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Full Length Research Article

Effects of Concept and Vee Mapping Strategy on Students' Motivation in Biology in Secondary Schools in Uasin – Gishu District, Kenya

[1]Namasaka, F. W., [1]Mondoh, H. and [2]Keraro, F. N.

Department of Curriculum, Instruction and Educational Technology, Pwani University, Kilifi –Kenya
Department of Curriculum and Instruction, Egerton University, Njoro – Kenya

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This study investigated the effects of using concept and Vee mapping strategy (CVMS) teaching approach on secondary school students' motivation in Biology. A non – equivalent control group design under the Quasi – experimental research was used in which a random sample of 4 co-educational secondary schools was obtained in Uasin – Gishu District. These 4 schools were randomly assigned to four groups. Each school provided one Form Two class for the study hence a total of 144 students were involved. Students in all the groups were taught the same Biology content but in two groups they were taught through CVMS approach while the rest were taught using regular teaching methods. Before the four weeks course started, the students in the treatment groups were trained in concept and Vee mapping learning techniques. Two groups were pre-tested prior to the implementation of CVMS treatment. At the end of teaching, all therefore groups were post – tested using the students motivation questionnaires (SMQ1 and SMQ2) The data was analyzed using one-way ANOVA and t-test. The results show that students exposed to CVMS approach have significantly higher motivation than those taught through regular methods. The Researchers conclude that CVMS is an effective teaching approach which Biology teachers should be encouraged to use.

Key words: Achievement, Concept Mapping, Vee Mapping, Conventional Teaching Methods

INTRODUCTION

Over a decade Kenya's secondary school students' biology achievement has remained low according to the Kenya national examinations council (KNEC, 2004). This has caused a lot of concern among many Kenyans because knowledge of Biology plays a significant role in enhancing natural development. In addition to the overall low achievement, there is a gender disparity in performance in favour of boys (KNEC, 2004). The teaching approach that a teacher adapts is a strong factor that may affect the student's motivation towards learning and this affects their achievement (mills, 19991). Educationists all over the world have been struggling to develop methods that can optimize the attainment of teaching and learning objectives (Kithaka, 2003). In order to enhance teaching/learning, a teacher must make use of effective teaching strategies and methods (Kerlinger, 1983). Teaching methods may be defined as a way of carrying out actual teaching in the classroom. They are the means by which the teacher attempts to impart the desired learning or experience (Cheloti, 1996).

The initial studies on the use of concept mapping and Vee mapping with high school science students had its origin in initial work on problem solving (Novak, 1958) wherein teaching strategies were conceived to facilitate students' ability to solve problems in science. Novak, Gowin and Johansen (1983) of Cornell University, New York carried out studies focusing on Ausubel's (1968) assimilation theory of cognitive learning on the central role that prior concepts play in the acquisition and use of knowledge and the contrast between rote and meaningful learning. From this theory, they developed the technique of concept mapping. Later, the Vee mapping technique was developed from the philosophical and epistemological origins of the project derived from the writings of Conant (1947) and later Kuhn (1962) and Toulmin (1972), but most specifically from the work of Gowin (1970, 1981). From the epistemological perspective, they developed the Gowins's Vee mapping technique, which has also become a curriculum and instructional tool. The Concept mapping and Vee mapping are two distinct techniques identified as recent advances/ innovations in science education that have been shown to enhance motivation and achievement of the learners in some other countries. The two learning techniques, though distinct, have many commonalities.

Motivation refers to the initiation, direction, intensity and persistence of behaviour. It means having the encouragement to do something. A motivated student can be reaching for a long-term goal such as becoming a professional writer or a more short-term goal like learning how to spell a particular word. Trying to teach students who seem to have lost interest in learning and are displaying no motivation to learn in school or who are defeated or turned off to school for any number of reasons, is a frustrating and all too common experience for teachers in today's classroom and schools (Deci & Ryan, 1985). Teachers tend to believe that when students are motivated to perform competently on academic tasks, they will learn in accordance with their academic abilities. For this reason alone, working to enhance students academic motivation is worthwhile. But in addition to maximizing student learning, another beneficial by-product of having highly motivated students in class is that they make the

*Corresponding author: F. W. Namasaka

teachers job of managing the instructional programme simpler. Academically motivated students tend not to disrupt the instructional environment; they infrequently need to be disciplined; they listen when listening is appropriate because they are interested in what is being said. They discuss when discussion is appropriate because they want to share their thoughts with others. When students are academically motivated, their teachers often become professionally motivated, working hard to provide students with worthwhile educational experiences and finding more satisfaction in doing so (Cheryl, 1992). Gantan and Huiqin (2005) investigated whether motivation is a more important factor than gender in determining performance differences in science among Canadian students. The results indicated that motivation is a more important indicator of achievement in science than gender. This study investigated how students' motivation is affected by the teaching approach. Specifically the study attempted to find out how the motivation of student is affected by use of the concept and Vee mapping strategy (CVMS) in Biology. The study also sought to establish how students' gender would affect their motivation.

Conceptual Framework

The conceptual framework used in this study was based on the constructivist theory of learning. In this theory, the teacher serves as a facilitator who attempt to provide an environment in which the learner organizers meaning at a personal level (Driver and Erickson, 1993). The study was based on the assumption that a teaching method that involves students participation and activity is more likely to lead to a worthwhile learning than a transmission method (Hanharan, 1998). The study therefore involved students in construction and reconstruction of concept maps and Vee maps. Diagrammatically, the framework is represented as follows:

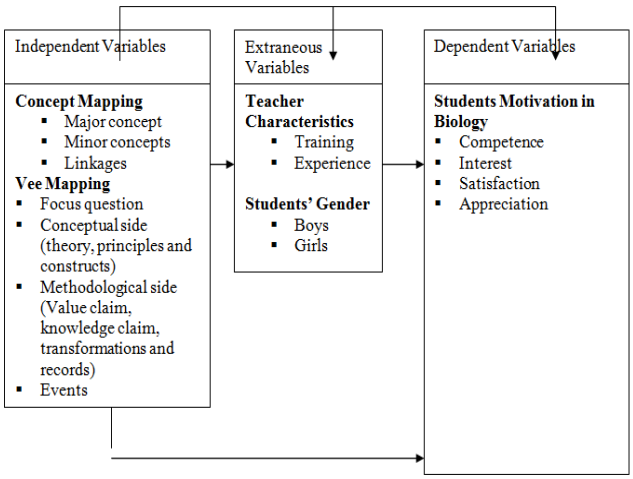


Figure 1

Conceptual framework showing variables that interact to influence students' Motivation in Biology

The study involved trained Biology teachers who had more than two years of teaching experience. Involving Form Two students who were approximately the same age controlled the variable of student's age. Purpose and objectives of the study. This study was designed to determine the effect of using CVMS approach on students' achievement in Biology its specific objectives were:

- To determine whether there is a statistically significant difference in student's motivation in Biology between those taught using CVMS and those taught using regular methods.
- To determine whether there is a statistically significant gender difference in motivation to learn Biology when students are exposed to concept and Vee mapping strategy (CVMS)

Hypothesis of The Study

The following null hypothesis were tested in this study

H_O2 There is no statistically significant difference in the level of motivation between students' taught using Concept and Vee mapping teaching strategy and those taught using conventional methods.

H_O4 There is no statistically significant gender difference in motivation to learn biology when students' are taught using Concept and Vee mapping teaching strategy.

Research Design

In this study, a quasi-experimental research design was used. This is because there was non-random assignment of subjects to the groups since the school authorities do not normally allow the classes to be dismantled so that they can randomly be re-constituted for the purpose of research (Gall, Borg & Gall, 1996). The design that was adopted in this study is Solomon Four – Group Design.

The Solomon Four – Group Design is as follows:-

Group I O_1 x O_2

Group II O_3 – O_4

Group III ___ x O_5

Group IV — O_6 —

Where: O_1 and O_3 are pre-tests: O_2, O_4, O_5 and O_6 are post – tests. X is the treatment where students were taught using Concept mapping and Vee-mapping strategies.

__ means no treatment. It refers to the control group.

Group 1 is the experimental group, which received the pre-test, the treatment (X) and the post-test.
Group II is the control group, which received a pre-test followed by the control condition and lastly a post-test.
Group III received the treatment X and a post-test but did not receive the pre-test.
Group IV received the post-test only.

Group II and IV were taught using conventional teaching methods.

The Solomon Four – Group Design was used because as Gall, Borg & Gall (1996) argue, it is considered suitable in achieving the following purposes:-

- Assess the effect of the experimental treatment relative to the control treatment.
- To assess the effect of a pre-test relative to no pre-test.
- To assess interaction between pre-test and treatment conditions.
- Determine the extent to which the groups are uniform before giving the treatment

The Solomon Four Group design controls for all major threats to internal validity except those associated with interactions of selection and history, selection and maturation and selection and instrumentation (Cook & Campbell, 1979). To control for interaction between selection and maturation, the schools were assigned randomly to the control and treatment groups. No major event was observed in any of the sample schools that would have introduced interaction between selection and history. The conditions under which the instruments were administered were kept as similar as possible in all the sample schools to control for interaction between selection and instrumentation.

Sampling Procedures and Sample Size

The sampling unit was the secondary schools and not individual students since students operate as intact groups. The study used provincial secondary schools to ensure that students involved in the study had academic abilities that were comparable. A list of provincial secondary schools in Uasin Gishu District was used as a sampling frame. Purposive sampling technique was used to select four schools that formed the study sample. This sampling technique was preferred because the District has only five mixed provincial schools. The sampled schools are far apart and this minimized experimental treatment diffusion. In schools that had more than one form two stream, simple random sampling was used to select one stream for the study. The schools were randomly assigned to the four groups. The schools in each group were as follows:-

Group I (Experimental group), N = 32
Group II (Control group), N = 30
Group III (Experimental group), N = 44
Group IV (Control group), N = 38

A total of 144 form two students participated in the study.

Instrumentation

Students Motivation Questionnaire 1 (SMQ 1)

The SMQ 1 was used to measure the students' motivation and interest towards Biology when they were taught using the Concept and Vee mapping strategy (treatment group). Students' motivation is a good indicator of effort and devotion in studying the subject and it is an important factor in determining achievement (Nitcher, 1984). The researcher adapted and modified the SMQ developed and used by Kiboss (1997) and Wachanga (2002) to suit the study. The adopted SMQ was re-written to find out students' opinion and perception on Biology and the strategies used for instruction. The adapted SMQ 1 had 37 five-point likert scale items. A higher number on the scale represented agreement with the item on the scale and a more favourable disposition of that item. Such scale scoring was consistent with typical scale interpretations in Kenya's education system where, in normal ranking or in rating candidates on achievement measures larger numbers represent higher and desirable achievement and smaller numbers represent poorer and undesirable achievement. In this study, a perception was taken to be a measure on a continuum from strongly negative effect to strongly positive effect. In analysing the data, an item such as "learning biology using Concept and Vee maps prepared by students made me feel as if I was wasting my time" had the scores reversed since "strongly disagree" would reflect a high positive effect toward Biology. Two representative items of 2 scales and their relative interpretations are presented in Table 5. Like the BAT, the SMQ 1 was pilot-tested in the same school in order to determine its reliability coefficient. Like the case with BAT, the formula developed by Thorndike & Thorndike (1994) was used to calculate the Cronbach's coefficient alpha, which was found to be 0.82. It was thus accepted as a reliable measuring tool.

The Student's Motivation Questionnaire 2 (Smq 2)

The SMQ 2 was used to measure the students' motivation and interest towards Biology when taught using the conventional teaching methods (control group). It was adapted from Wachanga (2002) in the same way as the SMQ 1 and similarly, it was used to find out students' opinions and perceptions on Biology and the conventional teaching methods used. The SMQ 2 was a 30-item fixed-response format questionnaire comprising two scales with 15 items per scale. The students responded to a five point system on the Likert scale as the one described for SMQ 1. Its interpretation framework was also similar to that of SMQ 1. To determine reliability of SMQ 2, the instrument was pilot-tested in a different mixed provincial secondary school from the experimental and control groups to avoid influencing the treatment. The school was also located in Nandi district. The choice of school was based on the same reasons given for the other pilot school. Like the case with BAT, the formula developed by Thorndike & Thorndike (1994) was used to calculate the Cronbach's coefficient alpha, which was found to be 0.80 and the instrument, was thus accepted for use in the study.

The Development of Instructional Materials

The subject content used in the study was based on the Kenya National Examinations Council (KNEC, 2002) and the Kenya Institute of Education approved Biology syllabus (KIE, 2002). The Concept and Vee mapping strategy required the teacher to have a manual (booklet) throughout the teaching period. The manual (appendix G) was prepared by the researcher and contained the content outline, teaching and learning activities. The following subtopics were covered:

- Definition and significance of respiration
- Respiratory substrates
- Aerobic respiration
- Anaerobic respiration
- Comparison between Aerobic and Anaerobic respiration
- The role of enzymes in respiration
- Respiratory Quotient

- Factors affecting respiration

The researcher inducted teachers for the experimental groups for one week. Prior to the commencement of the treatment, a pre-test was administered to the learners in group I and II. The treatment was then administered for a period of 1 month (4 weeks) to the experimental groups. Each week had four lessons, one double lesson of 80 minutes and two single lessons of 40 minutes each. During the lessons, teachers taught using the Concept mapping and Vee mapping strategies in about equal proportions. The control groups were taught using the conventional approach. After the treatment, the researcher with the help of regular teachers administered the post-test.

Data Collection

The researcher began the study after pilot-testing the research instruments. The first step was to induct two teachers for the experimental groups (I and III) on the use of Concept and Vee mapping strategy in teaching. The two teachers for experimental groups used the CVMS to teach their students (group I and III) while those of control groups II and IV used conventional teaching methods. For treatment groups, teachers begun by first introducing the concept mapping to students. The final instructional sequence used with experimental groups I and III was (1) "Learning how to learn" activities; (2) Concept mapping, introduce examples and explain principles behind concept mapping with subsequent practice in conjunction with regular Biological science activities; and (3) Introduction to Vee mapping, usually after class work, with an experiment that lent itself to Vee mapping (teachers illustrated Vee mapping with subsequent practice by students). The use of Concept mapping and Vee mapping continued from the beginning to the end of the topic. Finally, SMQ 1 was administered to experimental groups (I and III) while SMQ 2 was administered to control groups (II and IV). The three instruments were then scored appropriately.

Data Analysis

This study generated Quantitative data, which was analysed with the help of the Statistical Package for Social Sciences (SPSS) version 11.5. T-test was used to test for different groups and between gender of the students. Analysis of Variance (ANOVA) was used to test for differences in post-test between the four groups under study. ANOVA was preferred over Analysis of Covariance (ANCOVA) since the study did not have an appropriate covariate. In conducting both the ANOVA and t-tests the predetermined 0.05 significance (probability) level was used in order to reject or accept the null hypotheses, which postulated equality or non-significant differences between groups.

Results of the Pre-Test

The Solomon Four Group Design used in this study enabled the researcher to have two groups sit for the pre-test. Group 1 and 2 sat for the pre-test BAT. As recommended by Gall, Borg and Gall (1996) this was necessary because it enabled the researcher to:-

(i) Assess the effects of pre-test relative to no pre-test.
(ii) Assess if there was an interaction between the pre-test and the treatment conditions.
(iii) Assess the similarity of the groups before administration of the treatment.

Performance in BAT Pre-test between experimental and control groups

To assess the similarity of experimental and control groups, a BAT pre-test was administered to form two students in groups 1&2 prior to the experiment. The pre-test contained 30 items that sought to test students' mastery or understanding of the topic respiration, which was the focus of this study. The pre-test scores were then expressed as a percentage. 100 marks. Group 1 and group 2 schools were used as experimental and control groups respectively. The mean scores for each group were compared using an independent sample t-test statistic to establish if there were any statistical differences in their performance. Table 1 shows the t-test results.

Table 1: Independent samples t-test of the pre-test mean scores on BAT

Group	Mean	Std. Dev.	T-value	P-value
1	6.94	5.04	-0.937	0.352(ns)
2	8.40	7.13		

Group 1, N = 32; Group 2, N = 30
ns= not significant at P< 0.05 level; Std. Dev = Standard deviation

An examination of the results in Table 1 shows that the mean scores for groups 1 and 2 on pre-test BAT are not statistically different. The T-value of 0.919 has a significant level (p–value) of 0.362, which is much greater than the acceptable 0.05 level. The implication is that the two groups are homogenous in their learning ability.

Performance in pre-test BAT between boys and girls

A comparison was made on the pre-test BAT scores for boys and girls for group 1 and group 2 schools which had been subjected to the pre-test. In this test the two groups were combined and their means established based on gender. The gender based pre-test means scores were then compared using an independent sample t-test to establish whether there were any differences in the performance. The results showed no difference between boys and girls.

Effects of CVMS on Students' motivation

The result of the post test SMQ mean score for the respective groups are shown in Table 2

Table 2: SMQ post-test mean score obtained by the students in the four groups

Group	N	Mean score	Std. Dev.
1	32	85.53	7.73
2	30	84.20	10.67
3	44	88.60	9.69
4	38	70.24	15.37
Total	144	82.16	13.39

As shown in table 2 students of group 3 showed the highest motivation level followed by group 1 and 2 respectively. Students of group 4 showed the lowest level of motivation. The motivation level was tested with reference to the teaching methods used i.e. CVMS for groups 1 and 3 and the traditional teaching method for groups 2 and 4. To test hypothesis two, analysis of variance (ANOVA), was carried out on SMQ scores. Table 3 gives the result of the ANOVA of the difference in the post test SMQ scores.

Table 3: ANOVA results of SMQ

	Sum of squares	df	Mean score	F	p-value
Between groups	7718.10	3	2572.70	20.08	0.00
Within Groups	17933.52	140	128.10		
Total	25651.61	143			

An analysis of variance for the post –test SMQ scores, as shown in table 3 indicates that there is a statistical difference in motivation between groups. This is because the p-value of 0.00 is less than the acceptable alpha of 0.05. the implication is that there exist differences in motivation levels across the four groups of students. After establishing that there was a difference between the means of various groups, it was necessary to carry out further tests on the various combinations of means using LSD, to find out where the difference really occurred. Table 4 gives the LSD post hoc comparisons

Table 4: Post Hoc Comparisons of the Post-test of SMQ means of the four groups

	1	2	3	4
1	-	1.33	-3.07	15.29*
2	-1.33	-	-4.40	13.96*
3	3.07	4.40	-	18.38*
4	-15.29*	-13.9	-18.38	-

* The mean difference is significant at the 0.05 level.

LSD post hoc comparisons indicate significant differences ($p<0.05$) between groups 1 and 4, 3 and 4,and 2 and 4. The difference between the mean scores of group 1 and 2, 1 and 3 and 2 and 3 was not significant at alpha of 0.05. The expectation was that the motivation level of groups 1 and 3 (experimental) be similar as well as groups 2 and 4 (control). The other expectation was for groups 1 and 3 to be different from groups 2 and 4. However, while group 1 and 3 gave expected results (were similar) group 2 and 4 did not. Group 2 had unexpectedly high mean scores, which was not statistically different from groups 1 and 3. The implication is that the students in group 2 drew their motivation for the subject from other factors other than the teaching method. To compare the performance in post-test SMQ between experimental groups and control groups, an independent sample t-test was employed. This was done by categorizing the four groups into two groups of experimental (group 1 and 3) and control (group 2 and 4) then running the test whose results are shown in Table 5

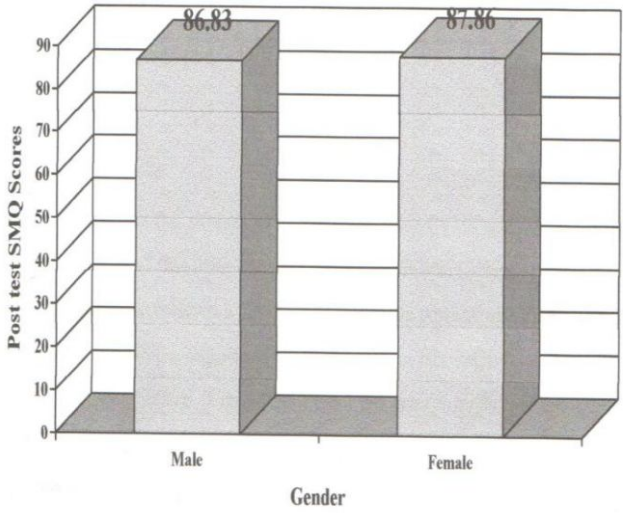
Table 5: T-test on mean difference in SMQ scores between experimental and control groups

Group	N	Mean	Std. Deviation	T	df	p-value
Experimental	76	87.31	9.00	5.33	142	0.00
Control	68	76.40	15.12			

Results in Table 5 show that the difference in motivation between experimental groups and control groups was statistically significant at $p<0.05$. Experimental groups scored higher on the motivation index compared to students in the control groups. CVMS strategy therefore has a positive effect on the motivation of students to learn biology. Hypothesis Ho2, which started that there is no statistically significant difference in the level of motivation between learners taught using concept and Vee mapping teaching strategy and those taught using conventional methods, is thus rejected.

Effects of CVMS on the motivation of boys and girls

The research also sought to establish the effect of CVMS on the motivation to learn biology among boys and girls. There were in total 41 boys and 35 girls in the experimental group whose mean scores on the motivation index for the SMQ is shown in Figure 4.



Difference in posttest SMQ mean scores based on

FIGURE 4

Results in Figure 4 show that girls' students scored slightly higher than boys on the SMQ with mean score of 87.86 and 86.83 respectively. To test Ho4, which sought to establish if there was a statistically significant difference in motivation between boys and girls taught using CVMS strategy, an independent t-test was used. The results are presented in Table 7.

Table7: Independent sample t-test for differences in motivation between boys

Gender	N	Mean	t-value	df	p-value
Male	41	86.83	-0.492	74	0.62
Female	35	87.86			

Results in Table 7 show that the test had a p-value of 0.62, which is far greater than the acceptable alpha of 0.05. There is, therefore no statistically significant gender difference in the motivation scores. This implies the motivation level of boys and girls who were taught using the CVMS STRATEGY was similar. Hypothesis H04, which stated that there is no statistically significant gender difference in motivation to learn biology when learners are taught using concept and Vee mapping teaching strategy is thus accepted.

DISCUSSION OF THE RESULTS

The results indicate that girls and boys taught using CVMS had similar scores on post-test SMQ implying similar motivation levels. From the findings of the study, CVMS is

shown to have eliminated the gender disparity in motivation to learn biology. These results are in agreement with work done by Keraro, Wachanga and Orora (2007) who investigated the effects of using the cooperative concept mapping (CCM) teaching approach on secondary school students' motivation in biology. According to their study, there was no statistically significantly gender difference in motivation towards the learning of biology among secondary students exposed to CCM. According to a research done by the Forum for African Women Education (FAWE, 1999), aimed at improving the partipaticipation and performance of girls I science and mathematics primary and secondary schools, it was reported that the achievement of girls in science in Kenya was far lower than that of boys. This was partly attributed to the poor attitude girls have towards science subjects in Africa (FEMSA, 1997) argued the poor attitudes of girls are due to the conventional teaching methods, which provides a conductive environment for teachers to consciously or unconsciously discourage girls' participation in learning. The FAWE (1999) also reported that teachers tend to give more attention and use positive reinforcement on boys than they do to girls. The tendency has effect of making girls believe that they are less able. This erodes their confidence thus leading to low motivation.

Conclusions

Consequently the use of CVMS in teaching biology leads to higher motivation of students to learn the subject compared to the traditional teaching approaches. Its interactive nature makes students desire to learn more about the subject at hand. A discussion with the students revealed that they were surprised on discovering the interplay between conceptual and methodological elements involved in practical work when taught using CVMS teaching strategy. This increased their motivation to learn the topic more. While the CVMS strategy leads to better achievements in biology for both male and female students, its impact on achievement is felt more among female students compared to the male students since the performance of girls has consistently been lower generally than that of boys, this strategy could just be the best to uplift the performance of girls in biology. Results also led to the conclusion that the use of CVMS teaching strategy increases the motivation to learn biology equally among male and female students. The method can therefore be useful in addressing the existing gender based differences in motivation to learn biology that is currently expressed with use of traditional teaching methods. CVMS make biology teaching more effective and therefore teachers should encourage to use this method. Teacher training institutions should incorporate the CVMS concepts in their training curriculum in order to produce teacher who can use the strategy

Final Conclusions

The following conclusion has been reached from this study:-

- The CVMS teaching approach enhances students learning in biology than the conventions teaching methods
- The CVMS teaching approach makes girls to do better than when they are taught using conventions methods implying that it could make girls perform equally as boys in biology.

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