

Latent Profile Analysis According to the Subject Selection Criteria of General High School Students

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Abstract

The purpose of this study is to analyze the type of latent profile for general high school students' subject selection criteria and to identify the characteristics of the latent class. The survey data of 1072 general high school students (male; 648, female; 424) in G city, Jeollabuk-do and the scale composed of 8 sub-factors: 'SAT orientation', 'academic achievement', 'ability orientation', 'pursuit of interest', 'teacher orientation', 'career development', 'others' recommendation', and 'subject availability' were used for latent profile analysis and cross-analysis between potential layers. As a result of the analysis, high school students' perceptions of subject selection were classified into four latent profiles. The four groups were named 'High Perception Type', 'Low Perception Type', 'Self-Directed Type', and 'Stability-Oriented Type' according to their types. It was found that there was a difference between the latent classes in the importance and performance level of the subject selection criteria. These results can help identify the subject selection tendencies of latent groups in the operation of the 2015 revised curriculum and the 2025 high school credit system that emphasizes the student-centered course selection curriculum and they can also provide customized course selection guidance considering individual differences.

Keywords: Latent Profile Analysis, Subject Selection Criteria, General High School Students

1. INTRODUCTION

The revision of the general high school curriculum aims to expand the choice of subjects by allowing students to choose subjects themselves according to their career, aptitude, and interest. The 2015 revised curriculum operates a liberal arts and science integrated curriculum and competency-based curriculum, allowing students to complete common subjects up to the first year of high school and then take a variety of general electives, career electives, and specialized subjects according to their careers, aptitudes and interests. It allows them to grow into creative convergence talents equipped with humanities literacy and natural science thinking skills [1]. The ultimate purpose of the introduction of the 2025 high school credit system is also to expand the choice of subjects in consideration of learners' level, aptitude, and career and to provide customized education centered on student choice [2, 3]. Efforts should be made to establish an educational environment in which various choices can be made autonomously according to reasonable selection criteria.

When considering the course selection procedure, it is necessary to first establish an educational environment that supports autonomy so that the criteria considered important when selecting a subject

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(hereinafter referred to as “importance”) can be applied even when actually selecting a subject (hereinafter referred to as “implementation”). In order to do this, first of all, the students, who are the subjects of choice, must first learn about the various subject selection criteria that students think are important, how they actually select subjects in consideration of their purpose, and how freely they choose such subjects themselves. It is necessary to diagnose the importance of subject selection and the degree of execution and autonomy of selection. However, although steady studies have been conducted on subject selection methods for such diagnosis, studies on the characteristics of high school students' subject selection criteria and methods for measuring them are insufficient. There is a need for systematic research on various aspects that can identify students' subject selection criteria and characteristics using scales whose reliability and validity have been verified.

Previous studies [4-6] on factors that influence general high school students' choice of subjects have focused on the factors that influence their choice. However, these studies have limitations in that they use measurement tools whose reliability and validity have not been verified. So, it is somewhat difficult to generalize the research results. And they do not consider how high school students are categorized according to the characteristics of sub-factors constituting the subject selection criteria. So, it is somewhat difficult to generalize the research results.

Latent Profile Analysis is a Person-centered approach that considers individual characteristics, unlike the Variable-centered approach like previous studies [7, 8]. This person-centered approach is useful for verifying heterogeneity within a group that is not directly revealed, finds a latent group showing the same pattern based on heterogeneity, and provides useful information for identifying the characteristics of study subjects through the latent group [9]. This study intends to explore the latent group of high school students' subject selection criteria by using the latent profile analysis that emphasizes the classification of the latent class. Exploring how high school students are classified according to the sub-factors constituting the subject selection criteria can provide information on the content and method of subject selection guidance according to group characteristics, which is useful for customized subject selection guidance considering individual differences. Based on the latent profile analysis data, it is also possible to check the difference in the subject selection criteria between the latent classes of importance and implementation.

Considering the fact, the purpose of this study is to determine whether general high school students are categorized into groups with certain characteristics in subject selection and there is a difference between latent classes in importance and performance through latent profile analysis. This is significant as the first study to analyze the latent profile of high school students for subject selection criteria. In addition, the latent profile analysis of importance and implementation in subject selection can help students in diagnosing and intervening in educational subject selection by understanding the psychological characteristics of students and providing information on subject selection criteria according to individual differences.

The research questions according to the purpose of this study are as follows.

First, how many types of latent profiles for general high school students' subject selection criteria are classified, and what are the characteristics of the classified potential groups?

Second, is there a difference between the latent class of importance and implementation in general high school students' subject selection?

2. METHODS

2.1 Research Model

This study aims to analyze the latent profile of high school students' subject selection criteria using the reliable and valid subject selection criteria scale [10, 18], and to analyze the difference between latent classes according to the importance (a criterion considered important when selecting subjects) and implementation

(the criteria applied when actually selecting subjects). To this end, it is necessary to consider two issues: how to reveal the characteristics of the type of latent profile and the difference in importance and implementation.

Accordingly, this study was divided into a latent profile analysis and a cross-analysis model of importance and implementation. In latent profile analysis, latent group classification and characteristics were analyzed, and in cross-analysis, it was analyzed by subdividing by latent class of importance and implementation. Figure 1 shows the structure of the latent profile analysis and the cross-analysis model of importance and implementation proposed in this study.

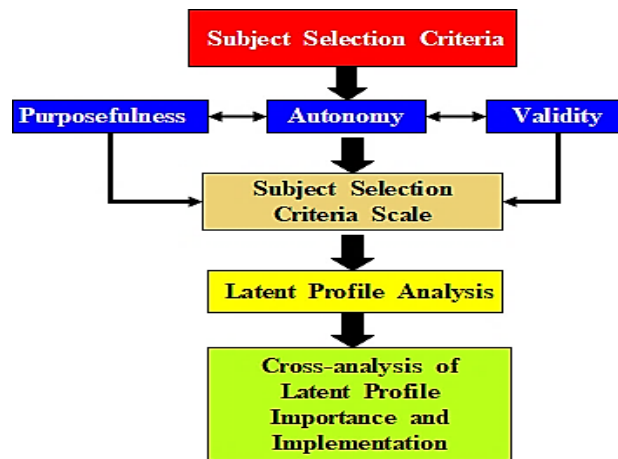


Figure 1. Research model

2.2 Research Subject

In this study, as shown in Table 1, a total of 1,072 students (male: 648, female: 424) who had actually experienced subject selection according to the research topic were included. A total of 530 people (male: 233, female: 297) participated in main examination. Among them, 520 people were actually studied by excluding 10 people who answered insincerely.

Table 1. Total number of study subjects

Division	Preliminary Survey		preliminary inspection	main examination	total
	3 rd	2 nd	2 nd		
sex	male	286	129	233	648
	female		127	297	424
	total	286	256	530	1,072

3. MEASURING TOOL

In this study, the valid subject selection criteria scale [10] was applied to analyze the latent profile of subject selection criteria. As shown in Table 2, the importance, which is a measuring tool for the recognition of subject selection criteria, and the implementation, which is an actual measuring tool, consisted of 34 items and 8 sub-factors, respectively. The eight sub-factors consisted of 'SAT orientation' 6 items, 'academic achievement' 4 items, 'ability orientation' 3 items, 'pursuit of interest' 4 items, 'teacher orientation' 4 items, 'career development' 5 items, 'others' recommendation' 4 items and 'subject availability' 4 items. Response categories ranged from 'Definitely not' (1 point) to 'Strongly not' (2 points), 'Slightly not' (3 points), 'Slightly yes' (4 points), 'Strongly agree' (5 points), 'Definitely yes' (6 points). It was done on a 6-point Likert scale.

Table 2. Factors, items, and reliability of subject selection criteria scale

Factor	Item No.	Item	Importance	Implementation
			Cronbach's α	α
SAT orientation	1	Subjects suitable for reaching the lowest grade	0.818	0.854
	2	Subjects that can get good grades in the SAT		
	3	Subjects designated as SAT subjects		
	4	Subjects designated by the desired university		
	5	Subjects that give additional points at the desired university		
	6	Subjects with good grades in the mock exam		
Academic achievement	7	Subjects designated in the comprehensive student record screening	0.788	0.804
	8	Subjects that overlap with school transcripts		
	9	Subjects with good grades		
	10	Subject with a large number of students		
Ability orientation	11	Subjects suitable for my learning level	0.733	0.720
	12	Subjects that are easy to learn		
	13	Subjects familiar with previous studies		
Pursuit of interest	14	Subject of interest	0.829	0.847
	15	My favorite subject		
	16	Subjects suitable for my aptitude		
	17	Interesting subjects		
Teacher orientation	18	My favorite teacher's subject	0.850	0.838
	19	Subjects that you think your teacher teaches well		
	20	A teacher's subject that I teach the way I like		
	21	Subjects from teachers popular with students		
Career development	22	Subjects related to my career	0.757	0.792
	23	Subjects related to the department you wish to enter		
	24	Subjects related to promising careers		
	25	Subjects to help you get your desired job		
	26	Subjects related to various occupations in common		
Others' recommendation	27	Subjects recommended by seniors	0.873	0.856
	28	Subjects recommended by parents		
	29	Subjects recommended by the teacher		
	30	Subjects recommended by a friend		
Subject availability	31	Courses opened through joint cooperation between schools	0.879	0.877
	32	Subjects designated by the school itself		
	33	Courses opened according to class organization adjustment		
	34	Courses opened in consideration of the order of each learning stage		
Total			0.873	0.878

4. DATA ANALYSIS

To categorize the subject selection criteria factors, latent profile analysis, one of the categorical variable analysis models, was performed. To determine the optimal number of latent groups derived through latent profile analysis, the four fitness indices were applied: information index, model comparison verification, classification quality, and intragroup classification ratio.

In order to determine the number of the first latent group, model fit is verified through the information reference indexes, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Sample-size Adjusted BIC (SABIC). Smaller values of AIC, BIC, and SABIC indicate that the model has the optimal number of latent types [11].

Second, the model comparison test used the LMRT (Lo-Mendell-Rubin Adjusted Likelihood Ratio Test) likelihood ratio test or the bootstrap likelihood ratio test BLRT (Bootstrap Likelihood Ratio Test). This method is a model comparison verification that compares the case of k and $k-1$ of latent profile models to determine the suitability. If there is a statistically significant difference by comparing the k latent group models with the $k-1$ latent group models, it means that the k latent group models are suitable, and if not significant, it means that $k-1$ latent groups are suitable [12].

Third, we look at the entropy value to determine how accurately each case was classified into a group. Entropy values range from 0 to 1, and the closer to 1, the more accurate the classification. If it is 0.8 or more, it can be said that more than 90% is properly classified [13].

Fourth, check the classification ratio within the latent group. Profiles containing less than 5% of the sample should be treated with caution as excessively large number of profiles are extracted [14-16].

Therefore, this study also considered the theoretical fit and interpretability of the number of latent layers along with statistical judgment criteria such as the fitness index, statistical significance, and classification ratio [17]. A one-way ANOVA was performed to confirm the difference in the latent group. A cross-analysis was performed to examine the difference in subject selection criteria between latent classes of perceived importance and actual implementation. Analysis was performed using statistical programs SPSS 26.0 and Mplus 8.4.

5. RESULTS

5.1 Analysis of Latent Classes Profile of Importance of Subject Selection Criteria

Table 3 shows the results of examining information index and model, entropy to understand the quality of classification, and model comparison test to classify the latent group and identify the characteristics of the group.

In order to extract a suitable latent group for the subject selection criteria, the fit and significance values of the model were examined while increasing the number of groups from 2 to 8. First, as shown in Table 2, as the number of groups increased, the size of the information indices of AIC, BIC, and SABIC decreased, indicating a good model. Second, the Entropy value, which identifies the quality of latent class classification, shows that values close to 1 indicate high classification accuracy. All models maintain 0.7 or higher and increase up to 5 groups. It means that the quality of latent class classification is good. Third, LMRT, which is a model comparison test, was not suitable for the type of model because it exceeded the standard of $p < 0.05$ from the three-group model, but BLRT showed significant significance in all of the criteria of $p < 0.05$. Therefore, it is difficult to determine which model is a good model with LMRT and BLRT. Fourth, looking at the latent class classification ratio, from the 5 groups, the group with less than 5% of the number of samples did not meet the criteria of the model. Therefore, when statistical indicators such as information index, classification quality, model comparison verification, and latent class classification ratio and interpretability were comprehensively judged, four potential groups were identified as the most suitable model.

Table 3. Comparison of model fit of latent profile analysis of importance of subject selection criteria

classification criteria	number of latent classes							
	2	3	4	5	6	7	8	
AIC	11415.941	11210.080	11076.439	10980.611	10924.802	10868.887	10825.519	
BIC	11522.287	11354.710	11259.354	11201.811	11184.285	11166.655	11161.572	
SABIC	11442.932	11246.787	11122.863	11036.751	10990.658	10944.460	10910.809	
Entropy	0.700	0.743	0.758	0.790	0.761	0.805	0.786	
LMRT(<i>p</i>)	0.0083	0.2576	0.1063	0.5007	0.5410	0.4402	0.6174	
BLRT(<i>p</i>)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	
Ratio (%)	1	49.6	12.9	5	1.9	4	4	2.3
	2	50.3	39.8	36.7	6.5	1.2	26.9	3.8
	3		47.3	24.8	27.3	27.5	25.6	19.6
	4			33.5	33.8	24.8	1.3	1.3
	5				30.3	22.7	31.5	23.8
	6					18.8	10.4	29
	7						19.8	9.6
	8							10.4

Considering the characteristics of each latent group of the importance of the subject selection criteria presented in Table 4 and the average chart of the subject selection criteria factors presented in Figure 2, the four group models that were finally selected were named as ‘High Perception Type’, ‘Low Perception Type’, ‘Self-Direction type’, and ‘Stability-Oriented Type’.

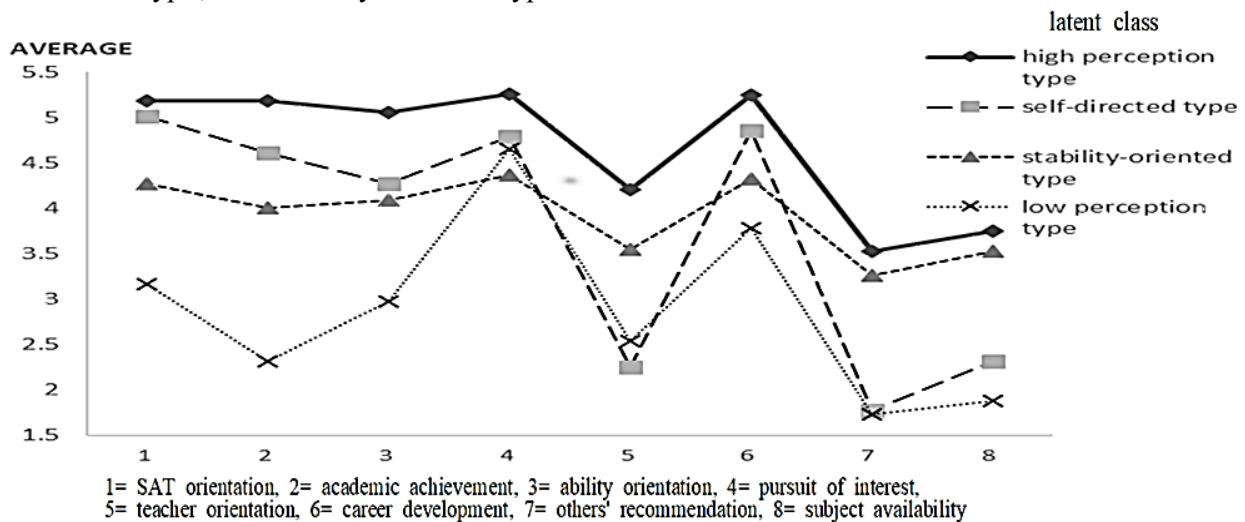


Figure 2. Profile chart between latent group of importance of subject selection criteria

Table 4 shows the results of examining information index and model, entropy to understand the quality of classification, and model comparison test to classify the latent group and identify the characteristics of the group. The mean and standard deviation for the four groups extracted through latent profile analysis are presented in Table 4.

Table 4. Latent group mean and standard deviation of importance of subject selection criteria

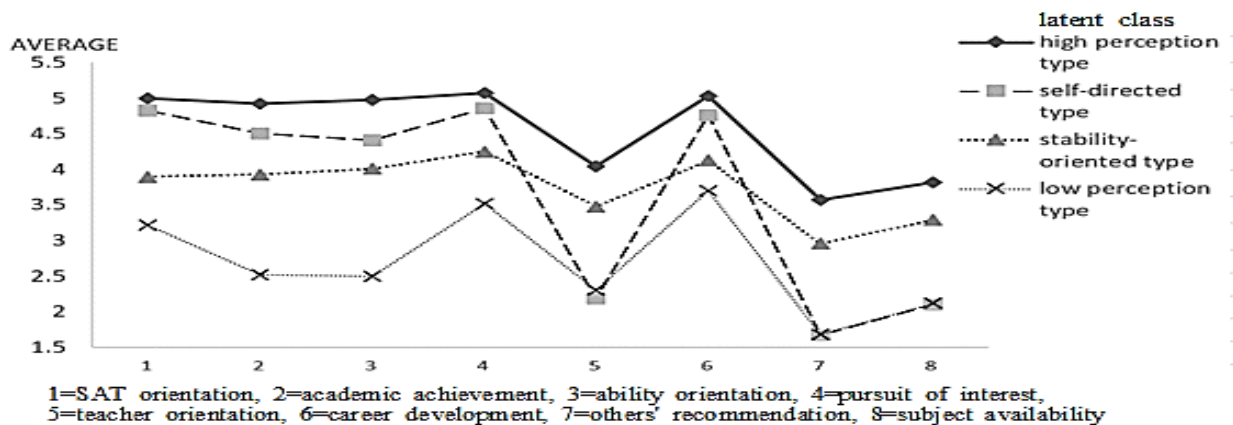
Factor	Low perception type(n=26)		Self Directed type(n=191)		Stability oriented type(n=129)		High Perception type(n=174)		F	p
	M	SD	M	SD	M	SD	M	SD		
SAT orientation	3.17	1.27	5.02	0.55	4.27	0.62	5.19	0.53	123.467	<0.001
academic achievement	2.32	1.01	4.61	0.77	4.01	0.70	5.19	0.60	156.917	<0.001
ability orientation	2.97	1.23	4.27	0.92	4.09	0.68	5.06	0.67	74.097	<0.001
pursuit of interest	4.65	1.18	4.79	0.88	4.37	0.83	5.26	0.66	30.027	<0.001
teacher orientation	2.54	1.26	2.25	0.96	3.55	0.85	4.21	0.98	137.131	<0.001
career development	3.78	1.37	4.86	0.75	4.32	0.74	5.25	0.52	59.866	<0.001
others' recommendation	1.73	0.69	1.77	0.71	3.26	0.88	3.53	0.95	163.585	<0.001
subject availability	1.88	1.13	2.31	0.96	3.53	0.92	3.75	0.96	92.270	<0.001
Total	2.88	1.14	3.74	0.81	3.93	0.78	4.68	0.73		

As a result of confirming the F and p values of the latent group by performing one-way ANOVA, it was possible to confirm the difference in the importance of the subject selection criteria for the latent group.

5.2 Analysis of Latent Class Profile of Implementation Chart of Subject Selection Criteria

In order to classify the latent group of the implementation of the subject selection criteria and to understand the characteristics according to it, the latent profile analysis was performed in the same way as the importance analysis. Table 4 shows the results of information index, model, entropy to grasp the quality of classification, and the comparison and verification of model. In order to find a suitable latent class model, statistical indicators such as information index, model comparison verification, classification quality, and latent class classification ratio and interpretability were comprehensively judged.

The final four groups were selected by considering the average chart of the subject selection criteria in Figure 3.

**Figure 3. Profile chart between latent groups of implementation of subject selection**

The final four groups were also selected by considering the characteristics of each latent group in Table 5 and as in the importance, they were named as 'stability-focused', 'self-directed', 'low perception type' and 'high recognition type'.

Table 5. Comparison of latent profile analysis model fit of implementation of subject selection criteria

Classification criteria	number of latent classes							
	2	3	4	5	6	7	8	
AIC	11724.398	11497.767	11337.869	11247.538	11192.659	11143.364	11106.635	
BIC	11830.743	11642.397	11520.784	11468.737	11452.142	11441.132	11442.687	
SABIC	11751.388	11534.474	11384.293	11303.678	11258.515	11218.937	11191.924	
Entropy	0.715	0.731	0.761	0.772	0.786	0.807	0.788	
LMRT(<i>p</i>)	0.0084	0.4525	0.0605	0.3436	0.1661	0.4661	0.5365	
BLRT(<i>p</i>)	0.0001	0.0001	0.0001	.0001	0.0001	0.0001	0.0001	
Ratio (%)	1	37	32.7	26.3	4	3.8	36.5	30.8
	2	63.3	21	30.6	13.1	28.7	5	36.5
	3		46.3	7.9	28.5	23.1	34.6	11.9
	4			35.2	24.8	13.7	24.4	8.1
	5				29.6	28.5	10.2	33.1
	6					23.1	30	16.9
	7						23.3	5.6
	8							17.7

Table 6 shows the mean and standard deviation for the four groups extracted through the latent profile analysis of the implementation chart.

Table 6. Latent group mean and standard deviation of implementation of subject selection criteria

Factor	Stability oriented type(n=137)		Self directed type (n=159)		Low Perception type(n=41)		High Perception type(n=183)		<i>F</i>	<i>p</i>
	M	SD	M	SD	M	SD	M	SD		
SAT orientation	3.90	0.71	4.83	0.64	3.22	1.21	5.00	0.60	118.908	<0.001
academic achievement	3.93	0.62	4.51	0.90	2.52	1.11	4.92	0.68	123.294	<0.001
ability orientation	4.01	0.61	4.41	0.84	2.50	0.94	4.98	0.66	141.674	<0.001
pursuit of interest	4.25	0.89	4.86	0.92	3.52	1.40	5.07	0.71	47.055	<0.001
teacher orientation	3.48	0.80	2.19	0.93	2.31	1.15	4.05	0.93	133.886	<0.001
career development	4.13	0.72	4.76	0.85	3.70	1.29	5.03	0.64	53.368	<0.001
others' recommendation	2.96	0.81	1.67	0.66	1.68	0.68	3.57	0.92	187.066	<0.001
subject availability	3.29	0.76	2.10	0.97	2.12	1.07	3.82	0.95	116.303	<0.001
Total	3.74	0.74	3.67	0.84	2.70	1.11	4.56	0.76		

As a result of performing one-way ANOVA to find out the difference between the four latent groups, the *F* and *p* values between the latent groups were found to be significant. Significance probabilities are $p < 0.001$, and it was possible to confirm the difference between the latent groups in the subject selection criteria implementation chart.

5.3 The Latent Class Relationship between the Importance and Implementation of the Subject Selection Criteria

A cross-analysis was performed to examine the difference in subject selection criteria between latent classes of importance and implementation. As shown in Table 7, $\chi^2(9) = 504.698$, with $p < 0.001$ indicates that there is a difference between the latent groups in importance and implementation.

Table 7. The latent class cross-analysis between the importance and the implementation of the subject selection criteria

Importance	Implementation				Total
	Low Perception type	Self Directed type	Stability Oriented type	High Perception type	
Low Perception type	3(11.5)	4(15.4)	18(69.2)	1(3.8)	26(5)
Self-Directed type	23(12.0)	135(70.7)	12(6.3)	21(11.0)	191(36.7)
Stability Oriented type	83(64.3)	7(5.4)	7(5.4)	32(24.8)	129(24.8)
High Perception type	28(16.1)	13(7.5)	4(2.3)	129(74.1)	174(33.5)
Total	137(26.3)	159(30.6)	41(7.9)	183(35.2)	520

First, the importance low perception type showed the lowest distribution of 1 (3.8%) in the high perception type of implementation out of the total 26 people, and 18 (69.2%) were high in the stability-oriented type. The second group, the self-directed type, showed a low distribution in the stability-oriented type of implementation, which was 12 out of 191 (6.3%), and self-directed type, 135 people (70.7%) were the highest. The third group, the stability-oriented type, showed a low distribution of 7 people (5.4%) in both the self-directed and stability-oriented type of implementation with a total of 129, while 83 people (64.3%) in the low perception type. The high perception type of importance showed a distribution of 174 people. It also showed 4 (2.3%) in the stability-oriented type of implementation, and 129 (74.1%) in the high-recognition type. In terms of implementation and importance, it can be seen that the low perception type and the stability-oriented type have a high relationship with each other, and the high perception type and the self-directed type show a pattern with a high relationship between the same types.

6. DISCUSSION AND CONCLUSION

The discussion of specific analysis results according to the research question is as follows. First, the potential profile of general high school students' subject selection criteria presented as a research problem was classified into four groups: 'high perception type', 'low perception type', 'self-directed type', and 'stability-oriented type'. Considering the number of groups, low perception type is easy to access customized course selection guidance that takes into account the individual differences of each student. Because the 'low awareness type' latent group of importance can be reflected in the implementation, it is a group that requires special attention from teachers so that subject selection can be made in consideration of one's own interests, aptitude, career path, and ability when actually selecting subjects. Teachers' help is needed to break free from the perception that relying on and following the decisions of others is the right choice. High perception type has high autonomy and high dependence on others when choosing subjects. It is necessary to repeatedly provide detailed guidance on what kind of learning experience one has after choosing a subject and how the result is related to academic performance at university or activities in the world of work. In the 'self-directed' group, unlike the importance level, where the SAT orientation was the highest, the interest-seeking factor was prioritized in the subject selection in the performance level. The stability-oriented type is a group that shows the median average score of the other three groups in importance and implementation. In the course selection survey stage, it is necessary

to provide various opportunities so that students can repeatedly check which selection criterion is more educationally desirable, considering individual differences.

Second, it was confirmed that there was a difference between the latent profiles of importance and implementation in the subject selection of general high school students presented as a research question. In the cross-analysis between the latent profiles of importance and implementation, many differences can be found between the low perception type and the stability-oriented type. The low-perception latent layer of importance increased in the implementation, and the stability-oriented latent layer of the importance decreased in the implementation. It can be predicted that the stability-oriented type of importance, which had been waiting and waiting for career development in consideration of one's career, aptitude, and interest, has moved to the low-perception type of the implementation. In the course selection survey stage, it is necessary to provide an opportunity for students to repeatedly check which selection criterion is more educationally desirable, taking into account individual differences, through active educational intervention by the teacher. After carefully examining various internal and external factors that influence subject selection, such as college entrance examination, career path, occupation, aptitude, interest, and ability, it is necessary to provide customized course selection guidance considering individual differences.

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