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Achievement and interest in science, classification of perceived usefulness types, and an investigation of influencing factors – Focused on participation in scientific and cultural activities

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Abstract

The purpose of this study is to classify latent profile of science achievement, interest, and utility recognition and to test the effects of students and school factors on science lessons and participation in scientific cultural activities. To do this, latent profile analysis and multinominal logistic regression analysis were applied to data from 2015 PISA tests (15-year-old students). The findings of this study indicate a need to increase active scientific learning and participation in scientific cultural activities to increase awareness of scientific interest and usefulness. Additionally, science culture activities, education, and programs should be differentiated according to the identified latent classes.

Keywords: *Science interest, Science achievement, Scientific and cultural activities, LPA, Multinominal logistic regression analysis.*

1. Introduction

Considering the importance of the development of science and technology culture, the issue [1]of contradictory tendencies of South Korean middle school students in achievement and interest in science compared to the OECD standard has been consistently raised [8]. Despite the high number of students exhibiting excellent achievement in science, their interest in science is decreasing, ultimately resulting in students avoiding career choices in the fields of science and technology.

This is referred to as a social problem because students with excellent achievement in science are not choosing science and engineering, which ultimately becomes a loss for the nation [5]. Such a situation shows that an approach emphasizing science achievement alone can no longer increase the number of competent individuals in science and engineering [1]. Accordingly, in the United States, the importance of breaking away from completing a high level of science-related subjects and increasing opportunities for students to participate is also mentioned at the government level to increase career choices in science and [7].

At the present time, when national competitiveness in science and technology is ultimately linked to the competitiveness of the future society, it is important to understand the achievement, interest, and perceived usefulness of science for the school-aged students who will be responsible for the future. The reason is that such achievement, interest, and perception of utility in science will affect students' decision-making regarding future careers and become the

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foundation for the development of science and technology in South Korea. In addition, determining students' achievement, interest, and usefulness patterns, and identifying the influencing factors that affect the separation of classes, will compose the basic data for establishing an educational approach to science in the future.

Therefore, the present study attempts to promote students' participation in science activities and present educational approaches for career choices in science and technology by identifying patterns based on achievement, interest, or usefulness of science and determining the influence of students participating in specific types of science-related activities on specific subjects.

2. Research method

Study Participants. The participants in the present study were 15-year-old South Korean students who took the PISA 2015 test. A total of 5,749 students from 168 schools sampled by the Korea Institute for Curriculum and Evaluation for the test were used as participants in the present study. The present study was conducted based on data collected from 548 students from 23 middle schools and 5,201 students from 145 high schools.

Research instruments. A questionnaire was used in addition to the PISA 2015 science achievement data. The PISA 2015 survey consisted of student, teacher, and parent surveys, and relevant variables in the student survey were selected for the present study [3]. A latent profile analysis was conducted based on participants' interest in science and perceived usefulness of science along with students' science achievement, and the answers were classified into types. In addition, gender, level of education, parental support, and motivation were included (as personal variables) in addition to number of classes, school learning time, and four types of teaching methods related to learning science subjects in school to identify factors that affect the prediction of latent class pattern classification. Finally, the influence of types of student participation in scientific cultural activities on the group predictions of achievement, interest, and usefulness of science was analyzed.

Research methods. A latent profile analysis was conducted using Mplus 14.0 to determine the existence of heterogeneous latent groups and their number according to science achievement, interest in science, and perceived usefulness of science of middle school students. To determine the number of latent classes, AIC (Akaike Information Criteria), BIC (Baysian Information Criteria), and sBIC (Schwarz-Baysian Information Criteria) were calculated. Considering the number of estimated parameters and sample size, the smaller the calculated value, the better the model [6]. In addition, because the number of groups is proven to be appropriate when the entropy value is close to 1, the number of latent classes was determined based on that. Later, a multinomial logistic regression analysis was conducted using SPSS 22.0 to determine how the probability of belonging to a tested latent group changes depending on personal characteristics, school learning related to science, and the types of participation in scientific cultural activities.

3. Results

Model test. A latent profile analysis was conducted as shown in Table 1 to determine the number of latent classes according to students' science achievement, interest in science, and perceived usefulness of science. The goodness of fit indices and the estimation of class were compared while increasing the number of latent classes starting with the second class. The smaller the values of AIC and BIC, the more appropriate the model (Muthen & Muthen, 2000). And entropy values sharply increased to .93 from the fifth class. Based on the sharp increase,

the fifth model was selected as the final model (Log-likelihood = -20322.91, AIC=40689.82, BIC=40835.61, sBIC=40765.70, p<.001, entropy=0.93).

Table 1. Goodness-of-fit index test according to the number of latent classes

	Class 2	Class 3	Class 4	Class 5	Class 6
Log likelihood	-22374.13	-21812.73	-21588.50	-20322.91	-20276.13
df	10	14	18	22	26
AIC	44768.25	43653.45	43213.01	40689.82	40604.27
BIC	44834.53	43746.23	43332.30	40835.61	40776.57
sBIC	44802.75	43701.75	43275.10	40765.70	40693.95
Entropy	0.637	0.757	0.784	0.93	0.932
BLRT (p-value)	<.001	<.001	<.001	<.001	<.001
Class 1(%)	2278(40.82)	1004(17.99)	215(3.85)	660(11.83)	658(11.79)
Class 2(%)	3303(59.18)	3598(64.47)	826(14.80)	2266(40.60)	2264(40.57)
Class 3(%)		979(17.54)	3559(63.77)	172(3.08)	177(3.17)
Class 4(%)			981(17.58)	710(12.72)	669(11.99)
Class 5(%)				1773(31.77)	1768(31.68)
Class 6(%)					45(0.81)

Achievement and interest in science showed similar patterns, and Class 1, which is a group with high achievement in science, showed a high level of interest in science and perceived usefulness of science. The level of achievement, interest, and usefulness of science was slightly higher than the average for Class 2, while that of Class 3 was slightly lower than the average. Class 4 had a low level of achievement in science and significantly lower level of interest in science than the average while showing a high level of perceived usefulness patterns of science. Lastly, Class 5 showed the lowest level of achievement and interest in science and a very low level of perceived usefulness of science.

Influencing factors according to achievement in science and latent class of usefulness (focused on participation in scientific cultural activities). The results of identifying the influencing factors according to achievement in science and latent class of usefulness focused on participation in scientific cultural activities are shown in Table 2.

The criterion group was the low achievement/low perceived usefulness group; males were more likely to be in the high achievement/high perceived usefulness group than the criterion group, and students with high levels of parental support and achievement motivation had a higher probability to be in the high achievement/high perceived usefulness group. In terms of participating in scientific cultural activities, the higher the level of activities (such as watching related TV programs, purchasing related books, reading science articles, and participating in clubs), the higher the relative probability of being in the high achievement/high perceived usefulness group.

The probability of male students in the above average achievement/above average perceived usefulness is higher than that in the criterion group, and the higher the parental support, the higher the relative probability of being in the above average achievement/above average

perceived usefulness. In terms of participating in scientific cultural activities, it was found that the higher the level of activities such as watching related TV programs, purchasing related books, reading science articles, and participating in clubs, the higher the relative probability of being included in the above average achievement/above average perceived usefulness group.

The higher the number of science classes in school, the higher the probability of being included in the below average achievement/below average perceived usefulness than the criterion group. It was found that the higher the level of activities such as watching related TV programs, purchasing related books, reading science articles, and participating in clubs among scientific cultural activities, the higher the relative probability of being included in the below average achievement/below average perceived usefulness group.

Lastly, scientific cultural activities of the low achievement/high perceived usefulness group were relatively higher than those of the low achievement/low perceived usefulness group, and the higher the level of visiting science-related websites, the higher the relative probability of belonging to the low achievement/high perceived usefulness group.

Table 2. Influencing factors by latent classes

Group		High achievement/high perceived usefulness			Above average achievement/above average perceived usefulness			Below average achievement/below average perceived usefulness			Low achievement/high perceived usefulness		
		B	SE	Exp	B	SE	Exp	B	SE	Exp	B	SE	Exp
Gender (male)		.52**	.17	1.69	.40**	.14	1.50	.03	.13	1.03	.14	.24	1.15
Parental support		.10*	.04	1.10	.03**	.03	1.03	-.01	.03	.99	.03	.06	1.04
Achievement motivation		.23**	.04	1.26	.05	.03	1.05	-.00	.03	1.00	.01	.05	1.01
(School) number of science classes		.19*	.07	1.21	.11+	.06	1.12	.14*	.06	1.15	-.04	.11	.96
(Individual) science learning time		.06*	.02	1.06	.03*	.02	1.03	.02	.02	1.02	.02	.03	1.02
School teaching met	Experiments	-.23	.18	.79	-.12	.16	.89	-.01	.15	.99	.24	.27	1.28
	Theory	.70**	.11	2.00	.39**	.09	1.47	.12	.09	1.13	-.19	.17	.83
	Self-learning	-.04	.16	.96	.01	.13	1.01	.16	.13	1.18	.24	.24	1.28

hods	Discussion	-.21	.20	.81	.01	.16	1.01	.04	.16	1.04	-.01	.28	.99
Participation in scientific cultural activities	Watching TV programs	1.51**	.19	4.52	1.29**	.17	3.62	.96**	.17	2.60	.35	.30	1.42
	Book purchase	1.61**	.23	4.98	1.04**	.21	2.82	.41+	.22	1.50	.36	.35	1.44
	Web site visits	.41	.31	1.51	.26	.30	1.29	.35	.30	1.42	.67+	.44	1.95
	Science articles	1.16**	.23	3.19	.96**	.21	2.61	.56**	.21	1.76	.10	.37	1.11
	Participation in clubs	1.22**	.19	3.40	.85**	.18	2.35	.50**	.18	1.65	.25	.29	1.29

+ p<.10, * p<.05, ** p<.01, *** p<.001

4. Discussion and suggestions

The present study intended to identify the diffusion direction of science culture that can be considered to be non-formal education by identifying patterns based on achievement in science, interest in science, and science usefulness, and determining the influence of students participating in specific types of science-related activities on specific categories of student. To that end, students were classified based on latent class analysis, resulting in a total of five groups (high achievement/high perceived usefulness, above average achievement/above average perceived usefulness, low achievement/high perceived usefulness, and low achievement/low perceived usefulness).

Based on the results of latent group analysis, a classification of influencing factors for each group, centering on scientific cultural activities, was attempted, using multinomial logistic regression. The criterion group was established as the low achievement/low perceived usefulness group, and the higher the level of activities such as watching related TV programs, purchasing related books, reading science articles, and participating in clubs, the higher the relative probability of being in the high achievement/high perceived usefulness group compared to the criterion group. Results also showed that the higher the level of activities such as watching related TV programs, purchasing related books, reading science articles, and participating in clubs, the higher the relative probability of being included in the above average achievement/above average perceived usefulness group. The relative probability of being included in the below average achievement/below average perceived usefulness group was higher when the level of activities such as watching related TV programs, purchasing related books, reading science articles, and participating in clubs among scientific cultural activities was higher. The present study investigated the influence of students' approach to school education and science culture on their achievement in science, interest in science, and tendency regarding the perceived usefulness of science. The findings of the present study show the necessity of connecting current theoretical science education with students' voluntary participation. In addition, the findings also suggest the necessity of a cultural approach to science so that students can naturally increase their interest and perceived usefulness of science [2],[4].

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