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The validity and practicality of the SEDC learning model to improve students' HOTS in science learning

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ABSTRACT

As we move into the twenty-first century, education is becoming increasingly critical in order to ensure that every student has the skills necessary to meet the demands of the twenty-first century. The challenge in the world of education in Indonesia today is to provide quality education that is capable of producing competent human resources. To meet the demands of the twenty-first century, STEM-based education is required. Students in Era 4.0 must not only have high-order thinking skills, but also digital literacy. Teachers and students must be able to make the best use of technology, which would enable teachers to develop an online learning setting. The effects of the Covid-19 pandemic have hastened the adoption of information technology in the field of education. During the Covid-19 pandemic, teachers and students must study online using information technology due of limitations on activities and connects directly. By use of digital learning during COVID-19 offered excellent opportunities for teachers to gain experience in digital learning and teaching. The teacher must first plan by using a learning model that supports the online learning process, such as the Community of Inquiry (CoI). Therefore, the development of a STEM-based CoI learning model was carried out, namely SEDC. The aim of this study is to assess the SEDC learning model's validity and practicality. This study uses a 4D design to define, design, develop, and disseminate. In this study, 116 students participated in small-scale test, large-scale test, and dissemination studies, with two expert lecturers as validators and one teacher as users. The validation results were 95.6% with very valid categories. The result for practicality is 84.69% in the very practical category. As a result, this learning model can be concluded to be both valid and practical in rising HOTS. Therefore, it's suggested that it's used in the learning process particularly in terms of increasing student HOTS

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INTRODUCTION

Education is one of the most critical aspects of enhancing a country's quality of life. The success and quality of a country would be directly proportional to the quality of its education. As we enter the twenty-first century, education is becoming increasingly critical in ensuring that every student has the necessary skills to meet the demands of the twenty-first century (Andrian & Rusman, 2019). Learning in the twenty-first century necessitates the development of information management and technology skills, as well as the ability to learn and innovate, pursue a career, and achieve global consciousness, as well as good character (Utomo et al., 2020). In today's world of education in Indonesia, the challenge is to provide high-quality education capable of generating skilled human capital. The first step in tackling the problem is to improve student-centered learning. The teacher is no longer a learning center, but rather a facilitator who must help students become more engaged in their learning and prompt them to think critically (Hobri, et al., 2020). Students are expected to have not only expertise, but also a scientific way of thinking and 21st-century skills (Afandi, et al,, 2019). The hope is that students will develop into high-quality human resources capable of overcoming a variety of problems, especially in Indonesia.

One of the problems faced by the Indonesian is the low quality of education. This is supported by the findings of the Program for International Student Assessment (PISA) assessment, which indicate that Indonesia remains below the PISA average level, ranking 72nd out of 77 countries that took the PISA exam (OECD, 2019). Students' lack of knowledge, particularly in scientific literacy, reading skills, and mathematics (numeracy), may cause this gap (Anggraeni & Suratno, 2021). As a result, the learning process in schools should be meaningful to students and capable of providing skills and competencies for work (job and life skills) in accordance with 21st century demands (Lévano and Albornoz, 2016).

Meaningful learning is a learning process that provides students with learning opportunities and allows them to comprehend what they are learning. Developments and improvements in cognitive systems are often used to characterize meaningful learning. The knowledge acquired must be applicable to prior knowledge (Kostiainen et al., 2018). Learning must be able to trigger students to think at higher levels in addition to being meaningful. Teachers must be creative in order to teach students higher-order thinking skills (HOTS).

HOTS is a more abstract thinking capability that can be used to solve a variety of problems, such as critical and imaginative thinking. HOTS is described as the ability to analyze, evaluate, and create, according to Bloom's revised taxonomy (Apino and Retnawati, 2017). Higher order thinking skills are the ability to solve problems logically, critically, creatively, and independently. Logical thought is the ability to reason, or the ability to think in a way that is understood by common sense and follows scientific thinking principles. Reflective-evaluative thought is critical thinking (Setiawati, et al, 2019). HOTS is a collection of elaborative mental operations that require sophisticated judgment and analysis of difficult situations based on many criteria or the identification of a feasible solution to a difficult problem (Widana, 2018).

Brookhart (2010) classified HOTS into three contexts of understanding, includes (1) higher-order thinking as a transfer (students can apply their knowledge and skills which they can further develop into a new context); (2) higher-order thinking as critical thinking (express self-reasoning, responding, and decision making without teacher's intervention); and (3) higher-order thinking as a problem solving (serving students' ability to identify and solve their problems in the work and daily lives). Students will also need HOTS to help them define, analyze, develop, and apply knowledge that is relevant and useful in the workplace (Teo, 2019). Bloom's new taxonomy shows HOTS categories including analyzing, evaluating, and creating (Fastiggi, 2019). Teachers must prepare students to think at higher levels by introducing a learning process that stimulates HOTS, such as using the STEM approach. STEM (science, technology, engineering, and mathematics) approach, connects four disciplines to provide students with opportunities for practical learning (Ceylan & Ozdilek, 2015). Furthermore, STEM is a multidimensional approach that is intended to technique into problem-solving experts (Pimthong & Williams, 2018). The implementation of the STEM approach that has been carried out shows that there is a positive relationship with problem solving ability (Suratno, et.al. 2020).

Students in Era 4.0 must not only have HOTS, but also digital literacy. Teachers and students must be able to make the best use of technology, which would enable teachers to develop an online learning setting. The Covid-19 pandemic has caused social constraints, which have also affected learning activities. To reduce social interaction, teachers and students participate in online learning. During the COVID-19 epidemic, online learning is the primary strategy for maintaining maximum learning (Purwadi, et al., 2021). The effects of the Covid-19 pandemic have hastened the adoption of information technology in the field of education. By use of digital learning during COVID-19 offered excellent opportunities for teachers to gain experience in digital learning and teaching (Abdulrahim and Mabrouk, 2020). The teacher must first plan by using a learning model that supports the online learning process, such as the Community of Inquiry (CoI).

The CoI learning model is a three-framework online interactive learning model that includes social presence, teaching presence, and cognitive presence. The CoI paradigm can be used to provide basic theory and practice in the area of online learning (Junus, et al., 2019). This is very important to today's learning process, which makes online learning possible through the use of technology (Ristanto, et., 2022; Dewi, et al., 2021). There were many researchers bring out the topic of the CoI in education but there were still few teachers who were aware of the importance of CoI and how to implement it into learning (Rachman, et al., 2021). The results of research on the CoI learning model show that CoI has a significant impact on students' social skills (Syarifuddin, et al., 2020). Another study conducted by Junus et al., (2019) showed that there was an increase in metacognitive abilities. Furthermore, CoI learning has a substantial impact on the collaborative interactions of students (Hilliard & Stewart, 2019). But, no studies examines the impact of the CoI learning model on HOTS has been conducted.

In online learning contexts, students must still obtain HOTS in an online learning environment. Teachers can teach HOTS to students using the STEM approach. This is supported by Yusuf, et al. (2018) which reveals that STEM-based learning can boost students' HOTS competence. The STEM approach and the CoI learning model can be combined to provide resources for students to investigate in the learning community in order to achieve learning goals especially HOTS. The STEM approach was chosen based on questionnaires and interviews with various teachers, which revealed that up to 84,64% of teachers comprehended STEM. However, after doing more research, it appears that teachers simply know the acronym STEM, but not the integration and implementation of STEM in the classroom. As a result, a firm understanding of the STEM idea is required. The results of STEM research by (Apriyani, et al., 2019) show that STEM learning improves problem-solving skills, which is included in HOTS. In addition, STEM learning is also effective in improving the academic results of students (Çaycı & Örnek, 2019), developing critical thinking (C4) and problem-solving skills (C6) (Cetin, 2020).

The implementation of CoI learning also has weaknesses, such as the interaction with fellow pupils or lecturers is limited due to a lack of communication. Furthermore, because there is no ongoing collaboration among peers, the student learning experience is less deep and meaningful (Annand, 2019). Another flaw is that no attention is paid to the social and dialogical components of thinking (Breizek, 2016). The STEM approach can compensate for the weaknesses of the CoI learning model. A STEM approach may be used to complement this. STEM-based learning that focuses on group project activities can teach students how to work both synchronously and asynchronously. Students will be taught how to communicate and collaborate on a continuous basis as a result of this (Hacioğlu & Gülhan, 2021)

Based on the descriptions that have been described, it is necessary to develop a CoI learning model that is oriented towards the STEM approach in order to obtain learning that has the potential to increase students' HOTS. The development was carried out by combining the CoI model's learning stages, which consist of four stages: triggering events, exploration, integration, and resolutions, with the STEM approach's concepts. The learning model developed is stimulation, exploration, design and conclusion (SEDC), the SEDC learning model allows students to be more active and the learning process is more meaningful and improves higher-order thinking skills. Therefore, a development research was carried out on the learning model of stimulation, exploration, design and conclusion (SEDC) to increase higher-order thinking skills.

METHODS

Research Design

This type of research is research and development, which is used to produce good school materials. Thiagarajan's 4D model used in this research design. The first stage was define, the goal at this stage to define the terms of learning starting with the objective analysis of the constraints of the material being developed by the device. This stage includes 5 main steps, namely front-end analysis, student analysis, task analysis, concept analysis, formulation of learning objectives. The second stage was design, which aims to prototype a model in accordance with the learning objectives. This stage consists of constructing a criterion-referenced test, media selection, initial design. The third stage was develop, this stage is the stage that results in learning products that have been evaluated and consists of 2 stages. The first stage is the assessment of experts and users (teachers) and the second stage is small group trials. The last stage was disseminate, this stage has been carried out by distributing the SEDC learning model book product to several schools. However, in this article, the researcher only discusses the validity and practicality of the SEDC learning model

Population and Samples

The participants in this research were 7th grade students at SMPN 1 Dringu Probolinggo in the 2020/2021 academic year. The sample was one class, in the small-scale test using 9 students as respondents while for the large-scale test using one class. The dissemination stage follows, with the goal of exposing the product outputs to other teachers so they can be used in learning activities. The dissemination stages were carried out in three different schools including: SMPN 1 Kabat Banyuwangi, SMPN 1 Glagah Banyuwangi, Mts Hasyim Asyari.

Instrument

a. Learning Model Validity

The validity of the learning model is defined as the average percentage of assessment of the validation indicators from expert validators and users of the developed SEDC learning model. Validity of learning model was measured using a validation assessment sheet which includes an assessment of the validation of learning devices consisting of syllabus, lesson plans, test questions, students worksheet, and learning model book. The initial draft (learning model book) contains the background and objectives of the learning model developed, as well as the characteristics of the learning model that consist of model syntax, social systems, reaction principles, support systems, instructional impacts (Anggraini, 2021). The form of validation assessment carried out by the validator is by placing a check-list (√) in the column provided and writing down criticism and suggestions.

b. Practical Learning Model

The practicality of the learning model is defined as the average percentage of the learning implementation assessment from the learning observer, which is measured using the learning implementation observation sheet at least in the practical category In addition, to measure the practicality of the learning model used questionnaire Practicality data analysis was obtained from the questionnaire instrument for teacher and student responses to the learning model (Novitra, et al., 2021). The questionnaire designed aims to determine the response of teachers and students to the learning process of the SEDC model. The compiled questionnaire distributed using google forms to make it easier for teachers and students.

Procedure

The developmental design used is a 4D developmental learning model (Thiagarajan, 1974) consisting of the define, design, develop and the dissemination. The first stage is define, the goal at the define stage is define the learning requirements starting with the objective analysis of the material constraints the device develops. This stage includes 5 main steps, namely:

1) Front end analysis. Activities at this stage are analyzing the curriculum, school conditions and literature studies as the basis for developing models and developing tools used to support models developed in the implementation of limited trials. At this stage the researchers distributed questionnaires to several science teachers to find out which learning models had been used, to find out whether the teacher provided a stimulus or triggering event to students, trained students to make mind mapping, training in the form of experiments to students, directing students to ask questions, discuss, express opinions, and confirm in the learning process. This stage is carried out by researchers to get a picture of facts, expectations, and alternative problem solving that makes it easier to determine the learning model developed.
2) Analysis of students. This stage is carried out by analyzing the character of students including the academic ability of students in understanding and receiving learning through student learning outcomes in the previous material. In addition, an analysis of the HOTS of students was conducted.
3) Task analysis. The activity at this stage is that the researcher examines the possible tasks to improve active learning that is centered on students. In developing this model, it is practicing / experimenting, discussing to do exercises, presenting discussion results and making conclusions.
4) Concept analysis. The concept analysis stage is carried out by identifying the main concepts to be taught, systematically arranging and detailing the relevant concepts.
5) Formulation of learning objectives. This stage is carried out to convert the results of the task analysis and concept analysis into the goal of developing a learning model.

The second stage is design, the goal at this stage is to design a prototype model in accordance with the learning objectives. These stages include:

1) Constructing criterion-referenced tests. This stage includes the preparation of tests used in the implementation of the SEDC learning model at the development stage after validation by experts. The preparation of tests is carried out based on learning objectives in accordance with KD (Basic Competence).
2) Media selection. Selection of the media to be used must be in accordance with the character of the material in science subjects, including the use of powerpoints, simple experimental equipment, and the use of the surrounding environment.
3) Prototype model (Initial design). The initial design obtained is simulated in advance on material that can be studied contextually. Before the design continues at the next stage, it is necessary to validate the resulting product (learning model).

The third stage is develop consists of several stages, including a) expert and user validation of the SEDC model, b) small group testing, and c) large group testing. The fourth stage is disseminate, this stage attempts to publish the research findings.

Data Analysis Techniques

The data from the result of validation were calculated by using the following Formula (1).

$$V = \frac{T_{SE}}{T_{SM}} \times 100\% \quad \text{........ (1)}$$

Note :

V : percentage rate rating

T_{SE} : The total empirical score obtained

T_{SM} : Maximum total score

Table 1

The criteria for the validity of the SEDC learning model

No.	Score	Category	Conclusion
1.	81,25 %≤ x ≤ 100%	Very valid	Very good to use
2.	62,5% ≤ x < 81,25%	Valid	Can be used with minor revisions
3.	43,75% ≤ x < 62,5%	Less valid	Can be used after major revisions

No.	Score	Category	Conclusion
4.	25%≤ x < 43,75%	Not Valid	Should not be used

(Source: Akbar, 2013)

Analysis of the practicality of the learning model
The practicality of the SEDC learning model can be seen by analyzing the responses of teachers and students. Response questionnaires are given to respondents (teachers and students) after teaching and learning activities are completed. This questionnaire is in the form of a teacher response questionnaire to the SEDC learning model by the teacher and a student response questionnaire after participating in learning using the SEDC learning model. The data from the result of teacher and student responses were calculated by using the following Formula (2).

$$P = \frac{T_{SO}}{T_{SM}} \times 100\% \text{ .... (2)}$$

Note :
P : percentage rate rating
T_{SO} : Total score obtained
T_{SM} : Maximum total score

Table 2.
Criteria for the practicality of the SEDC learning model

No.	Score	Category	Conclusion
1.	81,25% ≤ x ≤ 100%	Very practical	Very good to use
2.	62,5%≤ x < 81,25%	Practical	Can be used with minor revisions
3.	43,75%≤ x < 62,5%	Less practical	Can be used after major revisions
4.	25% ≤ x < 43,75%	Unpractical	Should not be used

(Source: Akbar, 2013)

RESULTs AND DISCUSSION
1. Define stage

The definition stage is carried out by distributing questionnaires to teachers in several schools to find problems or needs needed by the teacher (need assessment). The results of the defining stage can be seen in Table 3.

Table 3.
Results of the define

No.	Define stage	Result
1.	Front-end analysis	a. The curriculum used Curriculum 13. b. 30.76% of teachers apply inquiry learning. c. 23.07% apply Problem-based Learning model. d. 15.38% apply Discovery Learning. e. 15,38 applying contextual learning. f. 7.6% Project-based Learning and 7.6% others. g. 76% of other students had higher order thinking skills in the less category. h. 84.61% know the STEM approach i. 61.53% apply STEM in learning j. 76.92% do not know CoI and 53.84% never apply it in learning
2.	Analysis of learners	a. 72.7% of students stated that the circulatory system material is difficult material. b. 43.6% of students stated that the teacher trained students to think critically c. 47.3% of students stated that teachers often provide questions that are relevant to everyday life. d. 60% of students stated that the teacher trained students to have problem solving skills e. 52.7% of students stated that the teacher had not taught designing activities in learning f. • 41.8% of students stated that the teacher did not provide activities that foster student creativity
3.	Task analysis	The task that will be given is in the form of Student Worksheet in which there are several questions that are discussed in groups.
4.	Concept analysis	The concept was relevant to the learning model developed basic

		competencies 3.7-4.7 and 3.8-4.8.
5.	Formulation of learning objectives	Formulate learning objectives to be achieved

Table 3 was the resume of the define stage; at this stage, questionnaires were distributed to teachers and students. The aim of a need assessment was determine the quality and knowledge about education. Various information required and expected can be gathered through a need assessment. The aim of front end and student analysis was to investigate knowledge and problems in the field, then find solutions. Task analysis used to evaluate the tasks that will be used to implement the learning model. A task list generated after a task review. Task analysis was a procedural analysis in which the stages of task completion are identified in order to achieve competence (Utami & Amiruddin, 2018). The fourth stage was concept analysis, which involves finding and evaluating whether the sub-material in the lesson plan was appropriate for the learning model being developed (Yunika, et al., 2020).

2. Design stage

In this planning stage, the researcher designs a prototype model in accordance with the learning objectives. The planning stage consists of three stages which include Constructing criterion-referenced test, Media selection, prototype model (initial design). The results of the design stage can be seen in Table 4.

Table 4.
Results of the Define stage

No	Design stage	Result
1.	Constructing criterion-referenced test	a. Tests were compiled based on the basic competence is used, which were basic competencies 3.7-4.7 and 3.8-4.8. b. Essay questions with a total of 6 questions (on test 1) and 8 questions (on test 2) c. • The number of questions is based on the range and complexity of the content covered in the basic competencies, with a 60-minute time limit for answering them.
2.	Media selection	Student Worksheets, powerpoints, science books, internet and the use of the surrounding environment.
3.	Initial design	a. Syntax planning of the SEDC model b. The purpose of developing the SEDC learning model c. • Theories that support the SEDC learning model

Table 4 was the summary of the design stages, activities undertaken at this stage are the preparation of learning outcomes, media selection, format selection, and early design of learning (Munir & Nur, 2018). The preparation of the test must be done precisely so that it can reveal the true condition of the measuring object. In terms of the success of the learning process and the enhancement of student learning outcomes, teacher-created assessments are crucial (Gulo, 2020). The next stage was media selection, which is critical for learning progress due to the media's strategic role. Learning media that are used correctly make the learning process more successful and usable, and useful tool in achieving learning objectives. Learning media were often used to get over the learning process's limitations (Puspitarini & Hanif, 2019). The learning model prototype was planned in the third level. A prototype is a physical representation of a concept (Suson et al., 2020). A learning model created at this point that combines the CoI learning model with the STEM approach. The syntax of the SEDC learning model and the theory that supports can be seen in Table 5.

Table 5.
Syntax of the SEDC learning model and learning theory

Syntax of SEDC learning	Learning Activity		Learning theory
	Teacher's Activity	Student's Activity	
(1)	(2)	(3)	(4)
Stimulation	The teacher gives authentic problems to students and guides students to make mind maps	Students solve problems from the teacher and students express their ideas, ideas and thoughts in mind mapping (Critical thinking and problem solving)	Cognitivism and constructivism learning theory
Exploration	The teacher instructs and guides students in exploration activities	Students carry out science activities such as observation, investigation, or practicum. (Collaborative)	Cognitivism and constructivism learning theory

Syntax of SEDC learning	Learning Activity		Learning theory
	Teacher's Activity	Student's Activity	
(1)	(2)	(3)	(4)
Design	The teacher assists students in finding a solution and listens to the results of student discussions.	Students work together in groups to design a solution (in the form of a work) to the largest issues and discuss the findings. Students also formulate result of activity Exploration and working on LDS (Creative thinking and innovative)	Social constructivist learning theory
Conclusion	The teacher gives the students constructive feedback, evaluation, and praise for their efforts.	The teacher provides feedback, appraisal, and gratitude to the students. Students can also confirm the results of the conversation with the teacher if they really do not resemble the theory (Communication)	Cognitivism and constructivism learning theory

3. Develop stage and disseminate stage

The develop stage consists of several stages, including a) expert and user validation of the SEDC model, b) small group testing, and c) large group testing. The validation procedure involves two experts (development experts) and one user (teacher). Validation is a crucial step in ensuring that the instruments built can accurately measure what needs to be measured (Ramli, et al,, 2020). Expert validation was performed to identify flaws, eligibility, and product development changes that were needed (Sofia, et al., 2020). The results of the validation of the SEDC learning model can be seen in Table 6.

Table 6.
The results of product validation results from the development process by experts and users (teachers)

No.	Instrument	Validator	Percentage	Criteria
1.	SEDC learning model guide	Expert lecturer	98.39	Very valid
		Expert lecturer	77.75	Valid
		Teacher	100.00	Very valid
		Validation mean	92.04	Very valid
2.	Syllabus	Expert lecturer	96.88	Very valid
		Expert lecturer	96.18	Very valid
		Teacher	97.74	Very valid
		Validation mean	96.93	Very valid
3.	Lesson plan	Expert lecturer	98.44	Very valid
		Expert lecturer	88.67	Very valid
		Teacher	98.44	Very valid
		Validation mean	95.18	Very valid
4.	HOTS test	Expert lecturer	100.00	Very valid
		Expert lecturer	84.37	Very valid
		Teacher	100.00	Very valid
		Validation mean	94.79	Very valid
5.	Teacher response questionnaire	Expert lecturer	100.00	Very valid
		Expert lecturer	75.00	Very valid
		Teacher	100.00	Very valid
		Validation mean	96.27	Very valid
6.	Student response questionnaire	Expert lecturer	100.00	Very valid
		Expert lecturer	100.00	Very valid
		Teacher	100.00	Very valid
		Validation mean	100.00	Very valid
Mean of all validations			95.86	Very valid

Table 5 is the resume of develop stage, at this stage a validation process has been carried out from expert lecturers and users. The purpose of validation assessed whether the product is ready to be implemented or not. The syllabus is a simple learning structure that includes a list of subjects, assignments, procedures, and learning contents (Sarigöz, 2019). The lesson plan SEDC learning can resolve the demands of the twenty-first century, which require students to have the skills required in this period such as HOTS. Students can better understand and learn 21st-century skills by integrating science, mathematics, technology, and engineering (Çalış, 2020). Along with quantitative data, the validation process of learning tools yielded qualitative data in the form of comments and recommendations from the validator. Table 7 shows validator criticisms and suggestions.

Table 7
Validators' comments and recommendations on research product

No.	Instrument	Validator	Notes	Follow-up
1	SEDC learning model guide	1st Expert lecturer	1. The font size has been increased, and the layout design has been adjusted to optimize the book's content. 2. The word "implementation" was added to the book's title. 3. There must be a clear connection between the underlying theory and the learning model.	1. The font size was increased from 11 to 12 points. The content section's arrangement is only on the boundaries, thus it doesn't take up much room. 2. Adding the term "implementation" to the book's title. 3. Make a detailed list of the relationship between the supporting theory and the learning model.
		2nd Expert lecturer	1. Remove the words "draft" from the title. 2. The authorship of the supervising lecturer must be listed. 3. A learning theory that underpins each step of the learning process is required. 4. The name of the abbreviation of the learning model must be changed without affecting the substance.	1. Remove the word "draft" from the book's title. 2. Adding a supervisor to the learning model manual as a writer. 3. Incorporating learning theory into the learning process. 4. Change the name of the acronym for the learning model without changing the substance
		Teacher	-	-
2	Syllabus	1st Expert lecturer	The RPP-adjusted curriculum has been included.	Adjusting the syllabus to include only the topics that will be used
		2nd Expert lecturer	-	-
		Teacher	The syllabus should include learning resources.	Add learning resources to the syllabus
3.	Lesson plan	1st Expert lecturer	-	-
		2nd Expert lecturer	-	-
		Teacher	-	-
4.	HOTS test	1st Expert lecturer	1. The test questions should be matched to the lesson plans' learning objectives. 2. The problem's stimulus must be based on reality.	1. Aligning questions with the lesson plan's learning objectives. 2. Changing the question stimulus to reflect the current situation
		2nd Expert lecturer	-	-
		Teacher	-	-
5.	Teacher response questionnaire	1st Expert lecturer	It is necessary to add an observation sheet for the implementation of the learning model.	Adding an observation sheet for the learning model's implementation.
		2nd Expert lecturer		

No.	Instrument	Validator	Notes	Follow-up
		Teacher		
6.	Student response questionnaire	Expert lecturer	-	-
		Expert lecturer	-	-
		Teacher	-	-

The practicality of the SEDC learning model can be seen from the data on the implementation of the learning model, teacher response questionnaires and student response questionnaires. Response questionnaires are given to respondents (teachers and students) after teaching and learning activities are completed. The results of the feasibility test of the SEDC learning model in the small group test can be seen in Table 8.

Table 8.
The results of observations of the implementation of the SEDC learning model

No.	Learning Activities	Treatment				
		Small group test	**Large group test**	**1st Dissemination**	**2nd Dissemination**	**3rd Dissemination**
1.	Introduction	100.00	90.00	93.33	100.00	100.00
2.	Main learning	75.00	91.67	100.00	83.33	91.67
3	Conclusion	77.78	100.00	100.00	100.00	100.00
	Average	84.26	93.89	97.78	94.44	97.22
	Category	Very Practical	Very Practical	Very Practical	Very Practical	Very Practical

A summary of the results's observations on the implementation of the SEDC learning model on small group tests, large group tests, and dissemination shown in table 6. Introduction, major learning, and conclusion are the three aspects of learning exercises. The treatment on the small group exam revealed that the scores were 75 and 77.78 in the main learning and conclusion phases, respectively. This is due to the implementation of the new SEDC learning model, which necessitates the use of trials to remedy weaknesses. Following that, changes to the SEDC learning model were made, including properly preparing learning tools, managing time, and interacting often with class teachers and students. The findings of the next study revealed an increase in scores when the SEDC learning model was implemented. This confirms that the SEDC learning model was practical in the classroom.

The SEDC learning model has been applied to environmental pollution materials in junior high schools. Pollution of the environment is a serious issue that must be addressed soon. As a result, in this SEDC learning model, students are taught how to analyze, evaluate and create solutions to environmental problems. The stages of the SEDC learning model are: in the Stimulation step, problem giving can train students' analysis skills (C4) and evaluation (C5), (2) exploration trains students to explore science and digital literacy activities, (3) design, students are trained to be able to create (C6) a product or work that can be used in everyday life, (4) a conclusion, at this stage the teacher guides students to be able to conclude and provide follow-up and assignments for the next meeting. These were supported by research (Parmin & Sajidan, 2019) that developing products is a type of problem-solving training for students, and its implementation had a large impact on student academic progress (Kurt & Benzer, 2020). The results of the teacher's questionnaire responses to small group test, large group tests and dissemination can be seen in Table 9.

Table 9.
Questionnaire for teacher responses

No.	Indicator	Treatment				
		Small group test	Large group test	1st Dissemination	2nd Dissemination	3rd Dissemination
1.	Achievement of Competencies and Learning Objectives	80.00	97.5	95.00	95.00	90.00
2.	Student Response	70.83	95.83	91.67	91.67	100.00
3	Implementing learning models is easy	75.00	95.83	100.00	100.00	91.67
4	Time sufficiency	93.75	93.75	100.00	88.00	100.00
	Average	79.89	95.73	96.67	93.54	95.42
	Category	Practical	Very Practical	Very Practical	Very Practical	Very Practical

A summary of the results's teacher questionnaire on small group tests, large group tests, and dissemination shown in table 9. The results of the indicator for student response in the small group test reveal a score of 70.83 in the practical category, as shown in the table above. This is due to the fact that students require time to adjust to the SEDC learning model. Similarly, in the practical category, the indicators for the ease of implementation of the learning model indicate a score of 75. Teachers, meanwhile, need to time to adjust to this new learning model. The Covid-19 epidemic has had an impact on educational activities as well. Online learning must be followed by both students and teachers. Online STEM learning activities are also new activities, therefore students need adopt and practice frequently. Large-scale social limitations imposed by the Indonesian government have had an impact on communal and educational practices. For schools that are only beginning to implement the School from Home (SFH) system, distance learning or online programs have provided options. SFH is a program that transfers learning from the classroom to the home. Schools must structure online learning to provide a meaningful learning experience for pupils without being overwhelmed by the pressures of meeting all curriculum standards, according to Ministry of Education and Culture directives (Rasmitadila, et al., 2020). Questionnaire students' responses to the learning model in small and large group tests can be seen in Table 10.

Table 10.
Questionnaire responses of students

No	Indicator	Treatment				
		Small group test	Large group test	1st Dissemination	2nd Dissemination	3rd Dissemination
1.	Learning activities like this make me happy.	68.06	80.61	82.81	82.81	82.35
2.	Learning activities like this make me interested in learning science	79.17	84.05	78.89	82.81	83.82
3.	I prefer science learning like this compared to usual science learning.	68.06	78.45	80.47	85.16	86.03
4.	Learning activities like this make it easier for me to understand the material	66.67	80.17	82.81	85.94	85.29
5.	Learning activities like this make me more trained in asking questions and thinking.	77.78	83.62	83.59	85.94	86.76
6.	Learning activities like this make me more trained in expressing opinions.	75.00	82.76	84.38	86.73	86.03
7.	Learning activities like this make me more active	81.95	85.34	82.81	84.38	83.82
8.	Learning activities like this make me better understand how to solve a problem.	84.72	81.90	86.72	87.80	86.76
9.	Learning activities like this make me more trained in working together to solve problems and find solutions.	79.17	84.48	84.38	85.94	85.29
10.	If this kind of learning is applied to the next chapter, I'll be satisfied.	66.67	83.19	87.50	87.50	88.24
	Average	74.72	82.46	83.44	85.50	85.44
	Category	Practical	Very Practical	Very Practical	Very Practical	Very Practical

Table 8 shows the findings of the average student's questionnaire in the small group test, large group test, and dissemination stages. The SEDC learning model has a good impact on the learning process, as seen by this. When practitioners or experts state that the learning tools developed can be used in the field, the learning is said to be practical. It is clear from the table above that a lot of indicators have low values (indicators of numbers 1,3,4, and 10). This is due to the fact that students prefer direct learning, which is currently online learning. They use this questionnaire to compare learning before the pandemic, allowing them to conclude that students prefer direct learning. Students experience boredom while learning online, according to research conducted by (Rasmitadila, et al., 2020), who found that students were enthusiastic about learning at the start of SFH and online learning, but after two months, they were bored and lost interest in learning. Teachers must also discover strategies to lift the morale of their students.

In the field of education, online learning is the fundamental technique for maintaining the maximal learning process during the COVID-19 pandemic. Fears about COVID-19 infection, boredom, insufficient information, lack of touch with classmates, friends, and teachers, lack of personal space at home, and family financial losses all arise when students learn from home. To establish the success of online learning, qualitative and quantitative evaluations are required. The rise of emotional connection and learning motivation is the key to online education's effectiveness (Özhan & Kocadere, 2020)

The teacher's ability to carry out learning in the classroom can also be used to determine the usefulness of educational materials. The teacher plays a crucial role; if the teacher can function as a good facilitator and guide in learning, the learning model will be implemented to its highest capacity (Wulandari, 2018). The study's practicality was determined by the use of the learning model sheet, as well as teacher and student response questionnaires. The response questionnaire was used to get feedback from users of the learning tools developed on how easy the models and learning tools were to use. If teachers and students respond successfully to learning models and resources, they can be called to be practical. Responses to learning models and tools are evaluated using instruments that have been validated by experts on the subject.

CONCLUSION

The SEDC learning model and its instruments and tools are stated to be very valid based on the validation results from expert validators and users. The SEDC learning model is valid for improving higher order thinking skills or Higher Order Thinking Skills of students with the following characteristics of the SEDC learning model: (1) in the Stimulation step, problem giving can train students' analysis skills (C4) and evaluation (C5), (2) exploration trains students to explore science and digital literacy activities, (3) design, students are trained to be able to create (C6) a product or work that can be used in everyday life, (4) a conclusion, at this stage the teacher guides students to be able to conclude and provide follow-up and assignments for the next meeting. The SEDC learning model is stated in a very practical category, this is indicated by the acquisition of practicality test results of the SEDC learning model which is divided into feasibility tests, teacher responses, and student responses.

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