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Emotional Game Hypothetical Inquiry Learning Model to Empower Student Socioscientific Argumentation Skills

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Abstract

The prevalent models of learning that promote scientific argumentation have flaws. As a result, a new approach to learning is necessary. This research intended to promote, investigate the effectiveness and determine the impact or significance of our new learning model, called the emotional game hypothetical inquiry model (EGHIL), in enhancing arguments. Students' pre-test and post-test scores, as well as data from interviews and questionnaires, were gathered, analyzed, and written up by using multiple methods. The participants of this investigation were 120 students that took part in hybrid classes. Our data analysis utilized Structural Equation Modelling, which identifies the impact of EGHIL syntaxes on socioscientific argumentation skills (SAS) components. The result demonstrated that all parts of the argumentation process, were effectively augmented by all of the EGHIL's syntaxes. One of the EGHIL models' syntaxes, named Verification (VER), had the greatest impact on enhancing argumentative abilities.

Keywords: *Socioscientific, Argumentation skills, EGHIL learning model.*

INTRODUCTION

The improvement of Socioscientific Argumentation Skills (SAS) increased critical thinking, problem-solving, and active communication, all of which enhanced the long-term retention of scientific concepts. The enhancement also facilitated the decision-making process in everyday life, this was based on empirical evidence (Guilfoyle et al., 2023). Additionally, argumentative skills have an important role in the description of the relationship between experimental results and conclusions (Chen et al., 2011). By employing argumentative abilities, students should be able to combine scientific knowledge and values associated with scientific knowledge. The coordination outcome is beneficial because it helps to reach conclusions, differentiate some arguments, and comprehend the patterns of reasoning (Lazarou & Erduran, 2021; Wilson et al., 2023). All of these will help students to become more informed, have the capacity to create compelling arguments and possess their own scientific knowledge (Khishfe, 2020). Students who have scientific knowledge should be able to differentiate the similarities and differences between various arguments, follow the societal rules that require students to speak and write arguments with a proper style, and also overcome life's challenges with ease (Osborne, 2012). High level arguments can enhance the quality of the learning,

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increase the communication experience, promote scientific thinking and allow students to have an accurate self-assessment of their knowledge. Additionally, the ability to argue across disciplines is considered paramount to addressing practical problems in life. This is also proven by the research results of Irawan, et al (2024) also show that communication or argumentation skills have a significant and positive influence on policy implementation, while resources do not have a significant positive influence on policy implementation.

However, there are some concerns associated with students' ability to discuss arguments, such as an lack of idea exploration, insufficient participation in arguments, low self-confidence, lack of knowledge, lack of experience, lack of evidence, poor reasoning, incorrect arguments and having difficulty finding relevant sources of information to support arguments (Yıldız-Feyzioğlu & Kıran, 2022). These issues are often caused by the ineffective implementation of instructional models (Lim et al., 2020). Conventional teaching methods typically involved a 'spoon feeding' or transmission of knowledge from the top to the bottom. Sadly, this trait is frequently employed despite its lack of consideration for individual or social aspects (Lim et al., 2020). To date, several investigations have attempted to combine various teaching methods, including peer interaction, goal-oriented instruction, argument-based inquiry, technology integration, games, question prompts, argument mapping, etc. in order to improve the teaching method or model (Nussbaum, 2021; Koenitz, 2023). However, the results of these investigations still have some limitations. This will lead to the conclusion that the effect of the argumentation skills increase via integrated methods or models is not significant.

To accomplish this demand, we propose a new educational model: the Emotional Game Hypothetical Inquiry Learning (EGHIL). This model is thought to be the proper solution to addressing the problems associated with the prevailing learning models in terms of enhancing argumentative abilities. The EGHIL model incorporates several components, including the emotion-based approach, the Trapping Cycle strategy (Aji et al., 2023). the hybrid digital board game (created by us for this study), and the Applied Hypothetical Inquiries that originate from the framework of inquiry (Wening, 2011).

The EGHIL model was intended to enhance students' ability to advocate their point of view. As a result, this paper describes the theoretical basis of the model's demand, and we assess the practical effects of the model on students' argumentative abilities. Additionally, the association between the EGHIL model's steps or syntaxes and each component of students' advocacy abilities is also considered here. Today, there has been no research conducted to explore the effects of a learning model like EGHIL on the ability to argue. As a result, this research is considered to be significant in this field. The EGHIL model is expected to dissociate from the dependence on traditional educational models that rely on students to learn knowledge passively. Additionally, the model is also appropriate to address the needs of future students, particularly in terms of increasing their capacity for argumentation. The background information above led to the goals of the research: 1) How does the Emotional Games Hypothetical Inquiry Learning (EGHIL) model theoretically enhance students' ability to argue? 2) Does the EGHIL model have effectiveness, and if so, what impact or implication does it have on students' ability to argue?

LITERATURE REVIEW

Teacher Assesment oriented Framework (TAF) and its connection to EGHIL

The TeacherAssessment-oriented Framework categorizes the argumentative component into data that express the results of investigations, a pro claim that is based on evidence, an opinion that is consistent with a statement, a counter claim that is based on evidence, content knowledge that is relevant and correct, and value grounded that is based on the

student's values and emotions (Christenson & Chang Rundgren, 2015). The component of the Teacher's assessment that is concerned with argumentation is appropriate for use as an indicator of the EGHIL model of learning. EGHIL is a framework for learning that employs emotional components to augment your argumentative abilities. The utilization of TAF allows for the measurement of student values, whether or not they utilize logic or emotions in their arguments. Understanding the students' values is beneficial when using the EGHIL learning model because it allows for a more accurate measurement of the degree to which sensitive topics are addressed that will cause students to feel emotionally.

Emotional Games Hypothetical Inquiry Learning (EGHIL) model

The EGHIL model is a new educational model that has never been created before. Despite primarily intended for use in science education, this model has a capacity to be employed in other disciplines. The creation of the EGHIL model was inspired by the combination of cognitive learning theories. Its procedures are uniquely designed to enhance HOTS, particularly in regards to arguments. The unique attributes of EGHIL that distinguish it from other learning models are: (1) The utilization of a hybrid digital game board as a medium for learning that is combined with an ethnoscientific approach.

The game promotes the practical application of Hypothetical Inquiry and facilitates the students' recognition of environmental cultural aspects. The game involves a number of steps, the first of which is Questioning (raising questions), the second is Predicting (making hypotheses), and the third is Resolving (providing solutions). (2) The utilization of emotional components via the Trapping Cycle strategy to inspire students to participate in arguments and increase their knowledge of content (Aji et al., 2023). The Trapping Cycle strategy, which was developed by Aji et al. (2023), involves a few steps, the first of which is making sure the topic is sensitive, creating arguments and discussing arguments. (3) The utilization of the Hypothetical Inquiry model, developed by (Wenning, 2011), to augment students' curiosity and promote their independence.

The Hypothetical Inquiry’s steps include Observation (observing phenomena), Manipulation (debating ideas), Generalization (building new principles), Verification (verifying), and Application (applying and concluding) (Wenning, 2011). The combination of the three features results in the EGHIL model's syntax. The syntaxes are: Questioning with sensitive topics-QUS (presenting and observing open-ended questions or problems that use sensitive terminology and ethnological components), Predicting-PRE (gathering data that will form the basis of an argument that is considered the solution to the problem), Verification-VER (communicating with peers and other sources in the environment that are sensitive to the proposed solution), and also applying the fundamental concepts to everyday situations.

This research can be employed to address the issue of how to utilize the EGHIL model to demonstrate the role of emotions, specifically in enhancing students' ability to argue. Also, the EGHIL model employs a emotional approach along with the Trapping Cycle strategy (Aji et al., 2023), along with ethnological components, this will motivates students to participate in arguments about the environment, which will lead to a increase in their commitment to the cause. The strategy also has the effect of instilling students an awareness of the cultural aspects of their surroundings. The combination of the strategy and the ethnological components will enhance students' capacity to discuss arguments, because the students will be encouraged to develop multiple alternative approaches to problem-solving, participate in arguments during discussions, and increase their knowledge of the cultural context.

METHODOLOGY

Research Method

This research utilized a quantitative approach (Creswell, 2009). Numerous quantitative data were gathered through pre-test and post-test, both orally and written, questionnaires and structured interviews. Semi-structured interviews facilitate the researchers in obtaining information from students' accounts. The research findings were derived from students of an Islamic college and a public college. The EGHIL model was employed in the classes as the treatment for the example. The students' ability to discuss arguments in both before and after treatment scenarios was assessed using the Teacher Assesment-based Framework (TAF) components of argumentation that were developed by Christenson & Chang Rundgren (2015). The components of the argumentation skills here are data, a claim in support of the argumentation, a claim against the argumentation, content knowledge and value.

Population, Sample and Sampling Techniques

Four classes participated in the study. Two classes were taught at a national university that possessed 35 students in total. The other two classes were from Islamic state university, each of them had 25 students. As a result, the total number of participants was 120 students. We studied the students' ability to discuss arguments during the educational process. The primary goal of this study was to assess the effectiveness of the EGHIL model toward students' ability to argue. This research was conducted at the National State University and the State Islamic University in order to determine if there were differences in the ability to argue of students at the two different universities. The content of the curriculum at Islamic universities is supposed to be consonant with Islamic religious principles, while the content of the curriculum at state universities is not supposed to be so.

Research Instruments

The data collection tool included assessment sheets that facilitated the assessment of argumentative abilities. The pre-test comprised 10 questions that were administered prior to the treatment. After the procedure, a post-test was conducted among the students to assess if their capacity for argumentation had been enhanced by using the EGHIL model. The students' ability to speak in favor of themselves was also evaluated during the educational process. Each of the argumentation skills tests took place over two hours. The technique of analysis involved the comparison of pre-test and post-test data regarding students' argumentative abilities. The interpretation of g values that is based on the g value's composition includes three categories: low, medium, and high (Hutchins et al., 2020).

Throughout the educational process, the assessment framework developed by Christenson & Chang Rundgren (2015), called the Teacher Assesment Oriented Framework (TAF) was employed to evaluate the students' ability to argue. The assessment framework was chosen because it had components that measured the emotional aspects of students' arguments. Additionally, we also attempted to assess how students' ability to advocate, which is depicted in their test answer, corresponded to the subjects they had learned in the Basic Biology curriculum.

Data Collection

The information in this study was derived from the students' test, question answers and structured interviews. The data from the questionnaire was obtained through 12 components of argumentative skills that used a scale of frequency that was comprised of never, rarely, often, and always, as well as 15 checklists of the EGHIL model's steps that used a scale of frequency that was comprised of strongly disagree, disagree, agree, and strongly agree.

In this research, the teachers directly observed how the students' ability to improve their arguments could be enhanced through the EGHIL method. Also, observations were conducted through virtual conversations and discussions using WhatsApp and Google meet to assess students' ability to argue. The coding process was on the data gathered via questionnaires. The students were observed and interviewed about how they experienced the process of learning using the EGHIL model, as well as its effect on their argumentative abilities. Additionally, semi-structured interviews were also conducted to explore the students' experience of learning with the EGHIL model and how this enhanced their ability to advocate their positions. Semi-structured interviews are typically conducted once per group at the conclusion of the research and have a duration of 30-60 minutes (Kutluca, 2021). The coding process was conducted on interviews.

The outcomes of the interviews were recorded and categorized according to the steps of the EGHIL model, which were undertaken by students in the process. Coding facilitated the classification of tasks and students' responses according to the four stages of EGHIL model. Additionally, the results of the interviews were analyzed via thematic analysis, which is based on the emerging topics. The analysis pertaining to the students' experience of utilizing the EGHIL model, their opinions of the benefits and drawbacks of the model, the problems they encountered while applying the model and the role of the group members during the discussion of the EGHIL model. Additionally, the results of the interviews were analyzed through a process of construction. This procedure can offer new information about the narrative process (Quayle & Sonn, 2019). This data analysis was employed as the impetus for our discussion of the association between steps of the EGHIL model and argumentative ability.

Data Analysis Techniques

This research also employed Structural Equation Modeling (SEM) and Partial Least Square (PLS) to create a relationship between constructs and indicators by taking into account measurement error (Kono & Sato, 2023). This method is also beneficial for maximizing the variance of the endogenous latent variables described in a population. The information analyzed here was comprised of questionnaires' answers and experimental results. Both had three variables from QUS that asked about sensitive topics, five from PRE that predicted, four from VER that verified, and three from RESA that resolved and applied. Conversely, the components of the argumentation skills that were abbreviated as D (Data), CP (Claim Pro), CC (Claim contra), CK (Content knowledge) and V (Value) have four variables that describe their construct.

Hypotheses

The hypotheses of this investigation were: 1) The EGHIL model is theoretically capable of enhancing students' ability to participate in arguments, this is because it employs four different steps/symbols (QUS, PRE, VER, and RESA). 2) The EGHIL model, which is basically a student empowerment model, has a practical effect on enhancing students' ability to argue.

FINDINGS AND DISCUSSION

Structural Equation Modelling using Partial Least Square

The dependability associated with the EGHIL model was found to be very high, additionally, the validity of the instrument's construction was proven. This was demonstrated by the value of Cronbach's alpha and rhoA for all components that were greater than 0.7. The validity of the EGHIL model's instrument was also found to be exceptional because the minimum AVE value for each component was greater than 0.5. An AVE value of greater than 0.5 is considered indicative of the instrument's validity (Hair et al., 2021). The R squared value associated with this model is also indicative of

the variance in the endogenous components of EGHIL that is well predicted by the predictor components.

The EGHIL model is also considered to be beneficial by the theory based on the fit model's value, the value of the EGHIL model is said to be less than 0.08. As a result, it had achieved the appropriate model value as stated by Henseler et al. (2014). The consistent nature of the research findings here demonstrated that students as participants and subjects had a consistent response pattern, additionally, the questions were employed in the data collection process and did not lead to conflicts. Conversely, the high validity demonstrated that the items were capable of creating each research variable with ease. The research data also exhibited a highly effective capacity to make predictions about hypotheses. Additionally, the standard deviation value was found to be small, which indicated that the data was well distributed (tstatistic> 1.96 and p-value <0.05). All of the outer data that has a value of over 0.7 has a strong effect. An outer loading value of over 0.7 is considered to indicate that the association between an indicator and its latent variable is strong, acceptable and maintained for the next analysis (Hair et al. (2021). The interpretation of the f2-effect size in Hair et al. (2021) and Henseler et al. (2014), is 0.02 (low) 0.10 (medium) 0.20 (big). In general, f2 is the magnitude or degree of association between the latent variables. This discussion is significant because the magnitude of the effect is used to assess the overall importance of a research study.

Effects of EGHIL Model's Steps on Data (D)

The data from SEM PLS that describes the effects of the EGHIL steps on Data (D) is depicted in Figure 1.

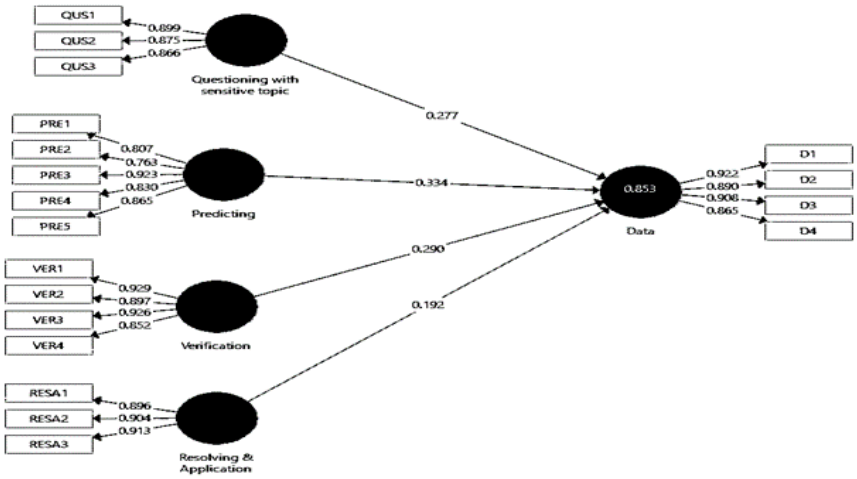

Figure 1. Path coefficient appearance which describes the effects of EGHIL model's steps on Data (D)

In Figure 1, the F2 values for the EGHIL steps are shown, they are QUS (0.282; strong), PRE (0.362; strong), VER (0.282; strong) and RESA (0.104; medium). In the QUS and PRE steps, students were encouraged to observe the exhibited problems, explore and combine information to acquire genuine, relevant, accurate and sufficient data. The procedure of observation (QUS) and exploration (PRE) had a beneficial effect on students in obtaining information. The information then was utilized to develop arguments (to strengthen the claims) and propose them, improve the quality of arguments and maintain the evidence. In the VER step, students evaluated the validity of the proposed arguments (including the data associated with them) by talking to friends or checking the arguments using external sources.

Effects of EGHIL Model's Steps on Claim Pro Argumentation (CP)

The SEM PLS analysis that describes the effects of the EGHIL steps on the Claim Pro theory of argumentation (CP) is depicted in Figure 2.

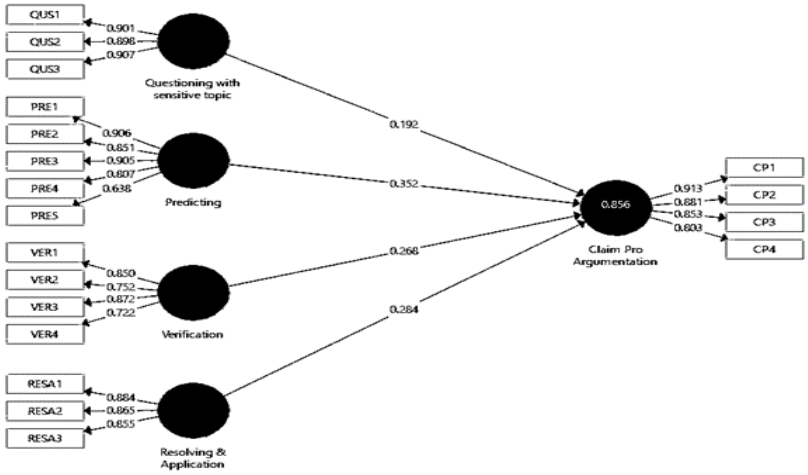

Figure 2. Path coefficient appearance which describes the effects of EGHIL model's steps on Claim Pro argumentation (CP)

In Figure 2, the F 2 values for the EGHIL steps are shown, they are QUS (0.116; medium), PRE (0.349; strong), and VER (0.217; strong). Additionally, the F 3 value is presented (0.336; strong). The QUS step attempted to educate students in expressing their thoughts (along with their Claim Pro argument) through the presentation of issues. However, the PRE process had the greatest impact on Claim Pro's (CP) argumentation. This was the case because of several reasons. In the PRE step, students attempted to describe the problems presented, attempt to solve them, and create their own knowledge. This was accomplished by conducting investigations to gather information that would be used to strengthen claims in favor of arguments (e.g., support a claim by means of evidence). The arguments, which were derived from developed concepts, were logical and rational, so they could be considered hypotheses (proposed arguments that would solve the problems presented). Additionally, the Claim Pro methodology and Data were found to have a reciprocal relationship. Student can utilize the information gained during the PRE procedure to augment their capacity to develop a Claim Pro argument. The results of this study demonstrated that at the start, students still had a hard time developing an argumentative strategy called Claim Pro.

Effects of EGHIL Model's Steps on Claim Contra Argumentation (CC)

The SEM PLS analysis that describes the effects of the EGHIL steps on Claim Contra's arguments (CC) is depicted in Figure 3.

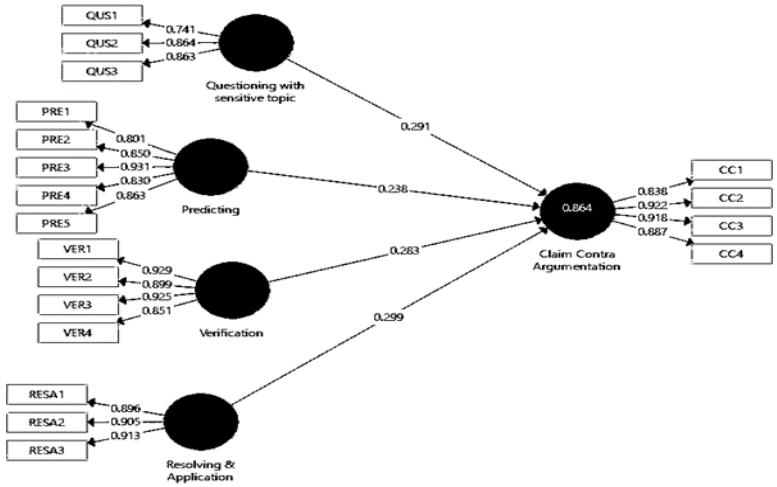

Figure 3. Path coefficient appearance which describes the effects of EGHIL model's steps on Claim Contra Argumentation (CC)

In Figure 3, the squared F values for the EGHIL steps are demonstrated, they are QUS (0.376; strong), PRE (0.194; medium), VER (0.295; strong), and RESA (0.273; strong). In Claim Contra's argumentation (CC), students voiced their own opinions that contradicted the statements that were originally made. In this research, a emotional approach that employed sensitive topics and arguments was employed to inspire students, this approach led to them wanting to verify the data and propose solutions to the problems presented. This method triggered students' emotions, which they used to advocate for their counter-arguments (opinions that are dissimilar to the subject).

Effects of EGHIL Model's Steps on Content Knowledge (CK)

The SEM PLS analysis that describes the effects of the EGHIL steps on content knowledge (CK) is depicted in Figure 4.

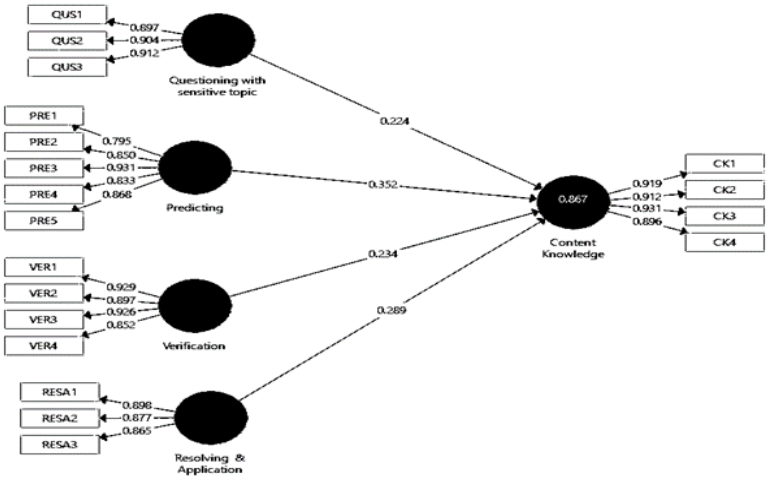

Figure 4. Path coefficient appearance which describes the effects of EGHIL model's steps on Content Knowledge (CK)

In Figure 4, the squared F values for the EGHIL steps are demonstrated, they are QUS (0.154; average), PRE (0.433; strong), and VER (0.202; strong). Additionally, the squared F value for the RESA step is demonstrated. The students participated in discussions that supported or opposed specific statements about content using content knowledge. The knowledge of content should be accurate, pertinent and in line with the subject they covered. When observing students (QUS) and exploring them (PRE), the students were collecting knowledge and information. Additionally, the students connected the knowledge and data they obtained to create an idea or argument, this activity increased their argumentation abilities. In the QUS step, the students gained more information than they knew. In the VER step, students employed scaffolding and a collaborative method which had a positive effect on their knowledge of content.

Effects of EGHIL Model's Steps on Value (V)

The SEM PLS analysis that describes the effects of the EGHIL steps on value (V) is depicted in Figure 5.

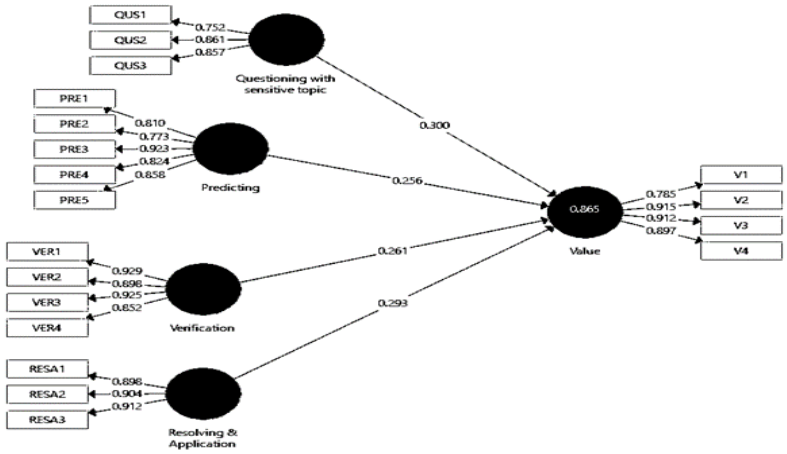

Figure 5. Path coefficient appearance which describes the effects of EGHIL model's steps on Value (V)

In Figure 5, the squared F values for the EGHIL steps are demonstrated, they are QUS (0.400; strong), PRE (0.228; strong), VER (0.254; strong), and RESA (0.263; strong). The value (V) of an argument is a component of the argumentation skill that describes the justification of students who support an opinion but disagree on the subject. The explanation is intended to demonstrate moral assessments, which reflect the students' emotions, and discuss the causes of statements that also include the potential consequences that are more generally applicable and reasonable.

Effectiveness of EGHIL Model in the Argumentation skills

Additionally, the results of the analysis with n-gain demonstrated an increase in the component of argumentation skills that is effective, namely Data (0.729), Claim Pro argumentation (0.738), ClaimContra argumentation (0.711), Content knowledge (0.736), and value (0.759) as a result of the implementation of EGHIL's steps. These findings were consonant with the results of the EGHIL model and the argumentation skills coding that demonstrated that all components of argumentation skills were at a high percentage.

EGHIL model and Argumentation skills using manual coding

The results of EGHIL model and argumentation skills using manual coding from semi structured interview are presented in Table 1.

Table 1 Results of EGHIL model and argumentation skills coding

EGHIL vs. Argument.	QUS	PRE	VER	RESA	Total	Percent
Data	6	6	7	5	24	20
Claim Pro argument	5	6	7	6	24	20
Claim Contra argument	6	4	7	6	23	19.17
Content Knowledge	5	6	7	6	24	20
Value	6	6	7	6	25	20,83
Total	28	28	35	29	120	100.0
Percentage	23.3	23,3	29.16	24,16	100.00	-

Table 1 indicates the order of the components of the argumentation skills from the greatest to the smallest percentage, which are Value, Data, Claim Pro, Content knowledge, and Claim contra. As an example, Data, Claim Pro's argument, and Content knowledge have the same percentage. Table 1 also indicates that all parts of the EGHIL model had a significant effect on the Value. This discovery suggests that the EGHIL

model has a positive impact in schools, this is manifested in the enhancement of character education. The discussion of sensitive topics that can triggers emotions throughout the EGHIL model also adversely affected Claim Contra's arguments. The claim against the argumentation of the other emerged when students were encouraged to counter the argument of the other. When students' emotions are triggered, their humanity (morals) and compliance with relevant rules and regulations (grounded) will be more apparent than only based on logic (non-grounded value).

The coding outcome in Table 1 also indicates that the VER (Verification) step had a significant impact on all parts of the argumentation process. This was the case because the VER process increased Data and Content knowledge through the discussion process. The step also encouraged students to participate in the discussion of the arguments of the two camps, Pro and contra, in order to make decisions, and also advocate for the morality of the human condition while using logic and human values (morals) together in the discussion. However, based on our analysis of the data during this study, the emotional topics that are sensitive are effective in causing students to become emotional. This prompted the students to become extremely eager to debate, they often posed questions that helped to clarify the subject or dispel the arguments. Typically, discussion has a beneficial role in enhancing learning.

Through discussion, science can be learned by using sensitive topics that provide students and teachers with a forum to discuss their thoughts, clarify issues or paradoxes, understand the scientific phenomena, and possibly alter their perspectives based on the new information gained. Students' participation in discussion that is interactive can help them to participate in the creation of knowledge, increase their passion for learning, and improve their learning results. Students who took advantage of the benefits most were students who believed in themselves, had the capacity to manage time and discipline in their pursuit. A learning environment that encouraged interaction between students and their peers, this would promote social and emotional trust. Discussions between students also afforded students opportunities to participate in useful scaffolding that can be utilized to assist with students' learning difficulties and also to promote reflection.

In the QUS step, students began to observe the problems presented that contained delicate topics. Since this sort of topics was employed, the discussions between students eventually led to their motivation to create a Claim Contra argument because of the emotional impact of the topics employed. Students are also documented to share resources that facilitate innovation and change in the QUS approach. Our findings during the learning process suggest that the QUS's activities that involve data observation can lead to significant professional gains and a starting point for developing awareness, skills and confidence in arguments. By following the steps of the EGHIL model, including the QUS step, students can gain knowledge based on their past experiences. The procedure of creating knowledge based on experiences is thought to enhance argumentative abilities.

The outcomes of the coding analysis in Table 1 demonstrate that the PRE component's value regarding the Claim Contra argument is less significant than the other components. This was the case because in the PRE stage, students focused on data and content-related investigations on their own. The discovery of this study was the Pre-step that can assist students in activating and maintaining their own thoughts, feelings, and behavior, as well as controlling the process in order to achieve educational goals. Additionally, Table 1 also indicates that the value of the RESA step is less significant on the Data than on the other components. This outcome was derived from the fact that in the RESA step, students gained more knowledge about content during the search process for solutions, whereas the data was obtained during the execution of the QUS step and the PRE step. Another consequence of this research was that the RESA step increased students' capacity to address issues in real life. Additionally, when the capacity is employed during the learning process, then students' critical thinking and conceptual understanding will be enhanced. Additionally, students' ability to reflect and think critically about their work is

also augmented when students complete cases that require them to deal with issues with multiple layers and complex dimensions.

CONCLUSION

The research's results indicate that EGHIL's theoretical foundation is capable of enhancing students' ability to argue, which is according to the components of the Teacher Assesment Based Framework (TAF). This is because the EGHIL model is concise, entertaining, and inspiring students to participate in the discussion, increasing their independence in learning. Additionally, the EGHIL model is demonstrably effective in enhancing all aspects of argumentative abilities, according to TAF. The procedure of the EGHIL model that is highly influential and beneficial in enhancing students' ability to argue is Verification (VER). Conversely, the component of argumentative abilities that is most affected by the EGHIL model's steps is Value (V). All of the stages of the EGHIL model have been demonstrated to facilitate higher-order thinking skills like critical thinking, creative thinking, and problem solving. Additionally, the instructors' abilities as facilitators of learning also determine the degree to which the steps of the EGHIL model have an effect on students' ability to argue.

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