes. Multimedia quality data, motivational data and benefits obtained through questionnaires, student learning outcomes data obtained through learning outcomes tests, learning outcomes tests used for the Hess Law Reaction material are objective questions.

Tabel 1
Research design

Sampel	Pre-test	Treatment	Post-test
A	Y_1	X	Y_2

Data analysis of learning outcomes is done by t-test. The significant level (α) used in this study is 5% with a probability (1 - α) dk = (n1 + n2 - 2), if -table <t count <table, then Ho is accepted which means there is no average difference significant between the pre-test results and the post-test results, and Ho is rejected for other t values (Sudjana, 2001).

RESULTS AND DISCUSSION

Analysis of Multiple Small Group Multimedia Trial Based Data Analysis (macroscopic, microscopic and symbolic) Hess Law Reaction

Analysis of multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in small group trials for aspects of learning, content / material, and media can be seen in Tables 2 and 3.

Table 2
Frequency distribution Assessment of aspects of learning, content / media, and media in a small group multimedia test based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	7	58,3	6	50	4	33,3
Good	5	41,7	6	50	8	66,7
Sufficient	0	0	0	0	0	0
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	12	100	12	100	12	100

Table 2 shows the distribution of assessments in the multimedia small group test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in a small group test in terms of learning or pedagogy, content / material, and media are included in the criteria either.

Table 3
Quality of multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction results of small group trials

Assessment	Mean	Criterion
Pedagogy	4,21	Good
Content	4,17	Good
Media	3,77	Good
Total mean	12,15	Good
Mean average	4,05	

Analysis of Data Field Trials based on multiple multimedia representations (macroscopic, microscopic and symbolic) Hess Law Reaction

In this part we report the Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction, Motivation and benefits aspects, and Learning outcomes.

Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Analysis of multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in field trials for aspects of learning, content / material, and media can be seen in Tables 4 and 5.

Table 4
Frequency distribution Assessment of aspects of learning, content / media, and media in the pilot multimedia field based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	14	58,3	13	54,2	10	41,7
Good	9	37,5	9	37,5	13	54,1
Sufficient	1	4,2	2	8,3	1	4,2
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	24	100	24	100	24	100

Table 4 shows that the distribution of assessments in the multimedia field test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in the field test in terms of learning, content/material, and media are included in good criteria.

Table 5
Quality of multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction results of field trials

Assessment	Mean	Criterion
Pedagogy	4,17	Good
Content	4,13	Good
Technology	4,18	Good
Average	12,48	Good
Rerata keseluruan	4,16	

Motivation and benefits aspects

In general, students stated that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction can foster motivation and provide meaningful benefits in the learning process of voltaic cells. More detailed data analysis can be seen in Table 5.

Table 5
Analysis of data on motivational aspects and benefits in multimedia field trials based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

No	Indicator	Yes (%)	No (%)
1.	The material for Hess's Law Reaction was easy for me to learn through multimedia	100	0
2.	The concept presented is easy for me to understand	91,7	8,3
3.	The Hess Law Reaction material presented challenged me to study better	95,8	4,2
4.	I want to learn a lot through multimedia based on multiple representations (macroscopic, microscopic and symbolic)	100	0
5.	Through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction gives me the opportunity to learn at my own pace	100	0
6.	multimedia based on multiple representations (macroscopic, microscopic and symbolic) Legal Reaction Hes this lesson helped me in learning Hess's Law Reaction	100	0
7.	Working on evaluations helped me understand Hess's Law Reaction material	100	0
8.	Hess Law Reaction material presented through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction made me learn faster	79,2	20,8
9.	I enjoy using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction for learning	100	0

10.	I want to learn by using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction learning (multimedia), on other courses	91,7	8,3
11.	Without being accompanied by a lecturer, I experienced confusion and lack of confidence	25	75
12.	Presentation of interesting material because with a variety of media (text, images, and videos)	100	0
13.	The instructions that make me confused	16,7	83,3
14.	I study the material coherently	100	0

All students (100%) who were respondents in the field trial stated: The material presented in multimedia is based on multiple representations (macroscopic, microscopic and symbolic). Hess's Law Reaction is easy to learn; Respondents want to learn a lot through multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hesss Law Reaction, meaning they are motivated to learn as much material as possible; By using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction respondents can learn according to their abilities; Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction helps respondents in learning the material of Hess Law Reaction; Respondents can measure their understanding by working on evaluation questions that exist in multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction; Respondents feel happy to learn through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Reaction of Hess's Law, meaning multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction is not boring and interesting; Presentation of material with a variety of interesting media (text, pictures, videos), this becomes a motivator for students in learning; Respondents study the material coherently.

Some respondents (91.7%) stated that the concepts presented in multimedia are based on multiple representations (macroscopic, microscopic and symbolic). The Hess Law Reaction is easy to learn. Some respondents (95.8%) stated that they felt challenged to learn better because the material was relatively easy to learn and they were actively involved in the learning process. Some respondents (79.2%) stated that they could more quickly learn the material of the Hess Law Reaction. Some respondents (91.7%) stated that they wanted to learn with multimedia in other subjects. Only a small proportion of respondents (25%) stated that they were confused and were not confident if they were not accompanied by a lecturer, meaning that 75% of respondents were able to study independently with the Hess Law Reaction. Only a small proportion of respondents (16.7%) stated that the instructions provided made them confused, meaning 83.3% of respondents found it easy when using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction in learning so that the learning process went smoothly .

In general it can be concluded that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction provides benefits for students who learn to use multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction. Students also become more motivated in learning the material presented. It can be said that multimedia is based on multiple representations (macroscopic, microscopic and symbolic). The Hess Law Reaction contributes positively to the learning process of the Hess Law Reaction.

Commented [WU1]: What do you want to say specifically?

2.3 Learning outcomes

To find out the effectiveness of multimedia based on multiple representations (macroscopic, microscopic and symbolic), the Hess Law Reaction in the field trial carried out pre-test and post-test data analysis at the end of learning. Data analysis was performed by means of the different statistic test using the t test for paired samples. multimedia based on multiple representations (macroscopic, microscopic and symbolic) The Hess Law Reaction is said to be effective if there is a significant increase in scores between pre-test and post-test scores. Statistical testing was carried out with the help of the SPPS program

Pre-test and post-test data were normally distributed, then t tests were performed.

It is necessary to formulate a hypothesis to make a decision whether the pre-test and post-test mean scores differ significantly or not with the following formula:

H0: The two mean test scores are identical (pre-test and post-test scores are not significantly different), H1: The two mean test scores are not identical (pre-test and post-test scores are significantly different). Decision making is based on probability values, namely: 1) H0 is accepted if probability> 0.05, 2) H1 is accepted if probability <0.05

Commented [WU2]: H0 should be H_0; H1 should be H_1

From the paired samples test table (Appendix 2) the Sig. (2-tailed) or the probability is 0,000 less than 0.05. So it can be concluded that H0 is rejected which means the pre-test and post-test scores differ significantly. It can be said that there was a significant increase from the test scores before using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction to test scores after using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction. Based on the results of statistical analysis it can be concluded that multimedia b multimedia-based multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction is effectively used in the learning process of voltaic cells.

CONCLUSION

Multimedia quality criteria based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction from the aspects of learning, content / material, and media are included in both criteria with an average score of 4.05 for small group trials and

4.16 for trials field. Students can learn Hess's Law Reaction material more easily, faster, more active, not boring, more independent, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction. The results of the t-test mean pre-test and post-test scores showed that the mean pre-test and post-test scores differed significantly with a probability value of 0,000 small than 0.05. Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction is effectively used in the learning process of Hess Law Reaction.

Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction can be utilized in the learning process of Hess Law Reaction so that learning is more effective and efficient and student motivation and independence can be improved.

Acknowledgment

Thank you to the Republic of Indonesia Ministry of Research, Technology and Higher Education for funding this Research through the 2018 Higher Education Applied Research Grants.

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Content	4,17	Good
Media	3,77	Good
Total mean	12,15	Good
Mean average	4,05	

Analysis of Data Field Trials based on multiple multimedia representations (macroscopic, microscopic and symbolic) Hess Law Reaction

In this part we report the Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction, Motivation and benefits aspects, and Learning outcomes.

Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Analysis of multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in field trials for aspects of learning, content / material, and media can be seen in Tables 4 and 5.

Table 4
Frequency distribution Assessment of aspects of learning, content / media, and media in the pilot multimedia field based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	14	58,3	13	54,2	10	41,7
Good	9	37,5	9	37,5	13	54,1
Sufficient	1	4,2	2	8,3	1	4,2
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	24	100	24	100	24	100

Table 4 shows that the distribution of assessments in the multimedia field test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction in the field test in terms of learning, content/material, and media are included in good criteria.

Table 5
Quality of multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction results of field trials

Assessment	Mean	Criterion
Pedagogy	4,17	Good
Content	4,13	Good
Technology	4,18	Good
Average	12,48	Good
Rerata keseluruan	4,16	

Motivation and benefits aspects

In general, students stated that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction can foster motivation and provide meaningful benefits in the learning process of voltaic cells. More detailed data analysis can be seen in Table 5.

Table 5
Analysis of data on motivational aspects and benefits in multimedia field trials based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction

No	Indicator	Yes (%)	No (%)
1.	The material for Hess's Law Reaction was easy for me to learn through multimedia	100	0
2.	The concept presented is easy for me to understand	91,7	8,3
3.	The Hess Law Reaction material presented challenged me to study better	95,8	4,2
4.	I want to learn a lot through multimedia based on multiple representations (macroscopic, microscopic and symbolic)	100	0
5.	Through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction gives me the opportunity to learn at my own pace	100	0
6.	multimedia based on multiple representations (macroscopic, microscopic and symbolic) Legal Reaction Hes this lesson helped me in learning Hess's Law Reaction	100	0
7.	Working on evaluations helped me understand Hess's Law Reaction material	100	0
8.	Hess Law Reaction material presented through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction made me learn faster	79,2	20,8
9.	I enjoy using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction for learning	100	0

10.	I want to learn by using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction learning (multimedia), on other courses	91,7	8,3
11.	Without being accompanied by a lecturer, I experienced confusion and lack of confidence	25	75
12.	Presentation of interesting material because with a variety of media (text, images, and videos)	100	0
13.	The instructions that make me confused	16,7	83,3
14.	I study the material coherently	100	0

All students (100%) who were respondents in the field trial stated: The material presented in multimedia is based on multiple representations (macroscopic, microscopic and symbolic). Hess's Law Reaction is easy to learn; Respondents want to learn a lot through multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hesss Law Reaction, meaning they are motivated to learn as much material as possible; By using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction respondents can learn according to their abilities; Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction helps respondents in learning the material of Hess Law Reaction; Respondents can measure their understanding by working on evaluation questions that exist in multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction; Respondents feel happy to learn through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Reaction of Hess's Law, meaning multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction is not boring and interesting; Presentation of material with a variety of interesting media (text, pictures, videos), this becomes a motivator for students in learning; Respondents study the material coherently.

Some respondents (91.7%) stated that the concepts presented in multimedia are based on multiple representations (macroscopic, microscopic and symbolic). The Hess Law Reaction is easy to learn. Some respondents (95.8%) stated that they felt challenged to learn better because the material was relatively easy to learn and they were actively involved in the learning process. Some respondents (79.2%) stated that they could more quickly learn the material of the Hess Law Reaction. Some respondents (91.7%) stated that they wanted to learn with multimedia in other subjects. Only a small proportion of respondents (25%) stated that they were confused and were not confident if they were not accompanied by a lecturer, meaning that 75% of respondents were able to study independently with the Hess Law Reaction. Only a small proportion of respondents (16.7%) stated that the instructions provided made them confused, meaning 83.3% of respondents found it easy when using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction in learning so that the learning process went smoothly .

In general it can be concluded that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction provides benefits for students who learn to use multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction. Students also become more motivated in learning the material presented. It can be said that multimedia is based on multiple representations (macroscopic, microscopic and symbolic). The Hess Law Reaction contributes positively to the learning process of the Hess Law Reaction.

2.3 Learning outcomes

To find out the effectiveness of multimedia based on multiple representations (macroscopic, microscopic and symbolic), the Hess Law Reaction in the field trial carried out pre-test and post-test data analysis at the end of learning. Data analysis was performed by means of the different statistic test using the t test for paired samples. multimedia based on multiple representations (macroscopic, microscopic and symbolic) The Hess Law Reaction is said to be effective if there is a significant increase in scores between pre-test and post-test scores. Statistical testing was carried out with the help of the SPPS program

Pre-test and post-test data were normally distributed, then t tests were performed.

It is necessary to formulate a hypothesis to make a decision whether the pre-test and post-test mean scores differ significantly or not with the following formula:

H0: The two mean test scores are identical (pre-test and post-test scores are not significantly different), H1: The two mean test scores are not identical (pre-test and post-test scores are significantly different). Decision making is based on probability values, namely: 1) H0 is accepted if probability> 0.05, 2) H1 is accepted if probability <0.05

From the paired samples test table (Appendix 2) the Sig. (2-tailed) or the probability is 0,000 less than 0.05. So it can be concluded that H0 is rejected which means the pre-test and post-test scores differ significantly. It can be said that there was a significant increase from the test scores before using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction to test scores after using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess Law Reaction. Based on the results of statistical analysis it can be concluded that multimedia b multimedia-based multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction is effectively used in the learning process of voltaic cells.

CONCLUSION

Multimedia quality criteria based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction from the aspects of learning, content / material, and media are included in both criteria with an average score of 4.05 for small group trials and

4.16 for trials field. Students can learn Hess's Law Reaction material more easily, faster, more active, not boring, more independent, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess's Law Reaction. The results of the t-test mean pre-test and post-test scores showed that the mean pre-test and post-test scores differed significantly with a probability value of 0,000 small than 0.05. Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction is effectively used in the learning process of Hess Law Reaction.

Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess Law Reaction can be utilized in the learning process of Hess Law Reaction so that learning is more effective and efficient and student motivation and independence can be improved.

Acknowledgment

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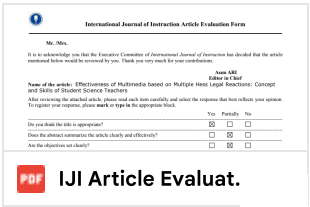

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Effectiveness of Multimedia based on Multiple Hess' Law: Concept and Skills of Pre-service Science Teachers

In ideal conditions, learning is centered on pre-service science teachers with learning media that are not only sourced from reading books or texts, but there are also multimedia-based multiple representations (macroscopic, microscopic, and symbolic) so that learning becomes more interesting. The purpose of this study was to determine: 1) the attitudes and motivations of pre-service science teachers in learning Hess' Law using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess' Law ; 2) the learning outcomes of the participated pre-service science teachers after experiencing the learning through the multimedia, and 3) the effectiveness of the multimedia in improving the mastery of pre-service science teachers' science processes and concepts about Hess' Law. The method used in study is quasi-experimental; pre-test and post-test were addressed through a questionnaire and test. Data analysis was performed through multimedia quality data based on the multiple representations (macroscopic, microscopic and symbolic) and t test. The results showed that pre-service science teachers could learn Hess''s Law material more easily, faster, more actively, more independently, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess' Law. The results of the t-test for the difference before and after treatment was significant ($p < .005$).

Keywords: multimedia, multiple representations, Hess' Law , effectiveness, learning outcomes.

INTRODUCTION

Physical Chemistry is one of the sciences that give rise to abstract phenomena. Much of the materials in chemistry learning are difficult to illustrate in real form and two-dimensional images. In the process of learning PhysicalChemistry, pre-service science teachers are often faced with abstract material that is outside their daily experience so that the material is difficult to teach and difficult to understand. This phenomenon is known as "multiple representations".

Representations are categorized into two groups, namely internal and external representations. Internal representations are defined as individual cognitive configurations that are thought to originate from behaviours that describe several aspects of physical processes and problem solving, while external representations~~. They can be described as~~ structured physical situations that ~~can be seen as~~ the embodiment of physical ideas (Bayraka & Bayramb, 2010; Chandrasegaran, Treagust, & Mocerino, 2007). Johnstone as cited in Chittleborough and Treagust (2007) divides chemical phenomena into three levels, namely. Firstly, Macroscopic level that is obtained through real phenomena that may directly or

indirectly be part of student experiences on daily bases, which can be seen or perceived by the five senses. For example changes in color, temperature, pH of the solution, formation of gases and deposits that can be observed when a chemical takes place. Secondly,sub-microscopic level consists of real chemical phenomena, which indicate a particular level so that it cannot be seen. The sub microscopic representation is very closely related to the theoretical model underlying the particle level explanation. The representation model at this level is expressed symbolically starting from simple action to using computer technology, namely with words, two-dimensional images, and three-dimensional images, both still and moving animation or simulation. Lastly,symbolic level consists of kinds of representation images, algebra and computerized forms (Chittleborough & Treagust, 2008).

Hess' Law is a material in the Physical Chemistry course which is incorporated in the scientific and skills subjects' group. The existence of this Hess' Law material is very important, but many pre-service science teachers are less enthusiastic and interested in learning it, which is marked by the low learning outcomes. So far, the learning in the Chemical Education of an Indonesian state university has been only done with lectures and discussions. Even though this lecture material requires more active student involvement, it is deemed necessary to use multiple multimedia-based representing the Hess' Law which can help pre-service science teachers understand the Hess' Law material. Through multimedia based on multiple representations on the Hess' Law , the gap between ideal conditions and existing real conditions is expected to be overcome. Real conditions is conventional that learning resources are usually only in the form of reading books / texts and learning. In this way the learning process is expected to be effective and efficient and the level of mastery of the concepts and science process skills of pre-service science teachers towards the Hess' Law material will be better. Therefore, this study is to determine the attitudes and motivations of pre-service science teachers in learning Hess' Law using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess' Law. The study also aims at revealing the learning outcomes of the participated pre-service science teachers after experiencing the learning through the multimedia and the effectiveness of the multimedia in improving the mastery of pre-service science teachersprocesses and concepts about Hess' Law. Three research questions were added within this study: 1) what are the attitudes and motivations of pre-service science teachers in learning Hess' Law using multimedia based on multiple representations (macroscopic, microscopic and symbolic), 2) what are the learning outcomes of the participated pre-service science teachers after experiencing the learning through the multimedia, and 3) How effective does the multimedia

improve the mastery of pre-service science teachers' science processes and concepts about Hess' Law.

REVIEW OF LITERATURE

Hess' Law **is** is a correlation in Physical Chemistry published in 1840. The law elaborates that the total number of enthalpy change during the complete courses of chemical reactions are the same whether the reaction is based on single step or multiple steps.

Macroscopic, microscopic and symbolic in this studyare interconnected and contributed to pre-service science teachers to be able to understand the abstract material of Physical Chemistry. This is supported by the statement of Tasker, Roy, and Dalton (2006), that chemistry involves processes of change that are observed in terms of (e.g. changes in colours, odours, and bubbles) in macroscopic or laboratory dimensions, but in terms of changes that cannot be observed with eyes, such as changes in structure or processes at the sub micro or imaginary molecular level can only be done through modeling. These changes at the molecular level are then depicted at the abstract symbolic level in two ways, namely qualitatively using special notation, language, diagrams, and symbolically and quantitatively using mathematics (equations and graphs).

Based on the characteristics of Physical Chemistry, the modes of representation of Physical Chemistry are classified in terms of levels of representation, namely macroscopic representation, submicroscopic representation and symbolic representation (Chandrasegaran et al., 2007). Macroscopic representation is a chemical representation obtained through tangible observation of a phenomenon that areseen and perceived by the sensory level or can be in the daily experience of the learner. Subcompact microscopic representations are chemical representations that explain the structure and processes at the particle level (atoms or molecules) against the macroscopic phenomena observed.

Sub-microscopic representation is closely related to the theoretical model underlying it, so pre-service science teachers can explore the dynamics that occur at the particle level. The mode of representation at this level can be expressed starting from simple to using computer technology, which uses words, two-dimensional images, three-dimensional images, both still and moving (animated) or simulation. Symbolic representations are chemical representations qualitatively and quantitatively, namely chemical formulas, diagrams, drawings, equations, stoichiometry and mathematical calculations (Acree, Cormae, Fulbright, Weaver, & Krantzman, 1995; Domagk, Schwartz, & Plass, 2010; Treagust, Chittleborough, & Mamiala 2003).

Although macroscopic observations of chemical phenomena are chemical bases, the explanation of these phenomena is actually based on the representation of submicroscopic and symbolic levels. Consequently, an important aspect to reduce explanation depends on

the ability of pre-service science teachers to understand the role of each level of representation and the ability to transfer one level to another. Acquisition of knowledge without a clear understanding will cause pre-service science teachers to experience confusion, because at the same time they have to deal with macroscopic, submicroscopic and symbolic levels. There are two categories of learners' understanding related to the depth of understanding and the ability to apply knowledge, namely; instrumental understanding (knowing how) and relational understanding (knowing why). The level of instrumental understanding reflects learning.

RESEARCH METHODS

The population of this study is all Chemistry Study Programme pre-service science teachers in Indonesian universities that attended Physical Chemistry courses I. We applied a simple random sampling for this study. Two tests were conducted; small-group test and field test. The sample for the small group test consisted of twelve pre-service science teachers and the sample for the field test consisted of twenty-four pre-service science teachers attending a Chemistry Study Programmeof a university that is ~~located~~ in Jambi provincial in southern part of Sumatra, Indonesia. The report of this study is a part of research and development study using ADDIE model that was fully funded by the 2018 Higher Education Applied Research Grants. It takes 2 years to finish all projects.

The review of literature helped researchers to analyse the theories and concepts and to determine methods and instruments to be adapted (Hair et al. 2016). We adapted and constructed survey instruments from previous related studies . For face and content validity, a panel of three users an three experts (was involved in discussing the adapted instruments. The process was done through interactive interview. The experts were professors in the fields of Physical Chemistry. After the discussion, some items were revised and few were eliminated since they could not be used in the Indonesian context

~~The~~ independent variable was a learning system using multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess' Law and the dependent variable is student learning outcomes on the Hess' Law material, this study uses quasi-experimental research methods. The study design can be seen in Table 1.

The data in this study were obtained from pre-service science teachers in the form of multimedia quality data, motivation and benefit data, and student learning outcomes. Multimedia quality data, motivational data and benefits obtained through questionnaires, student learning outcomes data obtained through learning outcomes tests, learning outcomes tests used for the Hess' Law material are objective questions.

Tabel 1
Research design

Sampel	Pre-test	Treatment	Post-test
A	Y_1	X	Y_2

Data analysis of learning outcomes is done by t-test. The significant level (α) used in this study is 5% with a probability (1 - α) dk = (n1 + n2 - 2), if -table <t count <table, then Ho is accepted which means there is no average difference significant between the pre-test results and the post-test results, and Ho is rejected for other t values (Sudjana, 2001).

RESULTS AND DISCUSSION

Analysis of Multiple Small Group Multimedia Trial Based Data Analysis (macroscopic, microscopic and symbolic) Hess' Law

Analysis of multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law in small group trials for aspects of learning, content / material, and media can be seen in Tables 2 and 3.

Table 2
Frequency distribution Assessment of aspects of learning, content / media, and media in a small group multimedia test based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law

Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	7	58,3	6	50	4	33,3
Good	5	41,7	6	50	8	66,7
Sufficient	0	0	0	0	0	0
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	12	100	12	100	12	100

Table 2 shows the distribution of assessments in the multimedia small group test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law in a small group test in terms of learning or pedagogy, content / material, and media are included in the criteria either.

Table 3
Quality of multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law results of small group trials

Assessment	Mean	Criterion
Pedagogy	4,21	Good
Content	4,17	Good
Media	3,77	Good
Total mean	12,15	Good

Mean average	4,05

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Multimedia quality based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law

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Criterion	Pedagogy		Content		Media	
	Frekuensi	%	Frekuensi	%	Frekuensi	%
Very good	14	58,3	13	54,2	10	41,7
Good	9	37,5	9	37,5	13	54,1
Sufficient	1	4,2	2	8,3	1	4,2
Less	0	0	0	0	0	0
Very less	0	0	0	0	0	0
Total	24	100	24	100	24	100

Table 4 shows that the distribution of assessments in the multimedia field test is based on multiple representations (macroscopic, microscopic and symbolic). The mean multimedia quality assessment based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law in the field test in terms of learning, content/material, and media are included in good criteria.

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Assessment	Mean	Criterion
Pedagogy	4,17	Good
Content	4,13	Good
Technology	4,18	Good
Average	12,48	Good
Rerata keseluruan	4,16	

Motivation and benefits aspects

In general, pre-service science teachers stated that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law can foster motivation and provide meaningful benefits in the learning process of voltaic cells. More detailed data analysis can be seen in Table 5.

Table 5
Analysis of data on motivational aspects and benefits in multimedia field trials based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law

No	Indicator	Yes (%)	No (%)
1.	The material for Hess''s Law was easy for me to learn through multimedia	100	0
2.	The concept presented is easy for me to understand	91,7	8,3
3.	The Hess' Law material presented challenged me to study better	95,8	4,2
4.	I want to learn a lot through multimedia based on multiple representations (macroscopic, microscopic and symbolic)	100	0
5.	Through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess''s Law gives me the opportunity to learn at my own pace	100	0
6.	multimedia based on multiple representations (macroscopic, microscopic and symbolic) Legal Hes this lesson helped me in learning Hess''s Law	100	0
7.	Working on evaluations helped me understand Hess''s Law material	100	0
8.	Hess' Law material presented through multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law made me learn faster	79,2	20,8
9.	I enjoy using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess''s Law for learning	100	0
10.	I want to learn by using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess' Law learning (multimedia), on other courses	91,7	8,3
11.	Without being accompanied by a lecturer, I experienced confusion and lack of confidence	25	75
12.	Presentation of interesting material because with a variety of media (text, images, and videos)	100	0
13.	The instructions that make me confused	16,7	83,3
14.	I study the material coherently	100	0

All pre-service science teachers (100%) who were respondents in the field trial stated: The material presented in multimedia is based on multiple representations (macroscopic, microscopic and symbolic). Hess''s Law is easy to learn; Respondents want to learn a lot through multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess's Law , meaning they are motivated to learn as much material as possible; By using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess' Law respondents can learn according to their abilities; Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law helps respondents in learning the material of Hess' Law ; Respondents can measure their understanding by working on evaluation questions that exist in multimedia based on

multiple representations (macroscopic, microscopic and symbolic) Hess' Law ; Respondents feel happy to learn through multimedia based on multiple representations (macroscopic, microscopic and symbolic) of Hess''s Law, meaning multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess''s Law is not boring and interesting; Presentation of material with a variety of interesting media (text, pictures, videos), this becomes a motivator for pre-service science teachers in learning; Respondents study the material coherently.

Some respondents (91.7%) stated that the concepts presented in multimedia are based on multiple representations (macroscopic, microscopic and symbolic). The Hess' Law is easy to learn. Some respondents (95.8%) stated that they felt challenged to learn better because the material was relatively easy to learn and they were actively involved in the learning process. Some respondents (79.2%) stated that they could more quickly learn the material of the Hess' Law . Some respondents (91.7%) stated that they wanted to learn with multimedia in other subjects. Only a small proportion of respondents (25%) stated that they were confused and were not confident if they were not accompanied by a lecturer, meaning that 75% of respondents were able to study independently with the Hess' Law . Only a small proportion of respondents (16.7%) stated that the instructions provided made them confused, meaning 83.3% of respondents found it easy when using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess' Law in learning so that the learning process went smoothly .

In general it can be concluded that multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law provides benefits for pre-service science teachers who learn to use multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law . Pre-service science teachers also become more motivated in learning the material presented. It can be said that multimedia is based on multiple representations (macroscopic, microscopic and symbolic). The Hess' Law contributes positively to the learning process of the Hess' Law .

2.3 Learning outcomes

To find out the effectiveness of multimedia based on multiple representations (macroscopic, microscopic and symbolic), the Hess' Law in the field trial carried out pre-test and post-test data analysis at the end of learning. Data analysis was performed by means of the different statistic test using the t test for paired samples. multimedia based on multiple representations (macroscopic, microscopic and symbolic) The Hess' Law is said to be effective if there is a significant increase in scores between pre-test and post-test scores. Statistical testing was carried out with the help of the SPSS program

Pre-test and post-test data were normally distributed, then t tests were performed.

It is necessary to formulate a hypothesis to make a decision whether the pre-test and post-test mean scores differ significantly or not with the following formula:

H0: The two mean test scores are identical (pre-test and post-test scores are not significantly different), H1: The two mean test scores are not identical (pre-test and post-test scores are significantly different). Decision making is based on probability values, namely: 1) H0 is accepted if probability> 0.05, 2) H1 is accepted if probability <0.05

From the paired samples test table (Appendix 2) the Sig. (2-tailed) or the probability is 0,000 less than 0.05. So it can be concluded that H0 is rejected which means the pre-test and post-test scores differ significantly. It can be said that there was a significant increase from the test scores before using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess' Law to test scores after using multiple multimedia-based representations (macroscopic, microscopic and symbolic) Hess' Law . Based on the results of statistical analysis it can be concluded that multimedia b multimedia-based multiple representations (macroscopic, microscopic and symbolic) Hess''s Law is effectively used in the learning process of voltaic cells.

CONCLUSION

Multimedia quality criteria based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law from the aspects of learning, content / material, and media are included in both criteria with an average score of 4.05 for small group trials and 4.16 for trials field. Pre-service science teachers can learn Hess''s Law material more easily, faster, more active, less boring, more independent, and motivated in learning by using multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess''s Law . The results of the t-test mean pre-test and post-test scores showed that the mean pre-test and post-test scores differed significantly with a probability value of 0,000 small than 0.05. Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law is effectively used in the learning process of Hess' Law .

Multimedia based on multiple representations (macroscopic, microscopic and symbolic) Hess' Law can be utilized in the learning process of Hess' Law so that learning is more effective and efficient and student motivation and independence can be improved.

SUGGESTION

Chemistry teacher educators should have more resources to help pre-service science teachers develop their perception and understanding about Hess' law. The presence of the multimedia enriches resources for Chemistry education to understand more about Hess' Law material. However, A more comprehension on resources based on Hess' Law in different contexts and settings are recommended for future researchers to adapt. Other

approaches of research such as qualitative and quantitative are also recommended to conduct. A qualitative culture can address a more-in-depth understanding though its advantageous while quantitative method can have a wider study that involves a better number of subjects, and enhances the generalization of the findings. The findings are valid for Indonesian education and language science teachers' context. Thus, it is hoped it can be beneficial for all stake holders in Chemistry education.

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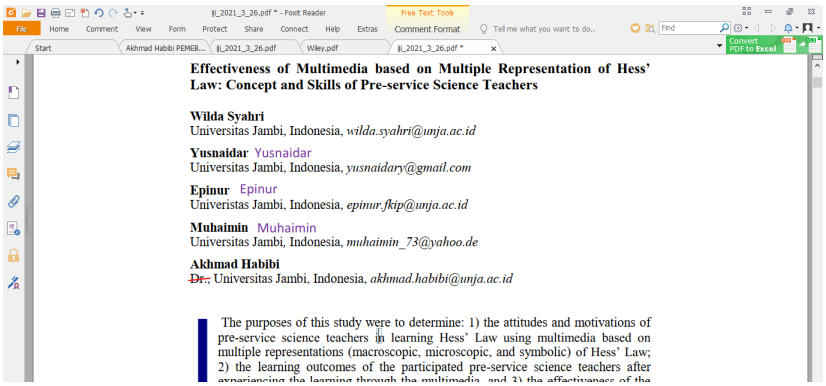

Effectiveness of Multimedia based on Multiple Representation of Hess' Law: Concept and Skills of Pre-service Science Teachers

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The purposes of this study were to determine: 1) the attitudes and motivations of pre-service science teachers in learning Hess' Law using multimedia based on multiple representations (macroscopic, microscopic, and symbolic) of Hess' Law; 2) the learning outcomes of the participated pre-service science teachers after

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The purposes of this study were to determine: 1) the attitudes and motivations of pre-service science teachers in learning Hess' Law using multimedia based on multiple representations (macroscopic, microscopic, and symbolic) of Hess' Law; 2) the learning outcomes of the participated pre-service science teachers after experiencing the learning through the multimedia, and 3) the effectiveness of the multimedia in improving the mastery of pre-service science teachers' science processes and concepts about Hess' Law. The method used in this study is quasi-experimental: pre-test and post-test were addressed through a questionnaire and