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Democratic interaction in explorative learning model HOTL-DI type B about pottery making

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Abstract
Making pottery is a physics process, so it can be used as an object of physics learning. This study aims to explore the making of pottery as an object of learning physics. This exploratory research uses the HOTL-DI (Higher Order Thinking Learning-Democratic Interaction) Type B model. This research was conducted at the Pulutan Village Training Center, Remboken District, Minahasa and in the physics department. The data in this study were analyzed using a mixed approach, namely qualitative and quantitative. The results of this study indicate that exploration activities make research subjects have experience and knowledge in the learning process of democratic interaction in making pottery because democratic attitudes and behaviors have been formed and developed through discussion group interactions, namely being brave in expressing opinions, can respect each other's opinion, encourage each other to be active, accept every criticism and opinion of group friends, be able to fit in the group, be fair between fellow groups and be willing to use personal facilities for the common interest so that research subjects can solve existing problems in pottery making.

Keywords: democratic interaction, explorative learning, local wisdom, pottery

Introduction

Physics is a science in which it studies the nature and phenomena of nature or natural phenomena and all the interactions therein. To study natural phenomena or phenomena, physics uses a process starting from observation, measurement, analysis and drawing conclusions. Physics subjects are used to equip students with basic knowledge of natural laws and become a condition of ability to achieve expertise program competencies (Saolika *et al*., 2012) [1]. The purpose of studying physics is that we can find out the basic parts of the object and be able to explain natural phenomena that occur. Moreover, teachers also believe that students must have a high level of competency in mathematics to understand physics concepts better (Oon & Subramaniam, 2011) [2]. Some research results show that physics is a subject that is less desirable because most students consider physics to be abstract so that it impacts on the low critical thinking skills and problem solving of students (Ekici, 2016; Sahin & Yagbasan, 2012) [3, 4]. but many people who hear the word physics are not fun and very difficult because of the factors from the teachers who explain only the material in textbooks and not. perna makes a direct connection to nature when in fact the nature around is the object of learning physics. Furthermore, Usmeldi (2016) [5] also revealed that learning physics is more likely to be teacher centered where students have not been actively involved in discovering facts, concepts, and principles of physics.

Contextual learning is a teaching concept t In a contextual classroom, the teacher's job is to help students achieve their goals.hat links learning material and applies it in everyday life. The teacher has more to do with strategy than with providing information. The teacher's job is to manage the class as a team that works together to find something new for class members (students). Something new comes from discovering yourself, not from the teacher's word. Democratic attitudes and behaviors can be built through learning interactions based on themes about the surrounding environment, where students have experiences (same or different) about these objects (Medellu *et al*., 2015) [6].

The exploratory process which includes identifying facts and phenomena, analyzing descriptions, exploring concepts and physical processes of physics and determining formulations, explorative learning is learning that emphasizes student activity in the learning process that begins with activities to understand problems, collect and analyze data, build conjectures, connect a concept with other concepts, then make logical conclusions based on the facts that are known and have been found.

The exploratory research used by the researcher is the HOTL-DI Type B exploratory learning model by Medellu and Silangen, (2019) [13]. HOTL-DI Type B Exploratory Learning is a collaborative study that assesses individual thinking skills and processes of democratic interactions that occur in groups. Democratic interactions are designed to share experiences, knowledge, and individual perceptions through group interactions. This research was conducted in 3 main stages, including: exploration by the research team and preparation of democratic interaction indicators; exploratory learning in democratic interactions by pilot groups; explorative learning in democratic interactions of target groups. This study aims to: (a) know the concepts and physics processes involved in making pottery (b) know the democratic interactions in the learning process to explore the physics concept of pottery making.

Conceptual Framework

Democratic Interadution (DI)

A democratic attitude is needed in a democratic Indonesian government. Recent developments show that democracy is not only understood as a form of government and political system, but democracy is understood as an attitude of life or a democratic way of life. Democracy requires real effort from every citizen and state administrator to behave in such

a way as to support the government or democratic political system (Winarno, 2007: 97) [6]. The exploration process which includes identification of facts and phenomena, analysis of descriptions, exploration of concepts and physical processes of physics and determining formulations, is individualistic because each individual has a different understanding of the same object, so it is necessary to develop democratic behavior so that initially very individual knowledge can be combined interactively through democratic interactions. Democratic attitudes and behaviors can be built through learning interactions based on themes about the surrounding environment, where students have experiences (same or different) about these objects (Medellu *et al*., 2015) [7]. Related to integrating experiences outside the classroom and classroom learning as a process of democratic interaction, the researcher uses exploratory steps starting with identifying facts and phenomena, analyzing descriptions of facts, exploring concepts and physical processes and analyzing the synthesis of formulations by interacting democratically.

Tacman (2006) [8] in his research stated, the democratic attitudes of classroom teachers which is important for improving people's democratic behavior. The learning process in democracy will be smoother and more focused if it is started in kindergarten during school (Suparno, 2002) [9]. Furthermore, it is said that learning democracy in schools will only run well and smoothly if teachers or educators who teach democracy, live and act democratically in their duties. Thus the cultivation of a democratic attitude needs to be implemented both in schools and outside schools which require the ability and participation of families, schools and communities. In schools, learning about democratic attitudes can be actualized through existing organizations in schools, as a vehicle for developing a democratic culture that can be manifested in the form of daily student behavior. At its core, democracy education is a fundamental part of civic education at school.

According to Carol C. Gould (Effendi, 2001) [10], there are at least five democratic personality traits: responsibility, tolerance, awareness of reciprocity, open-mindedness, and sportsmanship. Zamroni (2001) [11] states that democracy will grow solidly if the culture and values of democracy are growing, namely 1) tolerance, 2) freedom to express and respect differences of opinion, 3) understand diversity in society, 4) open communication, 5) uphold human values and dignity, 6) self-confidence or not depending on others, 7) mutual respect, 8) self-restraint, 9) togetherness and 10) balance. The democratic indicators used in this study were formulated by Medellu (2019) [13], namely: 1. dare to express opinions, 2. be able to respect other people's opinions, 3. help other friends to actively participate, 4. accept other people's criticism and opinions 5. be able to adapt in group, 6. being fair among fellow groups, 7. willing to use private facilities for the common interest.

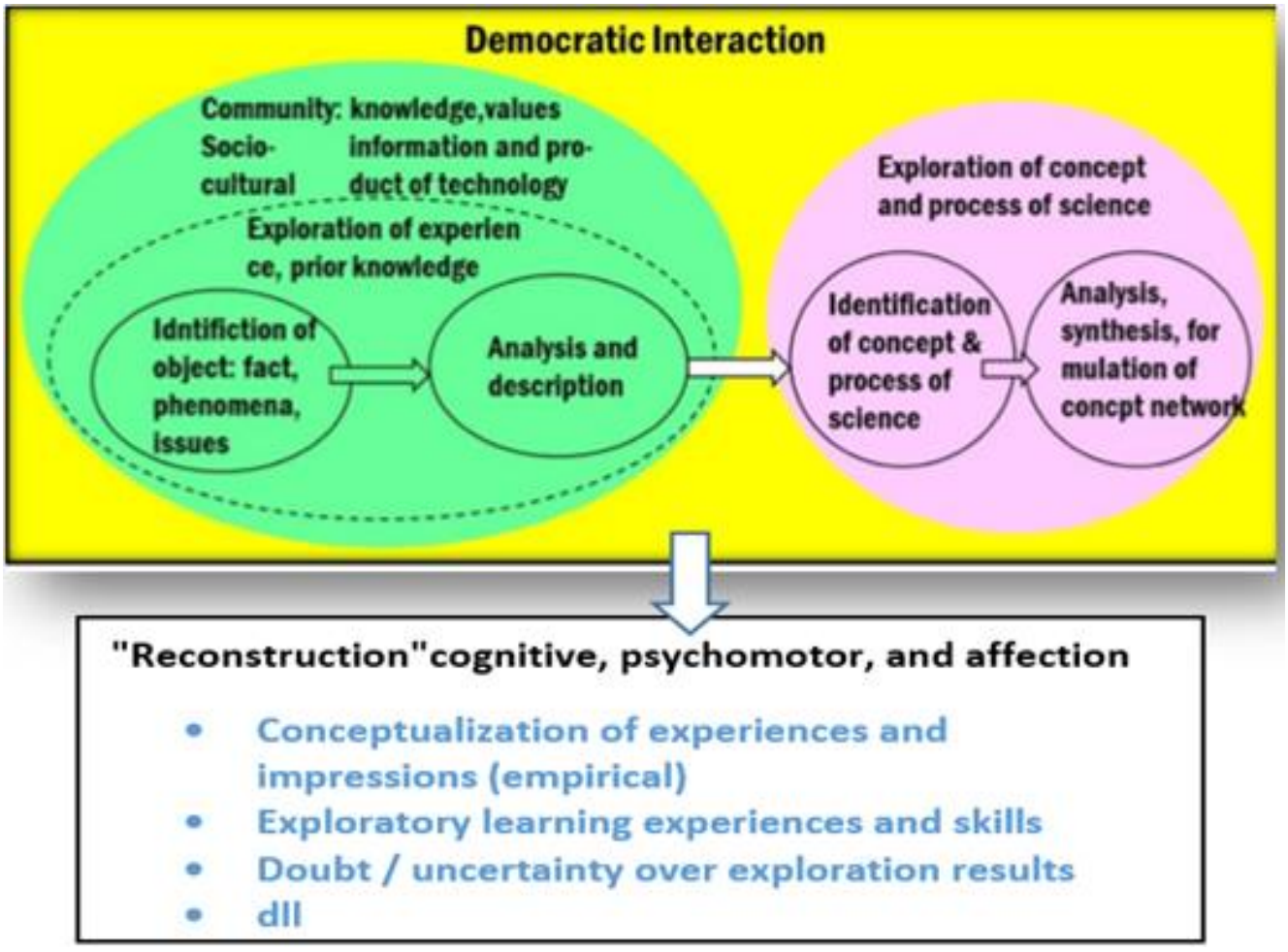


Fig 1: HOTL-DI Type B Model

Eksplorative Learning Model (HOTL-DI) Type B

The exploratory research used by researchers is the HOTL-DI Type (B) exploratory learning model by Medellu and Silangen, 2019 [13].

This model emphasizes the importance of acquiring information, knowledge and values in society. The assumption of this model is that knowledge and values in society form or frame individual experiences in understanding and analyzing facts and phenomena in the environment. Modification of model B from A is the framing of knowledge and values in society towards the construction of empirical experiences, impressions and individual responses. Format-3 is an exploration format that includes exploration of experiences, impressions and perceptions (blue column) and exploration of scientific concepts and processes (pink column).

Table 1: Format-3 Explorations (HOTL Process)

(1) Phenomenon Identification	(2) Description Analysis		(3) Eksploration Of Physical Concepts and Processes	(4) Synthesis-Analysis-Formulations
	(a) Local Wisdom	(b) Description of Fact Analysis		

Explanation of column contents

1. The phenomenon identification column. This column is filled with the main object of the phenomenon which is the basis of learning. for example in the first stage of making pottery, namely processing materials and so on.
2. Analysis column description. This column is filled with a description of the phenomenon analysis from (a) local wisdom and (b) a description of fact analysis in order to obtain a clear picture of the phenomenon that occurs.
3. The next step is to explore the concepts and physical processes of phenomena related to variables, the relationship between variables and to find references to obtain reinforcement from the results of the analysis.
4. Synthesis - analysis - formulation column. This step formulates the results of the description on the analysis, exploration of the process and physical concepts of pottery making

Method

This type of research the researcher uses is exploratory research. The explorative research used by researchers is the HOTL-DI- Type (B) exploratory learning model by Medellu, 2019 [13]. HOTL-DI Type B model is used for learning objects that emphasize facts and natural phenomena around. The object of this research is making pottery from clay. The subjects in this study were Semester III and V Students of the Physics Department, Faculty of Mathematics and Natural Sciences. This research uses a mixed approach, namely qualitative and quantitative. The use of 2 research methods is in a more complete view of the issue or research problem than the use of one of the research methods including.

In this study, data sources were obtained from two sources, namely primary data and secondary data. Primary data were obtained directly from interviews with an earthenware craftsman about pottery making. Secondary data, in this case the researcher collects and obtains study data of article documentation and journals regarding the history of pottery and its manufacture. In this study, data collection was carried out using observation, interview, documentation, and triangulation techniques. The data analysis used was a mixture of qualitative and quantitative data analysis. Data analysis techniques in mix methods research. The quantitative data used in this research is the exploration format of the trial and target groups.

Analysis carried out on qualitative data as the main frame that is dynamic (can develop) from the exploration process can be found quantitative data that is described through qualitative data. This study explores the concepts and physical processes of pottery making in the democratic learning process. This research was conducted in three main stages, including:

a. The first stage, exploration by researchers which aims to: 1) Provide experience to researchers in exploration stages of concept objects and processes. 2) Produce a reference matrix, an exploration that the researcher uses to facilitate exploratory learning activities for the trial / mentor and target groups.
b. The second stage, exploration by the pilot group with the aim; 1) Providing experience in conducting exploration stages individually or in group interactions. 2) Recruit mentors.
c. The third stage, Exploration by the Target Group with the aim of: 1) Providing experience in conducting exploration stages individually or in group interactions.2) Generating an exploration matrix. The final stage is facilitated by the research team together with the mentor who leads the target group in the exploration stage.

Results

This research was conducted in 3 stages, the first stage of exploration research was carried out by the research team using the HOTL-DI Type B model format table in Remboken from July to August 2019 continuing the second stage of exploration by the fifth semester student trial group of physics from October and November and provide experience doing the exploration stages individually or in groups and recruiting mentors from semester V physics students. The last stage or the third stage of exploration for the target group in physics education students semester III in December. Using the HOTL-DI Type B model format table.

Exploration and Formulation of Indicators of Democratic Interaction by the Research Team

Exploration in the manufacture of pottery consists of 5 stages, namely pottery processing, pottery formation, earthenware drying, pottery burning and finally, finishing in this finishing stage the pottery is finished and painted to beautify the pottery.

Table 2: Exploration Matrix of Step 1

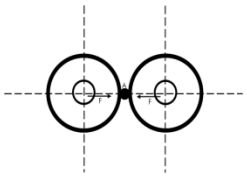
Phenomenon Identification	Description Analysis		Exploration of Physical Concepts and Processes	Synthesis - Analysis – Formulations
	Local Wisdom	Description of Fact Analysis		
Material Processing  *Milling machine*  *The inside of the milling machine*	Clay is taken and ground to smooth the clay.	Milling is the process of mechanically crushing the material to reduce the size of the solid so that the material becomes smooth.	▪ The fine material makes the constituent particles homogeneous, the heat distribution is evenly distributed ▪ Cross-sectional area of milling machine (A) ▪ External force (F)  ▪ The compressive stress of the clay (σ) ▪ The force needed to grind the clay (F)	▪ Cross-sectional area of milling machine (A) $A = l\ x\ w$ ▪ The compressive stress of the clay (σ) $\sigma = \frac{F}{A}$ ▪ The force needed to grind the clay (F) $F = \sigma . A . g$ where: g = Earth's gravitational acceleration (m/s^2)

Table 3: Exploration Matrix of Step 2

Phenomenon Identification	Description Analysis		Exploration of Physical Concepts and Processes	Synthesis - Analysis – Formulations
	Local Wisdom	Description of Fact Analysis		
Formation  *Rotary tool*	The pottery body is formed using a rotary technique with the direction of rotation adjusting to the comfort of the craftsman.	Forming is the process of converting clay using a rotary tool into the desired shape.	▪ The radius of the rotary tool (r) ▪ The circle area of the rotary tool (L) ▪ Circumference of rotary tool (K) ▪ The angle produced by the rotary tool (θ) ▪ Travel time rotation (t) ▪ The angular velocity of rotary tool (ω) ▪ Period of rotary tool (T) ▪ Centripetal acceleration (a_s) ▪ Moment of inertia of rotary tool (I): moment of inertia in a solid cylinder of radius R, the location of the axis through the center	The circle area of the rotary tool (L) $L = \pi r^2$ Circumference of rotary tool (K) $K = 2\pi r$ ▪ The angular velocity of rotary tool (ω) $\omega = \frac{\theta}{t}$ Period of rotary tool (T) $T = \frac{2\pi}{\omega}$ ▪ Centripetal acceleration (a_s) $a_s = \omega^2 r$ Moment of inertia (I) $I = \frac{1}{2} MR^2$ Rotational kinetic energy

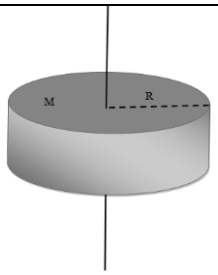
			 ▪ Rotational kinetic energy (KE_{rot}) ▪ The force that the hand exerts on the body of the potter (F) ▪ Normal force (N) ▪ Static coefficient of friction (μ_s) ▪ Kinetic coefficient of friction (μ_k) ▪ Static friction (f_s) ▪ Kinetic friction (f_k)	$KE_{rot} = \frac{1}{2} I\omega^2$ Static friction (f_s) $f_s = \mu_s . N$ Kinetic friction (f_k) $f_k = \mu_k . N$

Table 4: Exploration Matrix of Step 3

Phenomenon Identification	Description Analysis		Exploration of Physical Concepts and Processes	Synthesis - Analysis – Formulations
	Local Wisdom	Description of Fact Analysis		
Drying  *The pottery is dried by aerating*	▪ The pottery that has been formed is dried first, not directly under the sun so that the pottery does not crack. ▪ After drying, the pottery shrinks because the water content in the pottery decreases.	▪ Drying is the process of reducing the moisture content so that the pottery is denser so that it is not prone to cracks and breaks when burning. ▪ The decrease in water content causes physical changes in materials / objects, the pottery loses some of the water it contains, causing shrinkage.	▪ Sudden evaporation causes the bond particles to break so that the pottery cracks and breaks. ▪ Room temperature (T) ▪ Atmospheric air pressure ▪ High temperature, low humidity ▪ High temperature, low air pressure ▪ Strong wind speed causes faster drying time	▪ Room temperatre T = 27˚C ▪ Atmospheric air pressure 760 Hg = 1 atm ▪ Ideal wind speed 19-35 km/h

Table 5: Exploration Matrix of Step 4

Phenomenon Identification	Description Analysis		Exploration of Physical Concepts and Processes	Synthesis - Analysis – Formulations
	Local Wisdom	Description of Fact Analysis		
Combustion	▪ Burning pottery using a furnace and setting the temperature from low to high because if it goes directly to a high temperature, the earthenware	▪ Combustion is a process carried out to change the mass of clay into solid, strong, and hard. The temperature is raised slowly so that the potter does not crack. ▪ Pyrometer is used to measure very high	▪ The sudden burning causes the ties to break so the pottery cracks and breaks ▪ The homogeneous constituent particles cause evenly distributed heat ▪ Combustion temperature (T) ▪ Thermal radiation ▪ The greater the temperature, the greater the intensity of thermal	▪ Celcius temperature scale R = (4/5) C F = (9/5) C + 32 K = C + 273 ▪ Reamur temperature scale C = (5/4) R F = (9/4) R + 32 K = C + 273 or K = (5/4) R + 273 ▪ Fahrenheit temperature

 *The furnace*	▪ will crack. ▪ The tool for measuring the temperature during combustion is a Pyrometer which is placed close to the furnace. The combustion temperature is 600-650˚C.	temperatures, because if you use an regular thermometer it will melt. In the Pyrometer, temperature is determined by measuring the intensity of thermal radiation emitted by a very hot object.	▪ radiation emitted ▪ Celcius, Reamur, Fahrenheit, and Kelvin temperature scale	scale C = 5/9 (F-32) R = 4/9 (F-32) K = 5/9 (F-32) + 273 ▪ Kelvin temperature scale C = K – 273 R = 4/5 (K – 273) F = 9/5 (K-273) + 32

Table 6: Exploration Matrix of Step 5

Phenomenon Identification	Description Analysis		Exploration of Physical Concepts and Processes	Synthesis - Analysis – Formulations
	Local Wisdom	Description of Fact Analysis		
Completion  *Painted pottery*	▪ The potter is sanded to smooth the surface. ▪ Pottery is painted to make it look good to sell. The pottery is painted and then dried for 3-4 days.	▪ Sandpaper is used to make the surface of objects smoother by rubbing the rough surface of the sandpaper on the object. ▪ Paint is a liquid that is used to coat the surface of an object to beautify, strengthen and protect the object. After being applied to a surface and drying, the paint will form a thin layer that adheres firmly to the surface.	▪ The force applied by the sandpaper to the pottery (F) ▪ Normal force (N) ▪ Static coefficient of friction (μ_s) ▪ Kinetic coefficient of friction (μ_k) ▪ Static friction (f_s) ▪ Kinetic friction (f_k) ▪ Room temperature (T) ▪ Atmospheric air pressure ▪ High temperature, low humidity ▪ High temperature, low air pressure ▪ Strong wind speed causes faster drying time	▪ Static friction (f_s) $f_s = \mu_s . N$ ▪ Kinetic friction (f_k) $f_k = \mu_k . N$ ▪ Room temperature T = 27˚C ▪ Atmospheric air pressure 760 Hg = 1 atm ▪ Ideal wind speed 19-35 km/h

There are seven indicators for assessing democratic interactions, namely first, each student or student must have the courage to express opinions in the second group, can and can respect the opinions of others or their third group friends encourage other friends who are not active to actively participate or take part in the group, fourth, accepting every criticism and opinion of others if it is wrong or inaccurate can be corrected fifth, being able to fit ourselves in the sixth group, being able to be fair among fellow groups, don't be selfish and finally or seventh we are willing to use our personal facilities for the common interest if friends forget to bring stationery and so can we lend if there is more.

Exploration and Democratic Interaction by Pilot Groups

The first stage identifies the phenomenon of pottery making. The research team gave the experimental group the freedom to explore, determine the right initial steps in making pottery.

The second stage of the descriptive analysis of the research team directs students or research subjects to be able to analyze and describe phenomena in the previous stage (first stage). The third stage of exploration and physical concepts is filled based on the results of identification and analysis of physics concepts related to variables in stages 1 and 2. The fourth stage, the analysis of the synthesis of the formulations, the last stage, the subject formulates the written physical concepts.

Table 7: Indicators of Democratic Interaction for each Exploration Step on Objects 1

Object Exploration Steps 1	Average Indicators of Democratic Interaction						
	1	2	3	4	5	6	7
1.1	4,6	4,6	4,2	3.8	4,1	4,3	5
1.2 a	4,6	4,7	4	4	4	4,6	5
1.2 b	4,4	4,6	3,7	4	3,6	4,3	5
1.3	4,6	4,6	4	4	3,8	4,6	5
1.4	4,3	4,2	4	3,8	4,1	4,6	5

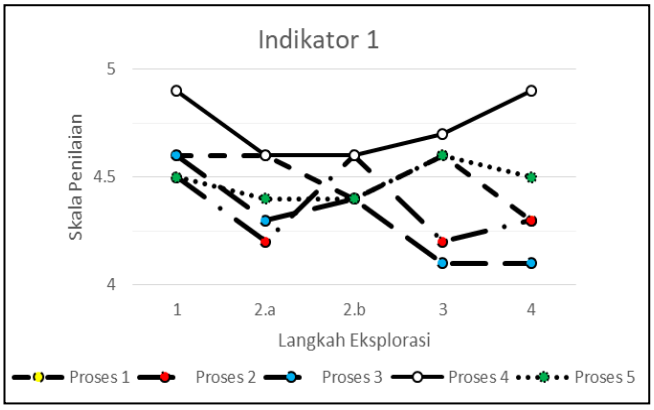
Table 8: Indicators of Democratic Interaction for each Exploration Step on Objects 2

Object Exploration Steps 2	Average Indicators of Democratic Interaction						
	1	2	3	4	5	6	7
1.1	4,5	4,7	4	4,3	4,2	4	5
1.2 a	4,2	4,2	4,1	4	4,3	4,7	5
1.2 b	4,6	4,6	4	4	3,8	4,5	5
1.3	4,2	4,7	3,7	3,8	3,7	4,6	5
1.4	4,3	3,6	4	3,8	3,8	4,6	5

The column mean score for the achievement of Democratic Interaction is the achievement score for each indicator which has been averaged from the results of each individual in the group.

Exploration and Democratic Interaction by Target Groups

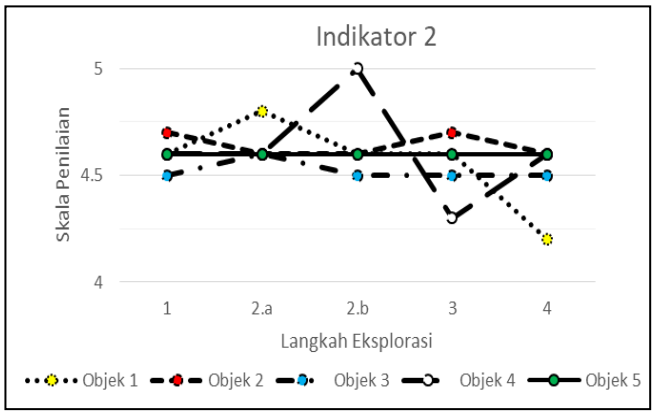
The data collected is then processed by the researcher, then analyzed in graphical form for each democratic indicator



Graph 1: Indicators (Dare to Express Opinions)

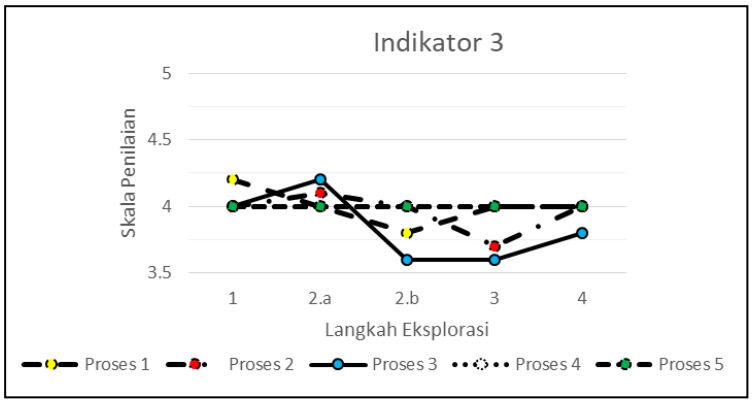
The results of the achievement of the score of democratic interaction indicator 1 dare to express opinions on object 1 graph shows the same value and in the graph evenly because in groups, they can mutually express their opinions. In object 2 the graph shows fluctuation, showing that each group member is very good at expressing opinions and in other steps group members are still lacking to express opinions. In object 3 the graph shows the ups and downs in each step, showing excellent scores and each group member actively expressing their opinion.

Object 4 shows that group members are brave to express their opinions and have very good values and each group member actively expresses their opinion. Object 5 shows democratic interactions. So from object 5, the exploration of physical processes and concepts shows that each member of the group is very good at expressing opinions.



Graph 2: Indicator 2 (Can respect other people's opinion)

The results of the achievement of the democratic interaction score indicator 2 can respect the opinions of others on object 1 showing that the interaction between group members is good. So from object 1 the identification of the phenomenon, indicator 2 shows the democratic interaction between groups that best respects the opinions of others. Object 2 of the democratic interaction graph shows that each group is very good and can respect the opinions of other group members. Objects 3,4, and 5 indicate that each member of the group is good, can respect the opinions of others.



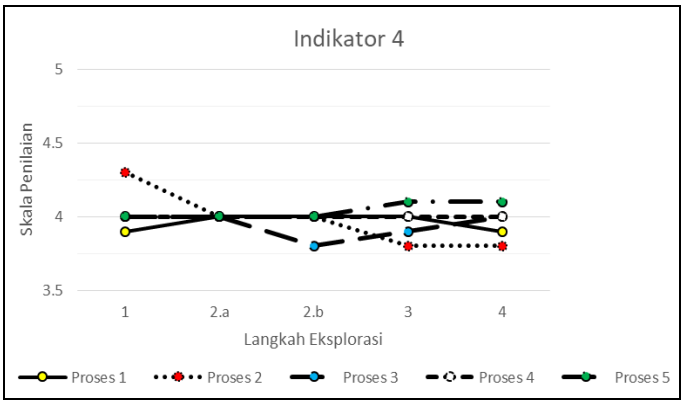
Graph 3: Indicator 3 (Encourages other friends to actively participate)

The results of the achievement of democratic interaction indicator 3 encourage other friends to actively participate in object 1 shows that the graph of democratic interaction is good and is on the highest rating scale of each step and at this step every member of the group is good.

In object 2 each group shows the best democratic interaction, but group members still do not encourage other friends to actively participate.

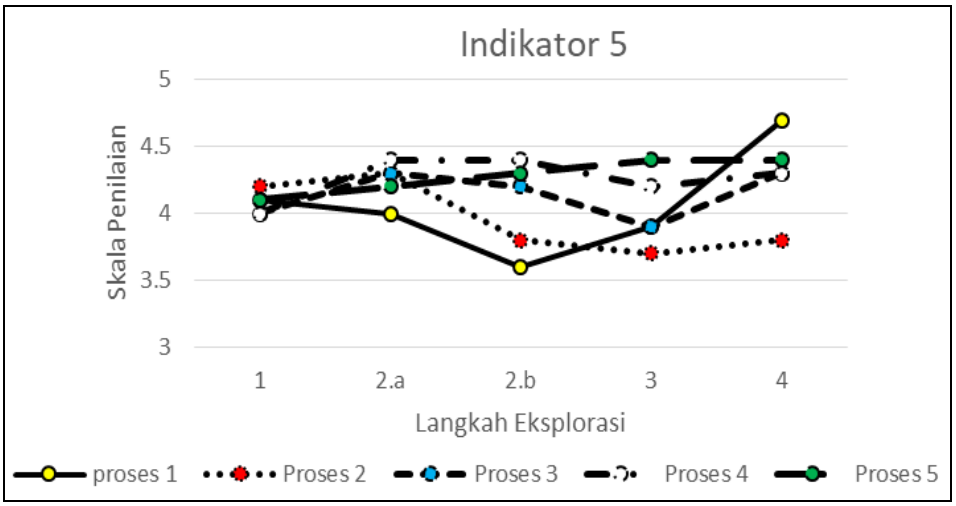
Object 3 shows the best local wisdom and the highest scale of existing measures and shows that group members are most actively participating. Object 4 shows a graph of democratic interaction in encouraging other friends to actively participate.

This is evenly distributed on the rating scale showing that each member of the group is good. Object 5 shows a graph of democratic interaction on indicator 3 in encouraging other friends to actively participate, this is evenly distributed on the rating scale showing that each member of the group is good.



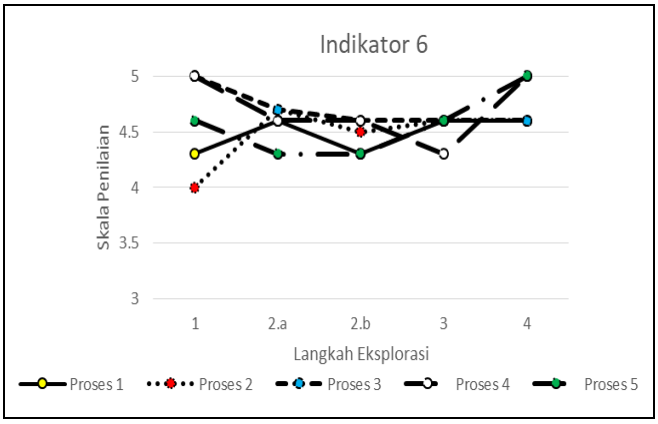
Graph 4: Indicator 4 (Receiving criticism and other people's opinions)

The results of the achievement of the democratic interaction score indicator 4, namely accepting criticism and other people's opinions on object 1 each member of the group both accepting criticism and opinions of other friends and the graph shows that the decrease in group members is still lacking in interacting to receive criticism and peer opinions. Object 2 shows the identification of phenomena and interactions that are lacking in the group. Object 3 shows a decline and group members are still lacking in accepting criticism and other people's opinions. Object 4 accepts other people's criticism and opinions equally on a rating scale showing that each member of the group is good. Object 5 shows the same rating scale so from this step group members are also good at receiving criticism and peer opinions.



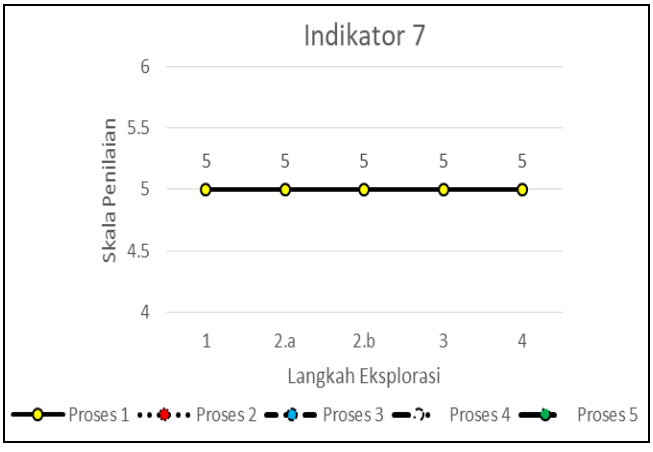
Graph 5: Indicator 5 Able to adjust in the group

The results of the achievement of the democratic interaction score indicator 5, namely being able to adjust in the group to object 1 group members are less able to adjust in the group. Object 2, namely local wisdom, the graph shows the highest rating scale and the group is good and able to adjust to the group. Groups only on a rating scale are sufficient and less able to fit into the group. Object 3 shows the highest rating scale and is the same so that the group is able and good to adjust to the group and the group is sufficiently and less able to fit in the group. The object of the 4 rating scale shows that all are good and able to adjust in the group. Object 5 shows a continuous increase and in this 5th object group members are good and able to fit in the group.



Graph 6: Indicator 6 (Being fair among groups)

The results of the achievement of the democratic interaction score on indicator 6, namely being fair among fellow object groups 1 at each step of the graph shows that the assessment scale is good for all and being fair between fellow groups. Object 2 is the highest rating scale for local wisdom. However, all steps show a good rating scale. Object 3 shows a decrease from the rating scale very good to good and members are fair among groups. Object 4 shows the ups and downs, ups and downs and the existing rating scale shows that the group is very good and behaves fairly between fellow groups. Object 5 shows rise, fall, rise and fall and is on a good rating scale.



Graph 7: Indicator 7 (Willing to use private facilities for common interests)

The results of the achievement of the democratic interaction score indicator 7 are willing to use personal facilities for the common interest of object 1 to object 5 and from each step there is a graph showing the scale of the assessment between group members is very good and is always willing to use personal facilities for the common interest between group members.

Discussion

Learning that emphasizes student activity and is thought to improve students' mathematical understanding and communication skills is exploratory learning. By realizing that each individual has the same interests, it is necessary to have an organization that is useful as a process of interaction to facilitate each of these interests in achieving a common goal (Soekanto, 2002). The final evaluation of this study was to determine the development of the ability to interact democratically of the research subject. The research subjects were divided into two groups, the first is the trial group and the second is the target group. Based on the results of this study, initially the research subjects were still lacking in democratic interaction among existing groups, but over time the subjects began to be able to interact between existing groups or began to apply democratic values. Research subjects who were initially unable to connect their daily experiences with formal learning in class so that the existing exploration process was identifying facts and phenomena, analyzing descriptions, exploring physical physics concepts, and determining formulations that initially the subject could not solve together (group) because democratic behavior has been built so that the research subject has the ability to explore the phenomenon with the group and solve problems together because the subject is able to apply the value of democratic interactions, namely; courage and freedom to express opinions, respect other people's opinions, encourage friends to actively participate, give positive criticism of friends 'opinions or work, respect friends' criticisms and provide an explanation of the similarities and advantages of personal opinions with those of friends, take the initiative to activate group activities, discipline and responsibility against mutual agreement, willingness to use private facilities for joint activities, etc. Obstacles experienced during research are some research subjects or research students are not used to connecting everyday experiences with classroom learning, some research subjects still have difficulty solving problems and are not used to implementing any democratic interacting behavior in groups. However, at the following meetings research subjects have begun to be able to relate experiences experienced outside the classroom and are able to apply democratic values and also because exploratory learning research subjects are able to understand problems, analyze, make assumptions and draw conclusions.

Conclusion

From the results and discussion above, it can be concluded that the research team and research subjects finally know the physics concepts contained in pottery making, namely compressive force, circular force, friction force and moment of inertia. Research subjects or research students ultimately have experience in the exploration process which includes identification of facts and phenomena, analysis of descriptions, exploration of concepts and physical processes of physics and determining formulations in making pottery and making research subjects able to relate learning in nature or outside the classroom with learning in the classroom.

The exploration process involved in making pottery, namely processing of pottery materials, forming pottery, drying pottery, burning and finishing enables research students to identify, analyze, explore and formulate any physics concepts in pottery making and research students are able to connect their daily experiences with formal learning in the classroom.

Exploration activities make research subjects have experience and knowledge in the learning process of democratic interaction in making pottery because democratic attitudes and behavior have been formed and developed through discussion group interactions, namely being brave in expressing opinions, being able to respect each other's opinions, encouraging other friends to be active, accepting every criticism and opinion of group friends, being able to fit in the group, being fair among groups and willing to use personal facilities for the common interest so that research subjects can solve problems that exist in making pottery.

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