International Journal of Education and Teaching Zone, Volume 1 (Issue 2): 08-10 (2022)
DOI: https://doi.org/10.57092/ijetz.v1i2.32

THE JOURNAL OF IJETZ
(International Journal of Education and Teaching Zone)
P-ISSN: 2963-7899 I E-ISSN: 2830-7925
jurnal.yayasannurulyakin.sch.id/index.php/ijetz

Chemistry Learning Through CIRC on DNA Base Materials: Hypothesis Testing the Kolmogorov-Smirnov Method on Male and Female Population Samples

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Article History:
Received: September 07, 2022
Revised: Septemebr 18, 2022
Accepted: Septemebr 24, 2022
Published: October 08, 2022

Keywords:
CIRC, DNA Bases, Kolmogorov-Smirnov Method

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Abstract: Cooperative Integrated Reading and Composition (CIRC) is one type of cooperative learning model that combines reading activities with other activities, such as writing, discussion, and presentation in an integrated manner. The purpose of this study is to provide a description of learning chemistry through CIRC on DNA base material. The method used in this research is experimental research. The characteristics of experimental research in this study include: manipulation, control or control, and observation. The research design used is the one-shot case study design, while the sampling technique used for this design is purposive sampling. The research hypothesis testing procedure used the Kolmogorov-Smirnov method for multiple sample groups. Based on the comparison between the D value in the table and the calculated D value, the D value is 0.142857. This value is smaller than the D value in the table of 0.726951. Thus, the null hypothesis which states that the posttest score category for male students is the same as the posttest score category for female students. In this condition, it can be concluded that Chemistry Learning Through CIRC on DNA Base Material for students of different sexes produces the same category of posttest scores. This means that this learning can be applied to male and female students equally well.

INTRODUCTION

Education has a very important role in the creation of an intelligent, democratic, and open life with the aim of providing a balance to the progress of science in all aspects of life (Mujakir, 2015). Learning is an activity process that is expected to bring about changes in attitudes and mentality for each student (Arini et al., 2019). Science learning is also inseparable from how to create so that students are able to understand and experience changes in attitude and mentality.

Natural Sciences (IPA) cannot be separated from the term science. Science itself is a word that comes from the Latin "*scientia*" which means "I know". While the word science in English comes from the word science which means "knowledge". Science itself later developed into social science or in Indonesian known as Social Sciences (IPS) and natural science which is better known as Natural Science (IPA) (Fatimah, 2012).

Natural Science (IPA) is a subject whose content includes various sub-disciplines across other subjects such as physics, biology, chemistry, space, and geology. Besides that, the content of science material also contains a blend of other subjects that are outside the field of natural science studies, this is easy to understand because science is not just a combination of physics, biology, chemistry and space, but is an integration of natural science studies. Science learning, if examined more deeply based on its characteristics, is divided into two sides. On the one hand, science learning is a product of the work of scientists and on the other hand, science learning is a process just as scientists work in producing knowledge (Waldrip etl al., 2010; Tala & Vesterinen, 2015).

The content in science learning must lead to the occurrence of scientific processes, create scientific products that are supported by experiments or experiments, and make scientific attitudes form (Sulthon, 2016; Fatimah & Kartika, 2013). The target emphasized in natural science itself is a way or guide in knowing nature systematically in the form of principles, concepts, laws, and the process of discovery (Amran & Muslimin, 2017).

Life cannot be separated from its existence with science. There is a very close relationship to all aspects of life with the existence of science. One of the things that can be seen is the very rapid development of technology in recent times which cannot be separated from the existence of science. Scientific discoveries are used by experts in developing various technologies (Nihlah, 2017). The nature of science itself is the basis as a basis for understanding science learning (Tursinawati, 2013).

A series of studies carried out by scientists are used as the basis for the development and discovery of scientific knowledge. Scientists in conducting a series of research are based on finding answers to the questions "what", "why", and "how" from what are known as natural phenomena and their application to technology and everyday life (Rahayu et al., 2012).

In the world of science, everything was originally born out of ignorance, curiosity, or on a development mission about it. Likewise with ancient scientists. They do not know what governs this life. Until one day, there were scientists who discovered the structure of the elements that are the main building blocks of life, which further opened up the horizons of learning about the main element which is now known as DNA.

At first, scientists only knew that life was governed by a cell centered in the cell nucleus, without further knowing what was contained in the cell nucleus, so that it could function to regulate life. Apparently, in the nucleus of the cell there are chromosomes whose contents are in the form of DNA. This collection of DNA (genes) carries information for their offspring. The DNA has a structure consisting of components, which function to carry certain information and can distinguish one creature from another. The DNA carries information to the offspring, so it is necessary for living things to reproduce themselves (Syatra, 2011).

Prior to the discovery of the molecular structure of DNA in 1947, a biochemist named Erwin Chargaff performed basic analysis of DNA in a number of different organisms. The results show that each species of organism has a different DNA composition. In fact, the number of the four nitrogenous bases in each species is also

unequal, but they do have a specific size and ratio of each other. Chargaff stated from his research that in the DNA of each species, the amount of adenine equals the amount of thymine and the amount of cytosine equals the amount of guanine. While the sequence of bases and length of DNA in each species is different.

This study intends to provide a description of chemistry learning through Cooperative Integrated Reading and Composition (CIRC) on deoxyribonucleic acid (DNA) base material for samples from male and female populations. So that the hypothesis testing used is the Kolmogorov-Smirnov method for multiple sample groups.

METHOD

The purpose of this study is to provide a description of chemistry learning through Cooperative Integrated Reading and Composition (CIRC) on deoxyribonucleic acid (DNA) base material. While the method used in this research is experimental research. Experimental research is one of the most powerful research methodologies used by researchers in conducting research. Experiments are the best way to establish cause-and-effect relationships of variables (Fraenkel et al., 2012). In general, the characteristics of experimental research in this study include: *Manipulation*: Researchers manipulate the independent variables by giving treatment. The treatment aims to achieve what the researcher expects in the research. The independent variable that was manipulated in this study was the learning model/method, namely Cooperative Integrated Reading and Composition (CIRC) on deoxyribonucleic acid (DNA) base material. *Control*: Control is done by adding other factors or eliminating other factors that are not desired by the researcher from the variables studied. These other factors are also known as control variables. This control variable is controlled and made constant so that the influence of the independent variable on the dependent is not influenced by other factors not examined. *Observation*: After the treatment is given for a certain period of time, the researcher makes observations or measurements to determine the effect of the manipulation/treatment given to the variables studied. Observations were made through data collection in the form of posttest.

The research design used is the one-shot case study design, the paradigm in this study is illustrated as follows in figure 1.

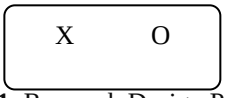

Figure1. Research Design Patterns

Information figur 1: X is treatment given (independent variable) and O is posttest (observed dependent variable) This design was used in the study because there was a group that was given treatment, and the results were then observed. The treatment as the independent variable and the observed results as the dependent variable. While the sampling technique used for this design is purposive sampling.

While the hypothesis testing procedure uses the Kolmogorov-Smirnov method. Basically, the procedure for testing the hypothesis using the Kolmogorov-Smirnov

method for multiple sample groups is focused on testing the validity of the null hypothesis, which essentially states that the first and second sample groups come from the same population. While the alternative hypothesis states that the first and second sample groups come from populations that are not identical or that one of them is higher or lower.

For multiple sample groups, the steps or procedures for testing the hypothesis that must be followed in the Kolmogorov-Smirnov method to determine the final conclusion include: Formulate the null hypothesis and alternative hypothesis,

a) Determine a certain level of significance
b) Formulate test criteria
   In testing the two-sided hypothesis, the null hypothesis is accepted if
   $D \leq D_a$
   While the null hypothesis is rejected if
   $D > D_a$
c) Calculating the value of D
   If the hypothesis testing procedure through the Kolmogorov - Smirnov method has reached this stage, the value of D must be calculated through several steps. The series of steps that must be taken to find the value of D are:
   1. Record the observations in the table
      The result of the observation is the value of each member in the sample group.
   2. Compile the cumulative frequency distribution of observations
      When the number of members from each category in each sample group has been recorded and entered into the table, then the cumulative frequency distribution of observations is compiled. For each frequency, the relative percentage value of each category is included. The display of the cumulative frequency distribution of observations along with their compiled relative percentages is marked with F1 for the first sample group and F2 for the second sample group.
   3. Calculate the difference in the value of F1 with F2 and look for the value of D

The value of the largest difference that is used as the value of D calculated results.

RESULT AND DISCUSSION

The The following is the treatment or stimulus used in this experimental study including the Cooperative Integrated Reading and Composition (CIRC) learning method and materials related to deoxyribonucleic acid (DNA) bases.

Cooperative Integrated Reading and Composition (CIRC)

CIRC is a type of cooperative learning model that combines reading activities with other activities, such as writing, discussions, and presentations in an integrated manner. The CIRC learning stages in this study include:

Table 1. Stages of Cooperative Integrated Reading and Composition (CIRC)

Fase	Description
Partner Reading	The teacher divides the students into several reading groups (reading partners) consisting of 2-3 people
Story Stucture and Related Writing	The teacher provides reading material containing material that must be understood by students
Words Out Loud	Students read the reading material aloud so that other students can listen carefully
Word Meaning	Students look for keywords or meanings contained in the reading material given
Story re-tell	Students retell their reading findings
Reflection	Reflection

Four Bases in DNA

With four bases and a long DNA, many possible base sequences are formed. Because genes are composed of a certain sequence of bases, the number of genes in DNA also has many possibilities. So, these four bases play an important role in determining the nature of each individual human being.

a. Cytosine

Cytosine is one of two N pyrimidine bases that have DNA and RNA. The ribose nucleoside is called cytidine and the deoxyribose nucleoside is called deoxysitidine. Cytosine binds to guanine in the DNA double helix, via three hydrogen bonds. Cytidine can form nucleotides when it binds to one, two, or three inorganic phosphate groups (PO43-) to form CMP, CDP, and CTP (called cytidine mono-, di-, or triphosphate, respectively). CTP can be a cofactor in biochemical enzymatic reactions and transfer a phosphate group to ADP to form ATP. Deoxysitidine triphosphate (dCTP) is required in PCR as a raw material for DNA synthesis. At certain moments, cytosine can undergo deamination to become uracil. These mutations can usually be recognized by enzymes involved in DNA repair. As in uracil, methylation can also occur in cytosine with the help of the DNA-methyl-transferase enzyme.

b. Thymine

Thymine or 5 methyluracil is one of the two N pyrimidine bases that make up DNA. RNA is different from DNA. It has no thymine and with the slight exception that uracil takes its place. In double-stranded DNA, thymine will bind to adenine through two hydrogen bonds to form a stable structure. Thymine together with the deoxyribose sugar forms a nucleoside called deoxythymidine or thymidine. Thymidine can form nucleotides when phosphorylated to dTMP, dTDP, or dTTP (deoxythymidine mono-, di-, or triphosphate). The dTTP element is required in PCR as one of the nucleotide raw materials.

c. Guanine

Guanine is one of the two purine N bases that make up DNA and RNA. The name, guanine is taken from guano because it was first isolated from guano (bird droppings fertilizer). In double-stranded DNA, guanine is bound to cytosine by three hydrogen bonds. Guanine forms a nucleoside together with a ribose sugar

called guanosine. The form of deoxy guanosine that binds to an inorganic phosphate group (dGTP) is one of the raw materials in the PCR technique. Chemically, guanine can exist in two tautomeric forms called keto enol tautomerism.

d. Adenine

Adenine is one of the two purine N bases used in forming nucleotides from the nucleic acids DNA and RNA. In DNA, adenine (A) binds to thymine (T) via two hydrogen bonds to form a stabilizing structure of nucleic acids. In double-stranded RNA (dsRNA), adenine binds to uracil (U). Together with the sugar ribose, adenine forms a nucleoside called adenosine. Meanwhile, together with deoxyribose, adenine forms deoxyadenosine. While adenosine can bind to an inorganic phosphate group ($PO4^{3-}$), and three phosphate groups are called adenosine triphosphate (ATP). ATP is one of the important compounds in the metabolism of all living organisms as a carrier of chemical energy for various biochemical reactions. Whereas in the PCR technique, deoxyadenosine triphosphate (dATP) is one of four free nucleotides that need to be provided before the process begins.

The following is an example of answers to post-test questions that students did related to DNA base material related to this experimental research

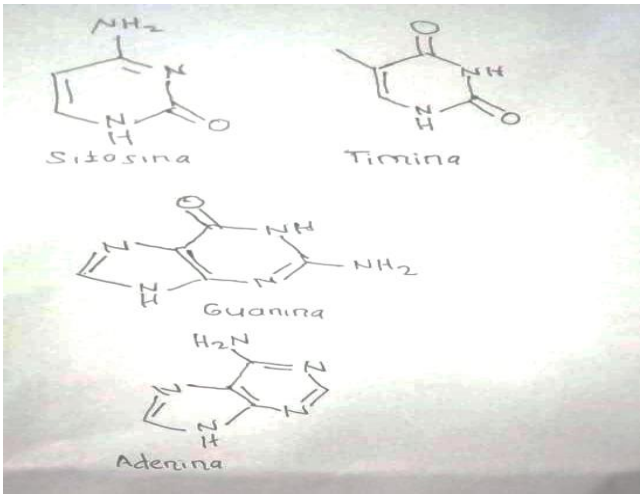

Figure 2. Example of Answers to Posttest Questions

Based on the posttest related to DNA base material given to 14 students, the posttest scores were obtained in the following categories

Table 2. Student Observation Data

Posttest Category	Gender	
	Male	**Female**
Very High	2	1
High	3	3
Currently	1	2
Low	1	0
Very Low	0	1
Total	7	7

From the data display in the table 2, it can be seen that the posttest score category for male students is the same as the posttest score category for female students. Thus, the formulated null hypothesis states that the posttest score category for male students is the same as the posttest score category for female students. Meanwhile, the alternative hypothesis states that the post-test score category for male students is not the same as the post-test score category for female students. So, if formulated symbolically the two hypotheses are

H_0 : $\mu_{\text{Categories of posttest scores for male students}} = \mu_{\text{Categories of posttest scores for female students}}$

H_1 : $\mu_{\text{Categories of posttest scores for male students}} \neq \mu_{\text{Categories of posttest scores for female students}}$

In this study, the significance level used was 5%. On the basis of the significance level, a D value in the table should be calculated. Because the applicable significance level is 5%, the value of D in the table is

$$1{,}36\ x\ \sqrt{\frac{7+7}{7\ x\ 7}} = 1{,}36\ x\ 0{,}534522 = 0{,}726951$$

The D value of 0.726951 is the basis for the formulation of the test criteria and the final conclusion in this study.

Thus, the hypothesis testing criteria applied in this study is that the null hypothesis is accepted if $D \leq 0{,}726951$ and While the null hypothesis is rejected if $D > 0{,}726951$

Furthermore, the value of D must be calculated through several steps. The series of steps taken to determine the value of D is shown in the following work table 3 and 4

Table 3. Working Table of the Double Sample Kolmogorov-Smirnov Method

	Gender			
Category Student Posttest Score	**Male Cumulative Frequency and Percentage (F1)**		**Female Cumulative Frequency and Percentage (F2)**	
Very High	2	0.285714	1	0.142857
High	5	0.714286	4	0.571429
Currently	6	0.857143	6	0.857143
Low	7	1	6	0.857143
Very Low	7	1	7	1

Table 4. Calculation of D Value for Multiple Sample Groups

Category Student Posttest Score	Gender		Difference F1 – F2
	Male Percentage (F1)	Female Percentage (F2)	
Very High	0.285714	0.142857	0.142857
High	0.714286	0.571429	0.142857
Currently	0.857143	0.857143	0
Low	1	0.857143	0.142857
Very Low	1	1	0

CONCLUSION

Based on the comparison between the D value in the table and the calculated D value, the D value is 0.142857. This value is smaller than the D value in the table of 0.726951. Thus, the null hypothesis which states that the posttest score category for male students is the same as the posttest score category for female students. While the alternative hypothesis which states that the posttest score category for male students is not the same as the posttest score category for female students is rejected. In this condition, it can be concluded that learning chemistry through CIRC on DNA base material for students of different sexes produces the same category of posttest scores. This means that this learning can be applied to male and female students equally well.

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