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COGNITIVE STRATEGIES FOR CRITICAL THINKING IN HIGH SCHOOL STUDENTS' ARGUMENTATIVE WRITING

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Abstract
This study aimed to examine the cognitive strategies of critical thinking in high school students' argumentative writing. Despite extensive research on critical thinking and argumentative writing, there is a lack of in-depth analysis of the specific cognitive strategies employed by high school students in their argumentative essays. Using a case study approach, data from 120 students at SMAN 2 Wonosari were collected through document analysis. Four findings related to the cognitive strategy of critical thinking were obtained in this study. (1) Interpretation is realised through the author's point of view and the formation of definitions, with positions expressed as either opposition or support. (2) The analysis was conducted by identifying the components and structure of arguments, where components included premises and conclusions, and structures were categorised as simple or complex arguments. (3) Inference is achieved through deductive and inductive reasoning. Deductive reasoning follows general patterns, such as chained arguments, modus ponens, and modus tollens, whereas inductive reasoning involves generalisation and causality. (4) The evaluation focuses on accuracy and logical correctness, with accuracy determined by the truth of the premises and logical correctness assessed through valid and strong arguments. The findings serve as a crucial resource for educators and students to enhance critical thinking skills in academic writing, potentially leading to improved teaching methods and student performance in argumentative essay writing.

Keywords: argumentation, cognitive strategy, critical thinking

Introduction
Critical thinking is considered an essential skill in the 21st century and a crucial component of school education. Several countries, including the United States, Australia, Germany, and Asian countries, have incorporated critical thinking into their school curricula (Aycicek, 2021; Dong et al., 2023; Murphy et al., 2024; Wang & Wu, 2023). Critical thinking is not only about thinking clearly, logically, and rationally, but also about thinking independently (Aycicek, 2021). Critical thinking encourages students to question assumptions, recognise biases, and

understand issues thoroughly, leading to more effective problem solving and decision making (Gonzalez et al., 2022; Spector & Ma, 2019). Critical thinking enables students to navigate vast amounts of available data and distinguish credible information from misinformation (Caled & Silva, 2022; Puig et al., 2021). Furthermore, critical thinking will foster someone's ability to analyse complex problems, make well-informed decisions, and develop innovative solutions. Thus, critical thinking contributes positively to personal and professional growth and academic success (Ku, 2009; Kusumo, 2022).

Students with strong critical thinking skills tend to exhibit different behaviours than those with weaker critical thinking abilities. Those with strong critical thinking skills are likely to be more engaged in learning and to achieve better academic performance (Almulla, 2023). In contrast, students with lower critical thinking skills lack a deep understanding and critical evaluation of certain issues. In the context of learning, they tend to be passive, resulting in less effective learning strategies and lower academic achievement (Dwyer et al., 2014). Consequently, students with high critical thinking skills are more adaptable to various complex challenges than those with lower critical thinking skills (Encabo-Fernández et al., 2023).

Critical thinking and argumentative writing are closely linked, supporting and enhancing each other. Argumentation can encourage critical thinking and the development of conceptual knowledge (Liu et al., 2024). Argumentative writing is a more complex process than simply composing words, phrases, and sentences. It requires a deep understanding of the topic, development of an argument, organisation of a coherent discourse, and conveying ideas in written form. Critical thinking establishes the basis for effective reasoning in argumentative writing. Critical thinking ensures that arguments are grounded in logical examination and trustworthy evidence (Demircioglu et al., 2023). In the educational context, student engagement in evaluating arguments and counterarguments helps students improve their critical thinking skills to produce sound decisions and reasonable arguments. For instance, Simonovic et al. (2023) found that strong argumentation is a factor in dismissing incorrect responses due to certain beliefs, which is part of critical thinking.

Critical thinking is based on cognitive theory. Cottrell (2005) and Park et al. (2023) defined critical thinking as the use of suitable cognitive skills that can raise the potential for achieving a good outcome. The cognitive process allows students to store and retrieve the information necessary for analysing and synthesising new knowledge (Brehmer et al., 2012). thus, Critical thinking actually tries to look at how people remember things, keep track of what they are thinking, and use logic to solve complex problems (Halpern, 2003). Therefore, this emphasis on cognitive processes helps us understand how people learn and use information more effectively, providing them with the skills they need to make good choices and evaluate information critically (Kusumo, 2022).

Many studies have explored argumentative writing skills and critical thinking, but very few have focused on how students apply cognitive strategies when engaging in critical thinking. For instance, existing research tends to focus on the product of argumentative writing, assessing the quality of arguments or the presence of critical thinking indicators (Christodoulou & Diakidoy, 2020; Preiss et al., 2013; Yin et al., 2023). However, there is a significant gap in understanding the

cognitive strategies students use when writing arguments. The mental processes underlying these outcomes (the "hidden" cognitive strategies) that students use when researching, planning, constructing, and revising their arguments have received less attention. Further investigation into the cognitive strategies of critical thinking that students use when writing arguments will be an important topic for discussion (Demircioglu et al., 2023; Shehab & Nussbaum, 2015). Based on this understanding, this research focuses on the cognitive strategies of critical thinking in writing argumentation.

A deeper understanding of the cognitive strategies used in argumentative writing can lead to the development of better teaching methods and educational resources. These resources would enhance students' critical thinking skills by providing structured support and guidance throughout the writing process. By focusing on specific cognitive strategies, educators can help students develop stronger arguments, better organize their ideas, and critically evaluate evidence (Kusumo, 2022).

Critical thinking

Critical thinking refers to phenomena related to individual characteristics, personality traits, or habits of mind (Pu et al., 2019). Most intellectual activities involving students learning to identify or create an argument, use evidence in support of that argument, draw reasoned conclusions, and apply information to solve issues revolve around critical thinking. Examples of critical thinking skills include interpreting, analysing, evaluating, explaining, sequencing, reasoning, comparing, questioning, inferring, hypothesising, appraising, testing, and generalising (Facione, 2015; Fahim & Eslamdoost, 2014). Thus, critical thinking represents higher-order thinking skills, such as analysis, evaluation, and creation, as outlined in Bloom's Revised Taxonomy (Moghadam et al., 2023). These skills are essential for processing complex information, making reasoned judgments, and generating innovative solutions to problems.

Critical thinking has been seen as a skill that is related to cognition. A simple view of critical thinking is expressed by Bloom et al. (2001), who define critical thinking as a cognitive form. Sternberg and Halpern (2020) viewed critical thinking as a cognitive process that involves understanding and analysing arguments. Facione (2011) articulated the same idea that critical thinking involves accurately evaluating a statement. According to some of these opinions, some experts initially defined critical thinking as a mechanical skill that a person needs to master. This mechanical skill can be learned by students and involves the intellectual activity of identifying, analysing, and evaluating arguments and propositions (Andrews, 2015; Fisher, 2011). Therefore, critical thinking is closely related to logic and the cognitive domain (Davies, 2015).

Cognitive strategies in critical thinking

The cognitive dimension underlies the critical-thinking process. Therefore, cognitive psychologists have attempted to describe some forms of cognitive skills responsible for one's ability to think critically. This set of abilities arises from critical thinking and is considered to represent critical thinking that exists in a person (Lai, 2011). Hence, Facione (2011) suggests that critical thinking consists

of several "core" skills related to cognitive skills, such as interpretation, analysis, inference, and evaluation.

Interpretation is an attempt to present information using various strategies so that others can appropriately translate it (Ruth & Murphy, 1984). Interpretation allows two or more people who do not share the same thoughts or language to engage in communicative interactions (Roberson, 2018). Providing a clear point of view and defining terms used in argumentative writing can facilitate interpretation (Facione, 2015). Readers will better understand the author's information if they understand these two aspects well.

Analysis is an attempt to break down information or a thing into smaller parts and understand their relationships with one another (Barnet & Bedau, 2011; Hidayah et al., 2017). Therefore, argument analysis can be done by showing the argument structure and its parts (Facione, 2015; Halpern, 2003). To show the anatomy of an argument, one must break it down into its components (premises and conclusions) and see how each component relates to the other.

In critical thinking, inference can be defined as a "movement" towards a conclusion from a premise (Butterworth & Thwaites, 2013; Fisher, 2011). In other words, inference is the process of drawing conclusions based on one or more premises. This shows that in critical thinking, conclusions can be obtained logically and reasonably by referring to the premises given previously (Paul & Elder, 2014). Bassham et al. (2011) point out two inference patterns that can be used in arguments: deductive and inductive.

Evaluation is a judgment process based on specific standards or criteria (Bloom et al., 2001). In addition, someone can think critically about all things that make sense to be evaluated. Reasoning plays an important role in forming opinions, judgments, and inferences when writing. Thus, Moore and Parker (2021) considered critical thinking to be an analysis of reasoning. Some consider whether the reasoning meets the requirements of common sense and logic. Therefore, logical correctness and accuracy are two features that must be considered in the evaluation (Kelley, 2014; Moore & Parker, 2021).

Argumentative writing

Argumentation is related to critical thinking. Cottrell (2005) revealed that the focus of critical thinking is on arguments. Arguments are present in the context of disagreement, and people try to resolve them rationally (Govier, 2014). Arguments can be viewed as complex symbolic structures in which some parts present reasons and evidence (premises) that support conclusions, while others present the conclusions (Hasnunidah et al., 2019). Arguments can also be considered complex speech acts that contain one or more acts of premise (propositions supporting the conclusion), acts of inference, and explicit or implicit markers to indicate the conclusion that follows from the premise (Hitchcock, 2007).

Arguments are often exchanged in communication practices. Any argument in communication can be assumed to be put forward by one person to another and is intended to be accepted (Besnard & Hunter, 2008). The term "argumentation" is often used in this process. The exchange of arguments can be done in writing as well. Argumentation writing is a well-known phenomenon in the exchange of arguments. The form of argumentation writing initially stems from the response or anticipation of a difference of opinion occurring in reality or the imagination. There

are two parties with an opinion, and the other party doubts the opinion (Besnard & Hunter, 2008; Eemeren et al., 2014). Argumentative writing is a form of communication in which one writes and exchanges reasons to defend or oppose a point of view in doubt or disagreement (Lewiński & Mohammed, 2016). Therefore, arguments are more concerned with the structure of premises and conclusions, whereas argumentation is concerned with human practices and actions. In other words, arguments occur as communicative acts.

Method

This study employed a case study to investigate the cognitive strategies of critical thinking in high school students' argumentative writing. The case study method was chosen for its ability to provide an in-depth exploration of the cognitive strategies of critical thinking within specific groups and contexts. By focusing on a group of high school students at SMA N 2 Wonosari in their authentic educational context, this study gathered rich and detailed insights into how cognitive strategies of critical thinking were developed and applied in argumentative writing tasks. This method facilitated the examination of students' written outputs, which were then used to identify, classify, describe, and explain the unique cognitive strategies of critical thinking employed by the students at SMA N 2 Wonosari.

Participants

This study involved 120 third-year students in their third year at SMA N 2 Wonosari, located in Gunung Kidul Regency, Special Region of Yogyakarta. All participants voluntarily agreed to participate in the study after being informed of its purpose and procedure. Participants were assured that their personal information and responses would remain confidential. They were also informed that they could withdraw from the study at any time without penalty. Students were selected based on two factors: cognitive readiness for critical thinking and readiness for argumentative writing. Third-year high school students, typically aged 17-19, were chosen as they were expected to have developed higher-level thinking abilities, including critical thinking skills. Additionally, argumentative writing is a competency that high school students are expected to have mastered according to the curriculum.

Research data

The research data consisted of units of ideas present in sentences, sentence clusters, paragraphs, paragraph clusters, and complete texts. This data was obtained from students through argumentative writing, which resulted from the assignments given to the participants. The data collected in this study were used to describe the cognitive strategies employed by high school students in critical thinking.

Data collection and instrument

In this study, document analysis was used to collect data, specifically through tasks focused on argumentative writing completed by participants. This data collection can provide a comprehensive understanding of the cognitive strategies used by participants in critical thinking to formulate their arguments. In addition, the interpretation, judgment, and contextual awareness of the researcher are crucial components that significantly enhance the depth of data understanding and

interpretation. By acting as a human instrument, the researcher applied a critical thinking perspective to analyse the data using the indicators established by Cottrell (2005) and Facione (2011), as outlined in Table 1. Integrating Cottrell and Facione's perspectives offers a holistic approach to argumentative writing and critical thinking. Cottrell's framework provides a structural foundation for constructing logical arguments, presenting evidence effectively, and analysing information systematically. Facione's core cognitive skills complement this by emphasising the mental processes essential for critical thinking, such as interpretation, analysis, evaluation, inference, explanation, and self-regulation. This approach provides a deeper analysis and more accurate insights because the researcher uses their expertise to interpret the data within its specific context.

Table 1 Indicator and sub-indicator of cognitive strategies in critical thinking

Research focus	Indicator	Subindicator
Cognitive strategies for critical thinking in argumentative writing	Expressing meaning in argumentative writing (Interpreting)	Adopting a clear position from a specific viewpoint (the author's perspective)
		Determining appropriate definitions in argumentative writing (definition formulation)
	Demonstrating inferential relationships between statements and ideas in argumentative writing (Analyzing)	Identifying premises and conclusions in argumentative writing (argument components)
		Presenting the structure of arguments in argumentative writing (argument structure)
	Drawing a reasonable conclusion based on strong evidence (Inference)	Applying patterns of inference in argumentative writing (inference patterns)
	Demonstrating the credibility and logical strength of inferential relationships in argumentative writing (Evaluating)	Using Accurate Reasons (Accuracy)
		Demonstrating a valid or strong form of argument (logical validity)

Data analysis

The data for this study were derived from students' argumentative writing tasks, which served as the basis for analysing cognitive strategies in critical thinking. The data analysis process involved three stages: data reduction, data presentation, and drawing conclusions. In the first stage, data reduction was conducted by carefully reading the students' written outputs to identify relevant information. This involved selecting, classifying, and codifying data related to the cognitive strategies used in formulating arguments. The codes were created based on the sequence of the text, paragraph number, and sentence number, with each component separated by a period. For example, the code A1.1.2 indicates the first text, first paragraph, and second sentence. The second stage focused on presenting the reduced data in a

structured and systematic manner. Specific methods used for data presentation included selecting representative quotations from students' writing to illustrate key points, and using visual aids. Finally, conclusions were drawn by interpreting the data to uncover patterns and insights into students' cognitive strategies. To ensure the accuracy and relevance of the findings, expert triangulation was performed by involving lecturers to review the data. These experts provided feedback and verified the findings, and the corrected data, incorporating their insights, were used to finalise the conclusions, offering valuable insights into how students applied cognitive strategies during critical thinking processes in argumentative writing.

Findings and Discussion

The cognitive strategies of critical thinking are interpretation, analysis, inference, and evaluation. The four forms of critical thinking cognitive strategies are described below.

The **first** strategy is **interpretation**. Interpretation involves clarifying ideas and meanings, which can be done by examining the author's point of view and the definitions formed by the participants (Facione, 2011). The author's point of view is the author's position on the issue presented. The author can position themselves as either opposing or supporting an issue. In arguments, a writer can present various pieces of information, but the position displayed may be unclear. This vagueness makes it difficult for readers to understand what the writer wants to convey and to follow the entire argument (Butterworth & Thwaites, 2013; Cottrell, 2005). The results showed that the participants demonstrated clarity in their position. The participants displayed two positions in their writings: opposition to and support for a problem.

1. *I **disagree** and believe that bullying is wrong and should be eliminated from school life. Bullying will result in physical or mental harm* (A67.1.1-2)

The verbal phrase *disagree* shows the author's point of view on bullying in schools. The sentence provides information that bullying is an act that should be avoided because it has many negative impacts on others, such as physical or mental injury. This indicates the participants' point of view opposing bullying in schools.

2. *Online teaching **should not be implemented** in schools. There are many obstacles encountered by students and teachers*. (A36.1.1-2)

The verbal phrase *should not be implemented* shows the author's point of view on "online earning". The sentence provides information that online learning will raise many issues. This indicates the participants' point of view, which is against online learning in schools.

Negation is the action of denying something (Syafar, 2016). As a means to deny something, the presence of a negative constituent in a sentence changes its meaning of the original sentence. The change in meaning due to the presence of negative constituents has significant effects. This can mean cancellation, denial, or negation (Ćoso & Bogunović, 2016; Darley et al., 2020). In this study, the participants displayed the negation form by using negative phrases (disagree, should not be implemented) in the predicate position. In addition, the negation

forms tend to be displayed explicitly. Expressing the explicit form of negation is easier than expressing the implicit form (Hu et al., 2018).

3. *Uniforms **are required** for all students, including high school students. As we know, uniforms can be used as a level differentiator for each student*. (A30.2.1-2)

The verbal word *are required* shows the author's point of view on the theme of "the use of uniforms in schools". The constituent provided information that the use of uniforms will show equality at school and bring confidence to students. This shows the point of view of the participants, who agree with the use of uniforms in schools.

4. *A large circle of social media users are teenagers, including high school students. The use of social media **can positively impact** various aspects of life.* (A33.1.2-3).

The verbal phrase *can positively impact* shows the author's point of view on the theme "media social in school". The constituent provides information that the use of uniforms tends to have a positive impact on students' behaviour. This shows the point of view of the participant, who agrees with the use of uniforms.

The position of supporting the participants' writing was achieved through paraphrasing. Affirmation is an action that supports or approves something given (Christensen, 2009). Thus, affirmation constituents in a sentence change the meaning of the sentence into a form of approval, support, or reinforcement. Furthermore, this affirmation is realised through affirmative sentences. In this study, the participants displayed affirmative sentences using phrases or words with affirmative meanings. These phrases or words are placed in the predicate position of the sentence. In addition, affirmation tends to be explicit. When making sentences, something explicit tends to be easier to understand and does not lead to multiple interpretations (Post & Bergsma, 2013).

The next interpretation is "definition formulation." Precise and accurate language definitions often determine the confidence in an argument. Poorly defined terms result in ambiguities (Lyons, 2010; Moore & Parker, 2021). Vagueness and ambiguity can impact the misinformation received. In this study, the participants performed definition formulation in an analytic form. An analytic definition is achieved by determining the features that something must have so that the defined term can be applied (Moore & Parker, 2021). This definitional process involves referencing the context in which the term is used and distinguishing it from other similar entities. Furthermore, this type of definition tends to be subjective because the definitions are produced by internalising participants' independent thinking.

5. ***Bullying** is the act of intimidation and coercion of a weaker individual or group to do things against their will and for the purpose of physical, mental, or emotional harm. A culture of bullying is particularly harmful to children's development*. (A25.1.1-2)

The definition of the word *bullying* describes the constituent *the act of intimidation and coercion of a weaker individual or group to do things against their*

will and for the purpose of physical, mental, or emotional harm. The constituent are the elements that more specifically describe the meaning of bullying. Furthermore, the term *is* is used as a marker of a definition with the defined term.

Definition formulation can also be accomplished through synonyms. This approach involves presenting other words or phrases that have approximately the same meaning as the defined term (Petcharat & Phoocharoensil, 2017). The participants revealed that this method is an easy way to form a definition. This involves looking at the lemma found in the dictionary. The process was practical and did not require a lengthy thought process (Bassham et al., 2011).

6. *Online learning is often referred to as **distance learning***. (A76.1.2)

The constituent of *distance learning* is shown to define the term *online learning* in a different form. the term *online learning* and *distance learning* also shows a similarity in meaning. Furthermore, constituents *is often referred* used as markers of a definition for what is being defined.

Definition formulation can also be accomplished using examples. This method involves pointing out, naming, or describing one or more examples of the type to which the term applies (Moore & Parker, 2021). This type of definition is used to simplify terms that are difficult to define verbally because the words are challenging to understand or the nature of the term is unfamiliar. This is done by pointing to, holding, or naming an object that serves as an example.

7. *Not all students have adequate electronic devices, such as **cellphones, laptops, and computers**, that can be used for online learning*. (A81.2.1)

Nouns such as *cellphones*, *laptops*, and *computer* are examples that can define the term *electronic devices*. Electronic devices are defined as equipment that has an electrical power source and is often used in online learning. Furthermore, the word *such as* is used as a marker to define what is being defined.

The **second** strategy is **analysis**. Analysis is an effort carried out by someone to observe something in detail. This detailed observation involves breaking things down into smaller parts and examining the relationships between these parts (Jackson & Newberry, 2016). Technically, arguments contain two main elements: premises and conclusions. In some cases, certain propositions need to be proven true. The propositions that need to be proven are called the conclusions. The evidence, in the form of another proposition, that supports the conclusion is often referred to as the premise. In other words, premises in an argument provide support for a conclusion, making it more credible (Kelley, 2014). Thus, the premises and conclusions of an argument are related to one another. This relationship is evident in the structure of their arguments.

Based on the results of the study, the participants displayed the elements and components of argument formation in their argument writing. The components of an argument are its premises and conclusions. In students' writing, premises and conclusions are realised in two ways: (1) explicitly, using numeral words, connecting words, or connecting phrases, and (2) implicitly, by utilising the meaning of the ideas contained in the propositions that appear in the argument. This

is consistent with Green's (2017) view that premises and conclusions are likely to be present explicitly or implicitly in an argument.

> 8. *Wearing uniforms has many positive effects.* ***First****, the gap between students is not visible at school … Then, the* ***second*** *effect is to increase student discipline ... The* ***third*** *is to show the identity of the school.* ***Therefore****, the use of uniforms in schools should be continuously implemented because it has a positive influence on students' social lives.* (A84.2.1-6)

Quotation 8 contains markers in numerals, namely *first, second, and third*, to indicate the presence of premises in the quotation. The participants used these numerals to establish coherence between the premises and support the conclusion. Furthermore, Quotation 8 also presents a conclusion, indicated by the use of a connective word. The conjunction *therefore* serves as an indicator of the conclusion within the quotation. The participants used this conjunction to build coherence between the premise and conclusion.

> 9. *Bullying can be* ***caused by*** *students wanting to be noticed by their friends.* ***In addition****, it can also be caused by encouragement from the surrounding environment, which is accustomed to bullying.* ***Thus****, students become eager to bully their friends* (A32.2.2-4)

Quotation 9 contains the markers *caused by* and *in addition*. These markers indicate the presence of premises. The participants used these phrases and conjunctions to establish coherence between the premises and support the conclusion. Furthermore, quotation 9 also presents a conclusion, as indicated by the use of a conjunction. The conjunction *thus* serves as an indicator of the conclusion within the quotation. The participants used this conjunction as a coherence builder between the premises and the conclusion.

> 10. *Online learning has a positive impact on students.* ***Students have plenty of time to learn other things*** *…* ***Online learning has also brought students closer to their families.*** *... The existence of this* ***online mode has a positive effect*** *by allowing students to learn many things while staying close to their families* (A53.2.1.6)

The constituents *Students have plenty of time to learn other things* and *Online learning has also brought students closer to their families* provide descriptions that can serve as evidence or reasons supporting the positive aspects of online learning in schools. All the evidence or reasons presented in the excerpt support the conclusion *online mode has a positive effect*. Therefore, this sentence can be considered the conclusion of the quotation.

To analyse the relationship between premises and conclusions, the researcher categorised the participants writing into two forms of argument. The argument structures observed in participants' argumentation writing are classified as simple and complex (Butterworth & Thwaites, 2013). Simple argument structures feature a single conclusion supported by one or more premises. In contrast, complex argument structures involve multiple conclusions that are supported by various premises. Additionally, the premises displayed by the participants could be

independent or interrelated in supporting a conclusion. Independent premises support a conclusion when each premise holds equal strength; an error in one premise does not undermine support for the conclusion. In contrast, interrelated premises mean that if one premise is incorrect or missing, the support for the conclusion may weaken or even disappear entirely (Bassham et al., 2011).

11. Premise 1 (P1) : *The use of uniforms strengthens relationships between students.*
    Premise 2 (P2) : *The use of uniforms reduces social status inequality in schools.*
    Premise 3 (P3) : *The use of uniforms increases student discipline.*
    Conclusion (C) : *The use of school uniforms can solve the problem of bad behavior among high school students.* (A100.2-3)

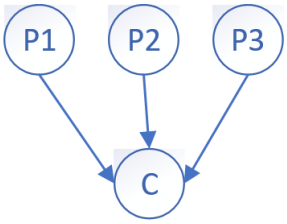

Figure 1. Simple argument structure

Quotation 11 shows three premises supporting the conclusion. This is illustrated by the structure, which displays three arrows from each premise (P) leading to one conclusion (C). In this quotation, Premise 1 (P1), Premise 2 (P2), and Premise 3 (P3) provide independent support or reasoning for the conclusion (C). Specifically, the three premises (P1, P2, and P3) each have the capacity to support their own conclusions. Thus, this form of argument exemplifies a simple argument structure with premises that offer independent support for a single conclusion.

12. Premise 1 (P1) : *Internet is not yet available in all parts of Indonesia*
    Premise 2 (P2) : *Internet subscription price is still quite expensive.*
    Minor Conclusion (MC) : *The Internet is not utilised evenly.*
    Premise 3 (P3) : *Students are less interested in online learning*
    Conclusion (C) : *Online learning still cannot run well* (A60.3-5)

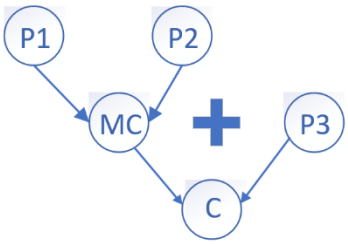

Figure 2. Complex argument structure

Quotation 1.12 shows the presence of two premises that support one minor conclusion and one premise, along with a minor conclusion that together support one major conclusion. This is illustrated by the structure, which displays two arrows

from Premise 1 (P1) and Premise 2 (P2) supporting a minor conclusion, and two arrows from the minor conclusion (CM) and Premise 3 (P3) supporting the major conclusion. The support for conclusions can be either interdependent, indicated by the + sign, or independent. Thus, this form of argument exemplifies a complex argument structure by combining two types of premises—independent and interdependent—to support two types of conclusions: minor and major.

The **third** strategy is **inference.** The conclusions are the products of inference. Some experts divide inference into two patterns: deductive and inductive (Bassham et al., 2011; Kelley, 2014). Based on the data analysis, the participants made inferences using both deductive and inductive patterns. A deductive pattern is a form of inference in which the premises logically support a conclusion in a strict manner (Douven, 2017). In contrast, an inductive pattern is a form of inference in which the premises support a conclusion in a less strict manner (Rainbolt & Dwyer, 2015).

In more detail, Bassham et al. (2011) revealed that deductive and inductive forms can be distinguished by examining the general patterns that appear in an argument. The analysis of the research data shows the existence of three general patterns characteristic of the deductive form: chain argument, modus ponens, and modus tollens. These patterns illustrate that the premises provide strict and logical support for the inference process. Additionally, the research data reveal two general patterns characteristic of the inductive form: generalisation and causality. These patterns indicate that the conclusions produced are more likely to be possibilities rather than being certain.

13. Premise 1 : *If students are bullied, their mental will be disturbed.*
    Premise 2 : *If a student's mental is disturbed, the student cannot follow the lesson well.*
    Conclusion : *If students are bullied, they cannot follow lessons well.*
    (A83.1.2-4)

Quotation 13 shows a chain argument pattern. This can be seen from the existence of premises and conclusions that are conditional statements, all of which are related. This relationship is evident from each proposition functioning as an antecedent (condition) for the next proposition, and the consequent (result) of one proposition serving as the antecedent for the subsequent proposition. Premise 1, premise 2, and conclusion in quotation 13 show a relationship of the following form.

Premis 1: If A so B
Premis 2: If B so C
Conclusion: If A so C

14. Premise 1 :*If the internet network is poor, then online learning conducted at school cannot run optimally.*
    Premise 2 :*Internet networks in schools often experience problems.*
    Conclusion :*Therefore, online learning at school does not run optimally*
    (A13.4.4-7)

Quotation 14 shows a modus ponens pattern. This is evident from the premise that presents a conditional statement form, a premise that asserts that the antecedent

of the previous premise is true, and a conclusion that asserts that the consequent is true. Premise 1, premise 2, and conclusion in quotation 14 show a relationship of the following form.

Premise 1: If A so B
Premise 2: A
Conclusion: Therefore, B

15. Premise 1 : *If high school students do not excessively use social media, it will not negatively affect their social lives. Social media will not have a negative influence on their social lives.*
Premise 2 : *Social media has a negative influence on the social lives of high school students.*
Conclusion : *High school students use social media excessively*. (A52.4)

Quotation 15 shows the modus tollens pattern. This is evident from the premise that presents a conditional statement, the premise that denies the consequent, and the conclusion that denies the antecedent. Premise 1, premise 2, and conclusion in quotation 15 show a relationship of the following form.

Premise 1: If A so B
Premise 2: Not B
Conclusion: Therefore, A

16. *However, the use of social media has a negative influence. Students who spend too much time using social media usually forget to study. In addition, unfiltered social media content, which continues to be viewed daily affects students' negative behaviour, such as pornographic content. Continued viewing of adult content causes addiction, which eventually disturbs the minds of students.* (A34.3.1-4)

Quotation 16 presents a form of inductive inference with a generalisation pattern. Quotation 16 attempts to derive a more general conclusion based on a specific phenomenon. The conclusion is stated in the constituent *However, the use of social media has a negative influence*. This conclusion is derived from several specific phenomena found in the constituents *spend too much time using social media usually forget to study* and *unfiltered social media content, which continues to be viewed daily affects students' negative behaviour*. The two specific phenomena were synthesised into a general conclusion, which asserted that social media negatively influences students.

17. *Bullying makes the victim more passive toward the environment and themselves. Children who are victims of bullying are constantly shamed or teased by their friends. They also tend to be shunned by their classmates for fear of receiving the same bullying treatment... In the end, they will become afraid of socializing and interacting with others*. (A74.2)

Quotation 17 presents a form of inductive inference with a causal pattern. This is evident in the constituent *bullying makes the victim more passive toward the environment and themselves*, which results from the negative behaviour exhibited

by friends or the surrounding environment towards victims of bullying. The negative behavior is reflected in the constituents *shamed or teased by their friends* and *shunned by their classmates*.

The **fourth** strategy is **evaluation.** Evaluation of critical thinking is crucial for valuable argument reasoning process. This is because evaluation assesses the credibility and quality of reasoning in arguments (Facione, 2015; Paul & Elder, 2002). Evaluation must be conducted carefully and follow certain criteria to avoid incorrect decisions (Bloom et al., 2001). Evaluating reasoning in an argument involves considering two aspects: accuracy and logical truth. Accuracy pertains to the truth of the premises presented in an argument (Cariani & Rips, 2017). Logical truth relates to the logical relationship between the premises and conclusion of an argument (Stephens et al., 2020). The data indicate that a small proportion of participants built evaluations by presenting correct premises. These correct premises are supported by the author's experience or observation and the use of credible sources. However, most participants did not present correct premises. Instead, they compiled premises based solely on personal opinions, which gave the impression of subjective or unreliable truth (Wang, et al., 2021).

18. *The use of uniforms needs to be continued. The use of uniforms will help schools discipline students. Sobri (2019) in his research_stated that uniforms help students to be more disciplined. Problems regarding social inequality can also be avoided using uniforms.* (A86.3)
19. *Regarding mindset, Indonesian society has a tendency to follow others. All Indonesian are accustomed to following well-known people; in other words, Indonesians easily follow others. According to them, famous people are good people who should be emulated*. (A43.1.2-4)

Quotation 18 shows that the argument has a true premise, based on credible sources. The use of a source from a journal can enhance confidence that the argument has a correct premise. The use of sources to strengthen the belief in the premise is evident in the constituent *Sobri (2019) in his research…* However, quotation 19 presents an argument that is not true. Excessive generalisation of a fact renders the premise questionable. This can be seen in the use of terms such as *all Indonesian* and *according to them*. The participant assumed that all Indonesians are the same, disregarding the differences among individuals. Of course, not everyone has a latent habit, as suggested by the participant.

Furthermore, the participants demonstrated two forms of logical truth related to deductive arguments: valid and invalid. A valid deductive argument indicates that the argument has the correct structure to ensure that a conclusion follows logically from the premises, while the invalid form is the opposite. The valid deductive argument form can be observed in the relationship between the premises and the conclusion in the truth table, which does not show that a correct conclusion can be derived from a false premise. This aligns with Jackson and Newberry ’s (2016) view that a good deductive argument ensures that a conclusion cannot be false if all premises are true.

20. Premise 1 : *If high school students cannot manage their time well, they will forget to engage in other activities.*

Premise 2 : *Because they use social media, high school students find it difficult to manage their time*
Conclusion : *High school students forget to engage in activities other than playing on social media, such as studying.* (A72.2)

Quotation 20 illustrates a valid deductive argument. This is evident from the following truth table.

Table 2. Valid truth table

P	Q	P→Q*	P*	Q (C)
T	T	T	T	T
T	F	F	T	F
F	T	T	F	T
F	F	T	F	F

The truth table shows the existence of two simple statements: *high school students cannot manage their time well* marked with the symbol "P," and *they will forget to engage in other activities* marked with the symbol "Q." Additionally, the truth table displays that the argument consists of two premises, marked with the symbol "*" and one conclusion, marked with the symbol "C." Furthermore, the first premise appears in the form of a conditional statement, marked with the symbol "→," and the second premise is a statement that agrees with the antecedent in premise 1. Meanwhile, the truth of the premises or conclusion is expressed with the symbol "T" if true and "F" if false. Premise 1, a conditional statement, is declared false (F) if a true antecedent (T) is followed by a false consequent (F). Based on the results of the analysis using the truth table, the argument does not exhibit a relationship between the premises and conclusion that violates the requirements of a valid one. A valid argument does not display a relationship in which all premises are true but produces a false conclusion.

21. Premise 1 : *If internet access is evenly distributed throughout Indonesia, online learning can take place effectively.*
Premise 2 : *Rural areas do not have good internet access.*
Conclusion : *Online learning cannot be conducted to its full potential.* (A67.1)

Quotation 21 shows an invalid deductive argument. This is evident from the following truth table.

Table 3. Invalid truth table

P	Q	~P	~Q	P→Q*	~P*	~Q (C)
T	T	F	F	T	F	F
T	F	F	T	F	F	T
F	T	T	F	T	T	F
F	F	T	T	T	T	T

The truth table shows two simple statements: *internet access is evenly distributed throughout Indonesia* marked with the symbol "P," and *online learning can take place effectively* marked with the symbol "Q." Additionally, the truth table indicates that the argument consists of two premises, marked with the symbol "*" and one conclusion, marked with the symbol "C." Furthermore, the second premise and the conclusion are negation statements, marked with the symbol "~" The first

premise appears as a conditional statement, marked with the symbol "→" and the second premise is a negation of the antecedent in premise 1. The truth of a premise or conclusion is expressed with the symbol "T" if true and "F" if it is false. A conditional statement is declared false (F) if a true antecedent (T) is followed by a false consequent (F). Based on an analysis using the truth table, the argument displays a relationship between the premises and the conclusion that violates the requirements of a valid argument. A valid argument does not display a relationship in which all premises are true but produces a false conclusion. However, this is evident in the third row of the truth table, where all premises are true but the conclusion is false.

In addition, the participants also demonstrated two logical truths related to inductive arguments: strong and weak. A strong form of inductive argument indicates that the premises in the argument provide "possible" logical support for the conclusion. The strong form of inductive argument from the participants was evident from the strength of the sample set or phenomenon (from the premise) in explaining the population (in the conclusion) and the strength of the assumption of a causal relationship, reinforced by providing a concrete example of an event (Bassham et al., 2011). However, not all participants presented a strong inductive argument. This was evident when the presented sample set could not represent the population in the argument. Additionally, a reasonable explanation of the causal relationship between the premise and conclusion was not well presented.

> 22. *Online learning is not entirely effective, because online learning requires a good signal and a lot of internet quota, whereas some students do not have a good signal and cannot afford to buy internet quota continuously. In addition, some students are not focused on online learning activities because they cannot understand the material*. (A3.2.4-5)

Quotation 22 shows a strong form of inductive argumentation. This can be seen in the selection of "samples" representing the "population." The population in this argument appears in the constituent *online learning is not entirely effective*. Meanwhile, the sample in the argument shows three problems with online learning. This can be seen from the constituents *some students do not have a good signal*, *cannot afford to buy internet quota continuously*, and *some students are not focused on online learning activities*. These three samples highlight issues such as poor internet connectivity, the cost of buying internet data, and students' lack of focus in online learning. Furthermore, the conclusion that online learning is not effective is supported by the problems encountered during implementation.

> 23. *Laziness is a problem in online learning. When I am at home, I feel lazy because I think no one is watching me. If I have homework, I do not do it right away because I can hand it anytime. During meetings, sometimes the teacher's voice is unclear, and I want to ask questions but do not know how to ask them.* (A54.2.1-4)

Quotation 23 shows a weak inductive form of argument. This can be seen in the selection of "samples" that do not represent the "population." The population in this argument is represented by the constituent *Laziness is a problem in online learning*. Meanwhile, the samples in this argument appear in the constituents *if I*

have homework, I do not do it right away and during meetings, sometimes the teacher's voice is unclear, I want to ask questions but do not know how to ask them. The first sample, related to procrastination on assignments, indicated a trait closely related to laziness. However, the second sample showed something unrelated to the population. The second sample tended to illustrate more about the constraints faced by students during online learning activities, which did not show a relationship with students' laziness in online learning. The number of samples in this argument is still not strong enough to describe the population. The sample in the argument only shows the behaviour of the author, indicated by the first-person pronoun (I). A sample limited to only one person is insufficient to draw conclusions about most online learners.

Conclusion

Based on the results and discussion, the cognitive strategy of critical thinking in the writing argumentation of high school students can be abstracted. Abstraction is carried out through the establishment of stances based on the cognitive strategies of critical thinking. Four findings related to the cognitive strategy of critical thinking were obtained in this study. First, interpretation is expressed through the author's position and formation of definitions. The author's position is expressed in the form of opposition and support. Second, analysis is expressed by identifying and examining the relationships between the elements/components of the argument. Identification is done by determining the two main components of the argument, namely premises and conclusions. Premises and conclusions are realised in two ways: (1) explicitly using numeral words, connecting words, or connecting phrases, and (2) implicitly utilising the meaning of the ideas contained in the propositions that appear in the argument. Furthermore, the relationship between these components appears to be simple and complex in terms of argument structures. Third, inference is done by determining the form of reasoning. The form of reasoning is realized in deductive and inductive forms. The deductive form appears from the general patterns used in the argument. The common patterns are chain arguments, modus ponens, and modus tollens. The inductive form is also evident from the general patterns used. The general patterns are generalization and causal. Fourth, evaluation is manifested in the form of accuracy and logical truth. Accuracy is realized in terms of true or false premises, while logical truth is realized differently depending on the form of reasoning used. In deductive reasoning, it is shown as valid or invalid arguments, whereas in inductive reasoning, it is shown as strong or weak arguments.

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