

# Learning Styles of Medical Students With Different Routes of Admission

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## Research article

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# Abstract

## Background

A learning style is the complex manner to learn material most efficiently and effectively and also a good predictor of their preferred learning behaviors. This study explored the status of new medical students' learning patterns between application and entrance examination.

## Methods

This is a cross sectional analysis of learning styles among newly enrolled first year medical students in each first academic year from September 2015 to September 2017. The Memletic Learning Style Inventory was applied as instrument for assessment. Latent class analysis was applied to classify different classes among medical students.

## Result

98 students underwent a national college entrance examination, and 150 students was enrolled through application. All medical students could be assigned into 4 classes according to learning styles, including logical type, solitary type, mix aural-verbal-visual type, and social type. Both gender and admission routes were strong predictors of latent class of learning styles.

## Conclusion

Through the interview process, we can screen out students with mix aural-verbal-visual class of learning styles through interview in application process. While examination route can select students with logical type and solitary type learning style. This study can improve our understanding of student learning patterns to design learner-specific courses and effective curricula.

## Background

The theory of learning styles is ubiquitous throughout educational systems. Educators should be aware that there are diverse learning styles in the student population. Educators should also consider students' learning styles and aid the learning process to achieve optimal learning effects. Usually, the learning style is defined as the complex manner in which learners most efficiently and most effectively perceive, process, store and recall the information that they are attempting to learn.[1] Learning styles are considered one of the most important factors of success in higher education. Different scales and classifications of learning styles, such as environmental preferences, sensory modalities, personality types, and/or cognitive styles, have been mentioned, and measures of learning styles have been described in the previous literature.[2]

The Taiwan first college entrance examination was held in 1945 and held in every July annually. In June of 1999, the Ministry of Education and the reform commission announced that the joint entrance

examination system in Taiwan would be replaced starting from 2002. A new "Diversified University Admissions System," a two-track program by which the candidates apply to universities either through traditional testing or through what is known as a "Recommendations and Screening Process," was to take the place of the old system. Diverse medical student selections in Taiwan were initiated, and more and more medical students were enrolled through application. Up to now, approximate 50% medical students were selected through applications rather than traditional cognitive examination. We supposed that it is better for medical students enrolled through application, however, there was no formal survey.

The appropriate selection of medical students is a challenging task. The course of study requires the possession of important cognitive and noncognitive skills, such as intellectual flexibility, inquisitiveness, critical reasoning, logical thinking, tolerance, ability to cope with uncertainty and problem solving.[3] Medical students often have high academic attainment in school, resulting in relatively homogeneous student groups.[4] This method of selection has been found to discriminate in favor of privately educated students and against students from poorer backgrounds. Selection by academic attainment alone tends to produce physicians who are unrepresentative of the populations they serve.[5] The selection of medical students encourages more diverse entrants. Many countries adopt the "Widening Access" policy that aims to encourage "nontraditional" students (i.e., those from different ethnic/cultural groups, those from disadvantaged backgrounds, mature students, and those with disabilities) to enroll in higher education.[6]

Previous studies have stated that learning style is an effective predictor of an individual's preferred learning behaviors.[7] The identification of students' learning styles helps educational planners and teachers provide them with the necessary educational support and design learner-specific courses and curricula.[8] Therefore, the purpose of the study is to explore the status of new medical students' learning patterns and the correlations among different admission criteria to improve physical teaching methods and create effective curricula for premedical students in the future.

## Methods

### *Samples*

Incoming students who entered medical school in three academic years, from September 2015 (academic year of 2015) to September 2017 (academic year of 2017), were enrolled. The structured questionnaire for learning style was distributed in the curriculum introduction and orientation in the first week of the academic year. The results were released to the students as a reference for conducting personal study plans for their individual learning style.

### *Research Instruments*

The questionnaire used to analyze learning styles was the Memletic Learning Style Inventory (MLSI), elaborated by Sean Whiteley. Seven different learning styles were recognized by the inventory, in accordance with the seven types of intelligence indicated by Gardner.[9] The seven types of intelligence include verbal (linguistic), visual, aural, logical, physical, solitary and social (i.e., involving relationships

with other learners). With different learning styles, individuals may have different learning characteristics, described as follows:

1. Visual (spatial): These learners prefer using pictures, imageries, and spatial perceptions.
2. Aural (auditory-musical): These learners favor using sounds and music.
3. Verbal (linguistic): These learners prefer using words through speaking and writing.
4. Physical (kinesthetic): These learners favor using their body, hands, and tactile sense.
5. Logical (mathematical): These learners prefer using logic, reasoning, and systems.
6. Social (interpersonal): These learners favor learning in groups or with other people.
7. Solitary (intrapersonal): These learners prefer to work alone and to be self-taught.

The questionnaire contained 70 questions, and each learning style was assessed by 10 questions. The outcome of a typical learning styles inventory is normally one dominating learning style, but in some cases, the outcome would yield two or three learning styles. The outcome provided information about the extent to which each style is used more often by a particular learner.

### ***Taiwan Medical Education System***

In Taiwan, there are presently three ways in which medical students are recruited: (1) the national college entrance examination, (2) personal application, and (3) recommendations made by senior high schools (Stars Program).[10] Medical schools previously recruited students only through the national college entrance examination, which does not assess personality or medical professionalism. The personal application process was introduced in 1998 and was expanded in 2000, and it provides all high school students with an opportunity to apply to their preferred colleges or departments. Currently, approximately 16-52% of medical students are selected through the application process. The results of the application process are based on the applicants' results on the General Scholastic Ability Test (GSAT) held in January, their portfolio and their academic performance review.

After students receive their GSAT results, they must decide whether they meet the entrance criteria of the schools in which they are interested. If a student is qualified, the medical school will invite the student to participate in the second stage of the screening process. During this stage, students may be asked to take additional tests, prepare a portfolio, and take part in interviews.

Depending on the method of enrollment used, the students' characteristics will differ in some areas. After admission to medical school, medical students must complete training in the seven-year medical education program, including two years of premedical courses, two years of clinical courses, and three years of clerkship and internship. Students with different characteristics could learn differently in the future.

### ***Interview***

The details of and criteria for portfolio reviews and interviews were set up independently by each school.

In the College of Medicine of National Cheng Kung University, the application process is divided into three stages: Introduction, Group Dynamic Interview (GDI), and Multiple Mini-Interview (MMI). (Figure 3) The GDI is a group interview process. Each group included 7-8 candidates. During the interview process, candidates were given a theme that they all had to agree upon within a limited time frame. These tests were used to assess candidates' social abilities, such as reasoning, leadership, sociability, extraversion, and verbal communication.

The MMI consists of a series of short interview stations in which all candidates respond to the same questions, and interviewers receive background information a priori.[11] The tests were used to assess candidates' resilience, problem solving, initiative, altruism, empathy, etc. With the combination of the GDI and the MMI, admissions committees have a great deal of flexibility in the interview protocol and dilute the effects of chance and examiner bias.

### ***Statistical Analysis***

Categorical variables, including sex and learning styles, were compared with the chi-square test. Continuous variables were compared using the Mann-Whitney test. Latent class analysis (LCA) was applied for measuring categorical latent variables based on a set of observed categorical variables. The LCA attempted to detect the presence of latent classes, creating patterns of association in the symptoms. The analysis can also be used to classify cases according to their maximum likelihood class membership. SAS 9.4 software was used for statistical analysis. A p-value of <0.05 was considered statistically significant.

## **Results**

During the three consecutive academic years from 2015 to 2017, 73, 86, and 89 students, respectively, entered the medical school (Table 1). The admission routes for incoming medical students in each academic year included applications, and entrance examinations.

The preliminary results of the MLSI are summarized in Table 2. The table shows the distribution of learning style for students with different enrollment methods. There is no statistic difference ( $p = 0.227$ ).

The results of the LCA are shown in Table 3 and Figure 2. The four-class model had better fit statistics with lower AIC and BIC values. These four classes can be clearly identified as class 1 (logical type) 20.56%, class 2 (solitary type) 27.15%, class 3 (mix type) 32.12%, and class 4 (social type) 20.16%. Both gender and ( $p = 0.01$ ) admission route ( $p = 0.0097$ ) were strong predictors of latent class membership. Mix type can be interpreted as those with aural, physical, visual and verbal style. Table 4 shows the  $\beta$  parameters for the effect of each covariate, as well as odds ratios. For gender, odd ratios are interpreted as female with the increase in odds of membership in logical type and mix type relative to male. For admission routes, odd ratios are interpreted as enrollment through application with the increase in odds of membership in mix type. On the contrary, enrollment through examination has increasing odds of membership in logical and solitary type.

## Discussion

The study has shown different types of learning styles among students admitted to medical school with and without the interview process. Four classes of learning styles were obtained through latent class analysis. Students who underwent interviews in their application process might have opportunities to mix type or balance learning style.

Interview is defined as an exchange of meaningful conversation that is supplemented with inflection, voice qualities, facial expression, glint of the eye, postures, gestures, and general behavior.[12] It is an essential component of the selection process in most U.S. medical schools, colleges, and universities.[13] It is the most commonly used selection component for all types of higher education and personnel evaluations. Interview formats can be categorized as one-on-one, group, board or panel, or a combination. Interview types can be classified into structured, semistructured, and unstructured.[14] Structured interviews can provide standardized interview content and sample answers for interviewers to rate. This standardization would help to reduce the impact of individual interviewers' biases and to improve reliability. A panel interview with more than one interviewer can rate candidates independently and provide a result by averaging their ratings or by consensus. It was believed that interviews aided in the selection of more applicants with other nonacademic abilities through de-emphasizing academic performance and focusing on nonacademic data. Such nonacademic skills included leadership, motivation, range of interest, and interpersonal skills.[15] Therefore, the screening targets or characteristics were determined by the committee. Many scholars believe that the manifestation of optimal clinical skills cannot simply be predicted by previous academic performance. Nonacademic-focused interviews are believed to be positively correlated with a clinical narrative evaluation and to predict those who would drop out of medical school because of a lack of motivation.[15-17] Therefore, the interview will, to some extent, screen for characteristics other than academic performance.

Interviews play an important role in the admissions process in the selection of suitable candidates to become competent health care professionals. Among all interview methods, MMI is widely used in the admissions process of various healthcare domains and nonhealthcare fields.[18] Compared to traditional interviews, MMI is a more impartial, reliable and valid assessment tool in testing noncognitive skills. [19] Traditional medical school admissions interviews have strong face validity but have low reliability and validity. Noncognitive skills, first defined in 1976, revealed the various aspects of an individual's personality, which is difficult to objectively examine through traditional interviews.[20] Therefore, the MMI was adopted as a part of the admissions protocol in conjunction with other academic selection criteria or with other different types of interview protocols for cognitive skills. The design is similar to our application process, which includes an introduction, a GDI, and a MMI.(Figure 3)

In our school, the main purpose of the MMI was to evaluate the noncognitive skills and ethical judgment of the candidate. The other skills that were assessed included problem solving, interpersonal communication, teamwork, flexibility and the reliability of a candidate. Therefore, based on the application committee's selection criteria, MMIs was designed to collect more information and to provide

insight into different aspects of candidates' eligibility for medical students. On the other hand, the process of the MMI itself required communication skills and listening skills. Candidates have access to the content of the station through high-quality communication and listening skills for a limited period of time, effectively managing their time to think under stressful conditions and then effectively expressing their ideas to the assessors. Therefore, candidates with high levels of communication and listening skills are screened invisibly. These skills cannot be developed via training within days before the application. We believe that candidates with good communication and listening skills must inevitably make good use of these skills in daily learning. Thus, in this study, we can determine that the application groups are largely composed of individuals with visual and verbal learning styles. In addition, from latent class analysis, it was found that students in class 2, who predominantly used the application method of admission, had a higher probability of having an aural learning style. However, students in class 3, who predominantly used the examination method of admission, consisted of students with a more logical learning style and less visual, aural, and verbal learning styles. Such results can reflect the finding that students selected through the MMI have multiple learning styles, including aural, verbal, visual, and physical. These characteristics resulted in better communication skills and self-expression skills. A previous study reported that the MMI score can be used as a predictor of further performance in examinations and clinical clerkships.[21] However, no study has investigated the relationship between learning style and future clinical performance. Thus, further follow-up of students' clinical performance is necessary.

Thus, we must design and offer a suitable course to meet the needs of each class that students can study effectively based on their learning strategies and tactics after realizing students' learning styles and the relationship of learning style and clinical performance if we can. For example, teaching styles and problem-based learning (PBL) and its variants can provide students with a more active role in acquiring knowledge, according to the most effective method for each learning style, and in contributing to discussions in class. Better learning outcomes can be achieved if teaching and learning environments are individually tailored to different learning styles.[22] For students, awareness of their learning styles will not only help them understand their past learning methods and thus increase their learning efficiency but will also help them understand their possible performance after entering the clinical environment. Clinical work relies more on communication and listening skills. Students may choose different specialties as their lifelong career based on their interests, career planning, and even the type of learning advantages they have.[23] Therefore, the patterns of learning styles can be used as a thoughtful aid in the recruitment, initial training, and choice of specialty in the future.

## **Limitations**

This study analyzed the medical students' learning style while newly enrolled. Learning patterns will be modified according to the environment based on students' accumulation of experience and education. Although we can identify the different characteristics of learning styles among students enrolled through different admission routes, learning styles cannot indicate which group is better. Besides, we simply

analyzed learning styles in newly enrolled medical students. Further relationships among academic performance, clinical performance, and learning style require further follow-up.

## Conclusion

This study demonstrated that the learning style of medical students differed by admission routes. Through the application process, including Group Dynamic Interview, and Multiple Mini-Interview, we can screen out students with mix aural-verbal-visual type learning styles. This study can deepen our understanding of student learning patterns to help educational planners and teachers provide learners with the educational support necessary and design learner-specific courses and effective curricula.

## Abbreviations

MLSI: Memletic Learning Style Inventory, GSAT: General Scholastic Ability Test, GDI: Group Dynamic Interview, MMI: Multiple Mini-Interview, LCA: Latent class analysis, PBL: problem-based learning,

## Declarations

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Authors' contributions:

HCH conceptualized and planned the project under the guidance of WJY. YCH gathered the data. HIS and SLJ analyzed data and completed the figures and tables. HCH prepared the initial manuscript and CHL made the revisions to the manuscript. CR and SR made critical revisions to the manuscript. All authors read and approved the final manuscript.

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Competing interests

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## Tables

Table 1. Demographic data of new medical students in academic year from 2014 to 2016 in National Cheng Kung University

	Academic year 2015 N=73	Academic year 2016 N=86	Academic year 2017 N=89
Gender			
Male (%)	46 (63.0%)	56 (65.1%)	58 (65.2%)
Female (%)	27 (37.0%)	30 (34.9%)	31 (34.8%)
University Admission Method			
Examination (%)	28 (38.4%)	36 (41.9%)	34 (38.2%)
Application (%)	45 (51.6%)	50 (58.1%)	55 (51.8%)

Table 2. Comparison of different learning styles between examination group and application group

	Academic year 2015		Academic year 2016		Academic year 2017		Total		P value
	Examination	Application	Examination	Application	Examination	Application	Examination	Application	
	(N=28)	(N=45)	(N=36)	(N=50)	(N=34)	(N=55)	(N=98)	(N=150)	
Visual	0	6	2	5	2	2	4	13	0.227
Aural	6	11	7	14	7	15	20	40	
Verbal	2	2	0	2	2	3	4	7	
Physical	0	5	1	5	4	7	5	17	
Logical	7	6	13	9	11	12	31	27	
Social	8	16	7	13	5	10	20	39	
Solitary	8	9	10	14	12	16	30	39	

p-value: by Pearson Chi-Square test

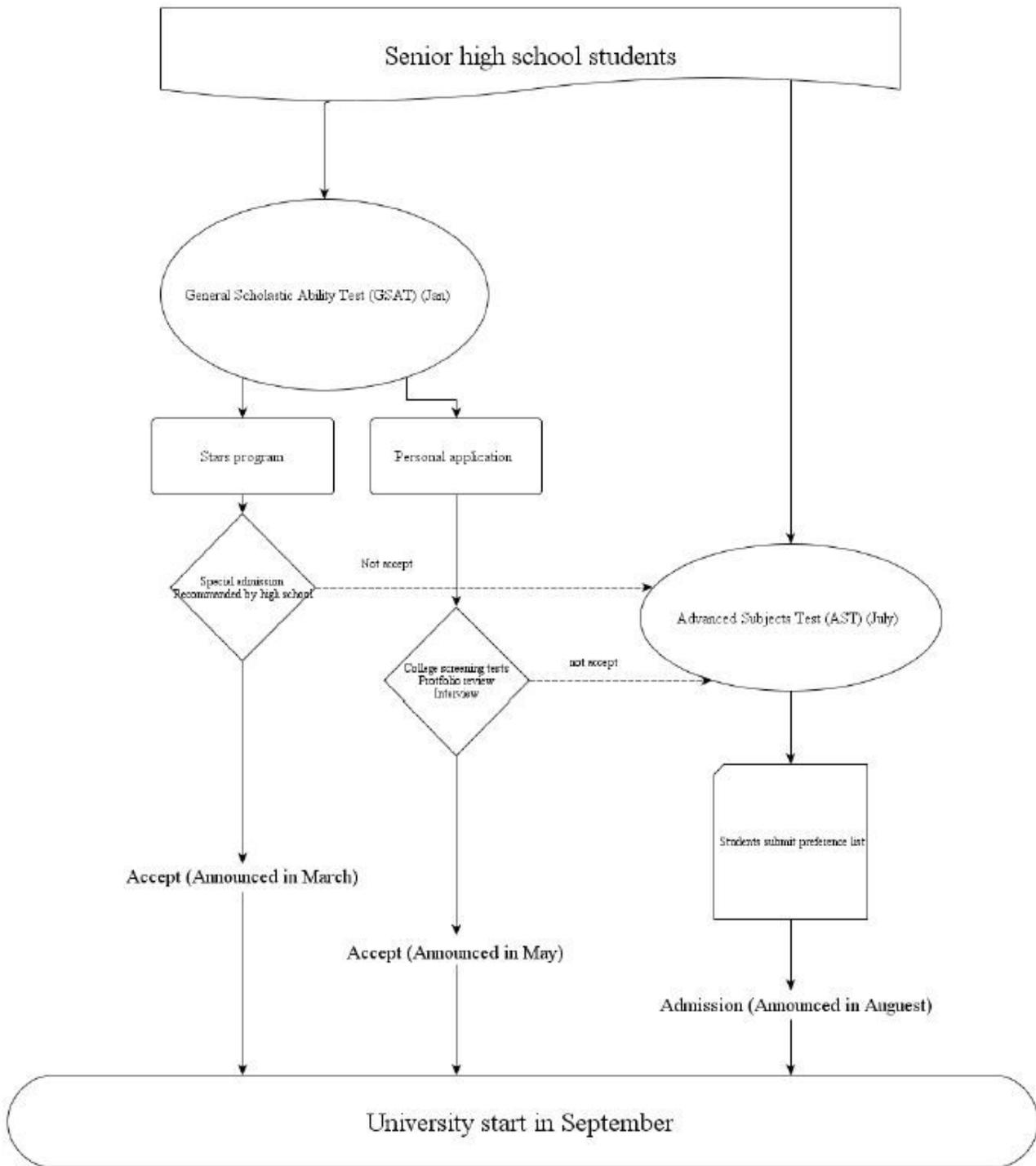
Table 3. The result of latent class analysis and prevalence of each observed variables in each subgroup

	Latent Class			
	Class 1	Class 2	Class 3	Class 4
	Logical type	Solitary type	Mix type	Social type
	20.56%	27.15%	32.12%	20.16%
<b>Visual</b>	0.0000	0.0133	0.1896	0.0200
<b>Aural</b>	0.0392	0.0284	0.6539	0.0800
<b>Verbal</b>	0.0196	0.0293	0.1007	0.0000
<b>Physical</b>	0.0196	0.0311	0.2248	0.0200
<b>Logical</b>	1.0000	0.1039	0.0000	0.0000
<b>Social</b>	0.0588	0.0891	0.0000	1.0000
<b>Solitary</b>	0.0000	1.0000	0.0208	0.0000

Table 4. Parameters estimated and odds ratios for covariates as gender and admission type

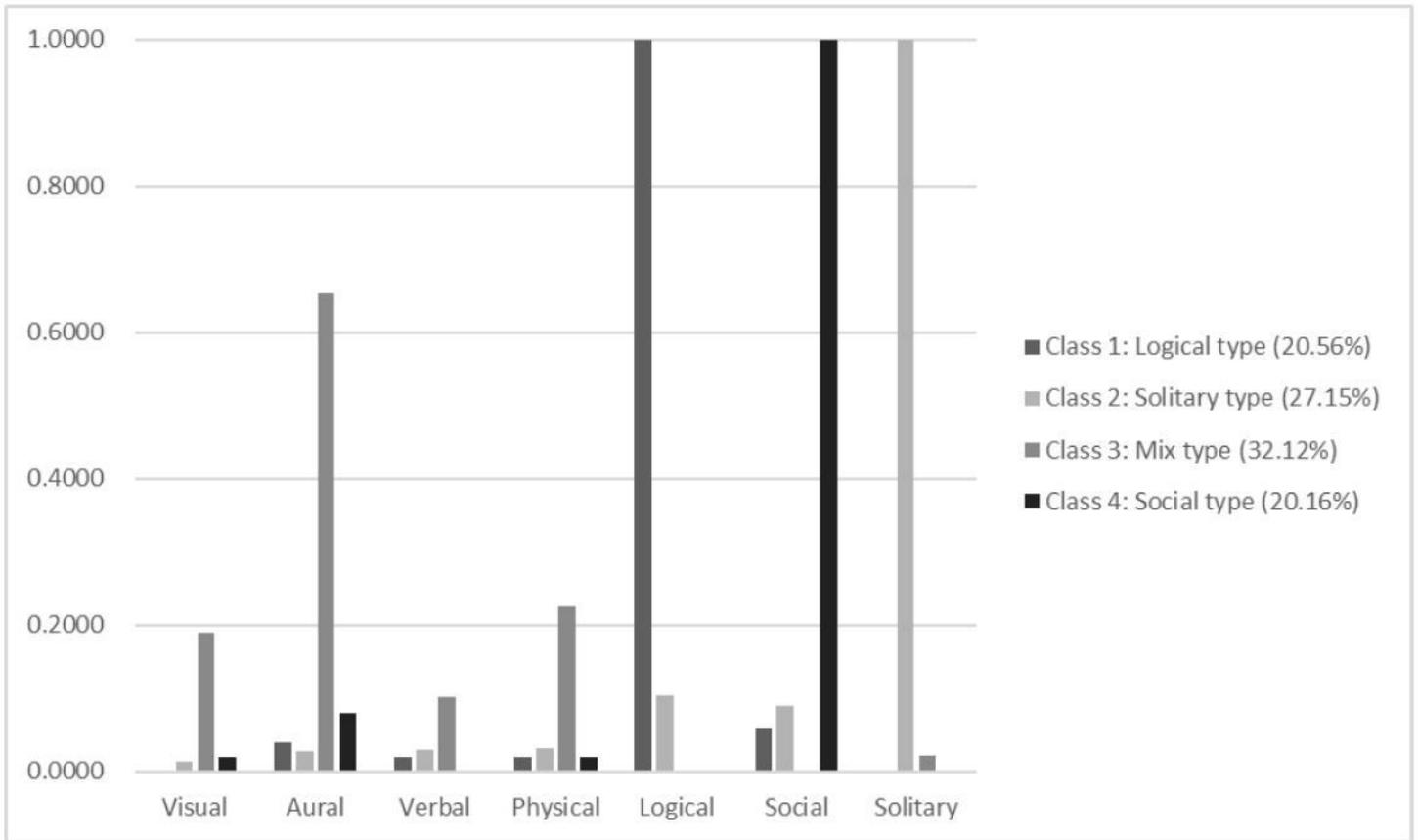
Class	$\beta$	Gender		Admission method		
		Odds Ratio	p-value	$\beta$	Odds Ratio	p-value
1: Logical type	0.782	2.1859	0.01	-0.9693	0.3793	0.0097
2: Solitary type	-0.1958	0.8222		-0.541	0.5822	
3: Mix type	0.8414	2.3195		0.2343	1.264	
4: Social type	1	1		1	1	

## Figures



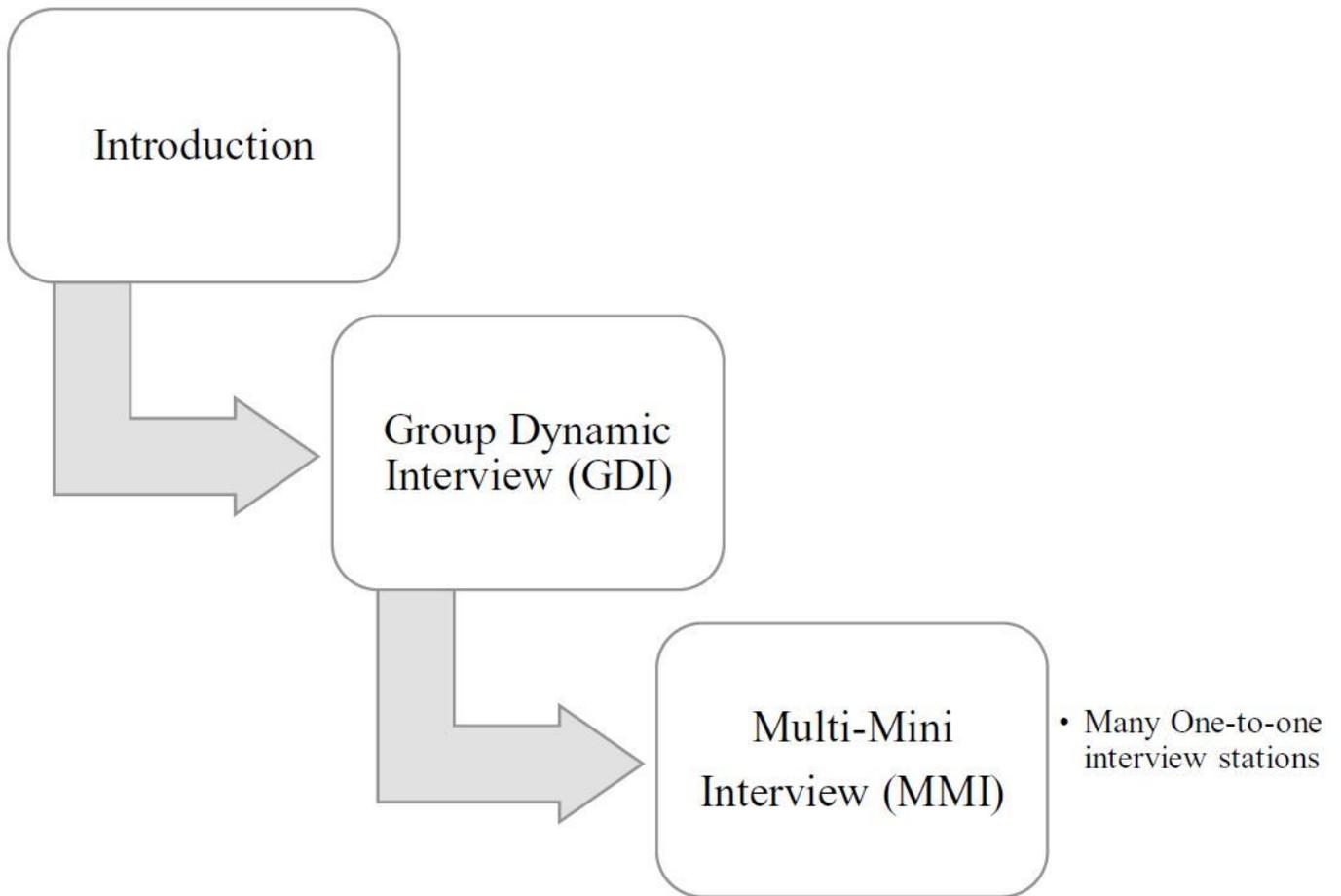
**Figure 1**

The recruitment of medical students in Taiwan



**Figure 2**

The prevalence of each observed groups according to latent class analysis



**Figure 3**

Application processes in National Cheng Kung University College of Medicine