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Developing an Interdisciplinary Hypothetical Inquiry Learning Model to Enhance Students' Higher-Order Thinking and Computational Thinking Skills.

by

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Abstract

This study aims to develop an Interdisciplinary Hypothetical Inquiry (IHI) learning model that is (1) feasible and practical, and (2) determine the effectiveness of this model in improving undergraduate students' higher-order thinking skills (HOTS) and computational thinking skills (CTS) in solving social problems in social science (IPS) education study programs. This research uses a design and development research approach that includes six stages: (1) problem identification, (2) goal description, (3) product design and development, (4) product testing, (5) evaluation of test results, and (6) communication of results. The development of the IHI learning model was tested through (1) feasibility tests by expert lecturers in the field of education, evaluation experts, and social science experts; (2) practicality test through observation of learning implementation and responses from lecturers and student users; and (3) effectiveness test using a quasi-experimental method with a sample of undergraduate students in Social Sciences Education, Universitas Negeri Yogyakarta. Result shows that IHI learning model (1) is feasible based on the assessment of expert lecturers; (2) practical with an implementation score of 4.54 (very practical), a lecturer response score of 3.9 (very practical), and a student response score of 4.5 (very practical); and (3) potentially effective based on the higher N-Gain HOTS and CTS values in the experimental class (0.63 and 0.56) compared to the control class (0.59 and 0.15), as well as the t-test results with significance value 0.00 ($p < 0.05$). The student-centered IHI learning model encourages collaboration and democratic learning through the stages: 1) problem orientation, (2) hypothesis brainstorming, (3) hypothesis development, (4) investigation design, (5) investigation data collection, (6) interpretation of investigation data, (7) reporting and communication of results. This research concludes that IHI learning model is feasible, practical, and effective for increasing HOTS and CTS for students in the social studies education study program.

Introduction

The rapid progress of science and technology in the 21st century has had a huge impact on various aspects of human life, requiring individuals to adapt to global digital networks and the abundance of information in the digital era. This development has brought significant changes to people's habits, such as dependence on technology, online communication, flexible learning, and the widespread use of e-commerce. However, this transformation also presents challenges, including the risk of low literacy levels, hedonistic behavior, and consumerism influenced by digital technology. (Masigno, 2014; Wilson, 2016).

Education in the 21st century is faced with the challenges of an increasingly complex digital world, especially in preparing students to enter a dynamic, technology-based world of work. One of the main challenges faced is the implementation of Problem-Based Learning/PBL, which is a significant demand in higher education to develop high-level thinking skills and capable computing abilities. However, the application of PBL in various scientific disciplines and educational contexts still faces a number of obstacles that need to be overcome to ensure its effectiveness.

Problem-based learning is a learning model that is oriented towards problem solving, by presenting problems in an authentic and relevant context. This approach aims to motivate students to carry out in-depth investigations of the problems presented (Kiswanto et al., 2016). Meanwhile, the inquiry learning model emphasizes the process of forming and testing hypotheses as part of problem investigation. This approach aims to develop critical thinking abilities and skills in solving complex problems (Ahern-Rindell, 2015; Lee et al., 2012; Li et al., 2020; Ngang et al., 2015; Wenning, 2010; J. Wing, 2008; J. M. Wing, 2008; You, 2017). The inquiry model is also designed to present problems related to social science that are relevant and complex. Students are invited to discuss and collaborate in order to find solutions or train their computational thinking patterns (Bauersfeld, H., & Chen, W. (Eds.), 2010; Erduran, S., & Dagher, Z. R., 2014; Sadler, T. D., 2011). Thus, the application of problem-based learning through the inquiry model can improve students' high-level thinking and computational thinking abilities. This process also encourages students to produce directed hypotheses and is based on in-depth analysis.

Although digital advances have the potential to increase people's literacy and productivity, there are growing concerns about the limited integration of these technologies into educational practice. Higher education plays an important role in encouraging positive use of digital devices, especially in developing students' higher-order thinking skills (HOTS) and computing abilities. However, many institutions still struggle to effectively implement problem-based learning models, which are important for preparing students for the demands of the digital era.

Students in the digital era need to have computational thinking skills, because this ability plays a strategic role in equipping them with knowledge, critical thinking skills, the ability to solve social problems, communication skills, and essential values to face the challenges of the 21st century in the context of the digital era (Banks, 2008). Wing emphasized that computational thinking is a fundamental thinking ability for students. This capability supports the adoption of new mindsets needed to solve problems and explore complex and diverse opportunities10 in modern digital life (Lee et al., 2012; Li et al., 2020; J. Wing, 2008; J. M. Wing, 2010). This mindset includes the ability to understand complex problems, think at various levels of abstraction, and design solutions holistically and systematically (Lee et al., 2012).

Students are trained to hone their skills in processing knowledge based on the information obtained to solve various problems they face. Critical thinking skills reflect a more complex level of thinking (Airasian et al., 2005; Aisyah et al., 2019; García, 2015). According to Bloom's Taxonomy of Educational Goals, critical thinking is an integral part of a framework that includes six levels of thinking abilities, from mastery of basic knowledge to analysis, synthesis, and evaluation. At the level of higher order thinking, critical thinking skills include analysis, synthesis, and evaluation skills which are realized through activities such as analyzing (C4), evaluating (C5), and creating (C6) (Airasian et al., 2005; Haolader et al., 2015; Heer, 2012; Spivey, 2007).

Higher order thinking and computational thinking can be understood as complex cognitive processes, which require students to go beyond the ability to simply memorize information. This process requires the involvement of critical analysis, in-depth evaluation, and synthesis of ideas to solve complex problems, both in the social and technological fields. (Janzen et al., 2011; Li et al., 2020; Voskoglou & Buckley, 2012; J. Wing, 2008). This ability should be an ideal competency for students, considering that existing demands require them to be able to solve problems holistically, deal with complex situations, and make decisions based on critical and computational thinking. Apart from that, students are also expected to think reflectively and produce innovative ideas that can bring positive change to society through their independent learning. The concept of high-level thinking and computing integrates various aspects of skills, such as the ability to analyze, evaluate, and create solutions to solve social problems effectively (Aisyah et al., 2019; Miller et al., 2005).

Constructivism theory emphasizes that students build knowledge through direct experience and interaction with their environment, as theorized by Piaget (1970) and Vygotsky (1978). On the other hand, Social Science theory focuses on learning that uses real-world social problems with social implications, as stated by Osborne and Dillon (2008). Furthermore, Critical Thinking theory shows the importance of critical thinking skills to analyze, solve problems, and make the right decisions (Paul & Elder, 2006). The Progressivism philosophy focuses learning on students, placing them as active subjects in the learning process (Gutek, 1974).

One of the main challenges in the Social Sciences (IPS) learning process is the lack of readiness of lecturers and students in adopting interdisciplinary-based learning models. Bergmark and Westman (2016) emphasized the importance of collaborative planning between teachers to effectively integrate various disciplines. This readiness includes curriculum preparation, teaching staff training, and introducing interdisciplinary concepts to students. As an alternative solution, a project-based approach can be implemented. For example, students can be given the task of analyzing the impact of educational disparities in rural areas by considering social, economic, and environmental aspects. This kind of approach has been proven to be able to develop critical thinking skills and increase students' collaborative capacity (Herczog, 2010).

The results of the National Conference held by the Association of Indonesian Social Sciences Education Study Programs (APRIPSI) on 12 to 13 August 2022 at Yogyakarta State University revealed various issues and challenges in the Social Sciences (IPS) learning process. Some of the main problems identified include: 1) The social studies learning process in general still has weaknesses in developing learning models that are effective and adaptive to the dynamics of current developments, 2) The social studies curriculum is considered less than optimal and not responsive enough to social changes and local contexts, especially in facing the digital era which moves very quickly, 3) The development of learning models is often monotonous, less innovative, and tends to be didactic. 4) The use of learning methods such as lectures and discussions has not provided sufficient encouragement to develop high-level thinking skills or computational thinking skills that are relevant to the demands of the digital era, 5) The assessment approach used is less than optimal in evaluating students' critical thinking and computational abilities, 6) Most students in the Social Sciences Education program show limited understanding of the social studies subject material, with a tendency to view it as simply rote or textbook-based material, 7) The opportunities for Social Sciences Education graduates to enter the world of work are still limited, so their career profiles are less diversified, 8) The social studies learning process in various institutions have not been fully integrated well and are often carried out partially without a holistic approach. These problems emphasize the need for strategic steps to reform social studies education so that it is able to answer the challenges and needs in the era of digital transformation and increase its relevance in the academic and professional world.

In observations carried out in the even semester of the 2022/2023 academic year on Social Sciences Education (IPS) students at Yogyakarta State University (UNY), in general the learning model still tends to be dominated by a monodisciplinary approach and does not fully reflect the characteristics of Social Sciences which integrates various scientific disciplines. Material is presented separately based on certain disciplines, such as history or geography, without any attempt at integration between fields. This approach risks weakening students' ability to critically analyze complex social problems. Based on the views of Munajim et al. (2020), an interdisciplinary approach offers flexibility in studying social problems by combining perspectives from various scientific disciplines. For example, discussions of demography and urbanization that are only approached from a historical perspective tend to ignore more comprehensive environmental, economic or social dimensions. This kind of approach is considered less appropriate to the demands of21st-centuryy education which emphasizes the need for interdisciplinary learning to face increasingly complex global challenges (Soedijarto, 2006).

Based on these problems, the importance of designing a social studies learning process in higher education that is not only oriented towards achieving cognitive aspects is formulated. The learning approach should include models that discuss relevant and contextual topics that can encourage students to question, analyze and deepen their understanding of social issues that exist in society. In addition, the implementation of the learning model is expected to focus on an active, creative, innovative and student-centered approach, thus providing ample space for the development of higher order thinking skills and computational thinking. This approach must also train students in solving problems in an integrated manner involving various scientific disciplines.

The focus of this research is the gap between current educational practices in higher education and the demands of the digital era. Specifically, it examines the challenges in cultivating critical, creative, and computational thinking skills among undergraduate students in social studies education programs. Current reliance on traditional teaching methods has limited students' ability to think analytically and innovatively, highlighting the need for problem-based interdisciplinary learning models that integrate digital technology. This research aims to develop a problem-based interdisciplinary learning model, namely Interdisciplinary Hypothetical Inquiry (IHI), which is designed to improve students' HOTS and computational thinking abilities. This model seeks to equip students with tools to analyze and solve complex social problems through a collaborative and integrative approach, in line with the needs of the 21st-century world of work (Ahern-Rindell, 2015; Lee et al., 2012; Li et al., 2020; Ngang et al., 2015; Wenning, 2010; J. M. Wing, 2010; You, 2017).

The effective implementation of the problem-based learning (PBL) model in higher education faces various challenges that require attention and resolution. These challenges may include inadequate resources, varying levels of faculty preparedness, and difficulty aligning PBL activities with varying student needs and institutional goals. Understanding these barriers is critical to designing and implementing strategies that make PBL models more effective and impactful. An interdisciplinary approach offers a promising avenue for enhancing students' critical, creative, and computational thinking skills. By integrating knowledge and methods from various disciplines, students are encouraged to think beyond traditional boundaries, fostering innovation and problem-solving skills that are essential in overcoming complex real-world challenges. Exploring the potential of this approach can provide valuable insights into improving educational outcomes (Bruner, 2020; Paul & Elder, 2006; Wiggins & McTighe, 2005)

It is hoped that the development of an Interdisciplinary Hypothetical Inquiry model based on social problems will be able to realize student-oriented learning. Students are expected to have high-level thinking skills and computational thinking through solving complex and relevant social problems. This learning requires integration and collaboration between scientific disciplines so that students can find solutions, build knowledge, and gain an understanding of the challenges presented by the modern era.

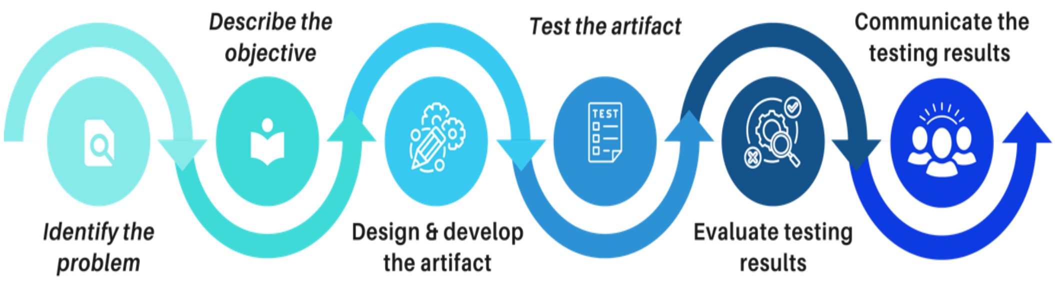
This research has a high urgency to produce a learning model that is tested in terms of feasibility, practicality and effectiveness. The empirically proven problem-based Interdisciplinary Hypothetical Inquiry Model is expected to be able to be used sustainably in line with current developments and technology. Furthermore, if the success of this model can be proven, then the application of this model can be expanded to other study programs to produce superior and adaptive human resources to face the digital era.

Through updating this interdisciplinary-based learning model and curriculum, IPS students are expected to be able to understand social issues in a deeper framework that is relevant to contemporary challenges. This approach is expected to not only improve the quality of social education in Indonesia but also strengthen the nation's competitiveness in facing global dynamics. Thus, this research is a strategic step for the development of an Interdisciplinary Hypothetical Inquiry learning model, especially to support the improvement of high-level thinking and computational thinking skills for social studies education students.

Methods

The product developed is an Interdisciplinary Hypothetical Inquiry learning model prepared for undergraduate students in Social Sciences Education. The target of using the Interdisciplinary Hypothetical Inquiry learning model is to improve Higher Order Thinking and Computational Thinking Skills in solving social problems. Users of the Interdisciplinary Hypothetical Inquiry learning model are lecturers in Indonesian Economics courses. The Interdisciplinary Hypothetical Inquiry learning model product was developed by following six stages or steps in Design and Development Research/DDR research, including: *(1) Identifying the problem, (2) Describe the objectives, (3) Design & developing the artifact, (4) Test the artifact, (5) Evaluate testing results, (6) Communicate the testing results* (Peffer et al., 2007).

Figure 1. Stages of Design and Development Research



Data collection techniques in this research include test techniques and non-test techniques. The instruments used in this research include test instruments and non-test instruments. The test instrument is in the form of High-Level Thinking and Computational Thinking ability test questions in solving environmental problems. Non-test instruments include study sheets and product assessments for lecturers who are experts in education and assessment, as well as for lecturers who are experts in environmental science, observation sheets on the implementation of learning using the Interdisciplinary Hypothetical Inquiry model, lecturer response questionnaires, and student response questionnaires.

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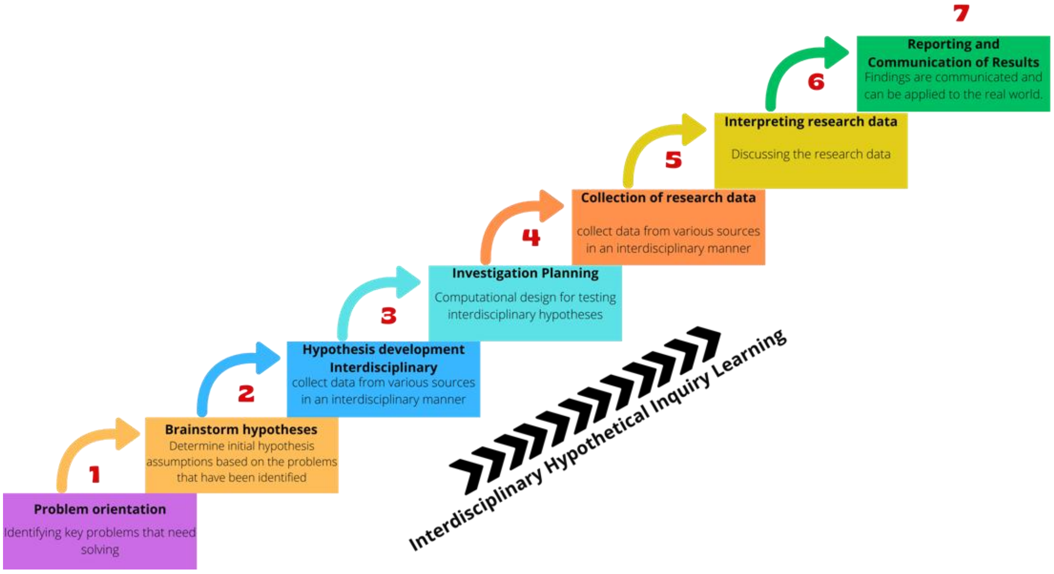
The feasibility test data for the Interdisciplinary Hypothetical Inquiry (IHI) learning model were analyzed descriptively and qualitatively, based on input from educational and social expert lecturers through validation instruments. This data is complemented by the results of the agreement in the Forum Group Discussion (FGD) after revising the model according to input. For the higher order thinking ability (HOTS) and computational thinking test instruments, the analysis was carried out empirically using the Quest program, with an evaluation of the items through a sensitivity index. Meanwhile, observation data on the application of the IHI model in learning was collected using observation sheets and analyzed descriptively based on the average score for each indicator, which was then converted into a practical scale of five categories using Widiyoko's adaptation criteria. Lecturer and student responses were also analyzed through the average questionnaire score which was converted to a scale of five to assess the level of practicality of the model. The effectiveness of the IHI model was evaluated based on the results of *pre-test* and *post-test* HOTS and students' computational thinking abilities. Data were analyzed by calculating the average value, standard deviation, and ability categories based on the value range. Increased ability is measured using Normalized Gain (N-Gain), with interpretations of high, medium or low. The influence of the model was analyzed through statistical tests using SPSS, starting with normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) and homogeneity (Levene Test). Hypothesis testing uses the Independent Sample t-test for normal and homogeneous data, or non-parametric statistics for data that does not meet the prerequisites. If necessary, the analysis is continued with a covariance test to identify differences between groups.

Results and Discussion

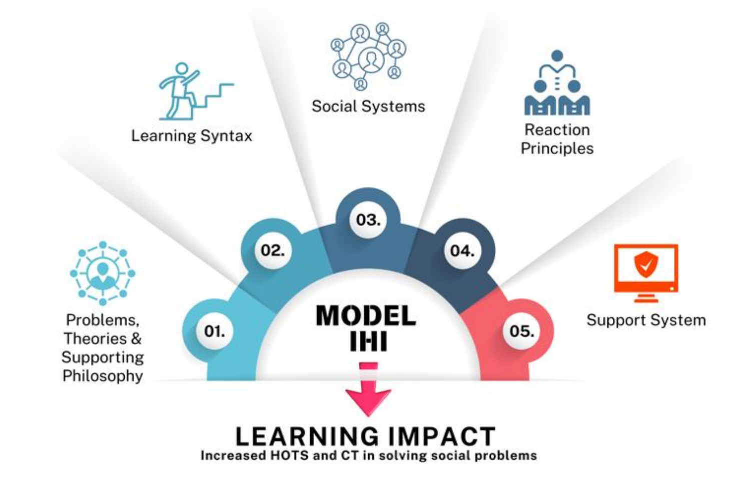
The Interdisciplinary Hypothetical Inquiry (IHI) learning model was developed to improve high-level thinking abilities (*Higher-order thinking*) and computational thinking (*Computational Thinking*) in solving social problems among undergraduate students in Social Sciences Education. The IHI learning model was developed with an interdisciplinary and hypothetical inquiry approach, based on constructivist learning theory and progressivism philosophy. The structure of the IHI learning model includes main elements such as syntax, social system, reaction principle, support system, and learning impact. These components were prepared by adapting the framework from (Joyce et al., 2016).

Figure 2. Syntax of the Interdisciplinary Hypothetical Inquiry Learning Model



The IHI learning model developed in this research is the result of applying research procedures *Design and Development Research*/DDR by carrying out 6 (six) research stages, as follows: *(1) Identify the problem, (2) Describe the objectives, (3) Design & develop the artifact, (4) Test the artifact, (5) Evaluate testing results, (6) Communicate the testing results*.

Figure 3. IHI Learning



The first stage is identifying problems and describing goals**.** Problem identification is carried out as a basis for product development. The problems underlying the development of IHI learning model products were identified through literature studies and field studies. Results of the problem identification stage. The results of an initial survey conducted by researchers on 205 UNY Social Sciences Education undergraduate students showed that students' HOTS abilities were in the low (2.24%) and very low (97.56%) categories. Based on this data, efforts need to be made to improve HOTS abilities among Indonesian students, especially university students. A review of the Semester Learning Plan (RPS) document as well as interviews with lecturers in the Social Sciences Education course at Yogyakarta State University (UNY) shows that current learning does not specifically target the development of HOTS abilities as one of the main achievements in the course. On the other hand, the results of literature studies show that learning that involves various scientific disciplines (interdisciplinary) can improve HOTS abilities (Brassler & Dettmers, 2017: 1; Everett, 2016: 29; You, 2017: 71-72).

The second stage is to describe goals**.** The result of the goal description stage is a description of the goals to be achieved from design and development research. The feasibility of the model is assessed based on the results of reviews and evaluations from expert lecturers in the field of education and assessment, which are then consolidated in a Forum Group Discussion (FGD) to reach a joint agreement. Practical criteria are based on the results of observations of learning implementation using the IHI model with minimum good/practical criteria as well as the results of responses or responses from lecturers and students who use the IHI model by filling in a questionnaire with minimum good/practical criteria.

The third stage is the stages of designing and developing artifacts/products, which are carried out in three steps/processes: (a) determining the product/artefact and conceptual framework, (b) systematic design of the product/artifact, (c) developing a product/artifact prototype for testing and evaluation. Products/artifacts are determined based on literature reviews and discussions with education expert lecturers, assessment expert lecturers, and social science expert lecturers. Next, systematic product design was carried out in the form of the IHI learning model, RPS, student worksheets, and HOTS and CT ability test questions in solving social problems. Systematic products that have been designed in the previous stage are developed into product prototypes at this stage so that they are ready to be tested and evaluated.

The fourth stage is the product testing level. The resulting product is a prototype of the IHI learning model and its supporting tools (RPS, LKM, HOTS, and CT ability test questions in solving social problems), which have been created and tested for feasibility, practicality, and effectiveness. Feasibility testing is carried out through expert reviews and assessments of IHI model products/artifacts and their supporting tools (RPS, LKM, HOTS, and CT ability test questions in solving social problems) by referring to the criteria or assessment aspects that have been determined for each product. Testing the practicality of the IHI learning model and its supporting devices is carried out in two ways: (1) Observing the implementation of the model components during model trials, (2) Providing questionnaires to students and lecturers who use the model to find out responses after using the model in trials. Testing the effectiveness of the IHI learning model and its supporting tools was carried out by measuring the ability of HOTS and CT to solve social problems for students before conducting a trial application of the model (*stop you*) and after trial implementation of the model (*post-tes*).

The fifth stage is the result evaluation stage. Data analysis related to the feasibility, practicality, and effectiveness of the IHI learning model was carried out through descriptive approaches and inferential statistics. Based on the results of the analysis, the IHI learning model is considered appropriate based on reviews and assessments provided by expert lecturers. In terms of effectiveness, the IHI learning model is proven to be able to improve HOTS abilities (*Higher Order Thinking Skills*) and CT (*Critical thinking*) in students solving social problems. This is based on empirical findings that show an increase in HOTS and CT capabilities based on the results of statistical analysis and testing.

The sixth stage The conclusion of the test results is presented and communicated both orally and in writing. Orally, the exam results are presented through seminars or open dissertation sessions. Meanwhile, in writing, research results are conveyed through the publication of articles in national and international journals, as well as the publication of books with ISBNs related to the model of Interdisciplinary Hypothetical Inquiry (IHI).

Product Trial Results.

Model testing was carried out to fulfill the research objective, namely, to produce an Interdisciplinary Hypothetical Inquiry (IHI) learning model that is feasible, practical, and effective in improving the critical thinking and computational thinking skills of undergraduate students in Social Sciences Education. This testing includes feasibility, practicality, and effectiveness tests. The IHI learning model was refined based on input and suggestions from expert lecturers. Next, expert lecturers review the revised IHI learning model to reach a mutual agreement regarding aspects or components of the model.

Overall, the results of the feasibility test of the model and supporting tools for the IHI learning model show that this model is ready to be implemented. Based on the results of the assessment and agreement with expert lecturers, the components in the IHI learning model were declared feasible. The Semester Learning Plan (RPS) and Student Worksheet (LKM) were also declared feasible after receiving input and approval from expert lecturers, taking into account the aspects reviewed. The CT ability test questions for solving social problems were declared appropriate based on expert assessment of the construction, content, and analysis of the questions.

The results of the feasibility test of the IHI learning model are in the form of 1) Observation data on the implementation of the model components and 2) Data on responses from students and lecturers who use the IHI learning model through filling out questionnaires. Both data were obtained during model testing. Observations on the implementation of the IHI learning model are carried out by observers by monitoring the implementation of the main components of the model, namely syntax, social systems, reaction principles, and support systems. A summary of the observation results of the application of the IHI learning model to each component is presented in Table 1.

Table 1. Observation Results of the Application of the IHI Learning Model in the Experimental Class

Model Components	Average Encounters 1-4
Syntax	4,35
Interdisciplinary problem orientation	4,83
Hypothetical brainstorming	4,33
Interdisciplinary hypothesis development	3,75
Investigation Planning	4,50
Research data collection	4,00
Interpret investigative data	4,75
Reporting and Communicating Results	4,25
Social Systems	4,67
Reaction Principles	4,33
Support System	4,83
Rate - Rate	4,54
Criteria	Very good

The results of observations of the application of the IHI learning model in the experimental class during four meetings showed very satisfying results. All meetings were assessed as meeting the "very good" criteria with a score of 4.54, which reflects the learning model being implemented optimally and consistently.

Apart from that, there is response data from students and lecturers who use this model, which was obtained from filling out questionnaires by lecturers and experimental class students who have carried out learning or lectures using the IHI model. The lecturer in the Social Sciences Education course at Yogyakarta State University (UNY), who implemented the IHI learning model trial, provided input regarding the level of practicality of the model in terms of model components. Lecturers' responses to the practicality of the IHI learning model show practical criteria with an average score of 3.9.

Table 2. Results of Lecturer Responses to the Practicality of the IHI Learning Model

Model Components	Average Lecturer Response Score
Syntax	3,6
Social Systems	4,3
Reaction Principles	3,7
Support System	4,2
Learning Impact	3,7
Rate-rate	3.9
Criteria	Very Practical

Furthermore, 45 experimental class students have responded to the level of practicality of the IHI learning model in terms of model components. Furthermore, the results of student responses are presented in Table 3 below.

Tableh 3 Results of student responses to the practicality of the IHI learning model

Model Components	Average student response score
Syntax	4.3
Social Systems	4.4
Reaction Principles	4.5
Support System	4.5
Learning Impact	4.5
Rate-rate	4.5
Criteria	Very Practical

The responses of experimental class students as users of the IHI learning model show very practical criteria with an average score of 4.50. The results of this assessment show that the lecturers assess that the IHI learning model can be applied easily and effectively in the learning process. Apart from that, the responses of 45 students in the experimental class also provided a positive picture of the practicality of the model.

The effectiveness of the IHI learning model can be seen from the differences in the influence of higher-order thinking skills and computational thinking in solving social problems between experimental class students and control class students based on the results of model trials. The trial was carried out using a quasi-experimental type research design *pre-test post test* non-equivalent control group design. Data on HOTS's ability to solve social problems for experimental class and control class students was obtained from the results of the pre-test and post-test. Data on high-level thinking abilities and computational thinking in solving social problems for experimental class and control class students is presented in Table 4.

Table 4. Data on HOTS and CT abilities in solving social problems in the experimental class and control class

Variable	Class	N	Test Type	Ideal Value	Max Value	Rate me	Average value	Standard Deviation
MEAN	Experiment	45	Pre Test	100	45,56	12,22	26,96	9,77
			Post-tests	100	84,44	44,44	60,59	10,53
	Control	48	Pre Test	100	50,00	16,67	32,18	8,39
			Post-tests	100	71,11	32,22	56,78	10,56
CT	Experiment	45	Pre Test	100	65,56	12,22	36,69	16,12
			Post-tests	100	84,44	34,44	63,65	10,81
	Control	48	Pre Test	100	66,67	16,67	42,92	12,66
			Post-tests	100	61,11	32,22	46,55	8,37

Table 4 shows the average value of high-level thinking abilities and computational thinking in solving social problems for students in each class. The average pre-test score for HOTS ability to solve social problems for experimental class students was 45.56, while the average post-test score was 84.44. Skill data High-level thinking and computational thinking in solving social problems are also presented by category. The HOTS and CT ability categories in solving social problems among undergraduate students of Social Sciences Education at Yogyakarta State University are presented in Table 5.

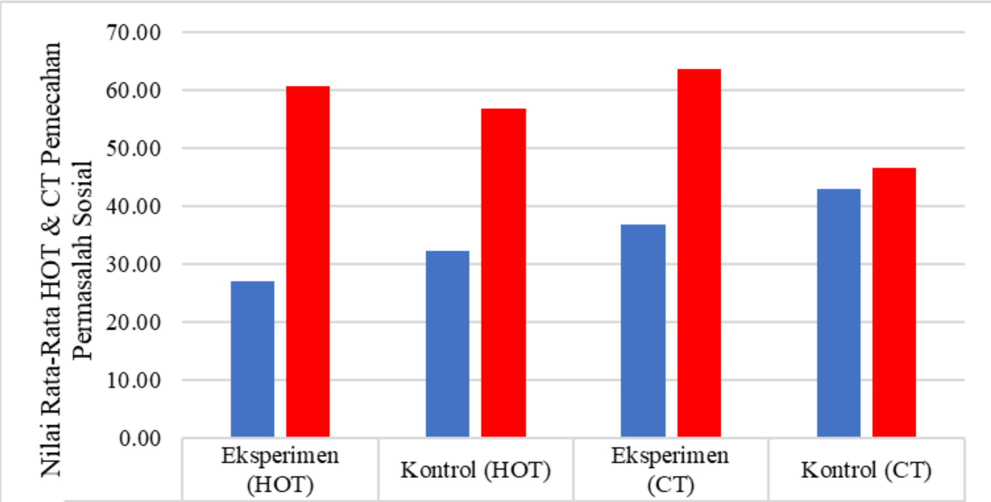
Table 5. *Categories of higher-order thinking abilities and computational thinking*

Category (Value Range)	I MEAN								CT							
	Experiment				Control				Experiment				Control			
	Pre Test		Post-tes		Pre Test		Post-tes		Pre Test		Post-tes		Pre Test		Post-tes	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Very high (81,26 < x ≤ 100)	0	0%	2	4%	0	0%	0	0%	0	0%	2	4%	0	0%	2	4%
High (71,51 < x ≤ 81,25)	0	0%	6	13%	0	0%	0	0%	0	0%	9	20%	0	0%	9	20%
Currently (62,51 < x ≤ 71,5)	0	0%	11	24%	0	0%	15	31%	3	7%	17	38%	5	10%	17	38%
Low (43,76 < x ≤ 62,5)	4	9%	26	58%	5	10,4%	26	54%	25	56%	16	36%	25	52%	16	36%
Very Low (0 < x ≤ 43,75)	41	91%	0	0%	43	89,6%	7	15%	17	38%	1	2%	18	38%	1	2%

Table 5 shows that experimental class undergraduate social studies students have HOTS abilities in solving social problems before being given treatment (*stop you*) in the very low (91%) and low (9%) categories, while after treatment (post test) it was in the low (58%), medium (24%), high (6%), and very high (4%) categories.

The increase in students' high-level thinking and computational thinking skills in solving social problems can be seen from the comparison of average scores between *stop you* and *post-tes*. A comparison of the increase in high-level thinking skills and computational thinking in solving social problems for students in each experimental class and control class can be seen in Figure 3.123

Figure 4. Improvement of Experimental and Control Classes



	Eksperimen (HOT)	Kontrol (HOT)	Eksperimen (CT)	Kontrol (CT)
Pre-test	26.96	32.18	36.69	42.92
Post-test	60.59	56.78	63.65	46.55

Figure 4 shows that the increase in high-level thinking and computational thinking skills in solving social problems for students in the experimental class was higher than in the control class. The figure depicts a comparison of the average pre-test and post-test scores for higher order thinking skills and computational thinking in solving social problems in the experimental and control classes. Overall, the data shows that the learning model applied in the experimental class is much more effective in improving students' higher-order thinking and computational thinking skills compared to the control class.

The N-Gain value was measured through the Normalized Gain (N-Gain) test to evaluate the extent of improvement in students' HOTS and CT abilities in solving social problems, both in the experimental and control classes. Information regarding the N-Gain value and its categories is presented in Table 6.

Table 6. N-Gain Values and Categories for Experimental and Control Classes

Model	Class	Average value Pre test	Average value Post test	Sign N-Gain	Category N-Gain
HOTS	Test	26.96	60.59	0,63	Currently
	Control	32.18	56.78	0,59	Currently
CT	Test	36.69	63,65	0,56	Currently
	Control	42.92	46.55	0,15	Low

Table 6 shows that the HOTS ability of the experimental class has a higher N-Gain value, namely 0.63 in the medium category, compared to the control class, namely 0.59 in the medium category. Furthermore, the CT ability of the experimental class also has a higher N-Gain value, namely 0.56 in the medium category compared to the control class, namely 0.15 in the low category. This shows that the increase in high-level thinking abilities and computational thinking in solving social problems in the experimental class is higher than in the control class.

Analysis of the influence of the IHI learning model on high-level thinking skills and computational thinking in solving social problems is used to determine the effectiveness of the IHI learning model in improving high-level thinking skills and computational thinking in solving social problems. Prerequisite tests are carried out to determine the continuity of hypothesis testing. Prerequisite tests include tests for normality of distribution and homogeneity of variance. The normality test is carried out to ensure whether the pre-test and post-test data for higher order thinking skills and computational thinking in solving social problems have a normal distribution before hypothesis testing is carried out. This test uses the Kolmogorov-Smirnov and Shapiro-Wilk methods with the help of SPSS 25 for Windows software. The results of the data normality test are presented in Table 7.

Table 7. Normality Test Results of Pre-test and Post-test Data

	Data	Class	df	Say. Kolmogorov-Smirnov	One. Shapiro-Wilk	Information
HOST	Pre Test	Experiment	45	0,074	0,148	Data Normal
		Control	48	0,136	0,068	Data Normal
	Post test	Experiment	45	0,15	0,203	Data Normal
		Control	48	0,063	0,231	Data Normal
CT	Pre Test	Experiment	45	0,15	0,105	Data Normal
		Control	48	0,2	0,098	Data Normal
	Post test	Experiment	45	0,18	0,082	Data Normal
		Control	48	0,19	0,121	Data Normal

In Table 7 the results of the analysis show that the significance value of the pre-test and post-test for HOTS abilities in the experimental class and control class is greater than 0.05. Likewise, the significance value of CT ability. Thus, the pre-test and post-test data for HOTS and CT abilities were declared to be normally distributed.

The homogeneity test was carried out to determine whether the pre-test and post-test data for HOTS and CT abilities came from a population with the same variance. This test uses the Levene test which is processed with SPSS 25 for Windows software. Data is declared homogeneous if the probability significance value is greater than 0.05. The results of the homogeneity test analysis are presented in Table 8.

Table 8. Data Homogeneity Test Results Pre Test and *Post test*

	Data	**Class**	**Significance**	**Information**
HOST	Pre Test	experimental and control classes	0,279	Data have the same variance (homogeneous)
	Post-tes	experimental and control classes	0,286	Data have the same variance (homogeneous)
CT	Pre Test	experimental and control classes	0,234	Data have the same variance (homogeneous)
	Post-tes	experimental and control classes	0,267	Data have the same variance (homogeneous)

Based on Table 8, the significance value *Based on the Average* for the four variables the results show greater than 0.05. Therefore, it can be concluded that the variance of two or more groups of data tested is homogeneous. This means that the variance in HOTS and CT abilities in both experimental and control classes is in the comparable or homogeneous category, which means there is no significant difference in variance between groups before the learning intervention is carried out.

Hypothesis testing aims to determine whether there is a difference in the average HOTS and CT abilities between the experimental class and the control class in solving social problems. Hypothesis test results with *independent sample t-test* and ANCOVA are presented in Table 9

Table 9. Hypothesis Test Results Pre-test and Post-test Data

Data	**Dependent Variable**	t	**df**	**Sig (2-tailed)**	**Say**	**Information**
Pre Test	HOTS's ability to solve social problems	-.931	91	.354	-	There is no difference in the average ability of HOTS to solve social problems in the experimental class and the control class
	CT's ability to solve social problems	1.104	159	0,271	-	There is no difference in the average CT ability to solve social problems in the experimental class and the control class
Post-tes	HOTS's ability to solve social problems	10.763	91	0,000	-	There is a difference in the average ability of HOTS to solve social problems in the experimental class and the control class
	CT's ability to solve social problems	- 10.053	159	0,000	-	There is a difference in the average CT ability to solve social problems in the experimental class and the control class

Table 9 shows the results of hypothesis testing on pre-test and post-test data. Test results *independent sample t-test* The pre-test data obtained a significance value of 0.354. The significance value is above 0.05 (sig. > 0.05) so that H0 is accepted and H1 is rejected, which means there is no difference in the average HOTS ability to solve social problems before being given treatment in the experimental class and control class. Next, for the computational thinking variable, test results of the *independent samples t-test* on the data *stop you* obtained a significance value of 0.271. The significance value is above 0.05 (sig. > 0.05) so that H0 is accepted and H1 is rejected, which means there is no difference in the average CT ability in solving social problems before being given treatment in the experimental class and control class.

Conclusion

The IHI learning model is declared suitable for improving the abilities of *Higher Order Thinking Skills* (HOTS) and *Critical Thinking* (CT) in S1 IPS students in solving social problems. This model is supported by the completeness, relevance, and accuracy of its components, which have gone through a review, assessment, and agreement process from experts in the fields of education, assessment, and social sciences. Practical IHI learning model for improvement of *Higher Order Thinking Skills* (HOTS) and *Critical Thinking* (CT) nature of solving social problems in S1 IPS students. This is proven through observations of the implementation of learning using the IHI model, which received a very good category, as well as positive responses from lecturers and students who stated that this model was very practical. The IHI learning model has the potential for significant effectiveness in improving abilities of *higher order thinking Skills* (HOTS) and *Critical Thinking* (CT). This is evident from the N-Gain value for the experimental class, which is higher than the control class, as well as the test results *independent sample t-test* which shows there is a significant difference in average ability *Higher Order Thinking Skills* (HOTS) and *Critical Thinking* (CT) between the experimental class and the control class.

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