Concept Attainment Worksheet to Enhance Concept Knowledge and Science Process Skills in Physics Instruction

by Syella Ayunisa Rani

FILE	SYELLA_REV_5.DOCX (120.24K)		
TIME SUBMITTED	10-JUL-2017 03:12PM	WORD COUNT	3581
SUBMISSION ID	829982516	CHARACTER COUNT	20930

Concept Attainment Worksheet to Enhance Concept Knowledge and Science Process Skills in Physics Instruction

S. A. Rani[1], Y. Wiyatmo[1], H. Kustanto[2]

[1]Physics Education, Yogyakarta State University, Yogyakarta, Indonesia
[2]Senior High School 1 Magelang, Central Java, Indonesia

Corresponding author: syellaayunisa@gmail.com

ABSTRACT

This was a development study by adopting 4-D models, which involved of defining, designing, developing, and disseminating. The study aims are to: 1) create student worksheet with concept attainment method, 2) identify concept knowledge progress, and 3) determine science process skills improvement. The developed worksheet was tested in SMAN 1 Magelang. About 20 students of grade XI participated in limited test and 33 students in field test. The findings reveal that: 1) final worksheet is created from the final revision which got from validator assessment, limited test, field test, and student questionnaire. All aspects on the validator assessment get the best category, except teacher score of learning using concept attainment method which include just in good category. Questionnaire results show that 78% students on limited test and 89% students on field test agree with the worksheet. 2) concept knowledge improvement for limited test is 56% and field test is 50%, all involved in medium gain and 3) science process skills enhancement isn't significant for all aspects.

Keywords: concept attainment worksheet, concept knowledge, science process skills

INTRODUCTION

One of the 21st century challenges is competition among countries in many aspects. Consequently, Indonesian have to build up the skills which needed to ensure their competitive in this globalization era, such as skills for life and career, learning and innovation skills, and for sure information, media, and technology skills (Trilling & Fadel, 2009).

Science included Physics is a study to understand about nature. There are four dimensions of science, such as a way of thinking, a way of investigating, body of knowledge, and interaction with technology and society (Chiappetta & Koballa, Thomas R, 2010).

Better quality of science education, essentially in Physics is assumed to be a solution for the 21st century challenges. But result of science literacy from PISA (Program for International Student Assessment) 2012, from 65 countries Indonesia get second rank from bottom. That's a level before Peru (OECD, 2013). The result shows that science literacy of Indonesian are still powerless. So it should be increased by how science or Physics exactly should be learned.

21st century learning of science is focused in investigation method through inquiry process. A learning strategy that using structure of inquiry process is concept attainment (J. L. Jones & Hilaire, 2014). Concept attainment is a learning method to help student easily understand about concept. This method applicable from pre-kindergarten to higher education because it includes critical inquiry, reasoning skills, and inductive thinking process (Mcdonald, 2015; Wenno, Wattimena, & Maspaitela, 2016). Concept attainment is designed to classify objects or events as same as the scientific procedure (Mohan, 2007). Through concept attainment method, students compare and contrast examples that contain concept attributes with examples that don't. By observing, students discuss and identify the attributes until they develop a concept definition.

Concept attainment lesson plan consist of identifying topic, deciding learning aims, choosing examples and non-examples, arranging examples and non-examples (Eggen, 2012). Based on (Anjum, 2014; Kaur, 2014; Kumar & Mathur, 2013), concept attainment is suitable method to understand about concept knowledge which different with conventional or traditional method.

So, one of idea to learn Physics more effectively is by implementing concept attainment method in a learning media, such as worksheet. This is expected to enhance not only concept knowledge but also science process skills. The common difficulty of learning Physics (Hung & Jonassen, 2006) is the lack of concept knowledge. (Kurniawan, 2013) stated that to get concept knowledge, students required to learn more active. With active and direct learning activity, students would get the concept in long term memory that very helpful for them.

Process skills also needed to get the learning comprehension, which means the whole of concept knowledge. Science process skills is main purpose of science concept. This skills include scientific inquiry which also support the 21st century learning of science (Chiappetta & Koballa, Thomas R, 2010). Concept knowledge and psychomotor skills are related each other. Real activity is important in creating the link of life, enabling students to more understand the lesson, getting knowledge, and developing psychomotor skills that include observation, measurement, classification, data recording, creating hypotheses, using data and gaining the creating ability, changing and controlling variables, and conducting scientific experiments (Sumarni, Wardani, Sudarmi & Gupitasari, 2016). Science process skills consist of basic and integrated skills. Basic science process skills consist of observing, classifying, communicating, using time and space relation, measuring and using number, predicting, and inferring. Then, integrated science process skills consist of defining operationally, controlling variables, interpreting data, hypothesizing, and experimenting (Karamustafaoğlu, 2011; Rauf, Rasul, Mansor, Othman, & Lyndon, 2013; Turiman, Omar, Mohd Daud, & Osman, 2012).

Equilibrium and Rotational Dynamics was selected as learning subject in this study because there are many applications in daily life but students mostly just memorize the formulas and apply it to solve problems without understand the concept. So, this study will create student worksheet using concept attainment method in Equilibrium and Rotational Dynamics to enhance concept knowledge and science process skills for grade XI.

METHOD

This study was included as research and development (R&D) and took 4-D model which developed by Thiagarajan and Semmel to create product (Trianto, 2009). The created product of this study was concept attainment worksheet to enhance concept knowledge and science process skills for grade XI, and using Equilibrium and Rotational Dynamics as the subject.

This study was conducted at SMAN 1 Magelang on January 2016. About 20 students of MIA 6 participated in limited test and 33 students of MIA 1 participated in field test.

Define, design, develop, and disseminate was included as steps in 4-D model. Define step was intended to determine the learning needed, which consisted of first analysis, student analysis, assignment analysis, concept analysis, and specification of learning purposes. Design step was conducted to provide learning media, comprised of four basic steps such as arranging instruments, choosing media, choosing format, and designing worksheet. Develop step purpose was to do some revisions which got from validator assessment, limited test, field test, and student questionnaire. First revision was conducted after lecturer and teacher doing theoretic validation of the worksheet. The last step was disseminate, which intended to distribute the created worksheet to other groups, like other classes, schools, or teachers.

This study used learning instruments and data collecting instruments. Learning instruments were involved of lesson plan and concept attainment worksheet. Data collecting instruments were comprised of validation questionnaire (lecturer and teacher), student questionnaire, pretest posttest, and science process skills observation sheet.

Data from this study were analyzed by feasibility and reliability for learning media, pie diagram for student questionnaire, gain interpretation for pretest posttest data, and bar diagram for science process skills observation sheet data.

Worksheet feasibility from lecturer and teacher score was calculated by using criteria of ideal assessment as seen at **TABLE 1.**

TABLE 1. Criteria of Ideal Assessment

Scores Range	Category
$X \geq \overline{X_i} + 1.8sb_i$	The Best
$\overline{X_i} + 0.6sb_i \leq X < \overline{X_i} + 1.8sb_i$	Good
$\overline{X_i} - 0.6sb_i \leq X < \overline{X_i} + 0.6sb_i$	Enough
$\overline{X_i} - 1.8sb_i \leq X < \overline{X_i} - 0.6sb_i$	Less
$X < \overline{X_i} - 1.8sb_i$	The Least

(Widoyoko, 2009)

Worksheet reliability was analyzed from lecturer and teacher score by using percentage of agreement. The formula was:

$$\text{Percentage of agreement} = \left(1 - \frac{A - B}{A + B}\right) \times 100\% \qquad (1)$$

Where A was high score and B was low score. Worksheet was categorized as a good instrument if coefficient of reliability was more than or equal with 0.75 or 75% (Borich, 1994).

Student questionnaire was examined by some steps, involved of changing positive and negative sentence into 1 – 4 scale (positive sentence: very agree = 4, agree = 3, disagree = 2, very disagree = 1, and negative sentence: very agree = 1, agree = 2, disagree = 3, very disagree = 4), cancelling inconstant scale in similar aspect between positive and negative sentences, counting overall students who give 1 – 4 scale in each aspects, and deciding the percentage (%).

The improvement of concept knowledge could be known from pretest and posttest data which calculated by gain score. The formula of normalized gain (g) was:

$$\text{Normalized gain}(g) = \frac{\%\text{posttest} - \%\text{pretest}}{100 - \%\text{pretest}} \quad (2)$$

Then the gain score was converted into the criteria on **TABLE 2.**

TABLE 2. Interpretation of Normalized Gain

Interval Gain (g)	Category
$(g) \geq 0.70$	High-g
$0.70 > (g) \geq 0.30$	Medium-g
$(g) < 0.30$	Low-g

(Hake, 2009)

Enhancement of science process skills was analyzed from observation result, which consisted of some steps, such as counting mean score of the both observers, counting mean score of each science process skills aspects, converting that quantitative score to qualitative using criteria on **TABLE 1**, counting the improvement of science process skills by normalized gain (g) and interpreting the criteria using **TABLE 2**. The progression of each science process skills aspects from experiment 1 – 6 could be seen using bar diagram.

RESULTS AND DISCUSSION

Concept attainment worksheet is a learning media which developed in this study. The purposes consist of creating worksheet with concept attainment method, identifying concept knowledge improvement, and knowing science process skill enhancement. Final worksheet is developed from revision in each steps, involve validator assessment, limited test, field test, and student questionnaire. The result of validator assessment can be seen on **TABLE 3**.

TABLE 3. Validator Assessment of Worksheet

Aspect	Score		PA
	Lecturer	Teacher	(%)
Language structure & worksheet design	32 (The Best)	34 (The Best)	96.97 (Good)
Learning using concept attainment method	11 (The Best)	10 (Good)	95.24 (Good)
Learning to improve science process skills	21 (The Best)	19 (The Best)	95 (Good)

All aspects on validator assessment of the worksheet get the best category, except teacher score of learning using concept attainment method which include just in good category. It because teacher thought that although there was hypothesis testing in analyzing phase but it didn't help for summarizing the concept knowledge. Moreover, teacher felt that closing and applying phase weren't appropriate with the concept attainment method. Results of percentage agreement show that reliability coefficient are more than 75%, so it can be concluded that the worksheet is categorized as a good instrument. First revision was conducted after getting comments from lecturer and teacher.

First revision product was implemented in development tests, which comprised of limited and field test. Grade XI, SMAN 1 Magelang was selected as the object of this study. About 20 students of MIA 6 participated in limited test and 33 students of MIA 1 participated in field test. Every tests involved of 3 session, first session students answered problems in pretest and conducted 1st and 2nd experiment, second session students worked with 3rd, 4th, 5th experiment, and third session students conducted the last experiment, answered problems in posttest, and filled questionnaire. Later revisions were happened after learning process in limited test, field test, and the questionnaire results were analyzed.

Concept knowledge enhancement of limited test is calculated and interpreted by normalized gain. The result can be shown at **TABLE 4.**

TABLE 4. Concept Knowledge Progression

Mean		
Pretest	Posttest	Gain Score
39	74	0.56 (medium-g)

Concept knowledge will be better if the students involved actively in the learning process. The improvement will be better than the students who passive or just listening to the teacher explanation (Atmojo, 2012). Based on the study of (Ates & Eryilmaz, 2011; Hussain & Akhtar, 2013; M. G. Jones, Andre, Negishi, Tretter, & Kubasko, 2003), active learning that included student learning interaction will produce significant result of student' achievement.

TABLE 4 shows that the mean of gain score from pretest posttest is 0.56 and categorized as medium gain. The result doesn't get high category. It could be caused by the created worksheet on limited test hadn't trained active learning process among students, consequently it should be any revisions for field test.

Science process skills progress of students in limited test can be known from observation sheets during learning process. There were seven examined skills, such as observing, hypothesizing, experimenting, classifying, interpreting, summarizing, and communicating. Observing, classifying, and communicating are involved as basic science process skills. Then hypothesizing, experimenting, interpreting, and summarizing are classified as integrated science process skills. The enhancement result of limited test can be seen on **FIGURE 1.**

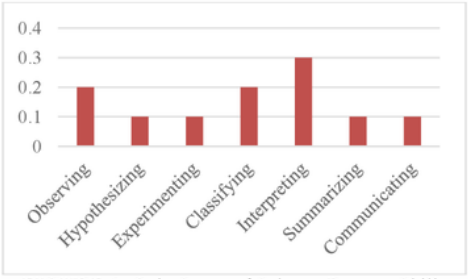

FIGURE 1. Gain Score of Science Process Skills

From **FIGURE 1**, all skills have increased with gain score from 0.1 – 0.3, which classified as low gain. The lowest aspects are seen on hypothesizing, experimenting, summarizing, and communicating. Based on the study of (Hodosyová, Útla, Vanyová, Vnuková, & Lapitková, 2015), from three science process skills: hypothesizing, interpreting, and summarizing, the hypothesizing aspect got the lowest score (33%) because of the limitation in the process of collecting data. In this study, hypothesizing aspect also got the lowest score of gain score 0.1 but the score was same with experimenting, summarizing, and communicating.

Questionnaire result of limited test is described by using pie diagram, which shown on **FIGURE 2.**

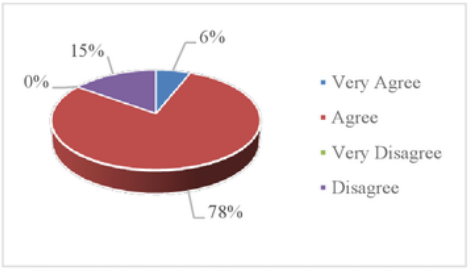

FIGURE 2. Limited Test Questionnaire Result

In this limited test, almost students agree to the created worksheet with percentage of 78% and just 6% who classified as very agree. The rest of students is disagree to the worksheet and none categorized as very disagree. There were some reasons why students disagree with the worksheet, such as 8 students thought that some sentences and pictures in worksheet cover weren't interesting, 7 students felt that the using of sentences in the worksheet weren't simple and too long, and 5 students judged that the worksheet didn't design with appropriate color and the combination among lines, shapes, phases, pictures weren't balance. All results from this limited test were analyzed as revision and product from its process was applied in later test.

Field test was larger test than the previous. It involved of some identic steps as the limited test did. There were 33 students who participated in this test. Concept knowledge improvement is calculated by normalized gain formula too and can be shown in **TABLE 5.**

TABLE 5. Concept Knowledge Improvement

Mean		
Pretest	Posttest	Gain Score
42	71	0.50 (medium-g)

The result of concept knowledge enhancement is 0.50 and just categorized as medium gain. Some revisions from limited test couldn't make the result improve into high category because there were more students in every groups (around 5 – 6), which made the experiments ineffective and students difficult to get concepts. It was different with total students in each limited test groups (around 3 – 4). Furthermore students hadn't common yet with the type of this created worksheet, so sometimes they felt confuse when doing the experiments. It caused the result wasn't satisfied. All data from concept knowledge progression explain that the developed worksheet haven't improve into high category yet. It just enhance into medium category, 0.56 or 56% for limited test and 0.50 or 50% for field test.

Science process skills improvement in field test is also got from observation sheets during learning process. The result can be shown on **FIGURE 3.**

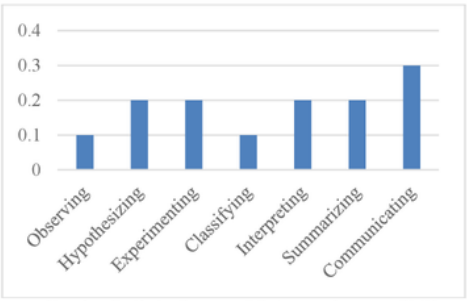

FIGURE 3. Gain Score of Science Process Skills

The diagram in **FIGURE 3** describe that all science process skills enhance into low gain category, except communicating which increase into medium category with gain score 0.3. The lowest category progression are in observing and classifying with gain score 0.1. It means that the developed worksheet can be used to enhance science process skills although it can't reach the highest score in limited and field test (enhancement just around 0.1 – 0.3). Based on study of (Sadi & Cakiroglu, 2011), student attitude can't get significant result if the treatment just given as long as short period (3 weeks). The result will be significant if it conducts more than 12 – 13 weeks. Same with the study of (Sadi & Cakiroglu, 2011), this study was also conducted as long as 3 meeting (2 weeks),

consequently the improvement result couldn't get significant score.

Questionnaire result in field test shows that the propensity result of students is agree to the created worksheet with percentage of 89%. The complete result is described by using pie diagram on **FIGURE 4.**

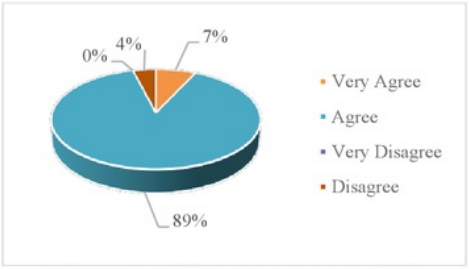

FIGURE 4. Field Test Questionnaire Result

In this field test, just 7% students who classified as very agree, the rest of students around 4% disagree to the created worksheet and none categorized as very disagree. The previous reasons why students disagree to the worksheet in limited test have reduce from 15% to 4%. From 8 students who thought that some sentences and pictures in worksheet cover weren't interesting, reduce to none student in field test. From 7 students who felt that the using of sentences in the created worksheet weren't simple and too long reduce to 4 students. From 5 students who judged that the worksheet didn't design with appropriate color and the combination among lines, shapes, phases, pictures weren't balance, reduce to none student. All results from previous limited test had been revised, which made the quality of created worksheet improve and impacted to the questionnaire result. This means that the developed worksheet can properly to be used in class.

CONCLUSION

The results of this study show that: 1) final worksheet is developed from the final revision which got from validator assessment, limited test, field test, and student questionnaire. All aspects on the validator assessment get the best category, except teacher score of learning using concept attainment method which include just in good category. Questionnaire results show that 78% students on limited test and 89% students on field test agree with the worksheet. 2) concept knowledge improvement for limited test is 56% and field test is 50%, all include in medium gain category, and 3) science process skills enhancement isn't significant for all aspects.

REFERENCES

Anjum, S. K. (2014). A Study of Effect of Concept Attainment Model on Achievement of Geometric Concepts of VII Standard Students of English Medium Students of Aurangabad City. *Scholarly Research Journal for Interdisciplinary Studies*, *2*(15), 2451–2456.

Ates, O., & Eryilmaz, A. (2011). Effectiveness of Hands-on and Minds-on Activities on Students' Achievement and Attitudes towards Physics. *Asia-Pacific Forum on Science Learning and Teaching*, *12*(1), 1–22.

Atmojo, S. E. (2012). Profil Keterampilan Proses Sains dan Apresiasi Siswa Terhadap Profesi Pengrajin Tempe dalam Pembelajaran IPA Berpendekatan Etnosains. *Jurnal Pendidikan IPA Indonesia*, *1*(2), 115–122.

Borich. (1994). *Observation Skilled for Effective Teaching* (2nd ed.). United States of America: Macmillan Publishing.

Chiappetta, E. L., & Koballa, Thomas R, J. (2010). *Science Instruction in the Middle and Secondary Schools*. United States of America: Pearson Education, Inc.

Eggen, P. (2012). *Strategi dan Model Pembelajaran*. Jakarta: Indeks.

Hake, R. R. (2009). Interactive-Engagement Versus Traditional Methods : A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses. *American Journal of Physics*, *64*(1998), 63–74. https://doi.org/10.1119/1.18809

Hodosyová, M., Útla, J., Vanyová, M., Vnuková, P., & Lapitková, V. (2015). The Development of Science Process Skills in Physics Education. *Procedia - Social and Behavioral Sciences*, *186*, 982–989. https://doi.org/10.1016/j.sbspro.2015.04.184

Hung, W., & Jonassen, D. H. (2006). Conceptual Understanding of Causal Reasoning in Physics. *International Journal of Science Education*, *28*(13), 1601–1621. https://doi.org/10.1080/09500690600560902

Hussain, M., & Akhtar, M. (2013). Impact of Hands-on Activities on Students' Achievement in Science: An Experimental Evidence from Pakistan. *Middle-East Journal of Scientific Research*, *16*(5), 626–632. https://doi.org/10.5829/idosi.mejsr.2013.16.05.1310

Jones, J. L., & Hilaire, R. S. (2014). Concept Learning in the Undergraduate Classroom: A Case Study in Religious Studies. *International Journal of Instruction*, *7*(2), 65–74.

Jones, M. G., Andre, T., Negishi, A., Tretter, T., & Kubasko, D. (2003). Hands-On Science: The Impact of Haptic Experiences on Attitudes and Concepts. In *National Association of Research in Science Teaching Annual Meeting*. Philadelphia.

Karamustafaoğlu, S. (2011). Improving the Science Process Skills Ability of Science Student Teachers Using I Diagrams. *Eurasian J. Phys. Chem. Educ*, *3*(1), 26–38. Retrieved from http://www.eurasianjournals.com/index.php/ejpce

Kaur, N. (2014). Effect of Concept Attainmnet Model of Teaching on Achievement in Physics at Secondary Stage. *International Journal of Advance Research in Education Technology and Management*, *1*(1), 6–11.

Kumar, A., & Mathur, M. (2013). Effect of Concept Attainment Model on Acquisition of Physics

Concepts. *Universal Journal of Educational Research*, *1*(3), 165–169. https://doi.org/10.13189/ujer.2013.010304

Kurniawan, A. D. (2013). Metode Inkuiri Terbimbing dalam Pembuatan Media Pembelajaran Biologi untuk Meningkatkan Pemahaman Konsep dan Kreativitas Siswa SMP. *Jurnal Pendidikan IPA Indonesia*, *2*(1), 8–11.

Mcdonald, D. (2015). Concept Attainment: Instruction Suitable for All. *Academic Exchange Quarterly*, *19*(2).

Mohan, R. (2007). *Innovative Science Teaching for Physical Science Teacher* (3rd ed.). New Delhi: Prentice Hall of India Private Limited.

OECD. (2013). *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading Science, Problem Solving and Financial Literacy*. OECD. https://doi.org/10.1787/9789264190511-en

Rauf, R. A. A., Rasul, M. S., Mansor, A. N., Othman, Z., & Lyndon, N. (2013). Inculcation of Science Process Skills in a Science Classroom. *Asian Social Science*, *9*(8), 47–57. https://doi.org/10.5539/ass.v9n8p47

Sadi, O., & Cakiroglu, J. (2011). Effects of Hands-on Activity Enriched Instruction on Students' Achievement and Attitudes Towards Science. *Journal of Baltic Science Education*, *10*(2), 87–97.

Sumarni, W., Wardani, S., Sudarmin, & Gupitasari, D. N. (2016). Project Based Learning (PBL) to Improve Psychomotoric Skills: A Classroom Action Research. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 157–163. https://doi.org/10.15294/jpii.v5i2.4402

Trianto. (2009). *Mendesain Model Pembelajaran Inovatif-Progresif*. Jakarta: Kencana Perdana Media Group.

Trilling, B., & Fadel, C. (2009). *21st Century Skills Learning for Life in Our Times*.

Turiman, P., Omar, J., Mohd Daud, A., & Osman, K. (2012). Fostering the 21st Century Skills through Scientific Literacy and Science Process Skills. *Procedia - Social and Behavioral Sciences*, *59*, 110–116. https://doi.org/10.1016/j.sbspro.2012.09.253

Wenno, I. H., Wattimena, P., & Maspaitela, L. (2016). Comparative Study between Drill Skill and Concept Attainment Model towards Physics Learning Achievement. *International Journal of Evaluation and Research in Education*, *5*(3), 211–215.

Widoyoko, E. P. (2009). *Evaluasi Program Pembelajaran*. Yogyakarta: Pustaka Pelajar.

Concept Attainment Worksheet to Enhance Concept Knowledge and Science Process Skills in Physics Instruction

ORIGINALITY REPORT

%4	%2	%1	%1
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to National University Student Paper	%1
2	www.newcaneyisd.org Internet Source	%1
3	Submitted to Universiti Teknologi MARA Student Paper	<%1
4	P Siahaan, A Suryani, I Kaniawati, E Suhendi, A Samsudin. "Improving Students' Science Process Skills through Simple Computer Simulations on Linear Motion Conceptions", Journal of Physics: Conference Series, 2017 Publication	<%1
5	Submitted to Universitas Pendidikan Indonesia Student Paper	<%1
6	media.proquest.com Internet Source	<%1
7	www.ijsr.net Internet Source	<%1

8	www.ippsr.msu.edu Internet Source	<%1
9	m.f1000research.com Internet Source	<%1
10	Ongowo, Richard Owino, and Francis Chisakwa Indoshi. "Science Process Skills in the Kenya Certificate of Secondary Education Biology Practical Examinations", Creative Education, 2013. Publication	<%1

EXCLUDE QUOTES	OFF	EXCLUDE MATCHES	OFF
EXCLUDE BIBLIOGRAPHY	ON		