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Facilitating Conceptual Changes of High School Students regarding Concepts in Static Electricity and DC Circuits through the Use of VMSCDCCText

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Abstract The purpose of this study was to find out the effectivity of using visual multimedia supported-conceptual development conceptual change text (VMS-CDCCText) in facilitating conceptual change of high school students related to the concepts in Static Electricity and DC Circuits subject matter. VMS-CDCCText consists of seven parts of the text. The method used in this study is a pre-experiment with one group pretest-posttest design. The number of research subjects was 80 students consisting of 46 female and 34 male students, at one high schools in West Java province Indonesia. Data about the state of students' conceptions were collected by conception test in the four tier test format. The results showed that the number of students who reached the type of construction and reconstruction on the two concept labels covered in the Static Electricity and two concept labels covered in the DC Circuits subject matter was above 70%. These results indicate that the use of VMS-CDCCText has a high effectiveness in facilitating the attainment of conceptual changes in construction and reconstruction types that lead to ownership of scientific conceptions.

Keywords VMS-CDCCText, Conceptual Change Type, Static Electricity, DC Circuits

1. Introduction

Since it was first developed by Wang and Andre [1], many researchers have used CCText for the purpose of remediating misconceptions that occur in students related to physical concepts or other scientific concepts, such as; Sahin et al [2]; Suhandi et al [3]; Arslan & Demircioglu [4]; Ozkan & Selcuk [5]; Cil [6]; Ozkan & Selcuk [7]; Cetin et al [8]; Tekin et al [9]; and Erdmann [10].

To enhance the role of the text in facilitating the achievement of scientific conceptions by high school students who have a variety of preconception conditions, CCText needs to be further developed into CDCCText which is abbreviation for Conceptual Development Conceptual Change Text. If CCText is only intended to facilitate the reconstruction of misconceptions, the CDCCText, besides can be used to facilitate the reconstruction of misconceptions, it can also be used to facilitate the construction of conceptions.CDCCText can be written in computer format, when the presentation is supported by visual multimedia. CDCCText supported by visual multimedia is called VMSCDCCText which is abbreviation for visual multimedia supported conceptual development conceptual change text. VMSCDCCText has seven parts of text, namely: part-1 of text, in the form of introductory text and the text of identification of students' conceptions; part-2 of text, in the form of conceptual development text (CDText); part-3 of text, in the form of text of identification of students' conception; part-4 of text, in the form of a confrontation text of students' conceptions belief; part-5 of text, in the form of conceptual change text (CCText); part-6 of text, in the form of statement of accommodation of new conception; and part-7 of text, in the form of a text of identification of final students' conception.

Table 1. Misconceptions found on four concept labels of Static Electricity and DC Circuits

Concept Label (CL)	Concept	Misconception
CL-1	Amount of electric charge on an objects	Larger objects will inevitably have a larger electric charge
CL-2	Interaction of Neutral Object	Neutral objects cannot interact (attraction or repulsion) with electrically charged objects
CL-3	The function of the battery in an electric circuit	The function of the battery in an electric circuit is as a source of electrons
CL-4	Parallel electrical circuit	When there is a change in electric current that passes through a branch of a parallel circuit, then the electric current in the other parallel circuit branch also changes

VMSCDCCText is very suitable to abstract physics concepts that contain microscopic phenomena. Visual multimedia used to support CDCCText include: images, video of phenomena, virtual simulations and dynamic analogy. Animations and simulations are used in order to increase interaction during computer assisted instruction practices [11, 12]. Animations and simulations boost understanding subjects and especially ease teaching abstract concepts in subjects [13-16].

The physics subject matter that often causes misconceptions in high school students is Static Electricity and DC Circuits. The results of investigating the state of students' conceptions related to Static Electricity and DC Circuits subject matter were found in at least eight misconceptions on eight concept label, as shown in Table 1.

The results of interviews with several high school students showed that the source of the appearance of misconceptions on the four concept labels is the textbook and the learning process used by teachers who do not provide explanation to the microscopic level when explaining the four concept labels.

This research was conducted with the aim to find out the effectiveness of using MVSCDCCText in facilitating conceptual changes in high school students related to the concepts covered in Static Electricity and DC Circuits subject matter.

2. Methods

The method used in this study is a pre-experiment with one group pretest-post-test design. The number of research subjects was 80 students consisting of 46 female and 34 male students, in one of the high schools in West Java province Indonesia. These subjects was divided into two groups, 40 students took part in VMSCDCCText activities related to Static Electricity and 40 other students took part in VMSCDCCText activities related to DC Circuits subject matter. The instrument used to collect data in this study is conception tests in the Four Tier Test format about static electricity or abbreviated as SEFTTest and about DC Circuits or abbreviated as DCCFTTest. The categorization of conception states of high school students based on conception test results data was carried out using guidelines formulated by Gurel et al [17]. Information about the state of students' conceptions before and after the CDCCText activity is used to determine the type of conceptual change that students achieve. Types of conceptual change consist of: 1) scientific conception from begining (SCFB), 2) static (ST), 3) disorientation (DO), 4) reconstruction (RC) and 5) construction (CT). Determination of the type of conceptual change based on the student's conception state at the time before and after the CDCCText activity follows the guidelines as shown in Table 2.

Table 2. Guidelines for determining the type of conception change

The state of students' conception before CDCCText	The state of students' conception after CDCCText	Type of conceptual change
Scientific conception	Scientific conception	Scientific conception from begining
Misconception	Misconception	Static
No conception	No conception	Static
Misconception	Scientific conception	Reconstruction
No conception	Scientific conception	Construction
Scientific conception	Misconception	Disorientation

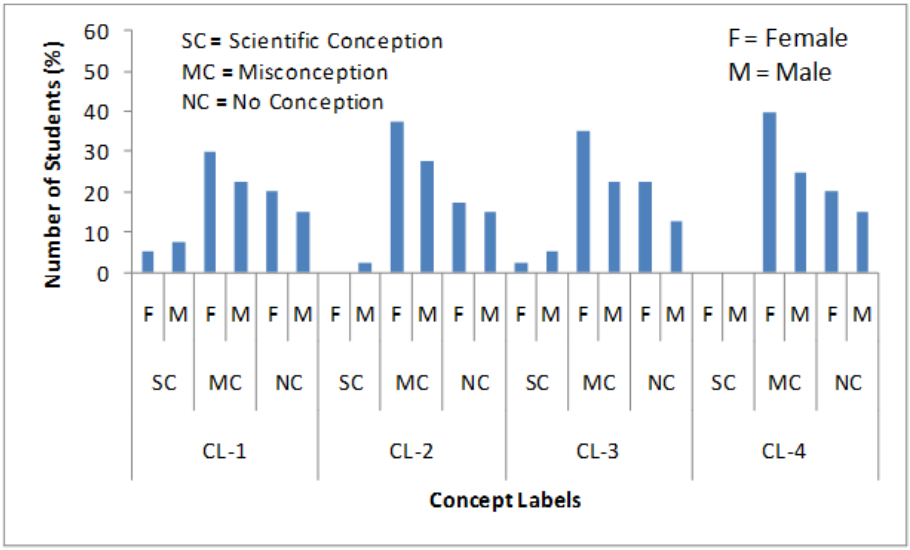

Figure 1. Percentage of students in each preconception state for the four concept labels

3. Finding and Discussion

By using conception tests related to concepts in Static Electricity and DC Circuits subject matter using SEFTTest and DCCFTTest, it can be identified the state of conception of students for each concept label both before and after the VMS-CDCCText activity. Figure 1 shows the percentage of male and female students in each conception state related to the four concept labels examined before the MVSCDCCText activity. In that figure, it appears that there is the same preconception pattern for each concept studied, i.e, a small proportion of students already have a scientific conception, most of students have a misconception and some of students do not have a preconception. The number of male and female students in each state of conception appears to be comparable, so there is no gender that dominates both the state of scientific conception, the state of misconception and the state of not having conception. This shows that male and female students have the same possibility to have a scientific conception and have the same possibility to have a misconception in physics.

Figure 2 shows the percentage of male and female students in each conception state related to the four concept labels measured after the MVS-CDCCText activity. In the figure, it can be seen that there is a change in the number of students in each conception state for the four concept labels studied. The number of students who have scientific conceptions increased significantly after participating in VMS-CDCCText activities, while the number of students who had misconceptions and did not have conceptions decreased dramatically. This change in conception towards scientific conception can be achieved both by male students and by female students. This shows that the treatment in the form of VMS-CDCCtext can facilitate male and female students to achieve scientific conceptions through the process of conception construction and conception reconstruction. The conceptual change achieved by students occurs for all concept labels on the Static Electricity and DC Circuits subject matter studied. This shows that the developed VMS-CDCCText can be used equally well for each label of the physics concepts studied.

Based on the initial conception state that students have before the VMS-CDCCText activity, the conception state that students have during the VMS-CDCCText process and the conception state that students have after participating in the VMS-CDCCText activity, it can be depicted the pattern of conceptual changes that occur from the initial conception state to the state final conception. The pattern of students' preconception changes to the

students' final conceptions for the four concept labels studied is described in the next section.

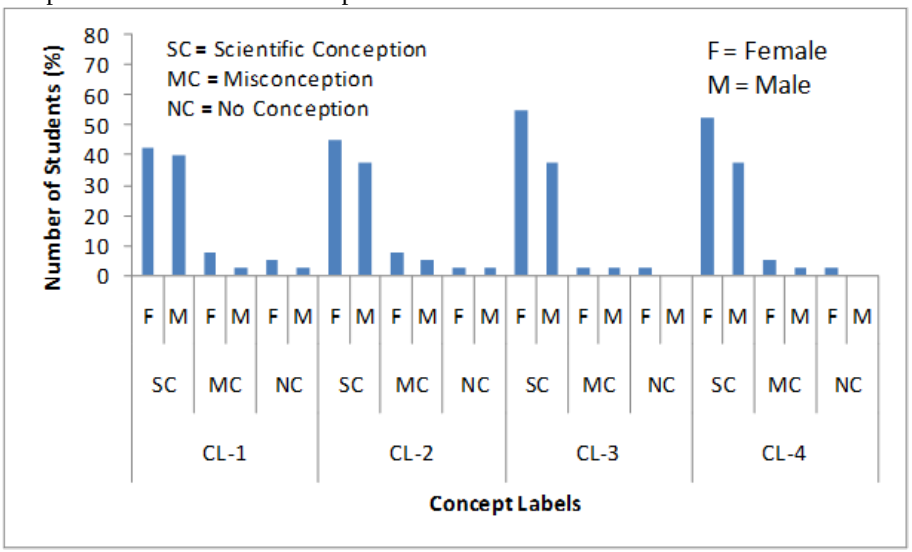

Figure 2. Percentage of students in each final conception state for the four concept labels

3.1. Finding of the Pattern of Changes in the Conception of High School Students in CL-1

Figure 3 shows the pattern of conceptual changes achieved by students for concept label 1, namely amount of electric charge on an object after participating in the VMS-CDCC Textactivity

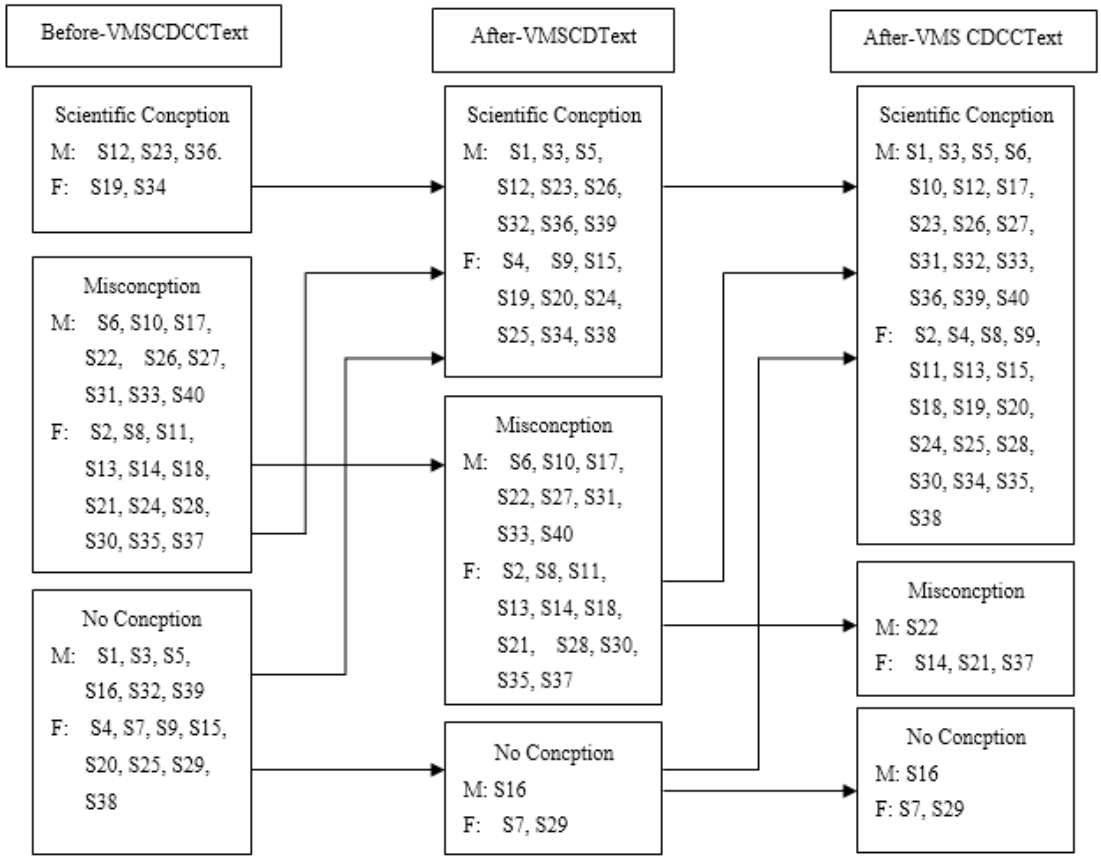

Figure 3. The pattern of changes in students' conceptions on the concept of amount of electric charge on an object

In Figure 3 it appears that the pattern of change that occurs is firstly a conception construction process occurs for students who do not have an initial conception to have a scientific conception which is facilitated by the conceptual development text (CDText) section, then followed by the conception reconstruction process for students who have misconceptions that are facilitated by the conceptual change text (CCText) section. After CDText, the number of students who experienced conception construction related to the concept of amount of electric charge on an object were83% of male and 75% of female and students who experience conception reconstruction were 11% of male and 8% of female. Whereas after reading the CCText section the number of students who experience conception reconstruction increased 87.5% of male and 73% of male and students who experience conception construction increased 0% of male dan 0% of female. In Figure 3 it also appears that the use of VMS-CDCCText can retain students who already have scientific conceptions from the beginning, can even further strengthen their scientific conceptions of the concept of amount of electric charge on an object.

3.2. Finding of the Pattern of Changes in the Conception of High School Students in CL-2

Figure 4 shows the pattern of conceptual changes achieved by students for concept labels 2, namely the concept of interaction of neutral objects with electrically charged objects after following the VMS-CDCCText activity.

In Figure 4 it also appears that the pattern of change that occurs is that the conception construction process first occurs for students who do not have the initial conception to have a scientific conception which is facilitated by the conceptual development text (CDText) section, then followed by the conception reconstruction process for students which has a misconception facilitated by the conceptual change text (CCText) section. After CDText, the number of students who experience conception construction related to the concept of interaction of neutral objects with electrically charged objects were 83% of male and 71% of female and students who experience conception reconstruction were 18% of male and 13% of female. Whereas after reading the CCText section the number of students who experienced conception reconstruction increased 78% of male and 77% of female and students who experienced conception construction increased 0% of male and 14% of female. In Figure 4 it also appears that the use of VMS-CDCCText can retain students who already have scientific conceptions from the beginning, can even further strengthen their scientific conceptions of the concept of interaction of neutral objects with electrically charged objects.

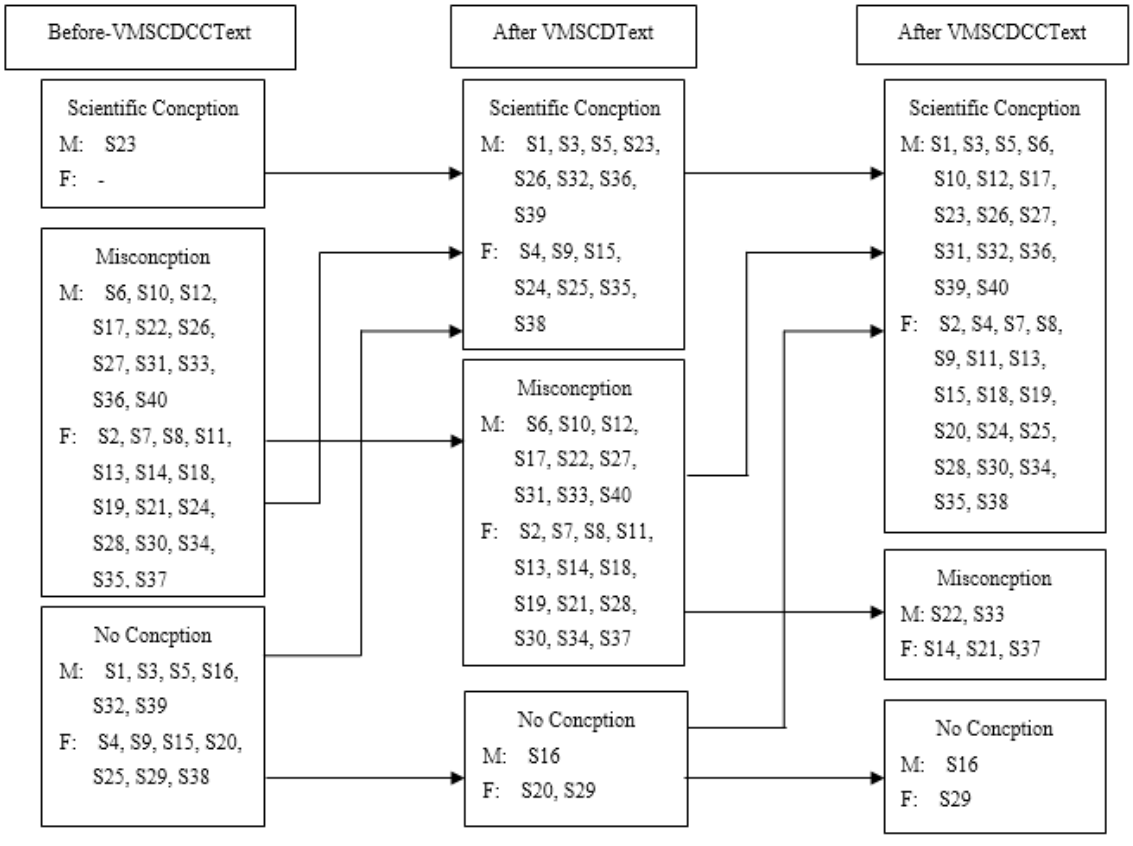

Figure 4. The pattern of changes in students' conceptions on the concept of interaction of neutral objects with electrically charged objects

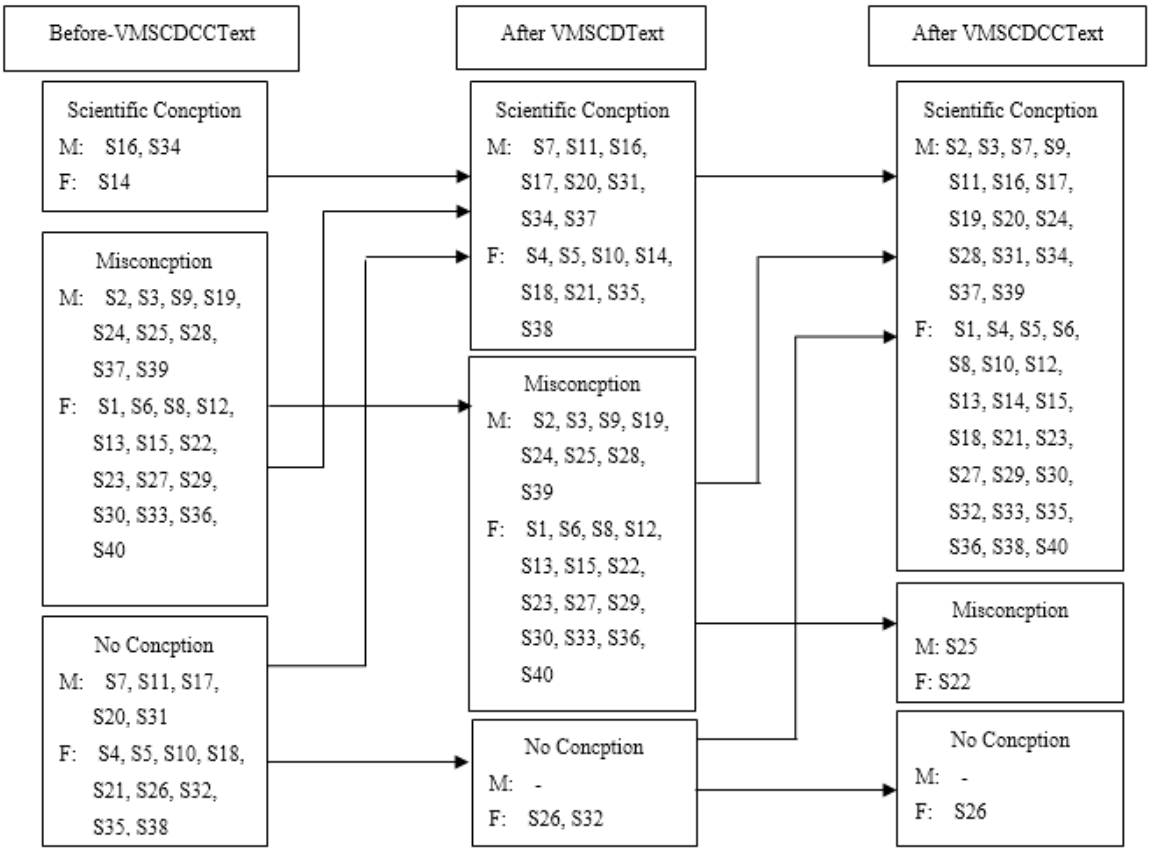

Figure 5. The pattern of changes in students' conceptions on the concept of The function of the battery in an electric circuit

3.3. Finding of the Pattern of Changes in the Conception of High School Students in CL-3

Figure 5 shows the pattern of conceptual change achieved by students for concept label 3, namely the concept of The function of the battery in an electric circuits, after following the VMS-CDCCText activity.

In Figure 5 it can be seen that there is a conceptual change pattern achieved by high school students in the concept of the interaction of neutral objects with electrically charged objects, almost the same as in the previous concept, which first occurs the construction process then followed by the conception reconstruction process. After CDText, the number of students who experience conception construction related to the concept of The function of the battery in an electric circuits were 100% of male and 78% of female and students who experience conception reconstruction were 6% of male and 0% of female. Whereas after reading the CCText section the number of students who experienced conception reconstruction increased 86% of male and 93% of female and students who experienced conception construction increased 0% of male and 6% of female. In Figure 5 it also appears that the use of VMS-CDCCText can retain students who already have scientific conceptions from the beginning, can even further strengthen their scientific conceptions of the concept of The function of the battery in an electric circuits.

3.4. Finding of the Pattern of Changes in the Conception of High School Students in CL-4

Figure 6 shows the pattern of conceptual change achieved by students for concept label 4, namely the concept of parallel electrical circuits, after following the VMS-CDCCText activity. In Figure 6 it can be seen that there is a similar pattern as in the three previous concepts, namely the construction process first occurs and then followed by the conception reconstruction process. After CDText, the number of students who experienced conception construction related to the concept of parallel electrical circuits were 100% of male and 88% of female and students who underwent reconstruction were 6% of male and 0% of female. Whereas after reading the CCText section the number of students undergoing conception reconstruction increased 88% of male and 89% of female and students experiencing construction increased 0% of male and 0% of female. In Figure 6 it also appears that the use of VMS-CDCCText can retain students who already have scientific conceptions from the beginning, can even further strengthen their scientific conceptions of the concept of parallel electrical circuits.

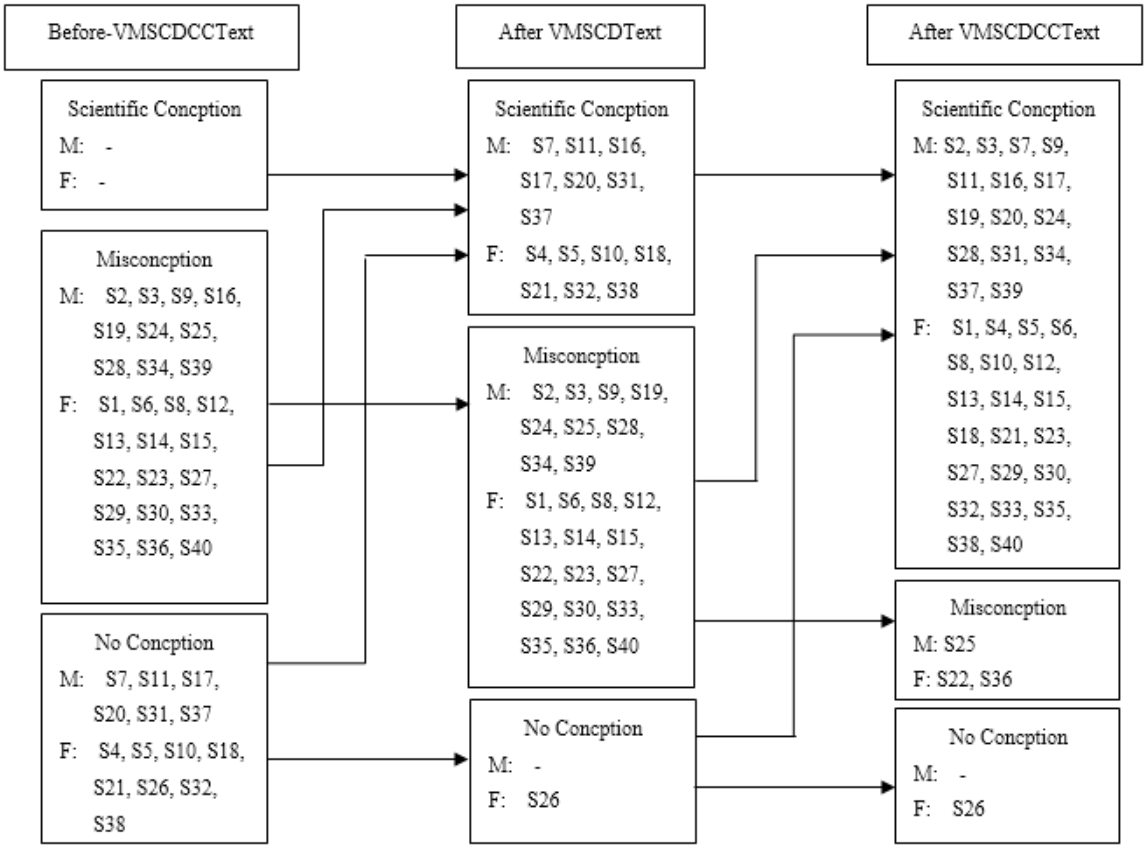

Figure 6. The pattern of students' conceptual changes to the concept of parallel electrical circuits

4. Conclusions

Based on the research data, it can be concluded that utilization of the VMS-CDCCText has a high effectiveness in facilitating the attainment of conceptual changes in construction and reconstruction types that lead to ownership of scientific conceptions. There is no gender bias in conceptual changes achieved by high school students as a result of using VMS-CDCCText. The high effectiveness of the use of VMS-CDCCText in facilitating conceptual changes in high school students is supported by the existence of the CDText and CCText part of the text structure which can simultaneously facilitate students who do not have an initial conception and who have misconceptions to achieve scientific conceptions. In addition, the effectiveness of VMS-CDCCText is also supported by the use of visual multimedia in some parts of the text that can be modeling microscopic phenomena into as if macroscopic phenomena that can be observed by students, so that the explanations given in the text can be more easily understood by students.

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