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Investigating the Relationship between the Skill of Observing A Scientific Phenomenon and Solving A Problem by School Kids in Remote Areas of Mongolia

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ABSTRACT: *The purpose of this study is to develop a questionnaire to test and detect the ability of 7th-grade students to independently solve problems and observe scientific phenomena, and to study the correlation between these abilities. The skill of problem-solving is one of the most important abilities of the 21st century and the key to exploring the ability to observe and learn. Also, it has a strong relation with consciousness, thinking, and interactions with others. Out of Bulgan, Huvsgul, and Orkhon provinces of Mongolia, 324 public school 7th-grade students participated in this study. To perform this study, a 19-item questionnaire was developed to investigate the skills of observation skill and solving a problem by students themselves, is based on the IDEAL model, and tested with the Varimax method (Table 1). Used the Pearson correlation method to find the relation between the skills of observing and solving a problem by students on their own (Table 3). From the results, the observation skill has identifying problems at 0.727 and the acting on the strategies at 0.712 which shows a strong positive correlation. Sub-factor reliability statistics Cronbach's alpha is at 0.721. From this, by showing scientific phenomena, developing children's skills to observe helps develop children's skills to solve a problem on their own.*

KEYWORDS *–Observation skill, Problem-solving, 21st Century skill, IDEAL model*

I. INTRODUCTION

The purpose of this study is to develop a questionnaire to test and detect the ability of public school 7th-grade students to independently solve problems and observe scientific phenomena. Problem-solving is the most important skill needed by today's children everywhere, including both in-school and out-of-school learning and achievement. It is one of the fundamental skills of the 21st century. Recent research in problem-solving suggests that educationalists, trainers, and policymakers are reviewing curricula to include incorporated learning environments that focus on students' use of analysis, evaluation, synthesis, etc. type skills, and especially, problem-solving skills as new learning theory has evolved and professional standards have been changed which created demands of the new workplaces [1].This study uses cognitive theory. Cognitive learning seeks the ways learners are taught to develop their thinking ability in interacting with the new situation building on prior knowledge that is relevant and meaningful [2]. Cognitive theory approaches learning to enhance learners' cognitive processes, knowledge, interest, ability, and aptitudes to interact with instructional stimuli toward meaningful information in memory [3]. In the last century, Jean Piaget proposed one of the most famous

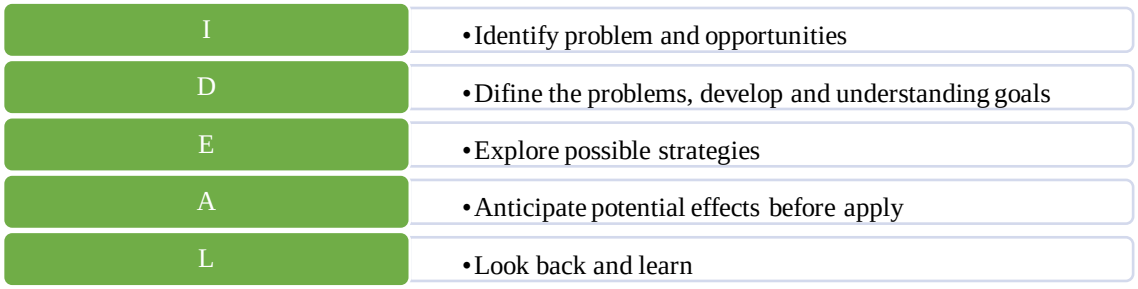
theories regarding cognitive development in children. Cognition is defined simply as a process of our thinking. It defines the very act of acquiring information through observation, thinking, imagination, memory, judgment, problem-solving, and selective attention [4] and [5]. (Van Groenestijn M. 2002) Action theory, with Vygotsky's view on interaction as a basis for cognitive development [6]. Observing skill is a part of the science process skills, which is a series of activities to collect data about an object using all the senses [7]. Observing skill is the most basic skill that bridges the mastery of higher-level science process skills [8]. Observing skills include skills using several senses, identifying the differences and similarities of an object, using tools to obtain data, and searching for relevant data [9]. Observing is a broad activity, not only using the sense of sight to collect data, but also using other sensory devices such as hearing, smell, taste, and touch [10]. Used tools are also required in observing activities to help improve the quality of the obtained data [11]. The observers were equipped with checklists of observing skill indicators that were compiled according to Rankin (2006) [12]. Formulating the hypotheses trains students to think critically and test their understanding based on the observations at the orientation stage [13]. Regarding that problem, skilled people solve problems to survive and face the various issues in their lives. The process of choosing the right strategy for learning aims to develop a meaningful learning process and allows students to make flexible decisions in solving mathematical problems. Students with flexibility in problem-solving will solve the problem with various strategies [14]. Observational skills are the basic tools of problem-solving. It is the first step to solving any type of problem around us. Problem-solving skills provide children with the chance to emphasize more clearly the procedures of seeing, systematically and empirically, and by means of that procedure to develop their skills to comprehend what they observe [15]. Additionally, Johnston (2009) found that kids observe utilizing their five senses, by observing details, organizing, combining, and classifying things, or sequencing events [16]. Basic science process skills are observing, classifying, measuring, and predicting. These skills provide the mental foundation for scientific inquiry, such as the ability to sequence and define natural things and events [7]. Therefore, observation skills must be cultivated in children so that they can use them effectively in solving any problems of life. Problem-solving skill is the most crucial ability demanded by our society and the vital element in enhancing students' comprehension knowledge and preparing them to survive future challenges in life[17]. Some Mongolian researchers Gendenjamts S., Amarzaya A., and Anu B., developed the paper "Measurement of Problem-Solving Abilities of Students and Task Analysis". Tumenbayar D. and Amarzaya A. analyzed how variations in student problem-solving skills among Mongolian students depending on socio-economic status [18]. In Mongolia, students' skill to observe has rarely been studied. This research is important for the development of children's observation skills.

II. METHODOLOGY

This research used identifying problems and opportunities, defining the problems, developing and understanding goals, exploring possible strategies, anticipating potential effects before applying, looking back, and learning (IDEAL). It is a common problem-solving strategy that can be used by an individual or by a team of people [19]. IDEAL learning strategy, students are given the opportunity to seek and solve a problem of their own [20]. Thus strategy can be used to describe the ability of thinking skills in the process of problem-solving [10]. L. D. Permata, T. A. Kusmayadi, and L. Fitriana investigated, categorized, and analyzed student's problem-solving skills about word problems of the linear program using IDEAL problem solver, which can be used as a basis tool to consider the learning improvement [14]. Indicators of mathematical problem solving adopted from IDEAL model which include the identification of problems, writing down the objectives of the problem given, planning and choosing the right solution strategy, and interpreting the results of the solution in the form of conclusions and IDEAL learning strategy, students are given the opportunity to seek and solve a problem of their own [20] and [21].The IDEAL approach to Problem-solving is based on many powerful ideas, yet it could be better in the sense of being perfect or the best system that could be created. Nevertheless, it can be very helpful to those who want to improve their problem-solving skills. The IDEAL approach is designed to help identify and understand different parts or components of problem-solving. Based on Fig. 1, Brandsford

identifies the five (5) stages of ideal Problem solving as vital to successful problem-solving as well as the relationship among these stages.

Fig. 1 Brandsford'd IDEAL model in problem-solving



*(*https://www.tntech.edu/cat/pdf/useful_links/idealproblemsolver.pdf)

Bransford and Stein introduced an IDEAL problem solver consisting of five indicators including:

(1) Identifying problems; identifying information, questioning, visualizing situations, and making them creative thinking opportunities to determine the next stages.

(2) Defining the problem; organizing information and questions, finding and selecting the necessary/essential information to answer the question provided.

(3) Exploring solutions; finding/creating possible strategies: pattern, table, or models to solve the problem.

(4) Acting on the strategies; using numeracy, algebra, or geometric capabilities to solve the problem given, and

(5) Looking back and evaluating; rechecking answers, determining alternative solutions, discussing and developing answers to other situations[22]. In this study, 324 7th-grade students of Bulgan, Huvsgul, and Orkhon provinces of Mongolia participated in the questionnaire. Itemed questionnaire was developed for investigating the skills of observation and solving a problem by students themselves which is based on IDEAL model and Varimax method. 19 itemed questionnaires are: Ob2, Ob3, I1, I2, I3, D1, D2, D3, D4, E1, E2, E3, E4, E5, A1, A2, A3, L1, L2 (Table1). The Pearson correlation was used to find the relationship between the observation skill and solving a problem by students themselves (Table 3).

Quantitative research methods (equations 1-3) were applied in this research and data was processed using SPSS-21.

Varimax Rotation Equation:$Varimax = \sum_{i=1}^{m}\left(\sum_{j=1}^{n} L_{ij}^{4} - \frac{1}{n}\left(\sum_{j=1}^{n} L_{ij}^{2}\right)^{2}\right)$(1)

Cronbach's Alpha:$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N}\sigma_i^2}{\sigma_{total}^2}\right)$(2)

Pearson correlation coefficient: $r = \frac{\sum(X_i-\overline{X})(Y_i-\overline{Y})}{\sqrt{\sum(X_i-\overline{X})^2\sum(Y_i-\overline{Y})^2}}$(3)

III. ANALYSIS

First, KMO and Barlett's were used to test the questionnaires to apply Varimax (equation 1). Next, Cronbach's

Category	**Observation skill**	**Problem-solving skills**				
sub-factor	**Observation skill**	**Identify the Problem**	**Define and Represent the Problem**	**Explore Possible Strategies**	**Act on the Strategies**	**Look Back and Evaluate**
Item code	Ob2, Ob3	I1, I2, I3	D1, D2, D3, D4	E1, E2, E3, E4, E5	A1, A2, A3	L1, L2
Variance	0.008	0.006	0.008	0.012	0.012	0.013
Varimax	0.730	0.771	0.816	0.871	0.760	0.710
Sig.(P<0.05)	0	0	0	0	0	0
Cronbach's Alpha	0.752	0.952	0.892	0.894	0.81	0.803
Mean	3.409	3.605	3.217	2.832	3.387	3.335
N of item	2	3	4	5	3	2

Alpha was estimated for the questionnaires (Table 1). Table 1 shows construct validity exploratory factor analysis and sub-factor validity. Table 2 describes Sub-factor reliability statistics. Lastly, Pearson correlation was applied (equation 3) to find a relationship between 'observation skill' and 'identifying the problem', 'defining and representing the problem', 'exploring possible strategies', 'acting on the strategies', 'looking back and evaluating' (Table 3).

Table 1 Construct validity and exploratory factor analysis

Table 2 Sub-factor reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.721	.751	6

Table 3 Pearson correlation value between the Observation skill and Problem-solving skills

		Observation skill	Identify the Problem	Define and Represent the Problem	Explore Possible Strategies	Act on the Strategies	Look Back and Evaluate
Observation skill	Pearson Correlation	1	.727**	.266**	.241**	.712**	.417**
	Sig. (2-tailed)		0	0	0	0	0
	N	324	324	324	324	324	324

Identify the Problem	Pearson Correlation	.727**	1	.177**	.138*	.353**	.304**
	Sig. (2-tailed)	0		0.001	0.013	0	0
	N	324	324	324	324	324	324
Define and Represent the Problem	Pearson Correlation	.266**	.177**	1	.177**	.310**	.199**
	Sig. (2-tailed)	0	0.001		0.001	0	0
	N	324	324	324	324	324	324
Explore Possible Strategies	Pearson Correlation	.241**	.138*	.177**	1	.265**	.142*
	Sig. (2-tailed)	0	0.013	0.001		0	0.011
	N	324	324	324	324	324	324
Act on the Strategies	Pearson Correlation	.712**	.353**	.310**	.265**	1	.582**
	Sig. (2-tailed)	0	0	0	0		0
	N	324	324	324	324	324	324
Look Back and Evaluate	Pearson Correlation	.417**	.304**	.199**	.142*	.582**	1
	Sig. (2-tailed)	0	0	0	0.011	0	
	N	324	324	324	324	324	324

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Each variable's Pearson correlation with the others has been calculated, along with significance values (p-values) to indicate whether the correlations are statistically significant (at the 0.01 level).

Fig.2 and Fig.3 demonstrate the correlation between observation skills and both identify the problem and act on the strategies' capabilities. In Fig.2, a linear regression analysis reveals a correlation between observation skill and the ability to identify problems, with a regression coefficient of determination 0.4425. This implies that as observation skills improve, students are more likely to accurately identify problems. In Fig. 3, the correlation between observation skill and the act on strategies is depicted with the coefficient of determination 0.5781.

Fig. 2 Observation skill and identify the problem

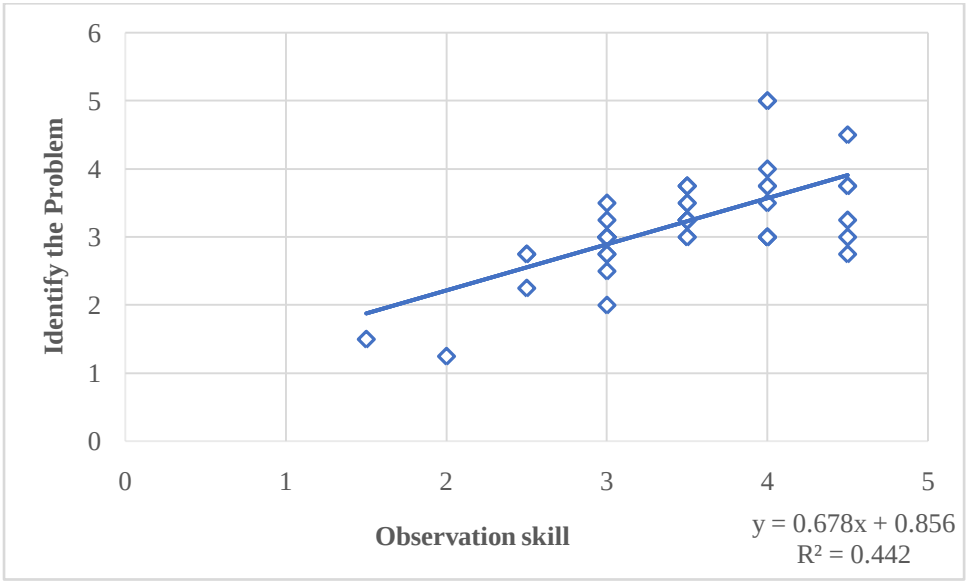
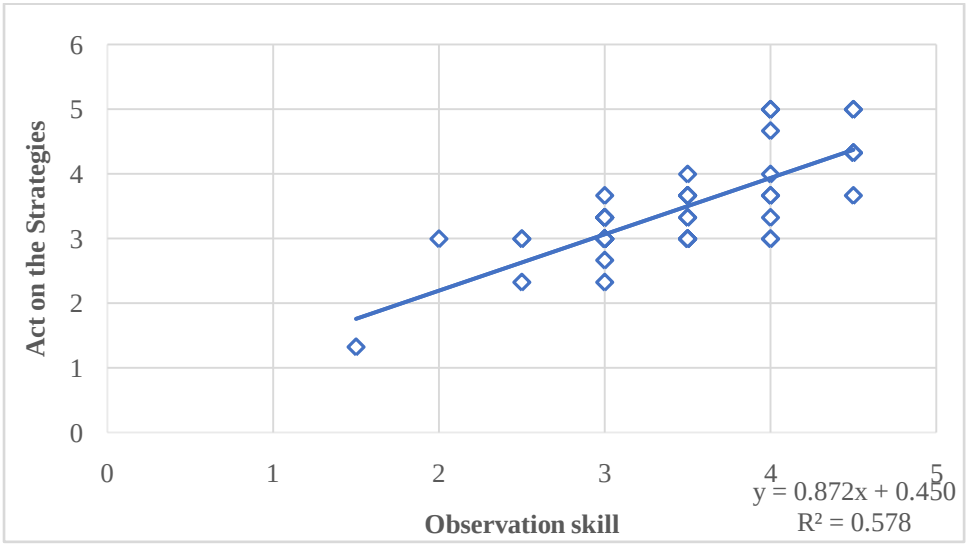


Fig. 3 Observation Skill and Act on the Strategies



IV. RESULTS

19 items of the questionnaire were developed for investigation of the skills of observation and solving a problem by students themselves which is based on IDEAL. The Varimax method was applied in this research (Table 1). The Pearson correlation method was used to find a relationship between the skills of observing and solving a problem by students themselves (Table 3). From the results, there is a positive relationship among observation skills, identifying the problem, and acting on the strategies. Cronbach's alpha of sub-factor reliability for observation skill, and 'identify the problem', 'define and represent the problem', 'explore possible strategies', 'act on the strategies', and 'look back and evaluate' has 0.721 (Table2). This indicates a stronger correlation between observation skills and acting on the strategies compared to identifying problems. Overall, these indicate that observation skills play a critical role in enhancing both identifying the problem and acting on the strategies. The

correlation with acting on the strategies suggests that students with higher observation skills may not only recognize issues more effectively but also respond more effectively by acting on the strategies. These insights underscore the importance of developing observation skills as a foundation for effective problem-solving and decision-making. Scientificphenomena can be scientific outreach programs.

V. DISCUSSION AND CONCLUSION

As artificial intelligence (AI) develops, enhancing the skills of students becomes more important. Unfortunately, the mass education system mostly focuses on giving knowledge, but not on developing skills. However, education like mass production in a factory is vulnerable in the age of AI. This research indicates that it is possible to develop a simpler way to enhance problem identification and strategy implementation skills by developing observation skills. This is especially important for education in rural areas of developing countries like Mongolia. Mongolia, which still has a large rural population, suffers from a deficiency of secondary school teachers in these areas. Even low-income urban areas lack enough teachers in their secondary schools. Therefore, creating educational methods based on this research output might help areas suffering from teacher deficiency. The results indicate that observational skills are related to problem identification and strategy implementation skills. This suggests that we can develop students' problem-identification and strategy implementation skills by enhancing their observational skills, particularly in observing scientific phenomena. Therefore, observing scientific phenomena in science classes can help students develop essential skills applicable to other subjects. It is important to study the basic skills of the 21st century in detail, develop training methods suitable for the conditions of Mongolia, and eliminate the difference between urban and rural areas.

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