



The socio-scientific inquiry assisted by mind mapping effect on students' critical thinking skills in the digestive system material

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Article Information

Keyword:

Biology education; 21st-century; Critical thinking; Socio scientific inquiry; Learning model

Kata Kunci:

Pendidikan biologi; Abad 21; Berpikir kritis; Socio scientific inquiry; Model pembelajaran

History:

Received : 02/04/2024
Revised : 16/06/2024
Accepted : 20/06/2024
Published : 23/06/2024

Abstract

Introducing social life issues is one attempt to enhance student innovation and critical thinking. One of the models that integrates socio-scientific issues is the socio-scientific inquiry (SSI) model. The SSI learning model is a model with a social scientific issue that connects the communication relationship between science, technology, and society about the environment. This study aimed to study the influence of the SSI model supported by mind mapping on the critical thinking skills of senior high school (SMA) students in the context of the digestive system. This research is a quasi-experiment. Data is collected using observations and test instruments in the form of essays. The research population is the entire student body of the natural science (IPA) program at one of the Islamic senior high schools (MA) in the Dairi Sidikalang district, consisting of 120 students in three classes XI MIPA. This study contains data on critical thinking skills with independent sample tests, first with prerequisite tests, namely normality and homogeneity tests. The prerequisite test results obtained normal and homogeneous distributed data. The result of the t-test is a sig. (2-tailed) value of 0.00. The sig. value is less than 0.05. This result means that if H_0 is rejected, H_1 is accepted, so it is concluded that there are differences in the critical thinking results of students due to the treatment of the SSI model. The results of this study showed that the critical thinking skills of eleventh-grade MA students were improved, as can be seen from the results of pretests and posttests in experimental and control classes. So, the SSI model is effectively used to improve the critical thinking of SMA or MA students.

Abstrak. Salah satu upaya untuk meningkatkan inovasi pembelajaran dan berpikir kritis siswa adalah dengan menghadirkan isu-isu yang berkaitan dengan kehidupan sosial. Salah satu model yang mengintegrasikan isu socio saintifik adalah model Socio-Scientific Inquiry (SSI). Model pembelajaran SSI adalah model dengan isu socio saintifik yang dimana mengaitkan antara hubungan komunikasi antara ilmu pengetahuan, teknologi, dan Masyarakat mengenai lingkungan sekitar. Tujuan dari penelitian ini untuk mengkaji pengaruh model SSI yang didukung oleh mind mapping terhadap kemampuan berpikir kritis siswa sekolah menengah atas (SMA), khususnya dalam konteks sistem pencernaan. Penelitian ini adalah penelitian eksperimen semu. Data dikumpulkan dengan menggunakan observasi dan instrument test berupa esai. Populasi penelitian ini adalah seluruh siswa program IPA pada salah satu Madrasah Aliyah (MA) di Kabupaten Dairi Sidikalang sebanyak 120 siswa yang terdiri dari tiga kelas XI MIPA. Penelitian ini memuat data kemampuan berpikir kritis dengan uji independent sample test dengan uji prasyarat terlebih dahulu yakni uji normalitas dan homogenitas. Hasil uji prasyarat diperoleh data berdistribusi normal dan homogen. Data hasil uji t test yakni nilai sig. (2-tailed) sebesar 0,00. Nilai sig. (2-tailed) lebih kecil 0,05. Hal ini berarti jika H_0 ditolak, maka H_1 diterima, sehingga disimpulkan bahwa terdapat perbedaan hasil berpikir kritis siswa akibat pemberian perlakuan model SSI. Hasil penelitian ini memberikan dampak bahwa keterampilan berpikir kritis siswa kelas XI MA mengalami peningkatan, dapat dilihat dari hasil pretest dan posttest pada kelas eksperimen dan kelas control. Maka, model SSI efektif digunakan untuk meningkatkan kemampuan berpikir kritis siswa SMA atau MA.

A. Introduction

Over time, the world of education will change. This age of revolution has turned the 21st-century into a period of globalization marked by significant transformations. This change leads to a monumental transformation in the industry, which encourages the need to improve the quality of education to match the dynamics of rapid development of the times. Therefore, the current demands of schooling must equip students with the skills required for the 21st-century (Astuti, 2017). Critical thinking ability is a skill suggested to be one of the skills that students need to master in the 21st-century.

Critical thinking is the ability to solve problems systematically (Prameswari et al., 2018). Higher-order skills are critical thinking abilities (Agnesa & Rahmadana, 2022). Furthermore, Facione (2011) defines critical thinking as a self-regulating decision-making skill to produce understanding, analyze, evaluate, and make conclusions supported by evidence, concepts, criteria, or considerations appropriate to the context. Mastering critical thinking skills is also recommended in the Qur'an in Q.S Ali Imran verses 190-191, which reads:

أَنَّ فِي خَلْقِ السَّمَوَاتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لآيَاتٍ
لِّأُولِي الْأَلْبَابِ 191 الَّذِينَ يَتَذَكَّرُونَ اللَّهَ قِيَامًا وَقُعُودًا وَعَلَى
جُنُوبِهِمْ وَيَتَفَكَّرُونَ فِي خَلْقِ السَّمَوَاتِ وَالْأَرْضِ رَبَّنَا مَا
خَلَقْتَ هَذَا بَاطِلًا سُبْحَانَكَ فَقِنَا عَذَابَ النَّارِ 192

Meaning: Surely in the creation of the heavens and the earth, and the alternation of the night and the day, there are signs (of Allah's greatness) for those who understand (190). (Those who remember Allah while standing, sitting, or lying down, and they think about the creation of the heavens and the earth (and say): "O Our God, You have not created this in vain; Glory be to You, so preserve Us from the punishment of hell" (191).

The Word of Allah contains Allah's direction to His servants to contemplate nature, the heavens, and the earth. Allah SWT instructs His servants to use their minds and pay attention to the alternation between day and night. The verse also explains that they are people with perfect minds and intelligence. The verse explains that Allah has given natural phenomena so that humans can use their minds to understand every natural event in the world so that, later, science will emerge.

According to Hamdani et al. (2019), in their research, the problem that often arises in class is the lack of student interest in learning. One of the causes is the selection of inappropriate learning methods, and students are less active in participating in the learning process. Therefore, low student interest impacts their low critical thinking skills. Research by Fernandez et al. (2021) also explains that students will always be forced to participate in learning activities without

interest. So, to increase students' interest in learning, teachers must find ways, methods, or models to make learning relevant, authentic, and valuable for students' lives. Afterwards, teachers can use students' learning interests as a natural source to encourage them to be more involved in learning. The same thing as research by Prameswari et al. (2018) is that learning objectives and increasing student interest in learning will be more straightforward if teachers use approaches, models, methods, and strategies to improve learning interest so that students' higher-order thinking skills are gained. Thus, learning does not only stay in students' memories, but it will remain in their memories until they grow up.

At every level of education, students must improve and practice critical thinking skills (Nainggolan et al., 2018). Furthermore, honing students' critical thinking skills teaches them to communicate their ideas, solve problems, and sort out the information received (Yunita et al., 2019). In addition, students trained from an early age are expected to become people accustomed to being responsible, more thorough, and do not give up easily. So, the problem always arises in the field is the lack of students' ability to think critically (Utomo et al., 2020). This is supported by data and the results of measuring students' critical thinking in one of the MA in Dairi district, Sidikalang city, which still uses a teacher-centred method, evident from the percentage of exam results using tests still within 23%. Based on this data, it is known that students' critical thinking skills are still low, especially in the critical thinking indicators of inference and analysis.

Efforts can be made to improve learning innovation and students' critical thinking by presenting social, community, and economic issues around students in the learning process. These issues are better known as socio-scientific issues. One model that integrates socio-scientific issues is the SSI model. The SSI learning model has socio-scientific issues that link the communication relationship between science, technology, and society regarding the surrounding environment. (López-Fernández et al., 2022). This SSI model is an option for learning models to improve students' critical thinking skills because the syntax of the socio-scientific model is applied by linking to science concepts that have an impact on people's lives so that students are accustomed to thinking independently by connecting learning with social issues so that they are trained to think critically (Lestari et al., 2021). In addition, this model has links to conceptual, procedural, or technological relationships in social science issues to influence students to analyze and know about social issues around them (Qamariyah et al., 2021). This SSI model is also related to students' critical thinking skills because it can improve scientific literacy, especially in biology subjects associated with social issues.

Therefore, critical thinking skills can increase in learning by using this SSI model because students are connected to social issues around the environment (Siska et al., 2019).

There have been many studies on the integration of socio-scientific issues in learning. However, most of these studies integrate socio-scientific issues in the Problem-based learning model into students' communication skills (Wilsa et al., 2017). Furthermore, based on research by Indriani & Jayanti (2022), who examined an SSI learning model with the title interactive socio-scientific inquiry (ISSI) effects on creative thinking skills, the research discusses applying the ISSI model to students' creative thinking. Therefore, this opens up opportunities for researchers to use the SSI model with a mind-mapping-assisted digestive system.

In connection with applying the SSI learning model, researchers combine it with the help of Mind Mapping. Mind Mapping is related to critical thinking because mind mapping requires students to analyze and connect between concepts. Mind mapping media helps students think critically, pour information obtained in the form of thoughts, and create concepts obtained from socio-scientific issues (Rodiyah, 2023). A mind map is a learning tool that uses tools to describe and analyze content or material to facilitate the learning process. As a tool, mind maps can be classified as cognitive organizers that stimulate the human mind to work more optimally and effectively (Hung et al., 2014; Li et al., 2021; Badriah et al., 2023; Chen et al., 2024). Therefore, this SSI model is assisted by mind mapping to help students analyze the results of critical thinking and evaluate the material in a more concise form by making mind mapping so that it is easier to understand. So, students also learn to analyze and assess learning outcomes well.

Based on this explanation, this study aims to examine the effect of the SSI model supported by mind mapping on the critical thinking skills of high school students, especially in the context of the digestive system. Researchers chose the digestive system in this study because some appropriate issues related to the digestive system support applying this SSI model. This research must be used because it can provide information on how the SSI model affects students' critical thinking skills. This combination of approaches is expected to stimulate students' analytical, evaluative, and reflective thinking while enriching their understanding of complex scientific material.

B. Material and method

This study used quasi-experimental research. Quasi Experiment was born because factors make it difficult to control other variables in research, especially in the classroom (Abraham & Supriyati, 2022). The experimental design used was the pretest-posttest control group design.

Sample and participants

The population in this study were all Science program students in one of the MA classes in Dairi Regency, Sidikalang, with 120 students consisting of three classes XI MIPA. The sample selection was obtained using cluster random sampling of as many as 80 students consisting of two courses for experimental and control classes.

Instrument

The research instrument used a critical thinking skills test in the form of essay questions with as many as six items. This question instrument refers to the critical thinking indicators by Facione (2011), including interpretation, analysis, inference, evaluation, explanation, and self-regulation (see Table 1). The critical thinking ability test instrument has been tested for reliability and validity and validated by a biology learning expert validator. Validity and reliability tests were carried out by distributing and testing to students first outside the research sample. The validity of each item of critical thinking ability was tested using Pearson products, and the results were all valid items. The instrument's reliability is calculated using Cronbach's alpha formula, and the reliability coefficient of the instrument for assessing critical thinking skills is 0.641. The Cronbach's Alpha value results are pretty low because there is one item with the calculation of the relatively low item variance, so calculating the total reliability value of all question items gets relatively low results.

Procedure

This research is divided into three phases, namely, the preparation phase, the implementation phase, and the completion phase. In the preparation phase, initial observations were made, identification of the research population was made, lesson plans were made, student worksheets, a lattice of assessment instruments, essay tests, and the validity of test instruments to expert lecturers of biological learning devices.

The activities in the implementation phase, namely, giving a pretest to students before giving the SSI model treatment, carrying out the stages of the digestive system material learning process using the SSI learning model according to Levinson et al. (2017) in learning in Table 2 with four stages syntax, namely ASK (determining authentic questions related to socio-science issues), Find Out (answering SSI-based authentic questions), ACT (determining solutions by taking action), and Evaluation (closing) stages which are associated with critical thinking indicators according to Facione (2011). Furthermore, the data analysis technique used is quantitative data analysis. Before testing the study results, the prerequisite test was carried out by testing normality and homogeneity tests. After that, the results obtained will be tested using the independent sample t-test on the SPSS program, with a significant level of 5%.

Table 1 Question rubric

Indicator	Question rubric
Interpretation	Based on what has been learned and discussed about mukbang, what do you think these mukbang issues have to do with the digestive system?
Analysis	Explain and analyze how the mukbang case can affect one of the digestive organ structures and what can happen to explain.
Inference	Do you think the keto diet will make your body healthy, or will it cause malfunction in the digestive system due to the small amount of nutrients from carbohydrates? Conclude in your own words!
Evaluation	From the discourse, phenomena, and data presented about mukbang. What do you think should be done so that social issues about mukbang are not followed by children and teenagers? But if followed because it is an economic source, how can the digestive organs be kept healthy?
Explanation	What if the keto or any other diet is not followed as a doctor or nutritionist recommends? Explain your reasoning or reasonable opinion based on the evidence you have known or read from various sources!
Self-regulation	Based on your mindset, do you agree/disagree that the keto diet can be one of the efforts to maintain the digestive system? Explain with reasons!

Table 2 Learning steps of the SSI model in face-to-face meetings

Syntax	Learning Activities
ASK	1. The teacher presents an SSI-based video on the mukbang phenomenon. 2. Students identify, then create questions and provide hypotheses from what they have watched. Identify how mukbang affects the organs of the digestive system.
Find out	3. The teacher distributes students' worksheets with digestive system material, and the teacher forms study groups. 4. Students are asked to analyze and answer the questions that have been presented. 5. Students conduct discussions, forming 4-5 people per group and discussing problems on students' worksheets.
ACT	6. Students can answer their questions and hypotheses according to what they see in the students' worksheets. 7. Students conduct literature reviews from several sources that have been agreed upon. 8. Students present the results and develop solutions based on what they have concluded from the mukbang phenomenon.
Evaluation	9. The teacher directs and asks students to summarize the discussion results on the issues and learning materials. 10. Gives appreciation to groups who have worked well together. Students summarize the learning outcomes.

C. Results and discussion

Research showed that students' critical thinking skills increased in both research classes. There was no significant difference in the results of the pretest data of the two classes. The results showed that the average value of the experimental class was higher than the control class. This indicates that the treatment using the SSI model suggests that learning associated with the issue, namely the SSI model, affects the results of students' critical thinking skills (see Figure 1).

Figure 1 shows the average difference between the pretest-posttest of classes A and B. In the experimental and control classes, there is an increase in critical thinking regarding the digestive system's material. Further research results regarding the effect of SSI are also available in Indriani & Jayanti (2022), showing the same results. The results in this study show the percentage increase in the experimental and control classes in the highest creative thinking ability on the indicators of original thinking and assessing thinking, with an average increase value of 17.5.

Further analysis is carried out on indicators of critical thinking skills, including interpretation, analysis, evaluation, inference, explanation, and self-

regulation, presented in Figure 2. Based on Figure 2, it is known that the SSI model treatment shows a high increase from the overall acquisition of pretest scores, with the lowest percentage of 28.70%, increasing to 92.50%. In the data, it can also be seen that the highest increase is in the inference indicator. The evaluation indicator has the highest percentage in the posttest assessment. The graph also shows changes in the percentage increase in students' critical thinking skills.

An independent sample t-test statistical test is applied to determine the difference in critical thinking skills by applying the SSI model with a pretest-posttest. The data used for the independent sample t-test must first be tested for prerequisites. The one-sample Kolmogorov-Smirnov test data received a sig from the prerequisite and hypothesis test results. value for the experimental pretest was 0.200, and the experimental class posttest data obtained 0.200. Meanwhile, the control class pretest data obtained a sig. value of 0.127, and the control class posttest data obtained a sig. value of 0.146. So, it can be concluded that all data is normally distributed (sig. > 0.5).

After doing the normality test, the next step is to do the homogeneity test. The homogeneity test is

carried out to show that two or more groups of sample data obtained come from populations with the same variance. Based on the data obtained using Levene's Test for Equality of Variances, it can be seen that the results of the homogeneity test of the pretest values show significant results with sig. 0.104, and the results

of the homogeneity test of the posttest values show sig. 0.177. So, the conclusion of the data obtained is homogeneous for pre and posttests. Furthermore, the results of the research data received from the independent sample t-test using SPSS 25.0 software are shown in Table 3.

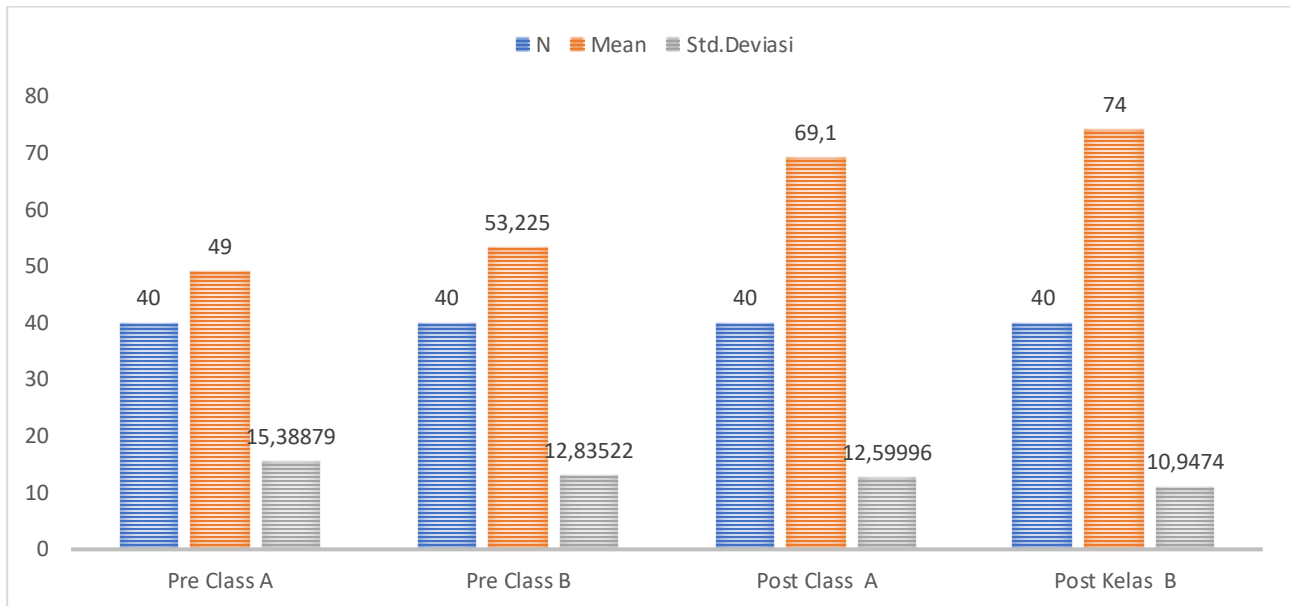


Figure 1 Average comparison of critical thinking skills

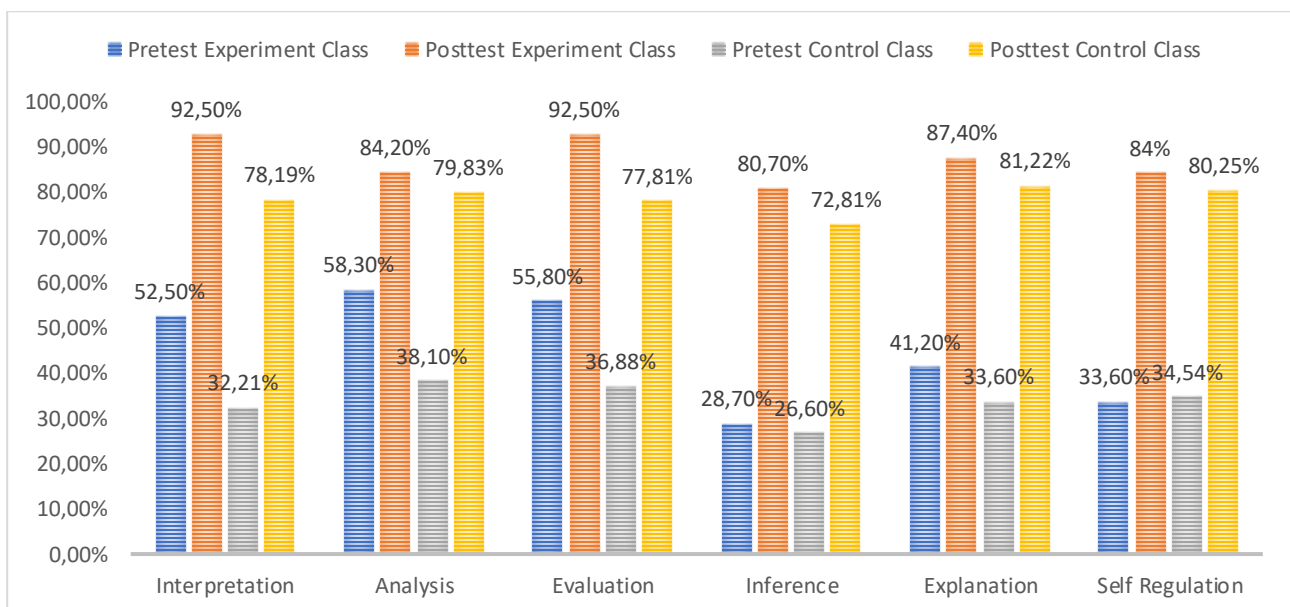


Figure 2 Graph of pretest-posttest difference between experimental and control class

Table 3 Independent sample t-test

	Levene's Test for Equality of Variances						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Pre. Equal variances assumed	2.708	.104	-1.389	78	.000	-4.40000	3.16843
Post. Equal Variances assumed	1.859	.177	-1.752	78	.000	-4.62500	2.63915

Table 3 shows the sig value. (2-tailed) of .000. The sig. value (2-tailed) is smaller than 0.05. This means that if H_0 is rejected, then H_1 is accepted. With the acceptance of H_1 , it can also be concluded that there are differences in students' critical thinking results due to the treatment of SSI learning models. It can also be said from the analysis results using SPSS because the probability value $< \alpha$, it can be said that the pretest and posttest values are different with a negative t-test coefficient value, meaning that the posttest value is better than the pretest.

The results showed a significant difference from the effect of the SSI learning model by introducing issues in the surrounding environment closely related to the digestive system material in one of the MA in the Dairi district. In the experimental class that received the SSI model treatment, there was an increase in value seen from the student's posttest scores. This study and analysis align with research proposed by Kumar et al. (2024) that subjects related to natural knowledge studied using the socio-scientific issues model can develop critical thinking skills that show an increase in development in analyzing information or data from the surrounding environment. However, these results are not in line with the research results of Hanifah et al. (2021), which show significant results from applying the SSI model. The average score was 75-85. The experimental class with moderate achievement assessed solutions, implementation, and evaluation with an average score of 70-75. The control class found the problem with its best score with an average score of 75-8. However, the comparison between these studies lies in the variables, namely critical thinking and problem-solving skills. However, the comparison of the increased results is the effect of this SSI model.

Thus, this SSI model, one of the 21st-century models, is superior to conventional learning models. This SSI model can also be one that elementary school teachers can use to appreciate the value of SSI teaching (Espeja & Lagarón, 2015). As we know, the 21st-century, or the century of globalization, is a century where information becomes more accessible (Indarta et al., 2021). By linking learning with information often accessed through social media, such as the issue of mukbang or keto diet issues, it can easily be related to learning materials, especially in biology subjects. This is in line with the research of Hanifah et al. (2021), the SSI model combined with introducing issues so that it has the potential to train students to think critically by solving the problems themselves according to the issues around us. With this stimulation, students' skills for critical thinking have increased.

The application of SSI in education is essential for several reasons: (1) making science learning closer to the real world of students; (2) making learning more focused on the reality of science; (3) increasing students' ability to evaluate and argue about scientific facts; and (4) including one of the essential parts of science literacy (Indriani & Jayanti, 2022). Students

must find ways to increase their potential so that students are accustomed to having the ability to solve problems (Jariah & Aminatun, 2022). Socio-scientific moral problems can help students think critically and engage in social and disciplinary issues by encouraging them to solve problems and learn science materials. In addition, socio-scientific problems can assist students in developing their confidence (Georgiou & Kyza, 2023).

The initial stage of ASK begins by trying to motivate students and directing students to determine questions and formulate them with group friends related to socio-science issues regarding the issue of mukbang and the keto diet. The teacher provides an overview of these social issues so that later, students find problems in the form of questions/problem formulations regarding the two issues. The second stage is the Find Out stage, which will train students to think more critically based on the indicators that have been described. At this stage, the teacher directs students to answer and discuss questions created by the teacher and questions that the teacher has presented in the students' worksheets by presenting questions related to social issues regarding the digestive system, namely the keto diet, and mukbang. Students will be trained to carry out critical thinking indicators ranging from interpretation, analysis, inference, evaluation, explanation, and self-regulation. In the third stage, namely ACT, students are asked to determine the solution to the problem of social issues being discussed. This stage also helps students to carry out indicators of analysis and evaluation. Finally, the closing/evaluation stage is the closing stage, and the teacher evaluates students in learning with the SSI model. At this stage, the teacher and students conclude and assess the results of the discussions during learning.

Another study slightly different from the SSI Syntax above stated by Rauch & Radmann (2020) in their research on "how SSI-based learning (SSIBL) promotes inquiry in climate issues: example for enacting socio-scientific issues in science education" explained that the stages of this issue-based inquiry model begin by raising meaningful and authentic questions about socio-scientific issues. For these questions, social and scientific inquiry is used (enaction). Finally, students are stimulated to take action, form opinions, and formulate solutions (action). It can be said that students determine the solution. Levinson et al. (2017) also formulated that the essential stages of this model are determining questions, investigating, and being stimulated to take action in the form of solutions or opinions. The comparison with this research lies in the last syntax, namely evaluation. This study emphasizes the four stages of the SSI syntax, while the survey emphasizes only the stage of determining the solution.

The novelty in this research proposes an issues learning model assisted by media mapping in teaching

biology that is more effective and also relates to the models needed in technology and learning in the current era. The results of this study can be applied to improve high school students' critical thinking skills by using learning models in the classroom. The scientific impact of this research on the future is that it will be a source in education, especially for teachers who can apply the SSI model to improve learning effectiveness and become an innovator in classroom teaching methods.

This research can provide solutions or information to apply the SSI model in biology learning. SSI helps teachers or students understand socio-scientific issues and relate them to how students think critically by thinking that how to incorporate the problems into learning in this era is essential. Therefore, Levinson (2018) states students know that social science issues relate to science.

D. Conclusion

The SSI model has changed the percentage increase in students' critical thinking based on the research and data analysis results. The results obtained from the independent t-test are normal, homogeneous, and valid. After learning using the SSI model, each indicator of critical thinking was increased. The results of this study indicate that this model can be used in classroom learning. SSI can be an alternative in the learning process as a facility and as an innovation in education in 21st-century learning. Recommendations for further studies in future research can be made by analyzing other factors or variables that can affect relevant results.

E. Acknowledgement

Special thanks go to Mr. Adi Hartono, M.Pd., as a validator of critical thinking question instruments, Dr. Nirwana Anas, M.Pd., as a validator of learning devices (learning plan and students' worksheet), MA principals, biology subject teachers and all students of class XI Madrasah Aliyah for their participation for the smooth running of this research process.

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