



1 **Exploring the Influence of Science Lessons Through Text-** 2 **Based Explanations and Game-Based Explanations Mixed** 3 **With A Socio-Scientific Approach on Issues on Rational** 4 **Thinking Ability and Mis-Understanding**

5 **NOVELTY**

6 The novelty in this research is that in carrying out this text-based explanation, the media
7 used is an SSI-based booklet where this booklet displays controversial phenomena. This
8 game-based explanation uses a mixed game, namely Monopoly and Blockerz (digital
9 games), so carrying out this learning uses a mixed game. The location used is MTs
10 Ma'arif Klego Ponorogo. Apart from that, the samples used are also different. The
11 sample used is students who have just entered junior high school and are elementary
12 school graduates, so the characteristics of these elementary schools are that they still
13 like games.

14 **ABSTRACT**

15 Both in private and public education, there are several institutions that may have used
16 game-based explanations. However, it does not rule out the possibility that the majority
17 of educational institutions use text-based explanations that make students tend to get
18 bored because only by reading and listening, so another alternative is needed in the form
19 of game-based explanations that can spur students to improve their rational thinking
20 skills by adding an approach that is socio-scientific issues to reduce student
21 misunderstanding. The method used within the research is a quantitative approach with
22 an experimental design research type so that the studies use control magnificence and
23 experimental elegance as an evaluation. The pattern used became fifty-six, with 29

1 because of the control class and 27 as the experimental elegance. The statistics obtained
2 show the difference in rational wondering potential of the two groups showed a
3 considerable distinction in the sport-based explanation is tons higher than the text-based
4 clarification in addition to misunderstanding.

5 ***Keywords***

6 Explanations, Games, SSI, Rational Thinking and Texts.

7 **1. Introduction**

8 In public and private education, game learning has been implemented and gained
9 recognition as a practical learning medium used in educational institutions. Students
10 cannot be separated from games; often, games are only used as a means of
11 entertainment, but behind that, games can be used as a means of learning so that
12 learning is not monotonous, which can cause students to tend to get bored.(Rahaju &
13 Hartono, 2017) Such as using learning methods that use games, for example, the Teams
14 Games Tournament (TGT) method, and quizzes using Quiziz. Learning combined with
15 games further increases students' ability to participate in learning. Based on research
16 (KumalaDewi & Suminten, 2020), Game-based learning has not been widely developed
17 and used by teachers. Recently, many have started to develop educational games
18 because they feel that games make students more enthusiastic and happy to participate
19 in learning (VD Astuti et al., 2021). Learning by providing games in digital (modern)
20 and traditional forms is not only used as a means of entertainment but also to train
21 students to improve their cognitive abilities and critical thinking skills (Chang & Yeh,
22 2021).

23 Oktavia (2022) shows that there are shortcomings in implementing game-based
24 learning, such as requiring a relatively large amount of time and also requiring
25 additional tools and media so that learning becomes exciting and students become

1 enthusiastic about learning. Apart from that, not all teachers who teach are proficient
2 with technology, so game-based learning can only be implemented by teachers who are
3 proficient with technology, even though teachers should create a fun and meaningful
4 learning atmosphere (Realize, 2019). This means that game-based learning, both
5 modern and digital, cannot be fully implemented. So, in the end, cognitive abilities
6 decrease to a low level in science teaching (Kulgemeyer & Wittwer, 2023). Based on
7 the data obtained by researchers, it shows that the development of games as a learning
8 medium has a positive impact, namely that it can improve students' critical thinking
9 skills (Chang & Yeh, 2021). The hypothesis shows that if game-based learning is
10 implemented, there will be an increase in students' abilities. The Monopoly game is a
11 traditional game that has been implemented to improve students' analytical skills and
12 has been proven to be successful (Rahaju & Heriyawati, 2020). The presence of games
13 using digital games also has a positive impact, namely increasing cognitive abilities,
14 critical thinking abilities, and the ability to increase motivation (Chang & Yeh, 2021;
15 KumalaDewi & Suminten, 2020). Apart from that, by conducting game-based learning,
16 there is an approach that can be used to improve students' analytical skills, namely the
17 Socio-Scientific Issue (SSI) approach (Berne, 2014). Which can be used to measure
18 rational thinking abilities. The Educational Policies Commission mentions several
19 indicators, including remembering, imagining, grouping, generalizing, comparing,
20 evaluating, analyzing, synthesizing, deducing, and making conclusions Joseph (1997)
21 (Nurachman & Irawan, 2020). This shows that there is a difference between learning
22 methods that only use text-based explanations, causing students to be less active and
23 even tend to get bored, compared to game-based learning, which can make students
24 active and interested in participating in learning. (Durin et al., 2019).

1 As game-based learning has become an increasingly established medium in
2 science teaching, the weaknesses of game-based learning should be examined as closely
3 as possible to its potential, and this research contributes precisely to this goal. The
4 current experimental study aims to find out the question of whether mixed game-based
5 learning with the SSI approach can improve rational thinking abilities. Apart from that,
6 it is also used to determine the level of knowledge attainment in phenomenal cases
7 regarding diffusion material. The combination of the Monopoly game and quizzes is
8 essential for science education because it can help teachers to use which methods to
9 choose which methods can be used to attract students' attention when needed.

10 **1.1 Literature Review**

11 **1.1.1 Science learning with games**

12 The game-based learning that has been developed is then used in education that
13 involves students to increase the achievement of an educational process. Two types of
14 games can be applied when learning, which are commonly used, such as traditional
15 games and technology. A Study Coco et al., 2001 in (Chang & Yeh, 2021) shows that
16 students are satisfied with the existence of game-based learning, which, apart from
17 being a means of entertainment in learning activities, provides a means of improving
18 and developing abilities students possess. Games in learning also contain instructions on
19 how to use the game, which will be played by students accompanied by the teacher
20 (Oktavia, 2022).

21 Cicchino (2015) revealed that recently, the mobile application developed has
22 attracted attention, which is characterized by direct interaction between students and
23 teachers and is easy to use, proven effective, and can improve students' critical thinking
24 abilities. Considering the advantages of traditional game-based and mobile learning, this

1 research tries to integrate these two types of learning to improve critical thinking
2 learning. We believe that when each game has passed a challenge, it will slowly pass
3 another challenge, namely a challenge that is at a higher level than the previous
4 challenge. This is an opportunity to develop learning media that have more potential to
5 be applied when teaching, which will have a positive impact on students, namely that
6 they do not tend to get bored because the learning method used by the teacher is
7 monotonous. Chang & Yeh (2021) revealed that mixed game-based learning can be
8 helpful for teachers to develop science within themselves through an approach that is
9 then transferred to both traditional and modern games. (KumalaDewi & Suminten,
10 2020)revealed that game-based mixed learning was felt to have a positive influence on
11 students. This shows that game-based learning is more effective than lecture-based
12 learning and assignments (Li & Tsai, 2013).

13 As time progresses, technology becomes more sophisticated day by day. Over
14 time, the era is in the 5.0 era, so there is a need for rapid technological development. As
15 technology develops, as an educator, you must quickly keep up with current
16 developments, like digital games, which contain games that can be applied as a learning
17 medium.(Nafrin & Hudaidah, 2021)This reminds us to develop distance learning during
18 the Covid-19 pandemic, which may be one solution to the new Covid development
19 which is rumored to be appearing in 2023, namely the Eris variant of the coronavirus
20 virus, which has entered several regions in Indonesia, such as Bali, Jakarta, Java. West,
21 East Java, and North Sumatra, there are also parole variant viruses that have been
22 detected in several countries, namely Denmark, England, the United States, Israel, and
23 South Africa. It is hoped that game-based learning, mainly digital, can become an

1 interactive learning medium between students and teachers during the pandemic (Jediut
2 et al., 2021).

3 One of the topics of this research is mixed game learning design with a Socio-
4 Scientific Issue approach to improving rational thinking skills. Most of the learning
5 designs lie in the games that will be applied to students, both traditional and digital
6 games (Chang & Yeh, 2021).

7 Rachmawati & Diningsih (2021) revealed that taking a socio-scientific approach
8 to issues can improve reasoning abilities. Besides that, R. Astuti et al. (2021) revealed
9 that using a socio-scientific approach to issues can improve thinking abilities, namely
10 the ability to think clearly and the ability to reason. These findings indicate that research
11 on socio-scientific approaches to issues generally focuses on rational abilities.

12 Septanto (2014) conducted research whose results showed that working on
13 questions was easier in multimedia than on paper because by using multimedia, the time
14 used was more effective. The grades came out immediately without making corrections
15 as was done on paper. Game-based learning was developed using the SSI approach,
16 which includes controversial phenomena. Then, in learning, there are also digital games
17 that can be used to measure students' cognitive abilities. In the student learning design
18 that will be implemented, there are several instructions that students should carry out
19 before using it. Adaptations can be made by 1) understanding the steps that will be used
20 when using traditional or digital learning and 2) the level of problem-solving that they
21 may experience. By students, 3) mastery of the material, and 4) phenomena that become
22 controversial issues. Adaptation to the learning design is easy to do because, in
23 traditional games, the majority of students are familiar with the game that will be
24 applied, whereas, in digital games, there needs to be guidance so that students can know

1 the flow of how to work on questions in multimedia. Based on several researchers, the
2 average shows that using mixed learning has a positive impact on students. For learning
3 using the SSI approach, students show an event that has a relationship with the diffusion
4 material. The SSI approach is expected to improve students' abilities, namely the ability
5 to analyze. In addition, the existence of a blending-based learning design is expected to
6 be able to improve rational thinking skills. The ability to reason can be improved by
7 changing less effective learning methods, such as learning with text-based explanation,
8 by changing learning methods that can accommodate differences in students' ways of
9 learning and challenge students' creativity and active involvement in learning activities
10 (Zahro & Hadi, 2022). Rational thinking skills can be achieved easily if there is special
11 treatment, namely improving rational thinking skills using a blended game learning
12 method with a socio-scientific issue approach. This follows research conducted by Nova
13 Pratiwi and her colleague Januardji in 2018. The title used when researching was
14 "Improving Students' Rational Thinking Ability Through Blended Learning with
15 Learning Independence Moderator Variables," which has gone through 2 cycles, and the
16 results prove that there has been an increase of 75% (Pratiwi & Januardi, 2019).

17 **1.1.2 Approach to Socio-Scientific Issues and Learning from Texts and Games**

18 Socio-scientific approach to issues, according to Zeidler in the journal (Sofiana &
19 Wibowo, 2019), SSI is an approach that has the aim of stimulating moral, ethical, and
20 intellectual development, as well as having an awareness of the relationship between
21 science and social life, which intersects directly or indirectly with human life.
22 Therefore, using this approach indirectly provides an understanding to students so that
23 they understand that everything in the universe is related to science. Rahmawati et al.,

1 (2018) Said that learning uses a socio-scientific issue approach as an approach to
2 learning. There are several definitions:

3 A socio-scientific issue approach is an approach that 1) has the aim of stimulating (a)
4 morals, (b) ethics, and (c) intellectuals and 2) has awareness about scientific matters (c)
5 directly (d) or indirectly.

6 This is similar to research conducted by Siska et al., (2020). There are several
7 criteria for taking a socio-scientific approach to issues. There are several criteria for
8 raising issues that will be used, including 1) Has a scientific basis, 2) involves forming
9 opinions and making choices at the individual and community level, 3) is often
10 highlighted by the media, 4) there is a lack of complete information, 5) leads to local,
11 national and global dimensions related to political and social frameworks, 6) involves
12 ethical values and considerations, 7) requires an understanding of various possibilities
13 and risks related to events in the surrounding environment. The researcher found
14 challenges for students if they used a socio-scientific approach to issues. These
15 challenges include, among other things, sharing ideas, knowledge, and values based on
16 social issues presented in learning. Then, analyze whether an error will occur, such as
17 there is no relationship between the phenomenon raised and the scientific concept.

18 The difference between learning that uses text-based explanation and game-
19 based learning used by educational institutions is still often found in using text-based
20 explanation. When using a game in learning, teachers will have difficulty finding
21 learning media that will be developed(Rahaju & Heriyawati, 2020)when teaching a
22 game, which is then linked to an approach. However, students prefer to use game-based
23 learning (Oktavia, 2022)

1 Researchers found one approach that can be used to improve rational thinking
2 abilities, namely the SSI approach, which in the research contains indicators of rational
3 thinking abilities. (Siregar et al., 2020) found that a scientific approach that brings up
4 controversial phenomena or issues can be used as a learning tool to improve critical
5 thinking skills, reconstruct rational thinking skills, and analytical skills. In other words,
6 learning methods used in learning activities to improve students' rational thinking
7 abilities should use a scientific approach, especially a socio-scientific issue approach,
8 which can be used as a benchmark for increasing students' rational thinking abilities.
9 This can illustrate that improving rational thinking skills can be improved using a socio-
10 scientific issue approach rather than using text-based explanation.

11 However, scientific literacy theory states that learning with two channels, such
12 as the use of the learning methods used and the learning media that will be used in
13 teaching, as well as comments that students will give on methods and media under
14 certain conditions, can help teachers take the next steps so that students can follow their
15 learning more effectively. Active so that the atmosphere in teaching and learning
16 activities becomes fun and not dull. Learning criteria are said to be successful if they
17 meet 3 criteria, namely. The success of the learning process is determined by three main
18 aspects, namely, students (students), educators (teachers), and learning resources
19 (materials/teaching materials). However, it cannot be denied that supporting aspects
20 such as schools, parents, and so on also have a role that is no less important. All of these
21 elements must mutually support the learning process. The aspect of educators (teachers)
22 as parties who act as facilitators, are expected to be able to create a dynamic, fun, and
23 innovative learning atmosphere and create a comfortable feeling for students to
24 understand the teaching material. The aspect of students (students) as the party who is

1 the subject of learning is expected to fully understand the subject matter to utilize the
2 knowledge appropriately learned. The third aspect (learning resources) is the media, an
3 intermediary in conveying the material. These three aspects cannot replace each other.
4 Teaching and learning activities can run smoothly and effectively if all components that
5 influence each other support each other (Trisnaning et al., 2017).

6 In conclusion, the learning method using a socio-scientific issue approach is
7 more complex than a text-based explanation because the socio-scientific issue approach
8 still looks for controversial issues or phenomena. So, it is unsure which method is
9 appropriate for teaching science concepts. So, a misunderstanding arises, which should
10 be measured to determine the misunderstanding of the teaching given through each
11 treatment. Mis-understanding means a concept that leads to one particular goal, but the
12 intended target differs.

13 New research shows that learning with game innovation in learning makes
14 students more enthusiastic about participating in learning (Baharizqi et al., 2023).
15 Revealed that there is a temporary hypothesis that using game-based learning can
16 increase students' enthusiasm for participating in learning. The Minister of Education
17 and Culture, Mr. Nadiem Makarim, believes that learning has a goal that every teacher
18 must have, namely creating a happy learning atmosphere and encouraging teachers and
19 students to innovate and improve the quality of their learning. Apart from using learning
20 media, innovation can also be done through approaches taken by teachers to create an
21 immersive sauna for students (Rahayu et al., 2022).

22 The basic idea is that the media overshadows how the explanation is delivered,
23 and some activities are actively involved so that students do not tend to get bored of
24 learning. Thus, the media that students usually use to interact superficially can give the

1 impression that the explanation is easy and they understand it. Therefore, learning
2 innovations can be made to adapt students' characters so that students have a sense of
3 enthusiasm for learning.

4 Then, there is a hypothesis which shows that games make students more
5 interested in learning. This is in contrast to just using text-based explanations, which
6 makes students increasingly bored of following the lesson and tend to ignore what the
7 teacher has said. For students, game-based learning may be considered new because
8 most students receive instruction using text-based explanations. So, there is a need for
9 game-based learning by providing instructions so students can use games related to
10 learning. However, it does not rule out the possibility that this game will entertain and
11 train students' skills, especially the ability to reason.

12 When comparing text-based explanation and game-based learning, there is
13 evidence that students are more engaged when given a game than just using text-based
14 explanations (Rahaju & Heriyawati, 2020). Using a mixed game between Monopoly
15 and Quizalize, a learning innovation that links the socio-scientific issue approach to
16 improving students' rational thinking abilities, has advantages, including students being
17 active, learning being challenged, and learning being fun. Even though it doesn't take a
18 day or two to make the media that will be used for learning, it doesn't rule out the
19 possibility that the longer the learning media is made, the better the results obtained
20 (Hafiyya & Hadi, 2023). In this way, a goal has been achieved in this research, namely
21 whether the mixed learning games that will be implemented, such as the monopoly
22 game as a traditional game and the equalize game, which is a mobile device game with
23 the SSI approach, can improve students' rational thinking abilities as a learning tool to
24 replace text-based explanation which is considered boring.

1 **2. Method**

2 **2.1 Research questions**

3 Rookies with little earlier information are often considered the number one goal
4 organization for well-known educational causes. Primarily based on the theoretical
5 concerns cited above, we identified numerous questions in this study concerning
6 combined game mastering of science causes compared to lecture reasons for college
7 kids with low earlier knowledge.

8 First, based on evidence from previous studies, it is clear that blended game-
9 based mastering benefits achievement. Primarily based on preceding studies, college
10 students locate it extra hard to apply a blended sports gadget than a text-based
11 explanation. The first speculation reminds us that media affects someone's notion of an
12 explanation. Text-based clarification that appears like textbook entries influences being
13 greater reliable and convincing, which also causes newcomers to overestimate their
14 information acquisition.

15 Therefore, the research questions of this study are:

- 16 1) Does game blended learning improve rational thinking abilities?
- 17 2) Can mixed game learning with the SSI approach foster rational thinking
18 abilities?

19 Because, as explained above, evidence from previous research is clear that it can
20 improve critical thinking skills, it is impossible to predict which media will have the
21 advantage in terms of achieving rational thinking. Therefore, in an attempt to answer
22 Question 1, we tested the following hypothesis:

23 Hypothesis 1: Game media produces achievements that lead to more excellent
24 knowledge of rational thinking abilities than text-based explanations. Alternative

1 hypothesis 1a: teacher-explained text-based explanation leads to greater attainment of
2 rational thinking knowledge than game-mixed learning. Alternative hypothesis 1b: text-
3 based explanation and blended learning produce the same rational thinking
4 achievements. 1c Alternative hypothesis: game-based explanation of the results of
5 achieving rational thinking abilities leads to

6 As explained above, rational thinking is the ability a person has to draw
7 conclusions that have a basis and can be justified and supported by logic, rules, and
8 data. Similar to Research Question 1, there is clear evidence regarding Research
9 Question 2. Therefore, the following hypothesis regarding Research Question 2 will be
10 tested:

11 Hypothesis 2: Mixed game-based explanations are more likely to lead to
12 misunderstanding than text-based explanations. Alternative hypothesis 2a: mixed game-
13 based explanations cannot improve rational thinking abilities. Alternative hypothesis
14 2b: game-based explanations are the same as other learning. 2c: Mixed game-based
15 explanations lead to fewer misunderstandings than text-based explanations.

16 Researchers use mixed learning, an innovation with material adapted to schools.
17 The material that will be used is diffusion material.

18 Learning progress from sport-based learning, specifically virtual-primarily based, is
19 immediately offered in the clarification. For conceptual knowledge, which involves
20 moving newly found ideas to other examples not without delay included inside the
21 rationalization, extra energetic mastering followed by gaining knowledge of obligations
22 is probably vital. Therefore, our research addresses the potential to suppose rationally as
23 a thrilling assemble.

24 **2.2 Context**

1 This research was conducted on science subjects for the SMP/MTs level at an
2 educational institution in Ponorogo. This subject is mandatory for all students.
3 Experiments were carried out before they were introduced to the classification of
4 materials. Students are required to participate.

5 **2.3 Sample and Design**

6 The participants used as samples were around 56 students using a random
7 sampling technique from grade 7, so 56 students remained as samples in this study. The
8 participants have been registered in the schools studied by looking at student
9 attendance. The sample used has achieved the same material in science subjects. Of the
10 56 participants, 29 and 27 students in grade 7 had just graduated, so the material taught
11 was not necessarily given in elementary school. Hence, they can be predicted to have
12 low prior know-how in physics, comparable to secondary school college students.
13 Therefore, this pattern is a sample that is straightforward to take but suitable for
14 exploration due to the fact the traits that cause them to be distinct from essential faculty
15 college students who're delivered to material class are expected to not substantially
16 influence the established variable of this examine (Bado, 2021).

17 Of these 29 students, 16 Diagnosed themselves as male, 13 as girl, and none as
18 non-binary. This is not abnormal because primary schooling is a topic everyone must
19 take. As a minimum, in Ponorogo, it's far by and large chosen by woman teachers. Their
20 average final primary faculty exam score is 80, on a scale of 1 ('superb') to 4
21 ('unsatisfactory'). Throughout education in Indonesia, this subject is a common subject
22 that is applied.

23 **2.3 Materials: Text-Based Explanation and Game-Based Explanation**

1 For this take a look at, we decided to use a sport-introducing material type. This
2 game was designed following a framework created by systematic researchers regarding
3 educational explanation standards related to a focus on science education. This
4 framework includes seven factors that influence game effectiveness(Rahaju & Hartono,
5 2017): (1) image structure, (2) adaptation to the recipient group, (3) use of suitable aids
6 to acquire edition, (4) minimal clarification that avoids deviations and keeps cognitive
7 load low, (5) highlighting the rationale itself that is relevant to students and other
8 components which might be very relevant, (6) provide learning responsibilities after the
9 sport, and (7) focus on rational concepts. The commands given through the trainer are
10 listened to and understood as a way to use Monopoly Recreation as a learning medium.
11 Then, the text-based explanation uses media as a printed booklet whose introduction is a
12 phenomenon as an introduction to material classification material.

13 The monopoly game can be played by throwing a dice where the number on the
14 dice comes out as a journey from one location to another. When they reach a particular
15 area, students are given a card containing problems, which they then ask the students to
16 analyze. The events obtained include what science concepts are based on and explain
17 their relationships. When all students have received their respective parts, ask them to
18 present what they got. This can be useful for students with genius thoughts but lack the
19 courage to express them, so this media helps them share as much knowledge as
20 possible. The presentation starts with the group that rolls the dice for the first time, and
21 there is a discussion regarding whether what is presented follows the material provided
22 or not. The instructional design in this research is a socio-scientific issue approach to
23 game-based learning to improve rational thinking abilities. All experimental instruction
24 was used through 7th grade with science subjects taught by the researcher. Instructions

1 for using the game can be seen in **Figure 1** as instructions for using the Monopoly
2 game, and **Figure 2** is a display of the game between Monopoly and Blokerz.

3 **Figure 1. Instructions for Using the SSI Monopoly Game**

4 **Figure 2. A Game-based Explanation that Blended Games Between Monopoly and**
5 **Blokerz (Digital Games)**

6 The purpose of technological know-how knowledge is to look at troubles
7 associated with technological know-how, simple technology standards, the significance
8 of statistics technology, and the utility and use of generation that can be used as a
9 science getting-to-know medium. Further, rational thinking skills are also advocated.
10 The material is adjusted to what's obtained by way of the sample. However, the teacher
11 reorganized and included the fabric with new articles, instances, and modern-day affairs
12 news. Learning results are evaluated via posttests. The type and design of questions for
13 the post-test is the form of material that has been presented.

14 **2.3 Measurement**

15 Researchers used several instruments we measured: (1) control variables (
16 experience using games pre-test), (2) rational thinking, which is part of the explanation
17 (pre-test and post-test), and (3) learning reflection (post-test only).

18 **2.4 Control variables**

19 The core aspect of the control variable is the final learning value in the material
20 classification material. This value is a good indicator of a person's success in the
21 academic field after learning, as stated (Ishlakhatu Sa'idah, 2020), and therefore,
22 reflects academic skills helpful in learning both in terms of text-based explanation and
23 game-based learning. This should be comparable between the groups. We also
24 measured participants' gender and academic self-concept in physics using a 4-point

1 Likert scale, not good, quite good, sound, and perfect. Examples of socioemotional
2 questions can be seen in **Table 1**.

3 **Table 1. Example of A Mis-understanding Question Using Socio-emotional**
4 **Questions**

5 Participants are generally asked to form groups (mainly consisting of five to
6 seven students in each group) in the first week of the semester. Then, each group listens
7 to instructions for the Monopoly game. Throwing the dice determines the steps given to
8 students to determine the topic they get. Meanwhile, the participants were asked to read
9 other articles via the internet on the topics obtained and then relate them to science
10 concepts.

11 After that, each group presented presentation activities. The group that has
12 already found the concept and presented it correctly will get 10 points as the starting
13 point of the game. With the presentation activity of the Monopoly game, students will
14 know the results and data on the results obtained by students. Presentation activities are
15 activities that are used as a means of sharing knowledge.

16 After the Monopoly game, continue understanding what has been conveyed to
17 answer the questions that will be tested on students as a measurement of students'
18 cognitive abilities. The exam is given via the Quizalize link with multiple-choice
19 questions. Experimental learning lasts for 2 weeks. The process of teaching and learning
20 activities is divided into two components: concept delivery and discussion. These two
21 components cover important things in rational thinking that can ensure learning
22 outcomes from the subject matter. During experimental instruction, a Monopoly game
23 was provided in the classroom to provide an opportunity to understand the description
24 of the Monopoly game. However, this learning-based monopoly game is only

1 implemented according to the needs of each teacher. Students are asked to bring their
2 smartphones to class when entering science lessons. During lessons, all students have
3 their smartphones with internet access. They are permitted to use the instructor's
4 desktop if the Internet is down or when students choose not to use their devices.

5 **2.4 Study Overview, Procedures, and Analysis**

6 This research uses an experimental design. Testing time is limited to 45 minutes.
7 After a brief introduction, the students were assigned to text-based explanation groups
8 and groups using game learning randomly. After that, they were given a pre-test, which
9 included game learning experiences and the ability to reason about material
10 classification. Then, they work with media according to categorized experimental
11 conditions. They take the test individually and are not allowed to surf the internet or use
12 any material other than the media that has been provided.

13 The pre-test and post-test instruments were the same between the two groups,
14 except for the phrasing of some statements in the perceived quality of explanation scale
15 according to the respective medium (e.g., the game was well implemented' versus 'the
16 text was well explained'). Both groups were tested offline in a predefined group-based
17 testing environment. Text-based explanation and game-based learning are embedded in
18 this offline testing environment.

19 Researchers analyzed the learning outcomes of both groups (hypothesis 1 and
20 alternative). Researchers used t-test and one-way ANOVA to compare the results of the
21 pre-test and post-test with the Socio Scientific Issue approach and scores on the rational
22 thinking ability scale. Next, we compared the correlation between declarative
23 knowledge and Misunderstanding scores for each experimental condition to obtain
24 information regarding the question of whether game-based learning can improve

1 rational thinking abilities. If hypothesis 2 is correct, researchers expect significant
2 differences between the experimental conditions regarding the achievement scores they
3 obtain. In addition, we hope that the presence of text-based explanations will not show a
4 correlation with learning based on a mixture of games. Research steps can be seen in
5 **Figure 3.**

6 **Figure 3. Research Procedures**

7 8 3. Results and Discussion

9 **3.1 Results**

10 **3.1.1 Descriptive Statistics**

11 Descriptive statistics of study variables, including control variables, have been
12 used previously. This can be seen in Table 3.

13 **3.1.2 Control Variables**

14 Using the t-test, we found no significant differences between the groups
15 regarding the control variables (Table 3). The results of the t-test based on 2 groups
16 between the control group and the experimental group produced results that were used
17 to determine the power of the sample size that was available, namely ($\chi^2(1) = 0.05$, $p =$
18 0.31), for the pre-test normality test in the experimental class and control class with
19 Monte Carlo measurements as in **Table 2** show that the data used is normally
20 distributed in both the control class and the experiment class.

21 **Graph 1. Anova Pre-test Control Class and Experimental Class**

22 The graph shows the results of the pretest ANOVA showing that ($F(1,54)=4.01$,
23 $f=0.13$); it can be said that there is no significant difference because it is less than
24 because the effect size obtained in the data is less than 0.3 so that in the pretest both

1 control classes nor the experimental class did not show significant differences. It is a
2 prerequisite for comparing groups.

3 **Research question 1: Do mixed game-based explanations improve rational**
4 **thinking abilities compared to text-based explanations?**

5 **Table 2. Descriptive Statistics of Study Variable**

6 **Graph 2. Anova post-test control class and experimental class**

7 The graph shows the results of the pretest ANOVA showing that ($F(1,54)=4.01$,
8 $f=0.38$). With this, it can be said that there is a significant difference between the
9 experimental group and the control group. This is proven if the effect size is more than
10 0.10, then there is a significant difference between the control group and the
11 experimental group. This is in line with hypothesis 1c, namely, by using game-based
12 explanations, students can improve their rational thinking abilities. Apart from that,
13 from the class average, it can also be seen that the average learning outcomes for
14 rational thinking skills are higher than the group that uses text-based explanations.

15 **Research question 2: Does game-mixed learning with the SSI approach lead to**
16 **more misunderstandings than text-based explanations?**

17 **Graph 3. Anova Posttest misunderstanding**

18 The graph shows the results of the ANOVA posttest misunderstanding showing
19 that ($F(1,54)=4.01$, $f=0,03$) it can be said that there is no significant difference because
20 the effect size conventions value obtained in the data is less than 0.3 so that the posttest
21 is good The control class and experimental class did not show significant differences. In
22 other words, the misunderstanding obtained between the control class and the
23 experimental class does not show a significant difference; this follows hypothesis 2b. To
24 gain further insight into how strong the relationship between remembering,

1 communicating, and analyzing is, we conducted a correlational analysis. A positive
2 correlation between actual understanding and understanding beliefs will provide a
3 realistic picture of a person's performance. We did not find a correlation between
4 rational thinking skills and misunderstanding in the post-test (game group: $r = 10.39$, p
5 $= 0.5$; text-based explanation group: $r = 7.88$, $p = 0.17$). (Handl & Kuhlenkasper, 2017)
6 The difference between these correlation coefficients is insignificant ($Z = 1.95$, $p =$
7 0.504). Overall, these results support alternative hypothesis 2c.

8 **3.2 Discussion**

9 We found differences between the groups that used text-based explanations and
10 their text-based explanation regarding their post-test scores on rational thinking skills.
11 This result is in line with alternative hypothesis 1c and shows the difference between
12 previous researchers who only used video-based explanations and game-based
13 explanations. These results indicate significant differences through ANOVA data based
14 on the average posttest results. In other words, apart from just using written-based
15 explanations, you can also use game-based explanations. In this research, game-based
16 explanations are suitable for application in schools. This follows previous research,
17 which applied games but differed in media and time allocation (Anggraini et al., 2021).

18 The results, overall, are consistent with alternative hypothesis 2b. This shows
19 that there are misunderstandings made by students who have carried out treatment in
20 both the control class and the experimental class, resulting in results that are not much
21 different or the difference is not much between the control class and the experimental
22 class. To call this a misunderstanding, we need evidence to identify this result as a false
23 belief. Two arguments support the conclusion of misunderstanding:

1 1. The first argument comes from a theoretical perspective and is related to the study of
2 material classification. From what we know about this, it can be said that both groups
3 will likely require further instruction to understand complex material
4 classifications fully. In science education, it is known that this particular concept is
5 difficult to understand because of the many misunderstandings and because conceptual
6 change is complicated to achieve in this context (Amin, 2019). The time used in one
7 meeting is most likely not enough and not optimal in developing learning, mainly
8 because there is a lack of required reading lists because there is an institution policy not
9 to allow smartphones to be brought. Additionally, as future science educators, we want
10 our students to be critical enough of themselves to remain open to further teaching. It is
11 very likely that between the control class and the experimental class if they require
12 further instruction, the class that requires further understanding is the class that
13 experiences misunderstanding. For example, in text-based explanations, although in
14 terms of material, it represents the entirety of the material, in terms of images, we
15 cannot yet understand whether the images are related to material classification or not, so
16 it does not rule out the possibility that classes that use text-based explanations require
17 further understanding of material classification.

18 2. The second argument comes from an empirical point of view. First, Anova of
19 the knowledge-adjusted misunderstanding scale in the post-test showed significantly
20 higher comprehension confidence in the text-based explanation group. Additionally,
21 both groups scored between 72% and 73% (no ceiling effect) on a test of rational
22 thinking skills designed only for students with low content knowledge. Yet both groups
23 were very positive about their understanding. This shows a misunderstanding.
24 Additionally, correlational analysis showed no relationship between test performance at

1 post-test and comprehension confidence in both groups. This supports the assumption
2 that neither group does not have a realistic understanding, but both have a
3 misunderstanding.

4 In summary, we would like to reiterate that neither group performed well in
5 actual learning, but the text-based explanation group performed poorly.

6 Based on these two arguments, we posit that both groups have
7 misunderstandings, but the text-based explanation group has a higher level of
8 misunderstanding. The text-based explanation medium (which looks like a textbook
9 entry) is the most likely reason, and the time used is not long enough, so there is still
10 misunderstanding, but not the only reason for this ('study limitations').

11 **4. Conclusion**

12 Overall, our research shows that game-based skills are superior to text-based
13 explanations in terms of rational thinking ability based on the data above. However, in a
14 misunderstanding between text-based and game-based explanations, there is no
15 significant difference because there is a less significant difference. After all, the
16 difference between the misunderstanding of text-based and game-based explanations is
17 slightly 1, but in game-based explanations, the misunderstanding value is slightly
18 higher. Superior to the value of text-based explanations. This does not rule out the
19 possibility that using learning media with games or text-based explanations is more
20 reliable regarding the ability to reason and reduce misunderstanding based on the data
21 obtained.

22 **Study Implications**

1 First of all, our consequences support growth in studying outcomes with
2 rational questioning abilities which, commonly acquired by using students among
3 recreation-primarily based causes are superior to text-facts-based causes.

4 We see no reason that textual content-based textbook factors must no longer stay
5 a part of technological know-how teaching. moreover, we argue that our consequences
6 spotlight the ability dangers of leaving establishments to their very own gadgets with
7 game-based or written-based explanations. each corporation confirmed signs and
8 symptoms of misunderstanding- ing. previous studies also show that studying with
9 explanations, in popularity, is only successful if the explanations are nicely embedded
10 in ongoing cognitive sports together with studying tasks (Wittwer et al., 2008). Possibly
11 running with studying tasks enables a person to better determine their overall
12 performance. therefore, the use of mastering responsibilities primarily based on the
13 content of educational reasons can serve as a countermeasure to the effect of text-based
14 total motives on misunderstanding.

15 Further research is needed to increase learning insight through explanations
16 using different media. However, we would reiterate that misunderstanding- ing has
17 potentially dangerous consequences for science learning (Acuña et al., 2011;
18 Kulgemeyer et al., 2022) if college students agree that they have fully understood a
19 subject, they'll resist in addition teaching, bearing in mind it is redundant and irrelevant.
20 In this way, they end up less cognitively energetic (a middle measurement of the
21 excellence of learning in technology). additionally, if they ought to choose in addition
22 coaching fabric (e.g., in unbiased studying), they may forestall as soon as they're
23 assured in their knowledge, and this can be authentic for each written and sport-
24 primarily based cause. This underlines that science coaching does not forestall

1 supplying reasons in a particular medium; similarly studying tasks are had to make
2 students aware of what they do not yet understand. further studies are needed to
3 discover the results of false impressions.

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9

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20

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23 **Notes**

1 Any additional relevant notes should be placed here.

2 Abbreviations

3 SSI, Socio-scientific Issue; Sig,Signifikansi; Anova, Analysis of Variance; F,Anova;
4 Asymp.Sig, Asymptotic Significance; Std.Deviation, Standart Deviation; SWT,
5 Subhanahu Wa Ta'ala; SMP/MTs, Junior High School; N,Number of Sampel;
6 Pre, Pretest; Post,postest; Exp,Experiment; Con, Control; p, effect size;
7 M,Mean.

9 Table Lists

10 **Table 1.**Example of A Mis-understanding Question Using Socio-emotional Questions

| |
|---|
| On Monday, Rama found trash scattered around. This waste is heterogeneous because it is mixed with other materials. He remembered that cleanliness is part of faith. The action that Rama should have taken was.... |
|---|

| |
|--|
| Dispose of rubbish according to the type of rubbish in the rubbish bin |
|--|

| |
|--|
| Dispose of rubbish properly in the rubbish bin |
|--|

| |
|--|
| Collect rubbish and then throw it in the trash |
|--|

| |
|---|
| Collect the rubbish, then sort it and throw it in the rubbish bin |
|---|

11 **Table 2. Descriptive Statistics of Study Variables.**

| | Game Class M(SD) | Text Class M(SD) | Range |
|----------------------------------|---------------------------------|---------------------------------|--------------|
| Rational Thinking Ability (Pre) | 0.42 (0.12) | 0.45 (0.10) | 0-1 |
| Rational Thinking Ability (Post) | 0.80 (0.07) | 0.73 (0.13) | 0-1 |
| Misunderstanding | 0.73 (0.13) | 0.72 (0.14) | 0-1 |
| Experience to use game education | 0.81 (0.14) | 0.80 (0.24) | 0-1 |

12 **Table 3.**Shows a comparison of these scales. Learning gains (ANOVA of post-test
13 results adjusted for pre-test scores) showed a difference ($F(1,54) = 1.09, p = 0.03$) This
14 result is in line with alternative hypothesis 1c

16 Figure Lists

SSI MONOPOLY GAME GAME INSTRUCTIONS MATERIAL CLASSIFICATION

- The game is played by a maximum of 4 people (1 person represents the group)
- The first, second, third and fourth players are determined by throwing the most dice
- The player who gets the most dice goes first, followed by the second, third and fourth players
- If the player is placed in a picture, the player and the group will discuss the picture and then present it in front of the class after the game is finished.
- If the player is placed in the question mark box, he will take a card in the middle of the monopoly which contains a quiz and must be answered directly. If the player is unable to answer correctly, the player will be punished according to the agreement of all players.
- The player who gets out first will get 20 points as the initial score, if at the end he gets a score of 5
- Players who can answer the quiz correctly will get 20 points
- Players who get more than 1 quiz will get an additional 5 points
- Players who can present an image and match the criteria will get 20 points
- Players who get more than 1 picture will get an additional 10 for each picture

1
2

Figure 1. Instructions for using the SSI Monopoly game



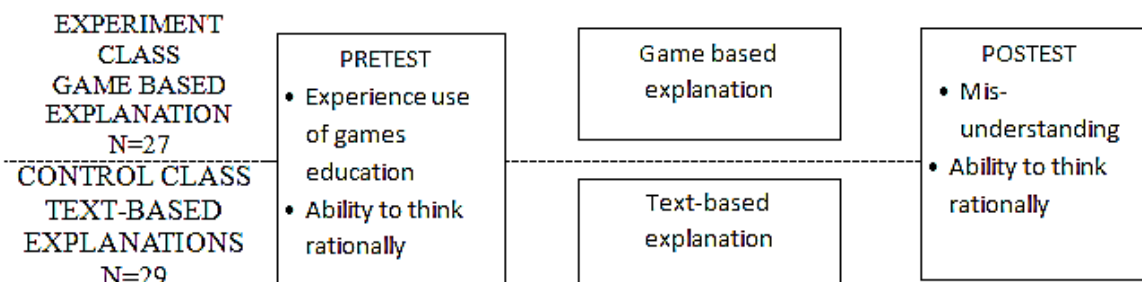
3
4

a. Monopoly game education

b. game blokerz education

5
6

Figure 2. A game-based explanation that mixes games between monopoly and blokerz (digital games)

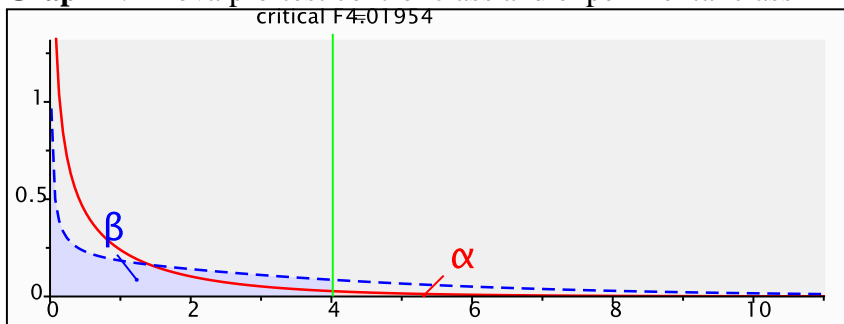


7
8

Figure 3. Research procedures

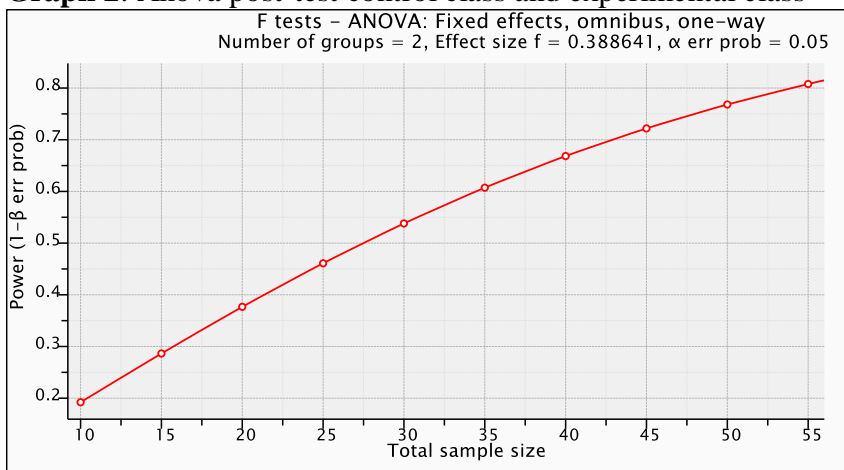
1 **Graph list**

2 **Graph 1. Anova pre-test control class and experimental class**



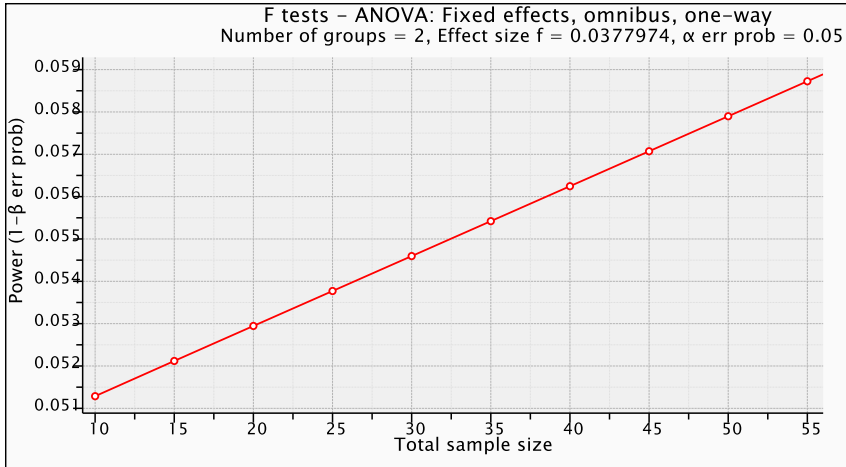
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4 **Graph 2. Anova post-test control class and experimental class**



5

6 **Graph 3. Anova Posttest mis-understanding**



1

2 **Graphical Abstract**

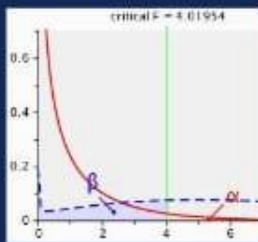
EXPLORING THE INFLUENCE OF SCIENCE LESSONS THROUGH TEXT-BASED EXPLANATIONS AND GAME-BASED EXPLANATIONS MIXED WITH A SOCIO-SCIENTIFIC APPROACH ON ISSUES ON RATIONAL THINKING ABILITY AND MIS-UNDERSTANDING



The aim of this research is to determine the effect of comparing learning outcomes with rational thinking abilities between text-based explanations or game-based explanations



This research uses G*power to process statistical data. Method to do this research is quantitative with kind research quasi-experiment.



The research results obtained show that there is a significant difference between text-based explanations and game-based explanations on rational thinking abilities. Meanwhile, there was no significant difference in mis-understanding, but based on the average mis-understanding test score, the mis-understanding score obtained by the game-based explanation group was higher than the text-based explanation. So it can be concluded that game-based explanations are appropriate to use as a teaching method for teachers to their students.

Highlight

- Game-based explanations can improve rational thinking skills because the posttest scores obtained are superior to text-based explanations
- In text-based explanations, the rational thinking skills are lower because, in this explanation, students are considered to talk more because they tend to get bored.
- The misunderstanding abilities obtained by students who took part in game-based explanations were, on average, slightly superior to students who took part in text-based explanations. However, there is no significant difference because the averages obtained in the misunderstanding test are slightly different.

Associated Content

Link Blokerz : <https://blockerzz.quizalize.com/player?quiz=ad9a5eee-e006-48d0-807e-9bf33117d87e&quizMode=standard&option=4>

1 In this digital game, students must be able to shoot arrow targets. The more targets they
2 shoot, the more points they collect. If you cannot shoot at a certain time, you
3 have to answer questions to be able to shoot. This game is considered
4 entertaining because apart from remembering the understanding that has been
5 learned, students can also be entertained by this game.

6 Link Booklet :

7 <https://drive.google.com/file/d/1qTDMYIMnnTFfb1JSG1ecAMinbdq2NPoA/view?usp=drivesdk>
8

9 This book explains the material completely and is presented in an interesting way. This
10 booklet belongs to Linda Prasata, which is an assignment for a basic biology
11 concepts course that has been validated by the lecturer and has gone through
12 several revisions. This booklet has explained the classification of material
13 clearly so that it is hoped that students will be interested in reading it.