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The Implementation of Interactive Conceptual Instruction (ICI) to Optimize Scientific Communication Skills Achievements on Impulse and Momentum Concept

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Abstract – *To face the challenges of the industrial revolution 4.0 and society 5.0, the Indonesian nation must continue to prepare quality future generations through education. Educational institutions are required to realize human resources who have creative thinking, critical thinking and problem solving, communicating, and collaborating called 4C. This study aims to get an overview of the implementation of interactive conceptual instruction with multi-representation to optimize the achievement of students' scientific communication skills on momentum and impulse concepts. Employing a descriptive research design with an observation method, this research was conducted at a senior high school in the 2020/2021 academic year. This study involved 20 students in the tenth grade which were selected by using cluster random sampling technique. The scientific communication skills were reflected in three sub-skills, namely scientific writing, group discussion, and knowledge presentation. The results of the study showed that the average values of student scientific communication skills (SCS) from the first to the fourth meeting are 53.3, 66.1, 89.3, and 97.8, respectively. The average value is the result of the average value of scientific communication skills of all respondents in each session. It can be concluded that the implication of interactive conceptual instruction with multi-representation approach can optimize the achievement of students' scientific communication skills on momentum and impulse concepts.*

Keywords: *Impulse and Momentum; Interactive Conceptual Instruction (ICI); Scientific Communication Skills*

I. INTRODUCTION

Scientific communication skills are intended as the ability of students to communicate the concept and are understood both verbally and non-verbally but still in the context of physics learning (Spektor-Levy et al., 2008). Communication skills become one of the skills that must be possessed in the world of work, including the science teacher and scientists. Someone who does not master the critical skills of the future will be in an unfavorable position in global competence and have difficulty facing challenges and obstacles that arise along with the development of science and technology (Edwards, 2013; Wijaya et al., 2016; Cantor et al., 2019).

Communication is also used to build a closer relationship between teachers and students to share knowledge, thoughts, and experiences (Fadly & Wasis, 2017; Patriot et al., 2018; Sari et al., 2017; Urwani et al., 2018). Communication skills, including listening, writing, speaking, and interpersonal skills, must be possessed by the teachers to facilitate students' understanding of the material being taught and have the ability to respond to learning effectively (Ihmeideh et al., 2010; Alpusari et al., 2019).

Based on the results of observations in a state senior high school at Palembang through a preliminary study questionnaire that one of the problems of physics learning outcomes that appear in the field is the low ability of students' communication skills. The students feel that their knowledge of scientific communication is still lacking. This is because the ongoing learning is still teacher-centered. Students do not get a learning process that trains scientific communication skills such as arguing in discussions, writing down the results of the material they get, and other sub-communication skills (Anderson et al., 2016; Dipalaya et al., 2016).

Interactive Conceptual Instruction (ICI) model was developed in 2001. This model was developed to support the development of students' thinking skills starting from the level of conceptual understanding. Understanding concepts requires interactive processes that provide opportunities to develop ideas, ideas or concepts through a process of dialogue and thinking (Nuraeni et al., 2014; Rahmaniar et al., 2015). Interactive processes are contained in the stages of an interactive conceptual instruction model.

Interactive conceptual instruction (ICI) is a learning that has four characteristics: focusing on conceptual focus, prioritizing classroom interactions, using research-based materials, and using text (use of texts) (Savinainen & Scott, 2002). Previous research has shown that Interactive Conceptual Instructions (ICI) can optimize student's scientific communication skills (Patriot et al., 2018; Nurlina, 2020).

In addition, the use of technology and media in learning becomes an exciting innovation. One of the physics learning media that can be used for a learning process is PheT simulation media (Physics Education And Technology). This medium is a simulation developed by the University of Colorado which contains physics learning simulations, biology, and chemistry for the sake of learning in class or individual study. This simulation can be used free of charge.

The results of the study show that the use of PhET Simulations can improve students' learning outcomes both in cognitive and affective aspects compared to students who do not use PhET Simulations (Correia et al., 2019). The other research presents the effect of interactive conceptual instruction models assisted by PhET Simulations on improving the ability of multiple representations of students' physics. As we know, multi-representations is one of the scientific communication sub-skills (Vegisari et al., 2020).

On the subject matter, researchers can conclude that there are differences in the effect of the ICI method with conventional learning on the improvement of mathematical communication skills of class VIII students at SMP Negeri 4 Batam. The impact of the ICI method in improving mathematical communication skills is more significant than using conventional learning (Bonita et al., 2016).

Then, the purpose of this study was to get an overview of the implementation of interactive conceptual instruction to optimize students' scientific communication skills. In this study, the update presented is the treatment of the implementation of the ICI aided by PhET simulation on material that has never been studied before, namely momentum and impulse.

II. METHODS

This research used pre-experimental research with a one-shot case study design to find out to what extent scientific communication skills optimize the students' achievement on impulse and momentum concepts. Researchers only conducted treatment that was estimated to have an effect, then a post-test was held.

According to Sugiyono (2017), one-shot case study design described as follows:

Table 1. One shot-case study design

Treatment	Observation
X	O

Information:

X = Giving treatment (treatment)
O = Observation of treatment every learning meeting

This study's population was all class X students at SMAN 22 Palembang. The sampling technique used in this study was the cluster random sampling method, where the sample were taken randomly out of the population. The sample in this study was half of class X IPA 3, namely 20 students as research subjects.

Data collection methods used were observation and interviews. Observations were conducted by observing each individual as a research subject. Interviews were conducted with several students who had received the learning process using an interactive conceptual approach.

In scientific communication skills there are sub-skills used to classify the ability to communicate to: 1) searching information; 2) scientific reading; 3) listening and observing; 4) scientific writing; 5) representing information; and 6) knowledge presentation (Spektor-Levy et al., 2008).

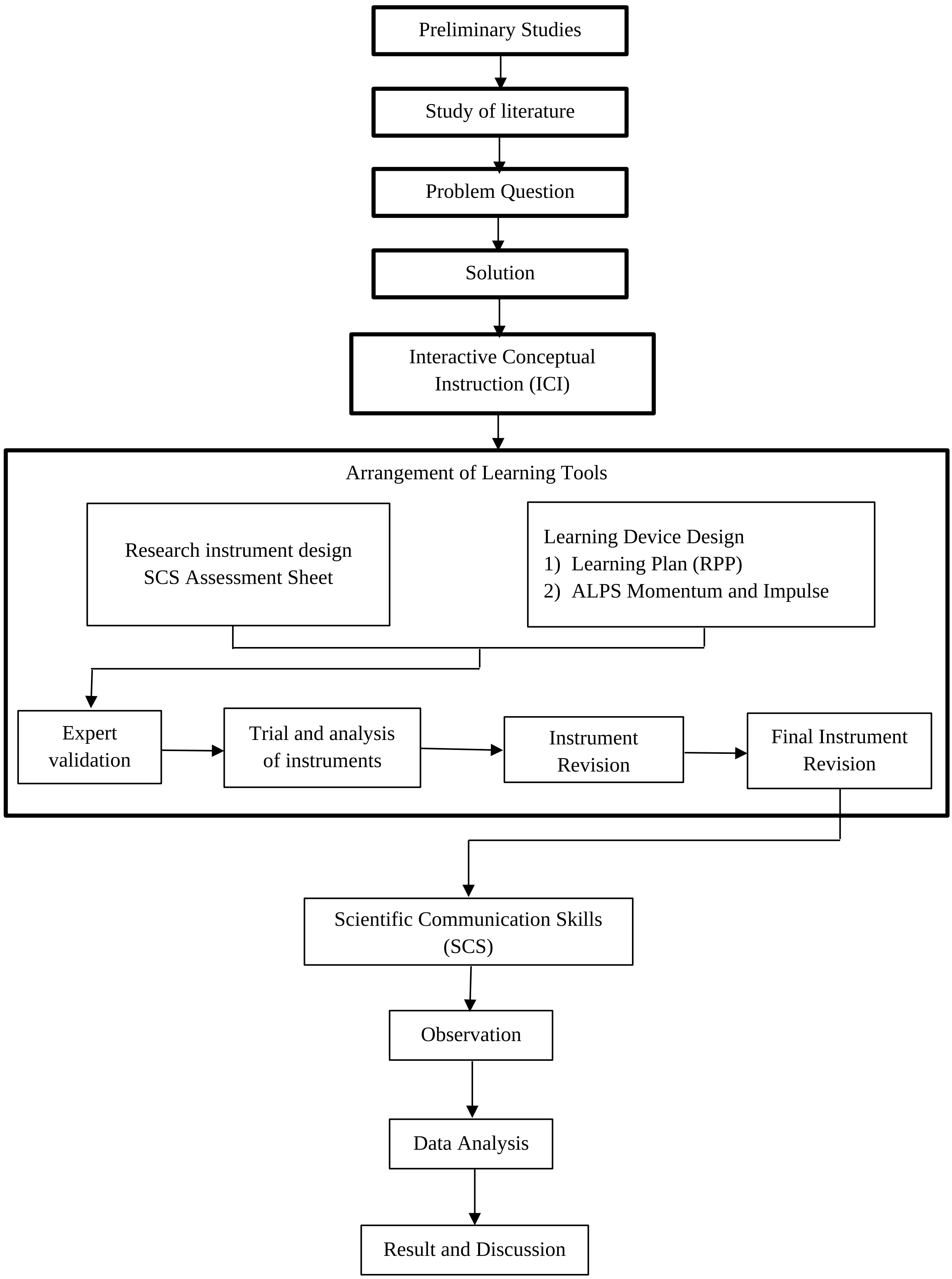

Figure 1. Research Flow Chart

The lesson plan is designed for 4 (four) meetings use the online learning with google meet and facilitated by PhET Simulations. Learning objectives are focused on the achievement of scientific communication skills (SCS), so that the worksheet that is designed refers to the ICI model and contains verbal, picture, mathematical, and graphic representations. The ALPS directs students to present the results of the data in a mathematical and graphical representations. The ALPS also presents questions at the end of the activity to guide students in making conclusions.

Table 2 shows interactive conceptual instruction aided by PhET Simulations on momentum and impulse matter:

Table 2. Interactive conceptual instruction model assisted by PhET simulations.

Syntax	Descriptions
Conceptual focus	Manage students to focus, provide motivation and brainstorming. Example: Linking the learning materials to be carried out with students' experience with the material previously. (In Newton's second law of motion an object, when an object moves an object generate speed, related to event momentum of the material to be discussed).
Use of the texts	Students use textbooks to review the results of data analysis based on theory. In this case teacher distributes ALPS (Active Learning Problem Sheets) on momentum and impulse via WhatsApp media.
Research-based material	Research-based exercise works develop student understanding. Students answer the questions about relation momentum and impulse, doing experiments on PhET Simulations guided by a worksheet (ALPS) from the teacher, students analyze the data. The teacher guides the students in doing discussion activities and provide assistance to students through WhatsApp and Google meets.
Classroom Interactions	At this stage, interactions are involved class. In class interactions, learning occurs involving friends of the same age. The teacher invites each group to present the results of their discussions through WhatsApp media.

The experimental class applies an interactive conceptual learning model with the help of ALPS and lesson plans that have been made. A performance test was conducted by observing the development of scientific communication skills during the learning process to measure the non-test of students' scientific communication skills. The components of scientific communication skills selected to be measured through the physics learning process were 1) group discussion; 2) compiling a resume according to the guidelines (writing); and 3) communicating the report orally (presentation) (Sarwi et al., 2013). Observing the students' performance test aimed to obtain the documentation of students' learning activities, resumes, presentations, etc. At the same time, the instruments used were essay question sheets and performance-test assessment sheets.

The observation sheet of SCS was already adapted to the researched and observed sub-skills as follows (Sarwi et al., 2013):

Table 3. The observation sheet of Scientific Communication Skills (SCS) Achievements

Sub-skills of SCS	Indicator of SCS Achievements
Group discussion	a. Fluency in opinion speaking b. Body language c. Clarity of speech and choice of words d. Submission of content of opinion e. Active in giving questions and answers, can express ideas, respect the opinions of other students
Compile a suitable resume (written)	a. Exposure quality b. Discussion of content in resume
Communicating reports orally (presentation)	a. Concept content in technology products (PPT, CD, Media) b. Ability to present material (focused, systematic) and display quality c. Language use


Active Learning Problem Sheets

MOMENTUM

I. PENGETAHUAN AWAL TENTANG DEFINISI MOMENTUM DALAM ILMU FISIKA

(Pre-knowledge and reasoning)

Petunjuk : Silahkan jawab pertanyaan berikut secara individu berdasarkan pemahaman yang kalian miliki

A. Gambar disamping merupakan gambaran peristiwa tabrakan antara mobil dan truk, setelah diamati mobil dan truk ketika mengalami tabrakan umumnya didapati bahwa mobil mengalami kerusakan paling parah dibandingkan dengan truk, mengapa hal tersebut dapat terjadi ?

....

....

....

....

B. Momentum memiliki beberapa syarat sehingga dapat dikatakan sebagai momentum menurut definisi dalam ilmu fisika. Berdasarkan fenomena fisis yang telah ditunjukkan oleh guru melalui video di depan kelas, sebutkan syarat apa saja yang dapat menyebabkan adanya momentum ?

....

....

....

....

Setelah mengetahui syarat yang menyebabkan adanya momentum, maka berikan definisi momentum :

Momentum adalah...

....

Jadi, momentum dapat dinyatakan dalam persamaan :

p =....................

Figure 2. ALPS (Worksheet) momentum and impulse

The assessment sheet in this study was used to determine scientific communication skills during the physics learning process. Scientific communication skills are seen as developments and improvements in each physics learning meeting. Analysis of students' scientific communication skills in terms of various components has been included in the sample assessment format.

Rubrics are arranged according to the components of scientific communication skills. In this study, a perfect performance gets a score of 3, and a version less than perfect receives a score of 1 (Sapriadil et al., 2018). Student performance observation sheets produce quantitative data that will be analyzed descriptively by using calculating the percentage. In processing the data, there are steps that must be taken, including calculating the total score of students from each observed performance component, calculating with the equation :

$$Score = \frac{Score\ obtained}{Maximum\ score} \times 100\% \qquad (1)$$

The Scientific communication Skills (SCs) are categorized as follows (Patriot et al., 2018):

Table 4. Score category of Scientific Communication Skills (SCS) values

Score	Category
100 – 81	Very Skilled
80 – 61	Skilled
60 – 41	Enough Skilled
40 – 0	Less Skilled

III. RESULT AND DISCUSSIONS

This research was conducted to figure out the achievement of scientific communication skills through the implementation of interactive conceptual instruction assisted by PhET simulation on the concept of momentum and impulses carried out at SMA Negeri 22 Palembang in class X. Based on the lesson plan using the Learning model, Interactive Conceptual or Interactive Conceptual Instruction (ICI) consists of four stages that cannot be separated, namely: 1) Conceptual focus (focusing on concepts); 2) Use of texts (using text); 3) Research-based materials (using research-based teaching materials); and 4) Classroom interaction (prioritize class interaction) (Savinainen & Scott, 2002; Marisda & Rahmawati, 2018).

Analysis of students' scientific communication skills reviewed of the various components that have been listed in the guide rubric evaluation. The result scientific communication skills (SCS) observation sheet produces data that can be seen in figure 3 as follows:

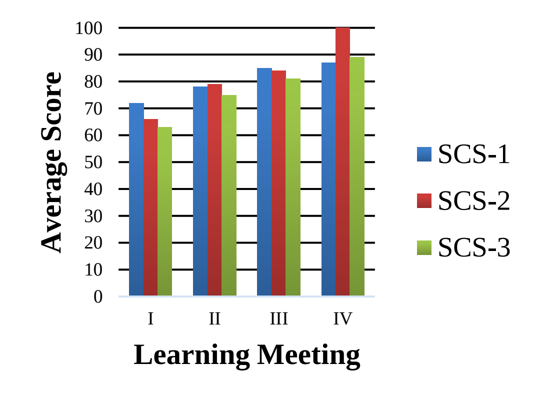

Figure 3. Histogram The Percentage of Observation Result

Based on figure 3 above, the observation data of scientific communication skills has increased at each meeting. Each learning meeting shows that the number of students who initially experienced less skill increased to become sufficiently skilled. Optimal achievement can be seen in the second scientific communication skill, compiling a resume according to the guidelines (writing). At the 4th meeting, this skill showed a 100% result for the percentage of very skilled.

These results are in line with previous research, which shows that interactive conceptual instruction assisted by PhET simulation can train students' scientific communication skills on work and energy subject matter (Patriot et al., 2018; Vegisari et al., 2020).

The increasing percentage of SCS at each meeting can we see through table 5 below:

Tabel 5. Increasing Percentage of SCS

Skills	**Meeting I to II**	**Meeting II to III**	**Meeting III to IV**
SCS-1	6%	7%	2%
SCS-2	10%	13%	16%
SCS-3	9%	4%	5%

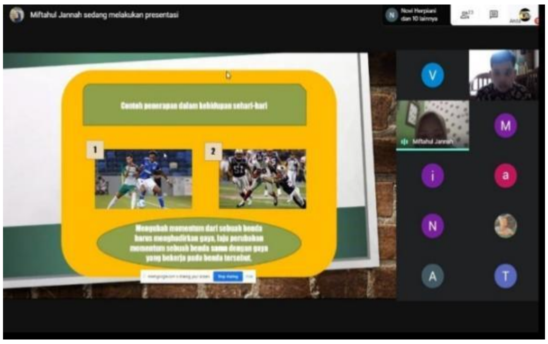

Figure 4. Physics learning process

The research process was carried out online by using Whatsapp and Google Meet applications. Through these media, researchers carried out the physics learning process according to the lesson plan using interactive conceptual instruction (ICI).

Based on the results of observations that have been made, there was an increase in the percentage of SCS-1. Table 5 shows that students continued to actively discuss the physics learning process. This is because they practiced the science communication sub-skill in writing individual resumes based on what they have learned and understood about the concepts of momentum and impulse. Interactive learning process is carried out through media in the form of simulations, videos, and ALPS and accompanied by presentations from each individual.

Research conducted by Sadikin & Hamidah (2020) shows that internet use and multimedia technology can change the way knowledge is delivered and can be an alternative to learning carried out in conventional classes. The fact is that students are able to participate in forums for online learning actively.

SCS-2 is part of students' SCS-3 there is an increase of 12% at the 1^{st} meeting to the 2^{nd} meeting, while other improvement achievements can be seen in Figure 2, the 3^{rd} and 4^{th} meetings of 6% and Online-assisted interactive conceptual instruction able to connect students with their physical learning resources separated or even far apart but can communicate with each other, interact or collaborate. Online learning is a form of distance learning that utilizes telecommunications technology and information, for example the internet Molinda in Sadikin & Hamidah (2020).

In line with the previous researcher's statement that simulation is able to make students involved in the virtual world in it,

so that they can apply their knowledge, abilities, and thoughts. In addition, simulations can guide students to build their critical thinking skills and are also able to describe something that is not visible and attract students' interest to be more involved in learning activities. PheT simulation needs to be applied to students at the secondary school level because it emphasizes the formation of skills to acquire knowledge and communicate it (Fithriani et al., 2016; Apriani et al., 2016).

In the preliminary activity, the researcher connected the learning to be carried out through students' experience with previous material. Researchers also provided examples in everyday life about momentum, for example a car moving has momentum and the ball initially at rest after given the impulse to move quickly. The preliminary activity showed by figure 5 :

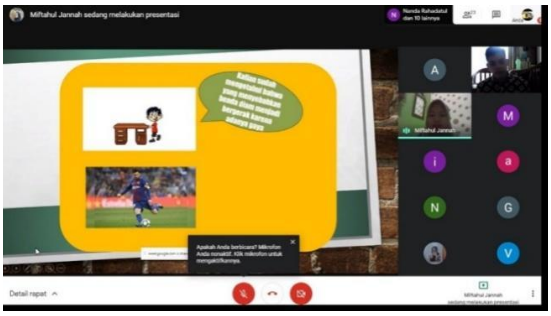

Figure 5. Preliminary Activity Stage in the Physics Learning Process

The core activities with the stages of interactive learning models include conceptual Focus stage (focusing on the concept) researchers have divided students into 4 groups, each group consists of 5 students. Then the researcher presented a power point and a video about learning that would be carried out through Zoom Meeting media and asked what students can explain about the event that happened related to the concept of the material being studied, namely momentum and impulses and provided a deepening of the concept of the material so that students can formulate it.

Figure 6. Conceptual Focus Stage (Focusing on Concepts) On Learning process

At the Use of Text stage, the researcher invited students to take notes on the material presented, asked questions about the concept of momentum and impulse assisted by PhET simulations and shared ALPS (Active Learning Problem Sheets) on the material of momentum and impulse through the media WhatsApp. The researcher invited students to discuss with their groups and answered the questions in the ALPS (Active Learning Problem) Sheets) individually via WhatsApp after learning carried out, due to limited learning time and to keep learning online effective.

The teacher provided simulations on the concepts of 1 and 2 dimensional collisions through PhET simulations. At this stage the teacher asked questions about "*how is the process of a perfectly elastic collision, partially elastic and not elastic at all*?". The PhET application displays a simulation graph in determining whether an object colliding is in one of the three types of collisions (Nana, 2020; Resmiyanto, 2017). Momentum and impulse simulations are shown in the figure below.

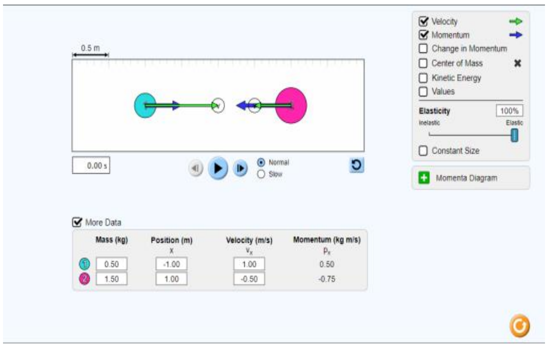

Figure 7. Collisions Concept Simulations.

At the Research-Based Materials stage (using-based teaching materials research), researchers and observers joined in the WhatsApp group so that researchers can guide and observing students in conducting discussion activities and giving assistance to students if they do not understand the problem in ALPS (Active Learning Problem Sheets) via WhatsApp media. The final stage was Classroom Interactions (prioritizing class interaction). As the current situation did not allow for interaction in class such as discussions, presentations or learning activities, the researchers invited each group to present the results of their discussions via WhatsApp media and divided the schedule of presentations based on agreement made with students.

Figure 8. Classroom Interactions Stage (Prioritizing Interaction Class) In the Learning Process

In this stage, the researcher only acted as a facilitator which directed students' mastery of important concepts and prompting questions, while students did constructing mastery of their own concepts. At the final stage, students were given the opportunity to present the results of the discussion and other students were given opportunity to respond to the presentation.

The effective communication in learning physics can certainly lead to a better learning situation so that there is interaction between students and students, as well as students and teachers. Knowledge is formed by students actively, not just passively received from the teacher. They also must communicate the process of thinking both orally and writing (Fadly & Wasis, 2017).

Patriot et al., (2018) states through communicative physics learning, students will be given space to do transfer of knowledge so as to realize physical knowledge that from the abstract to be easier to digest. In this case, the emphasis on physics learning is the cultivation of mastery concepts in depth and train students' scientific communication skills, the formation of solid mastery in students is very useful because the information or knowledge will be more meaningful.

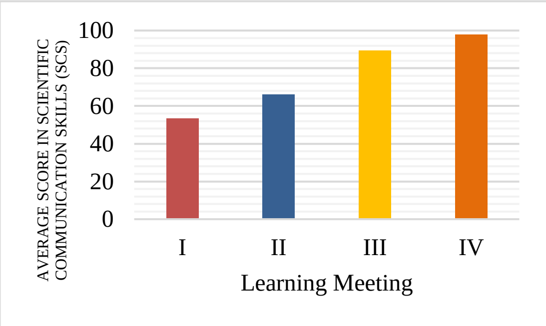

Figure 9. Histogram of Average Score in Scientific Communication Skills (SCS) on every Learning Meeting

Table 3 shows the average student SCS observation sheet data experience an increase in each meeting. In the second meeting, there was an increase of 12,8, in the third meeting, there was an increase of 23,2, and in the fourth meeting, the score improved by 8,5 point. This indicates that students are able to communicate every process in learning that takes place both orally and in writing.

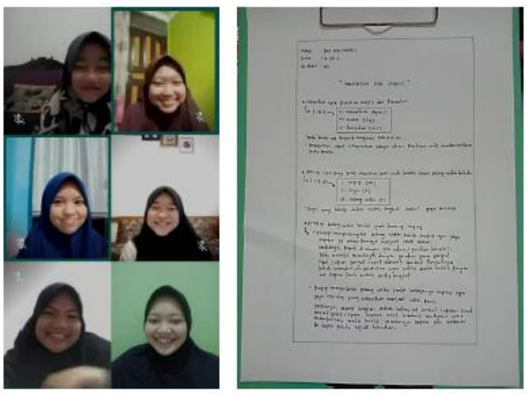

Figure 10. Resume and Presentation Process

The ability of students' scientific communication skills was measured by observation sheet with 3 main components, namely discussion in groups, compiling a resume according to the guidelines (writing), and communicating reports orally (percentage) with the assessment score criteria 1-3, where the most perfect performance get a score of 3 and below perfect performance get a score of 1. The first meeting experienced the most average low score because students are not accustomed to conducting discussions, writing resumes, and doing presentations. At the other meetings, students' ability improved as the students started to get used to conduct discussions, write resumes, and do presentations.

Through communication and interaction activities, students are accustomed to learning in an active environment to express opinions and share ideas. Such a learning environment is able to facilitate students' thinking and communication skills (Lunenburg, 2010; Malik et al., 2018; Rahman et al., 2012). In line with that, the current New Normal era with home learning conditions, students' SCs can be developed optimally. This can be realized through the teacher's questioning skills which are integrated into the students' worksheets (Hermita et al., 2020).

This is also supported by the previous research revealing that the interactive conceptual instruction model develops the memory level of students through experiments and computer-aided instruction. In this method, the systematic process of interactive conceptual instruction model begins with conceptual focus and classroom interaction with analogy (Pratiwi et al., 2020; Sapriadil et al., 2018; Sari et al., 2020).

The results of the previously described research data and theory shows that the interactive conceptual instruction (ICI) assisted by PhET simulations can be a solution to problems that occur in the process of learning physics and can provide new experiences to the process of learning that performs activities that can optimize the achievement of scientific communication skills student. (Kola, 2017; Malik & Ubaidillah, 2021; Win & Nyunt, 2021).

The advantages of this interactive conceptual learning model assisted by PhET simulation are (1) the contextual approach places students as learning subjects; That is, students, play an active role in every learning process by finding and exploring the subject matter themselves. (2) students learn through group activities, discussions, mutual acceptance, and giving, and (3) learning is related to real life (Marisda & Rahmawati, 2018).

Practicing science communication skills to students enables students to express their scientific ideas (Alpusari et al., 2019). Science communication skills enable students to obtain as much information as possible from observations, making it easier for them to solve various problems in learning material. Crucial to the success of these classroom interventions is a need for open communication skills (Chung et al., 2016).

This research has contributed to the world of educational research by implementing learning using interactive conceptual instruction assisted by PhET simulation on the concepts of momentum and impulse. Through this research, it can provide alternative knowledge that teachers can use to improve aspects of concept understanding and optimize the achievement of scientific communication skills in physics learning.

IV. CONCLUSION AND SUGGESTION

From the analysis of the findings, it can be conclude that the was an increase of students' Scientific Communication Skills average score in each meeting. The students' scores in the first, second, third, and fourth meeting were 53.3, 66.1, 89.3, and 97.8, respectively. This indicates that the application of interactive conceptual instruction with multi-representation approach can optimize the achievement of students' scientific communication skills on momentum and impulse concepts.

This research can certainly be developed for the better research. Suggestions for further research is to implement Interactive Conceptual Instruction (ICI) by using other media. The study could be replicated in another area of Physics like Mechanics, Thermodynamics and property of matter.

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