Reflective Question in Explorative Learning: Model HOTL-DI – A and B

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Reflective Question in Explorative Learning: Model HOTL-DI – A and B

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Abstract:- This article describes a summary of the results of explorative learning research using the model: Higher Order Thinking Learnig in Democratic Interactions (HOTL-DI) type A and type B. Two explorative learning research groups use the model of HOTL-DI type A, and two other collaborative studies using the HOTL -DI type B. The four collaborative research groups apply reflective questions, which are a set of questions that are formulated based on exploratory results, and are given to students to reflect on previous work and make revisions. The research involved first semester physics students as the target group, third semester students as the target and as a mentor, and fifth semester students as a mentor. The results showed that at the beginning, students experience difficulties at each stage of exploration, but could be improved at the next meeting. The results of individual and group student work assessments show a high variety of answers and misconceptions. The serious challenges of the exploration process are identified at the stage of identifying concepts and the scientific process, due to partial mastery of scientific concepts and no experience in linking context with concepts. Prior knowledge and use of terms obtained from the surrounding environment, affect the completeness and quality of the report on exploration activities, even giving rise to misconceptions. The application of reflective questions can encourage student initiatives to make corrections or reinforcement of the results of reflection, improve misconceptions, encourage group interaction, encourage initiatives to obtain learning resources. The results of the study concluded that the application of reflective questions became a necessity in each stage of exploration.

***Keywords:-** Exploration, Democratic Interaction, Reflective Question.*

I. INTRODUCTION

Science learning policies such as contextual learning have long been touted but have not been implemented well. Learning is still dominated by textual learning, and is very minimal or never connects the experience of children gained from outside the classroom with science learning in class. Learning that is dominated by concept development through exercises in textbooks causes difficulties for students in understanding the basic concepts of physics [1]. The potential use of the natural and socio-cultural environment around students enables students to understand problems in the real world, encouraging them to look for relationships and integrate ideas in authentic contexts [2]-[3]. [4] suggests that students can be trained to understand the concepts of physics through the real world that is around them[5], the learning context in the form of real phenomena and objects in daily life is not explicit like in a laboratory, the context must be found and studied. The context of learning science includes facts and natural phenomena, as well as issues in the surrounding environment. The socio-scientific approach emphasizes the integration of natural and socio-cultural elements in science learning [6], [7]. Sociocultural instruction directs students to learn scientific issues that have social implications [7]-[8] suggested that with a socioscientific approach, students can do various ways of getting information and exploration to provide reasons and arguments. Students must be facilitated to be able to compare, associate and finally integrate experiences from outside the classroom with science learning in class. In industrialized countries, science (physics) provides a rational and essential foundation of modern life [9]. This can be interpreted that in industrial countries, experience and knowledge gained from the environment support learning of science. In developing countries, the knowledge and experience gained from the socio-cultural environment negatively influences the learning of science [10].

Explorative research emphasizes observations and analysis of "hidden reality" to get an explanation of causal relationships and produce new approaches in problem solving [11]. Explorative research is research that is used to observe problems that are not clear.[12] suggested that explorative research has a strong tendency to associate problems with real-world problems. Reiter [11] argues that explorative research seeks to solve alternative problems with new approaches and perspectives in explaining reality.The exploration of concepts and scientific processes from facts, phenomena, and issues in the surrounding environment is basically explorative research activities. Exploration of scientific concepts and processes results in an explanation of the characteristics of the problem, the causal relationships of the elements or variables that construct facts, phenomena or issues in the form of scientific descriptions.The learning process with the main activity of conducting exploratory research on scientific concepts and processes, has two sides namely: (1) increasing the ability to do exploratory research, and (2) producing the reference for further research and explorative learning at the next stage.Explorative learning provides broad opportunities for students to build knowledge through the process and skills of linking initial knowledge with learning experiences [13]. The exploration of concepts and scientific processes for facts, phenomena and issues in the surrounding environment is a process of integrating experience with knowledge gained in class.Since 2014, our team has designed explorative learning research

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conducted in schools and departments: Physics and Natural Sciences, Faculty of Mathematics and Natural Sciences, Manado State University. Our team developed explorative learning with Higher Order Thinking Learning in Democratik Interaction (HOTL-DI) models.The principle of explorative learning emphasizes the exploration of concepts and processes of science about facts, phenomena and issues, as a process of learning to think at a higher level. The process of learning to think highly is an individual process. Democratic interaction is designed to share experiences, knowledge and perceptions of individuals through group interaction.Group interaction produces joint conclusions that are assumed to be better and more complete than the results of individual exploration, also to build the democratic attitudes and behavior of group members. The results found that individual and group exploration results varied and misconceptions occurred. Based on evaluating performance, products, and group interactions, our team formulated a mechanism for implementation of reflection questions. Reflection questions are based on individual and group answers. This article describes the process of exploring concepts and scientific processes on facts, phenomena and issues, individually and in democratic interactions.This article also describes the influence of initial knowledge and use of terms in daily life, and the application of reflection questions to improve stidentwork on own initiative, and to make improvements to misconceptions.

II. EXPLORATION LEARNING: CONCEPTS AND MODELS

Exploration of science concepts and processes about facts, phenomena, and issues in the surrounding environment is the process of integrating real-world experiences with science learning in the classroom. The integration of experience as initial knowledge will determine student learning outcomes [14]- [15]. [16] concluded that initial knowledge is the best predictor in determining academic success. [14] suggested that the structural model of early knowledge includes four types of knowledge, namely: knowledge of facts, knowledge of meaning, integration of knowledge, and application of knowledge. This type of initial knowledge is part of individual experience gained from outside the classroom [17] conducted an exploratory study of the relevance of four types of initial knowledge in determining academic progress in introductory subjects in physics and biology. [17] found that in biology learning, the only significant predictor was knowledge of concepts and principles, whereas in physics learning, a significant predictor was mastery of concepts, and the ability to apply knowledge in problem solving. This shows that material and exploration activities depend on cases or the problem being studied. The explorative learning of the HOTL-DI model that we developed emphasizes high-level thought processes, in the stages of exploratory contexts (facts, phenomena and issues) and the exploration of scientific concepts and processes. The HOTL-DI model includes two types namely the HOTL-DI type A model (Figure-1) and HOTL-DI type B (Figure-2)

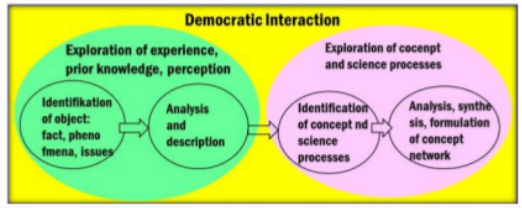

Fig. 1:- Model of HOTL-DI-type A

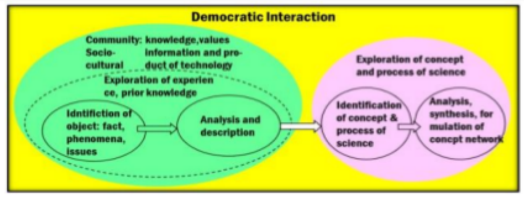

Fig. 2:- Model of HOTL-DI-type B

The explorative learning model: HOTL-DI type A was formulated by Medellu in 2019, the HOTL-DI-type B was formulated by Medellu and Silangen in 2019. Type A is used for objects in the form of facts and natural phenomena that are not related, or are not influenced by the social and cultural aspects.

Exploration activities focus on experiences, knowledge, and activities such as observing and measuring the physical dimensions of objects. Type B is used to explore objects related to socio-cultural aspects where knowledge, skills and values in a society are strong enough to frame the experience and knowledge of students. Social experience builds ideology as a representation of reality, including social bonds [18]. The blue circle in Figure-1 and 2 is the stage of exploration of the experience, knowledge or individual perception on objects in the form of facts, phenomena or issues. Exploration activities include: (1) identification of objects, and (2) analysis and description of objects based on preliminary knowledge. Object analysis, among others, is to get an explanation of changes in objects, the distribution of objects, influencing factors, variables and relationships between variables that characterize objects. The white circle is the stage of exploring scientific concepts and processes about facts, phenomena and issues. The stages of exploration of science concepts and processes include stages: (3) identification of scientific concepts and processes, and (4) analysis-synthesis-formulation of a comprehensive network of scientific concepts and processes as a scientific explanation of the facts, phenomena and issues. The stages of exploration (1) to (4) are the stages of a high-order thinking learning process. This stage corresponds to the category of high-level thinking learning, among others,[19],[20], [21]. Example of association of the HOTL-DI model with levels of abstract thinking (higher order thinking) according to Hailikari et al. [14] is presented in Table-1

HOTL-DI (as a process of exploring concepts and scientific processes about objects)	The level of abstract thinking (Hailikari et al., 2007)
Identify facts, phenomena and issues about learning objects	Knowledge of facts
Object analysis (the relationship between facts and phenomena, the relationship of phenomena and issues, and descriptions	knowledge of meaning Integration of knowledge
Identify scientific concepts and processes about the relationship between facts, phenomena and issues	
Comprehensive analysis-synthesis-formulation of concept networks and science processes	application of knowledge

Table 1:- Association matrix of stages of high order thinking learning (HOTL-DI) with the abstract thinking level according to Hailikari et al (2007)

The process of exploration is a process of high thinking, including analytical, evaluative and creative thinking [22] that is individualistic. Experiences, prior knowledge, values and perceptions about objects vary or differ between individuals.This difference requires the process of democratic interaction in explorative learning. Democratic interaction becomes a forum for sharing individual opinions to produce a joint [18]-[23], which is potentially better and more complete than individual formulations.Democratic interaction also builds individual attitudes and behavior such as: respecting the opinions of others, willingness to be criticized and giving positive criticism, collaborative initiatives, freedom of expression, etc. [1]. The HOTL-DI model is an explorative learning model (individual stages) in democratic interactions (group stages).

Prior Knowledge, Exploratory Talk, and Reflective Question

Prior knowledge determines an individual's capacity to build a more complete and more complex knowledge structure based on new information obtained. In learning physics, [24]; [25] suggested that initial knowledge largely determines learning outcomes. In applying the HOTL-DI model, prior knowledge includes experiences or pure knowledge from outside the classroom, or knowledge resulting from the integration of experience and knowledge gained from the surrounding environment with the knowledge gained in class. Liu et al (2015[26]) suggested that prior knowledge is a necessity for constructing and making valid connections between new science ideas.Knowledge of facts and meanings, experience and ability to integrate and apply knowledge is the initial knowledge of Hailikari et al. [14] can vary greatly between individuals. The diversity of prior knowledge can be a supporting or inhibiting factor in democratic interactions. 20019 [17]dan[27] suggest that prior knowledge is a major predictor of academic progress.

Exploratory talk is a high-quality talk idea to promote group work where each group member has the opportunity to actively contribute ideas [18].Lerman, [28] and Sfard (2001[29]) suggest that exploratory talk is important in explorative mathematics learning, because it is a window for individuals to correct opinions or interpretations about mathematics. [18], states that students enjoy criticism and constructively construct each other's ideas. Exploratory talk set by the teacher for the collaboration group encourages students to cooperate freely and not depend on the teacher [18].In collective groups, interactions are initiated and directed by students themselves [23]. In the HOTL-DI design, prior knowledge exploration becomes part of the individual exploration stage, while exploratory talk is involved in democratic interactions.

Reflective guestionis a set of questions that are formulated based on the results of evaluations of the exploration process and products, at each stage of HOTL-DI exploration. Reflective questions are formulated by our team for individuals and groups to reflect on the results of exploration in each stage of exploration. Based on the results of explorative learning research, reflective questions become a part that must be done in each stage of the explorative learning model HOTL-DI. [21] formulate reflection activities as a stage of high-level, contextual thinking in mathematics.Exploration will only produce valid and convincing findings in the social field if done transparently and through reflection [11].Reflective questions facilitate students individually or in groups to reflect on work, correct errors and / or complete the results of object identification, analysis and description, correct misconceptions at the stages of concept identification and the science process, complete the concept network formulation and a comprehensive description of the whole science process.Reflective questions facilitate students individually or in groups to reflect on work, correct errors and / or complete the results of object identification, analysis and description, correct misconceptions at the stages of concept identification and science process, complete the formulation of concept networks and a complete description of the science process.

III. METHODS

Explorative learning research is carried out in the Physics Education Study Program, Faculty of Mathematics and Natural Sciences, Manado State University. The research subjects were first semester students as target subjects, third students as target subjects and as mentors for semester 1 students, semester V students as mentors for third semester students. Researchers consisted of a team of lecturers and VII semester students who conducted

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collaborative thesis research.This collaborative research consists of four research groups. The first group conducted a study of the phenomenon of rainwater falling on open and vegetated ground, using the HOTL-DI-type A model. The target subjects were first semester students and mentors were third semester students. The second group examined the phenomenon of swinging coconut trees due to wind, using the HOTL-DI-type A model. The learning subjects were students in semester III, mentored by students in semester V.The third and fourth groups conducted explorative learning research using the HOTL-DI-type B model, with the target group being the third semester students, mentored by the fifth semester students.The theme of the third group research is pottery production, and the fourth group research theme is ceramic production. Each collaborative research group consists of two students. The first student examines the process, achievements and improvement of the ability to explore objects and the other examines the democratic interaction of the mentor student group with the target student. This collaborative research was conducted from May to October 2019.The stages of the research include: (1) establishing terms of reference of collaborative research by the lecturer team, (2) recruitment of researcher students, (3) explanation of stages, substance and research activities to researcher students, (4) exploration of learning objects by researcher students, (5) exploration of learning objects by groups of students who will be prospective mentors, (6) application of the HOTL-DI model (types A and B) to target students.

Exploration of objects by researcher students and mentor uses format-1 for the HOTL-DI-type A and format-3 for the HOTL-DI-type B. Exploration of learning objects by researcher students and mentor aims to (1) provide experience and improve the ability to explore, (2) produce reference material or exploration products that are used to facilitate the target group of students doing exploration.In the exploration process, the researchers identify and formulate learning activity choices, such as discussion, acquisition and analysis of references, observations, measurements etc. as part of the HOTL-DI process.The purpose of exploration activities for mentor groups is to provide experience in facilitating exploration activities by the target group.For the HOT-DI-type A learning group, exploration activities use format-2, while format-4 for the learning group of the HOTL-DI-type-B.Format-2 and format-4 are both an implementation and assessment format of the process of exploration and democratic interaction. Assessment of individual and group exploration results using rubric which is formulated based on exploratory references conducted by a group of researcher students.

Indicators of democratic interaction are formulated based on the results of initial evaluations and consultations with lecturers in the physics department regarding attitudes, behavior of target student groups in interacting with each other.Evaluation of democratic interactions using rubric prepared by a group of researcher students guided by a team of lecturers.

Exploration activities by the target group, carried out in stages, following the column-2, Format-2 and Format-4. For each stage, exploration activities begin with individual activities wherethe score are filled in columns (3) and (4), followed by group activities, wherethe score are filled in columns (6) and (7).For each stage of exploration, an assessment of democratic interactions is carried out based on indicators, where the data is filled in column (5). The application of reflective questions for individual exploration is done after the assessment of exploration results, before the implementation of group exploration activities.Group exploration activities are assessed simultaneously with assessment of democratic interactions. The results of group exploration assessment (column (6)) are the results of group work that reflects the mastery of the material, and the attitudes of group members in democratic interactions.The application of reflection questions to the group is done after the assessment of each stage of exploration activities by the group. At the end of each exploration stage, the researcher students and the teaching team, assesst the role of the mentor. The role of mentor is controlled to provide maximum opportunities for the target student groups to explore and interact democratically.Data of the mentor role assessment are presented in column (8) of Format-2 and Format-4. The role of the mentor is assessed from the initial stage to the next stage, and from the first object to the next object as an indicator of the development of independence of target group learning.

- This study uses a mix analysis. Qualitative analysis, among others, is used to analyze the diversity and patterns of answers, the emergence of misconceptions and the influence of prior knowledge, changes in answers after the application of reflection questions, the development of forms and variations in group interactions, etc.Quantitative analysis is used to describe the ability of target students to explore, the intensity of democratic interactions and their change from the initial stage to the next stage, the achievements of group learning, the development of the role of mentors etc

Object	Identification of fact, phenomena, issues	Analysis and description of fact, phenomena, issues	Identification of concept and description of science process	Analysis – synthesis – formulation of concept network and science process – integr.

Table 2:- Format-2 for design – implementation – evaluation of explorative learning model HOTL – DI – type A

Object	Steps of exploration and individual assessment of HOTL (process & achievement			Score of Democratic Interaction **)					Assessment on group exploration		Level of mentor interventi on
	Steps of exploration*)	Duration of work	score	indicators					Group achiev.	Duration of work	
				1	2	3	4	5			
(1)	(2)	(3)	(4)	(5)					(6)	(7)	(8)
1	Identification of fact, phenomena, issues										
	Analysis and dcsription of fact, phenomena, issues										
	Identification of concept and description of sc. process										
	Analysis – synthesis – formulation of concept network and science process – integr										
2	----										

Table 3:- Format-1 for exploration of object using model: HOTL-DI type A Notes: * Steps of HOTL to follow horizontal steps in format-1

** indicators and the number of indicators based on the results of evaluations of previous interactions.
The choice of indicators is based on the need to strengthen democratic interactions or control undemocratic interactions.

Object	Identification of fact, phenomena, issues	Analysis and dscription of fact, phenomena, issues framing by community knowledge and values	Identification of concept and descripti on of science process	Analysis – synthesis – formula tion of concept network and science process – integr.

Table 4:- Format-3 for exploration of object using model: HOTL-DI type B

Object	Steps of exploration and individual assessment of HOTL (process &achiement)			Score of Democratic Interaction **)					Assessment on group exploration		Level of mentor in terventio n
1	Steps of exploration *)	Duration of work	score	indicators					Group achiev.	Duration of work	
				1	2	3	4	5			
(1)	(2)	(3)	(4)	(5)					(6)	(7)	(8)
	Identification of fact, phenomena, issues										
	Analysis and dscription of fact, phenomena, issues framing by community knowledge and values										
	Identification of concept and description of sc. process										
	Analysis – synthesis – formulation of concept network and science process – integr										
2	----										

Table 5:- Format-4 for design – implementation – evaluation of explorative learning model HOTL – DI – type B

Notes: * Steps of HOTL to follow horizontal steps in format-3

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** Indicators and the number of indicators based on the results of evaluations of previous interactions.
The choice of indicators is based on the need to strengthen democratic interactions or control undemocratic interactions.

IV. RESULTS AND FINDINGS

A. Description of the process and achievements of the exploration of facts, phenomena and issues

a. Object exploration activities, starting from the identification stage, to the formulation of a concept network and a description of the whole science process were responded to very positively by the researcher students, mentor student groups, and target student groups.Student responses and motivations are demonstrated by efforts to obtain information related to facts, phenomena, issues, concepts and scientific processes through internet browsing, initiatives to conduct discussions and re-observations.

b. The mentor group and the target students experienced difficulties at the beginning of the exploration activities, mainly due to lack of experience. The first difficulty arises when students identify facts, objects, and issues. These obstacles then cause difficulties in the next exploration stage. At the beginning of the activity, the researcher's student intervention to the mentor group was carried out more intensively, between 40% and 55% of the exploratory reference. At the beginning of the activity, the mentor's intervention on the target student group was between 50% - 70%. At the next meeting, the intervention of the mentor to the target student group for the identification and description of objects is a maximum of 25%. This proves the potential for explorative learning activities are developed as independent activities

c. The lack of experience in identifying physical concepts and processes on objects, raises difficulties for groups of mentor and targets students in identifying concepts and processes that are relevant to the object of learning. Nevertheless, students really like and try to carry out this stage of exploration by searching material from the internet or consulting to researcher students and lecturer team.

d. Mentor and target student groups have difficulty in analyzing and / or synthesizing to produce a comprehensive network formulation of concepts and scientific processes to explain the facts, phenomena and issues studied. This difficulty was identified from the beginning to the end of the implementation of the activity. In individual exploration, the achievement of target students is only around 40 - 75%.In individual exploration, the achievement of target students is only around 40 - 75%. The achievements of group exploration activities range from 30-70%. The results of the interview revealed the weaknesses of students, because they partially understood the concept and were not related to the context.These results are consistent with the results of research by Binder et [17] which states that in physics learning, the factors that determine learning outcomes are mastery of principles and concepts (concept exploration) and the application of knowledge in problem solving (concept-context integration).This is caused by physics learning and lectures that discuss concepts partially. These results indicate the importance of context-based physics lectures, where concept networks are formulated following the context.

e. An open exploration process gives students the opportunity to formulate their experience, knowledge and opinions, according to the principles of democratic learning.The diversity of exploration results (some are distorted and some are too broad or not focus on the object), requires direction that can focus students on exploration. The solution chosen is to apply the refletive question.

f. individually, prior knowledge strongly influences exploration processes and conclusions, as identified at the analysis and description of facts, phenomena and issues. For some students, prior knowledge reinforces the conclusion of exploratory results, but for others it raises misconceptions.For example the collision event is interpreted and formulated as pressure. The concept of friction in making ceramics and pottery is interpreted by most students as a concept of pressure.The interview results show that this misconception is due to previous understanding and knowledge which interpret the event of contact between two objects or two surfaces as pressure. This misconception spreads to errors at the identification stage of concepts and scientific processes, and at the stage of concept network formulation.

B. General description of democratic interaction in the process of object exploration (HOTL-DI models A and B). The results of the interviews of the research students with the mentor and target group of students, concluded that the democratic interaction needed to be developed are: (1) freedom of expression, (2) willingness to accept criticism, (3) provide positive criticism of the opinions of friends, (4) the activity of working together to get a source of learning, (5) initiatives to motivate groups, (6) initiatives to validate or complement exploration results. The results of the democratic interaction assessment on the four research groups, showed that at the initial meeting, democratic interaction did not go well, but at the second meeting and so on positive interaction increased significantly.A summary of democratic interaction scores of four group of researchsis presented in Table 6.

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Indicator	Score of mentor group, act no…			Score of group of subject, act no…		
	1	2	3 etc.	1	2	3 etc
freedom of expression	30%-55%	60%-70%	80%-90%	25%-50%	40%-60%	60%-70%
willingness to accept criticism	20%-50%	55%-70%	65%-80%	20%-40%	45%-60%	60%-70%
provide positive criticism of the opinions of friends	30%-40%	65%-75%	70%-85%	20%-30%	50%-70%	60%-75%
the activity of working together to get a source of learning	65%-75%	70%-85%	85%-95%	40%-65%	65%-70%	70%-85%
initiatives to motivate groups	40%-65%	60%-75%	70%-85%	30%-50%	55%-75%	70%-85%
initiatives to validate or complement exploration results	0-30%	50%-70%	70%-80%	0-20%	40%-65%	65%-80%

Table-6. Range of scores for positive democratic interaction of mentor and target groups of students

Note: the percentage data in Table-6 shows the intensity (number of activities) of democratic interactions compared to reference at each stage of exploration. The intensity score is calculated using a rubric formulated by researcher students under the direction of the supervisor.

The data in Table-6 shows a fairly high variation in the range of interactions. This is because not all group members in the four research groups were actively involved in the discussion. The tendency of the lower limit of the range of scores in the target group which is lower than that of the mentor group is due to the inadequate interaction between the first semester student groups.The results of the interview revealed the first semester students' reluctance to interact with colleagues in the group, because they had not known each other for long. The results showed the potential for the development of explorative learning (lectures and assignments) through group interaction. The results of the interview revealed that differences in experience, prior knowledge, perceptions of objects can be bridged through democratic interactions.

C. Application of Reflective Question (RQ)

a. Reflective question identification results

Keywords of RQ that are identified from the results of observations, discussions and assessment of individual and group exploration tasks are presented in Table-7. Table-7 column-2 presents examples of RQ keywords, statements and correct concept identification. Column-3 presents examples of RQ keywords, statements and identification of distorted concepts, in study group I (the phenomenon of rainwater falling in open and vegetated land)

steps	Ketwords of RQ (right statement and concept)	Keywords of wrong statement or wrong concept	facts, phenomena and issues being studied
(1)-(2)	Collision	pressure	Raindrops fell on the open ground
(2)-(3)	momentum	pressure	Raindrops fell on the open ground
(3)-(4)	Momentum, potential and kinetic energy,	Pressure, force as: F=m.a	Raindrops fell on the open ground
(1)-(2)	Grass **elasticity**	Grass resistance	Raindrops fell on grassy ground
(2)-(3)	Elastic force and elastic energy	Raindrop pressure on the grass	Raindrops fell on grassy ground
(3)-(4)	Relationship between force and elastic energy, Changes in kinetic energy of raindrops into elastic energy, decrease in velocity of raindrops etc.	Not identified. The description is distorted and not well connected between concept.	Raindrops fell on grassy ground
etc.			

Table 7:-Results of RQ identification of the research group-1

b. The application and impact of applying reflective questions

The application of reflective questions is carried out at the end of each exploration stage. The reflection activity starts from individual activities, and then the group activities. The results of the identification and analysis of individual and group activities after reflection compared with before reflection, concludes that this Reflective Question is needed for the analysis and description of objects, and at the stage of concepts and processesidentification. The impact of reflection applied to the four research groups, shows that the percentage of correct exploration results for stages (1) - (2) is 86% -100%, while in stages (2) - (3) is 56% -78%.This percentage data shows the number of individuals who correctly revised their work after reflection, divided by the number of individuals whose exploration results are biased before reflection. The low achievement of reflection results in stages (2) - (3) is caused by the experience and ability of students to identify scientific concepts and processes on facts, phenomena and issues. This is due to the experience of attending lectures which only emphasizes the discussion of concepts. Physics

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concepts are partially understood and cause difficulties in carrying out formulation of concept networks and describing physical processes comprehensively (stage (4)). The results of the interview revealed that prior knowledge obtained by students from the surrounding environment, influenced the process of exploration and reflection. For example, the use of the term pressure which is better known to the public, creates obstacles in the reception and reconstruction of knowledge that is specific to facts and phenomena, such as collisions. Group reflection activities can improve the opinions and previous knowledge obtained from the environment. Group reflection activities can improve the opinions and prior knowledge obtained from the environment. An open exploration strategy combined with giving reflective questions, can reveal misconceptions, and then is used to facilitate students to revise their own knowledge. These individual exploration results are similar to the results of research by Kershner et al, 2012[23] and Alexander, 2005 in [18]. which implements exploratory talk. The results of the application of this RQ become a necessity in the process of exploratory learning, at each stage of HOTL both individually and in groups. The process of explorative learning is democratic, giving rise to the answers to very diverse exploration. The application of RQ can direct and focus individual or group answers.

D. Asessment on the role of mentor

Student mentors and research students act as learning facilitators for the target student group. All four study groups showed high mentor intervention at the beginning of the learning activities. The role of the mentor can be significantly reduced at the second meeting and beyond, especially for the exploration stages (1) - (2).From the initial meeting to the last, intensive mentor roles are needed in stages (2) - (3) and (3) and (4). Students need more experience and improving ability to identify concepts and formulate scientific processes on the facts, phenomena and issues studied.Another advantage of this mentoring system is the improvement of the academic climate in the form of cross-level learning interactions. Interaction in small groups that develop from this explorative research process has the potential to develop more broadly and can increase student academic interaction at the same level or across levels.

E. Findings

Important findings as a reflection and feedback on the implementation of lectures at the Faculty of Mathematics and Natural Sciences, Manado State University are:

1. Student attitudes and behavior in group learning interactions. Some students are passive and just waiting for group work to be done by friends who are considered capable. There are also students who just don't give a chance or accept their friends' opinions to be discussed and formulated as a group assignment.There is a group of students who accommodate and formulate all the opinions of group members as a product of the group's work, even though there are contradictions. Thirdly variations in attitudes and behaviors that are not democratic, and not productive. This is a strong reason that group learning must be monitored and facilitated for productive democratic interactions.
2. The diversity of answers or individual exploration results indicate that prior knowledge has a significant effect on the process of identifying and describing objects, the exploration of concepts and the scientific process. This diversity shows the importance of exploration activities that integrate experience with the material or information to be studied.The application of reflective questions that associate early knowledge with learning material becomes a solution that encourages students to reflect and construct their knowledge, as well as building a critical attitude in analyzing the relationship of context with concepts.

V. CONCLUSION

Explorative learning of the HOTL-DI model is responded to both by students and has the potential to develop research-based learning patterns, and integrate experiences with new information. Prior knowledge gained from the surrounding environment has a significant effect on the exploration process, can provide reinforcement but also has the potential to create obstacles in the exploration stage. Exploration of facts, phenomena and issues that are open, encourages individuals to express their experiences and prior knowledge. This open exploration can reveal the ability of individuals to focus on the analysis of problems and misconceptions, and individual behavior in demoraticinteractions. The application of RQ improves the focus of analysis, improves misconceptions, and encourages students individually or in groups to reflect and revise their work. The mentoring system in explorative learning in the HOTL-DI model can build open learning patterns and cross-level learning initiatives, thereby improving the academic climate on campus.

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REFERENCES

[1]. Medellu Ch. S., S. Lumingkewas, and J.F. Walangitan," Democratization of Learning through Thematic Assignment," *International Education Studies*; Vol. 8, No. 4. ISSN 1913-9020 E-ISSN 1913-9039. doi:10.5539/ies.v8n4p111,2015.

[2]. DiSessa A. Changing Minds," Computers, Learning, and Literacy, "Cambridge, MA: MIT Press.

[3]. Linn M. C. and S. Hsi, " Computers, teachers, peers: Science learning partners,"Mahwah, NJ " Lawrence Erlbaum Associates. 2000

[4]. Noel J," Science changes set to inspire students.,"*Physics Education*. 41 (2): 174-178,2006

[5]. Popov O ,". Developing Outdoor Physics Project Using Activity Theory Framework ,2008

[6]. Oulton C., J. Dillon, and M. Grace ,"Reconceptualizing the teaching of controversial issues.,"*International Journal of Science Education*, 26(4): 411–423.,2004

[7]. Sadler T.D., F.W. Chambers, and D.L. Zeidler,"Student conceptualizations of the nature of science in response to a socioscientific issue.," *International Journal of Science Education*, 26(4): 387-409, 2004

[8]. Eggert S., F. Ostermeyer, M.Hasselhorn, and S. Bögeholz," Socioscientific decision making in the science classroom:," The effect of embedded metacognitive instructions on students' learning outcomes. *Education Research International*, Vol 2013, Article ID 309894, 12 pages.,2013.

[9]. Hartmann S. and J. Mittelstra , "Physics is Part of Culture and the Basis of Technology paper appeared in German Physical Society - Physics Research: Topics, Significance and Prospects," Bonn: DPG, pp. 195–198, 2002

[10]. Bello, Th. O ,"Influence of Cultural Belief and Values on Secondary School Students' Understanding of Atmospheric Related Physics Concepts," *Journal of Education and Practice,* 6(36). ISSN 2222-1735 (Paper) ISSN 2222-288X,2015

[11]. Reiter B.. ," Theory and Methodology of Exploratory Social Science Research". International *Journal of science and research methodology (IJSRM),* 5(4), pp129-150,2017

[12]. Heikkinen H., P. Hästö, V. Kangas, and M. Leinonen ," (*Promoting exploratory teaching in mathematic"*. University of Oulu, June 30, 2015.

[13]. Yandari I.A.V, H. Nindiasari, E. Khaerunnisa, A.S. Pamungkas, Karso, and Nurjanah . "Self-Regulated Learning in Designing Explorative Learning Tools Among Mathematics Pre-service Teachers through Explorative Module". SHS Web of Conferences 42, 00106 (2017)

[14]. Hailikari, T., A. Nevgi, and S. Lindblom-Ylänne ." Exploring alternative ways of assessing prior knowledge, its components and their relationship to achievement: A mathematics based case study". *Studies in Educational Evaluation, 33*,pp: 320–337 .(2007)

[15]. Van Riesen S., H. Gijlers, A. Anjewierden, and T. de Jong ." The influence of prior knowledge on experiment design guidance in a science inquiry context". *International Journal of Science Education, 40*,pp:1327-1334,2018

[16]. Robbins S. B., K. Lauver, H. Le, D. Davis, R. Langley, and A. Carlstrom ." Do psychosocial and study skill factors predict college outcomes: A meta-analysis". *Psychological Bulletin, 130*, 261,2004.

[17]. Binder T, A. Sandmann, B. Sures, G. Friege, H. Theyssen, and P. Schmiemann ."Assessing prior knowledge types as predictors of academic achievement in the introductory phase of biology and physics study programmes using logistic regression". *International Journal of STEM Education,2019*

[18]. Murphy, C." Changing Teachers' Practices Through Exploratory Talk in Mathematics: A Discursive Pedagogical Perspective". *Australian Journal of Teacher Education*,2015.

[19]. Wang S., and H. Wang . Teaching and Learning Higher Order Thinking. *International journal of Arts and Sciences* 07(02): 179-187. CD-ROM ISSN: 1994 – 6934,2014

[20]. Barahal, S. Thinking about Thinking: Pre- Service Teachers Strengthen their Thinking Artfully, Phi Delta Kappan 90 (4),2008.

[21]. Samo D.D, Darhim, and B. Kartasasmita. Developing Contextual Mathematical Thinking Learning Model to Enhance Higher-Order Thinking Ability for Middle School Students. *International Education Studies*; 10(12) – article ISSN 1913-9020 E-ISSN 1913-9039,2017.

[22]. Pegg J.. Promoting the Acquisition of Higher-Order Skills and Understandings in Primary and Secondary mathematics. The University of New England. Research Conference 2010, [23] Kershner, R., P. Warwick, N. Mercer, and J. KleineStaarman . Primary children's management of themselves and others in collaborative group work: 'Sometimes it takes patience …'. Education 3-13: *International Journal of Primary, Elementary and Early Years Education*, iFirst Article,pp: 1-16, 2010.

[23]. Kershner, R., P. Warwick, N. Mercer, and J. KleineStaarman . Primary children's management of themselves and others in collaborative group work: 'Sometimes it takes patience …'. Education 3-13: *International Journal of Primary, Elementary and Early Years Education*, iFirst Article,pp: 1-16,2012.

[24]. Hazari Z., R.H. Tai, and P.M, Sadler . Gender differences in introductory university physics performance: The influence of high school physics preparation and affective factors. *Science Education, 91*(6), pp:847–876,2007.

[25]. Sadler P. M., and R. H. Tai . Advanced placement exam scores as a predictor of performance in introductory college biology, chemistry and physics courses. *Science Educator, 16*, pp:1–19,2007.

[26]. Liu, O. L., K. Ryoo, M.C.Linn, E. Sato, and V. Svihla . Measuring knowledge integration learning of energy topics: A two-year longitudinal

study. *International Journal of Science Education, 37*,pp: 1044–1066,2015.

[27]. Ramist L., C. Lewis, and L. McCamley-Jenkins . Using achievement tests/SATII: subject tests to demonstrate achievement and predict college grades: Sex, language, ethnic and parental education groups. New York: The College Board,2001.

[28]. Lerman, S. . Cultural, discursive psychology: A sociocultural approach to studying the teaching and learning of mathematics. *Educational Studies in Mathematics*, 46, 87113. [29] Sfard, A. There is more to discourse than meets the ears: Looking at thinking as communicating to learn more about mathematical learning. *Educational Studies in Mathematics*, 46(1-3), pp:13-57.2001.

[29]. Sfard, A. There is more to discourse than meets the ears: Looking at thinking as communicating to learn more about mathematical learning. *Educational Studies in Mathematics*, 46(1-3),pp: 13-57.2001.

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