〈オピニオン〉

Problems arising due to inconsistencies between existing graduation systems and newly introduced diploma policies and their solutions

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Abstract

This paper points out possible problems between graduation requirements and diploma policy requirements and proposes some solutions. By using formulas and the Monte Carlo simulation, this paper shows that: 1) there are students who cannot graduate despite having a higher level of diploma policy than students who can graduate have; 2) the student who achieves the top Grade Point Average (hereinafter GPA) is not necessarily the same student who acquires the top level of diploma policy; and 3) there is no high correlation between GPA and the achievement level of diploma policy. Such problems can cause students to feel unfair in the graduation system. One of the reasons for these problems is that many subjects contribute to multiple diploma policies. This paper proposes several solutions to these problems as follows: 1) curricula integration; 2) diploma policies subdivision; 3) constitutionalization of graduation requirements and diploma policy requirements; and 4) prior confirmation using simulations.

Keywords: diploma policy · curriculum policy · admission policy · curriculum map · GPA · compulsory subjects · optional subjects · Monte Carlo simulation

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Dear Professor Hiroshi Doihara,

It has been a great pleasure working with you for such a long time. Your wisdom, kindness, leadership, and ability to handle tasks as the graduate school executive have truly impressed me, and I have learned so much from you. I appreciate your dedication and guidance throughout our time working together. It's saddening to think that we won't be able to meet in the hallway of the general research building anymore, and I will miss our interactions. Nevertheless, I wish you all the best in your retirement, and congratulations on this well-deserved milestone!

1　Introduction

Since 2008, Japan has been developing three policies - diploma policy, curriculum policy, and admission policy - and preparing curriculum maps to guarantee the quality of undergraduate education.[1] With the addition of Article 165–2 of the School Education Law Enforcement Regulations in March 2016, the Ministry of Education, Culture, Sports, Science and Technology (hereinafter, MEXT) promulgated "Ministerial Ordinance to Partially Revise the School Education Law Enforcement Regulations" (2016 MEXT Ordinance No. 16) on March 31, 2016.[2] This revised ministerial ordinance stipulates the formulation and publication of the three policies at each university by law. From April 1, 2017, the date of enforcement of this revised ministerial ordinance, all universities were required to formulate and publish the three policies based on their educational objectives.

The author of this paper has been involved in the formulation of the three policies and the creation of curriculum maps at his undergraduate and graduate schools. Discrepancies were observed between the existing graduation systems and the three newly introduced policies, particularly the diploma policy, to wit: 1) discrepancy between diploma policy requirements and graduation requirements and 2) discrepancy between diploma policy achievements and GPAs. The purpose of this paper is to point out the problems that may occur due to the discrepancies and to address these by proposing

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[1]　According to the materials of the Ministry of Education, Culture, Sports, Science and Technology (2015) [5], the diploma policy (policy for conferring a degree) is based on the educational philosophy of each university, and what kind of power should be acquired to confer a degree. It is a fundamental policy to be established and is also a goal of students' learning achievements. The curriculum policy is a basic policy that defines what kind of curriculum should be organized and what kind of educational content and method should be implemented in order to achieve the diploma policy. The admission policy is a basic policy for each university to admit students which is based on the educational philosophy, diploma policy, curriculum policy, etc. of the university/faculty concerned. It indicates the learning outcomes required of the accepting students. In the MEXT (2017) [6] survey report on the reform status of educational content at universities in 2015, the curriculum map organizes the lesson subjects under the subject divisions that show the correspondence with the knowledge and abilities that students acquire, and the relationships between the subject divisions and the lessons and the courses taken. By showing the order (the prerequisite subjects needed by students per year level), it is said to refer to a diagram aimed at encouraging systematic taking of lesson subjects.

[2]　See the following link for details of Article 165–2 of the School Education Law Enforcement Regulations. "Search for School Education Law", https://elaws.e-gov.go.jp/document?lawid=322M40000080011. See the following link for details of the "Ministerial Ordinance for Partial Amendment of the School Education Law Enforcement Regulations," https://hourei.ndl.go.jp/simple/detail?lawId=0000138718&current=-1. See the following link for details of the reference material, "Notice Concerning Amendment of School Education Law Enforcement Regulations" of the Education Management Special Committee of the Central Council for Education University Subcommittee (2019) [2], https://www.mext.go.jp/content/1419954_10.pdf.

solutions.

The two terms used in this paper - diploma policy requirement and achievement of diploma policy - are defined in advance. Following the MEXT (2015)[5] (see footnote 1 in detail), the diploma policy requirement is defined as the lowest level of diploma policy that meets the diploma policy. In other words, it is the lowest level of ability that must be acquired for graduation. Expressed in the contraposition of, the inability to confer a degree means that this minimum level is not acquired. The achievement of diploma policy is defined as the degree of diploma policy acquired by taking classes. In other words, it is a measurement of the level of ability students need to acquire in order to graduate.

First, we introduce the first discrepancy. University subjects can be roughly divided into compulsory subjects and optional subjects. A compulsory subject is a subject that must be completed in order to fulfill the requirements of the educational objectives of the department.[3] Students will not be eligible to graduate unless all of the requirements for compulsory subjects are met. An inconsistency problem arises when the student meets the diploma policy but fails to complete all of the requirements for compulsory subjects.

The curriculum map clarifies the relationship between the diploma policy and the goals of each lesson subject. It describes how the goals of each subject contribute to each diploma policy. In fact, according to the curriculum map already published in Japan, only a few compulsory subjects contribute to the achievement of only one diploma policy while many other subjects contribute to the achievement of multiple diploma policies. This means that the sum of the achievements of the diploma policy achieved from the subjects other than the compulsory subjects may exceed the diploma policy requirements.

Next, we introduce the second discrepancy problem. Based on the clarification of the grade evaluation criteria of the university establishment standards in 1956, many universities have introduced GPA as a grade indicator that strictly and rigorously evaluates learning outcomes and accurately expresses them in order to encourage students to study independently.[4] Universities have a system to commend those with excellent academic performance in each faculty, and the GPA system is used at that time.

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[3] According to Article 20 of the University Establishment Standards, the curriculum is divided into compulsory subjects and optional subjects, and is further compartmentalized into each year level. See the following link for details. https://elaws.e-gov.go.jp/document?lawid=331M50000080028. And for compulsory subjects, see the following. https://www.mext.go.jp/a_menu/koutou/secchi/08010910.htm

[4] According to University Establishment Standards (Ministry of Education Ordinance No. 28, 1956) (Excerpt) Article 25–2, Paragraph 2, the university should be objective and strict in evaluating the achievements of learning and accrediting graduation requirements. In order to secure the standards, they shall be clearly stated to the students in advance, and they must be appropriately followed. See the following link for details. https://elaws. e-gov.go.jp/document?lawid=331M50000080028. See the following link for details on the "GPA system". https://www.mext.go.jp/a_menu/koutou/daigaku/04052801/003.htm

In particular, the top GPA student is referred to as the valedictorian (Soudai in Japanese) and is awarded at the graduation ceremony.[5] However, the top GPA students do not always match the top students in terms of achievement of the diploma policy. GPA mainly depends on the grades of the subjects which a student takes, but the achievement of the diploma policy depends not only on the grades of the subjects but also on the number of subjects a student takes. For example, comparing a student who scores 95 point in one subject with a student who scores 85 points in two subjects, the former has a higher GPA, but the latter may have a higher degree of achievement of diploma policy. The pitcher with the lowest Earned Run Average (ERA) is not always the pitcher with the most wins, and the batter with the highest batting average is not always the batter with the most hits.[6] This is because GPA, ERA, and batting average are averages, and diploma policy, number of wins, and number of hits are a summation or a cumulative concept.

Since the curriculum map describes how much each subject contributes to each diploma policy, the degree of achievement of the diploma policy can be calculated concretely. If the top GPA student and the top student with a high diploma policy achievement are different people, the question of which between the two should be prioritized may arise. Which student is more in line with the university's educational philosophy?

As a result, we conclude that: 1) the larger the number of compulsory subjects, the more likely it is that such a discrepancy will occur; 2) the larger the total number of subjects that have been set up, the more likely it is that such a discrepancy will occur; and 3) although it is a simulation result using fictitious data, we find that the correlation coefficient between GPA and diploma policy achievement is about 0.4, which is not so high. Based on the outcome of this analysis, we propose four solutions to this inconsistency problem, as follows: 1) Streamline the number of subjects by integrating similar subjects; 2) Subdivide the diploma policy and incorporate the knowledge and abilities that can only be acquired in that subject into the diploma policy items; 3) Constitutionalize both graduation requirements and diploma policy requirements in that diplomacy policy should be made a precondition

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[5]　According to the MEXT (2014)[4] "Improvement of Educational Content and Methods at Universities" and "Clarification of Grade Evaluation Criteria and Utilization of GPA System," 1) Guidance on advancement/ graduation enactment, withdrawal recommendation, etc. to students whose GPA value is below a certain value, 2) On the contrary, commend students whose GPA value is above a certain value, 3) or take measures such as allowing students to graduate early, these are effective from the viewpoint of motivating students to study. It can be said that it is effective from the viewpoint of motivating students to study, by taking measures such as giving guidance to students, commending students whose GPA value exceeds a certain value, or allowing students to graduate early. See the following link for details. https://www.mext.go.jp/a_menu /koutou/daigaku/04052801/003.htm

[6]　Although there are cases like Ichiro, Ichiro became the top hitter in 2004 with a maximum of 262 hits and a batting average of 0.372.

to graduation requirements and not merely a dispensable qualification; and 4) Utilization of computer simulations to understand discrepancies and the relationship between the optimal number of subjects and the degree of diploma policy contribution in advance.

This paper is codified into different parts. Section 2 summarizes the types of curriculum maps. Section 3 explains why the discrepancy occurs. Section 4 uses computer simulation to show the existence of the discrepancy. Then, the results of the simulation are analyzed and solutions are proposed. Section 5 states the conclusions. Finally, there is an appendix.

2   Types of curriculum map

The curriculum map was first presented by Walter (1976)[10] at the American Academy of Education under the name Instructional Curriculum Mapping. He defines Instructional Curriculum Mapping (ICM) as a set of guidelines for diagraming the interrelationships among objectives from different domains of learning. Based on the diploma policy, the curriculum map shows the item of ability to be acquired in relation to each subject at the time of graduation, and which subject contributes to the achievement of learning outcomes. Regarding the relationship between the curriculum map and the curriculum policy, Oki (2007)[8] states that the curriculum policy, which is based on the university's philosophy and goals, explains the consistency of the goals of each subject rationally and systematically in order to achieve the diploma policy of each faculty/department. Oki and Tanaka (2006)[9] explains about the basic concept of designing graduation policy and curriculum map.

There are six possible curriculum map formats: Type I marks a circle (○) only to the most relevant sub-diploma policy. Type II adds a circle (○) to all related sub-diploma policies. Type III adds a double circle (◎) and a circle (○) to all related sub-diploma policies. It means that a double circle (◎) is more relevant than a circle (○). Type IV adds a double circle (◎), a circle (○), and a triangle (△) to all related sub-diploma policies. It means that the relationships are higher in the order of double circle (◎), circle (○), and triangle (△). Type V describes the exact weight of the association. Type VI uses arrows in order to express the relevance instead of using a double circle (◎), a circle (○), a triangle (△), etc. Type VI is also called a curriculum flow chart or curriculum tree. Table 1 shows the format, the characteristics of the curriculum map and the name of the university used. Looking at the curriculum maps published by each university, four patterns of Type II, Type III, Type IV, and Type VI are often seen. No examples of Type I and Type V are currently available.

An FDSD (Faculty Development and Staff Development) study group was conducted at the author's university on October 20, 2021, to discuss the creation of a curriculum map. It was proposed to create a curriculum map such as Type V with the intention of providing more accurate information to students.

Table 1　Types of curriculum map

Type	Contents	Characteristics	Examples
I	Add circle（○）only to the most relevant DP.	Marking only one subject	Currently no example is found.
II	Add circle（○）to all related DPs.	Marking in mul-tiple subjects	Asia University, Hosei University, Nagoya City University, University of Tsukuba, Osaka University, Daito Bunka University, etc.[a]
III	Add double circle（◎）and circle（○）to all related DPs. Double circle（◎）means it is more relevant than circle（○）.	Marking in mul-tiple subjects + simple weighing of degree of rele-vance	Gakushuin University, Wakayama University, Hokuriku University, Kandai University, Mie University, Meiji University, etc.[b]
IV	Add double circle（◎）, circle（○）and triangle（△）to all related DPs, in the order of hierarchy of relevance, respectively.	Marking in mul-tiple subjects + moderate weigh-ing of degree of relevance	Kanazawa University, Aichi Gakuin University, Nara Women's University, Rikkyo University, etc.[c]
V	Describe the exact weight of the relevance.	Accurate weighing of degree of relevance	No example is currently found but it has been proposed by the FDSD Study Group of our university on October 20, 2021, and is a future task of the FDSD Study Group.
VI	Others	Using of arrows to illustrate degree of relevance	Chiba University, Chuo University, Hokkaido University, etc.[d]

[a] Hosei University: https://www.hosei.ac.jp/application/files/2915/6947/4634/Curriculum_Map_Economics.pdf, Nagoya City University: https://www.nagoya-cu.ac.jp/media/2020koukyou.pdf, University of Tsukuba: https://www.tsukuba.ac.jp/education/policy-tstandard/gcurriculum/cg_a_00.pdf, Osaka University: http://www-mmds.sigmath.es.osaka-u.ac.jp/structure/suuridsaitorikumi.pdf, Daito Bunka University: https://www.daito.ac.jp/education/literature/information/file/file_literature_cm01.pdf

[b] Gakushuin University: https://www.univ.gakushuin.ac.jp/life/1fe388e6b9006a0a4402b6837ca317f1f5df243e.pdf, Wakayama University: https://www.wakayama-u.ac.jp/_files/00213493/curri_map_f.pdf, Hokuriku University: https://www.hokuriku-u.ac.jp/doc/department/pharmacy_curriculummap.pdf?ud=20211105, Kandai University: https://www.kindai.ac.jp/sociology/files/research-and-education/curriculum/map-tree/map.pdf, Mie University: https://www.eng.mie-u.ac.jp/students-o/schedule/01_Mach_Curriculum_Map.pdf, Meiji University: https://www.meiji.ac.jp/hogaku/6t5h7p00003ahwxi-att/law_curriculum_map.pdf

[c] Kanazawa University: https://www.kanazawa-u.ac.jp/wp-content/uploads/2021/03/86247502145f6d72b5c5731f147d07ba.pdf, Aichi Gakuin University: https://www.agu.ac.jp/pdf/guide/data/2021/curriculum_map02.pdf, Nara Women's University: http://www.nara-wu.ac.jp/nwu/education/affairs/curriculummap/pdf/bun1.pdf, Rikkyo University: https://www.rikkyo.ac.jp/about/disclosure/educational_policy/qo9edr000000et2n-att/cp_department_02.pdf

[d] Chiba University: https://www.chiba-u.ac.jp/education/curriculummap/pdf/03_R2_lpe_map.pdf, Chuo University: https://www.chuo-u.ac.jp/uploads/2019/10/academics_faculties_globalmanagement_guide_curriculum_map_01.pdf?1636154654544, Hokkaido University: https://www.econ.hokudai.ac.jp/wp-content/uploads/2018/05/cmap_gakubu.pdf

Table 2　Type I

Subject	DP				
	DP_1	DP_2	DP_3	$\cdots$	DP_n
A_1	○			$\cdots$	
A_2	○			$\cdots$	
A_3		○		$\cdots$	
A_4		○		$\cdots$	
A_5			○	$\cdots$	
A_6			○	$\cdots$	
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
A_m				$\cdots$	○

Table 3　Type II

Subject	DP				
	DP_1	DP_2	DP_3	$\cdots$	DP_n
A_1	○			$\cdots$	
A_2	○	○		$\cdots$	
A_3		○		$\cdots$	
A_4		○	○	$\cdots$	
A_5			○	$\cdots$	
A_6			○	$\cdots$	○
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
A_m	○	○		$\cdots$	○

Table 4　Type III

Subject	DP				
	DP_1	DP_2	DP_3	$\cdots$	DP_n
A_1	◎			$\cdots$	
A_2	◎	○		$\cdots$	
A_3		◎		$\cdots$	
A_4		◎	○	$\cdots$	
A_5			◎	$\cdots$	
A_6			◎	$\cdots$	○
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
A_m	○	○		$\cdots$	◎

Table 5　Type IV

Subject	DP				
	DP_1	DP_2	DP_3	$\cdots$	DP_n
A_1	◎			$\cdots$	
A^2	◎	○	△	$\cdots$	
A_3		◎		$\cdots$	
A_4		◎	○	$\cdots$	△
A_5			◎	$\cdots$	
A_6	△		◎	$\cdots$	○
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
A_m	○	△		$\cdots$	◎

Table 6　Type V

Subject	DP					Total
	DP_1	DP_2	DP_3	$\cdots$	DP_n	
A_1	100			$\cdots$		100
A_2	80	20		$\cdots$		100
A_3		100		$\cdots$		100
A_4		70	30	$\cdots$		100
A_5			100	$\cdots$		100
A_6			75	$\cdots$	25	100
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
A_m	10	10		$\cdots$	80	100

Table 7　Type VI
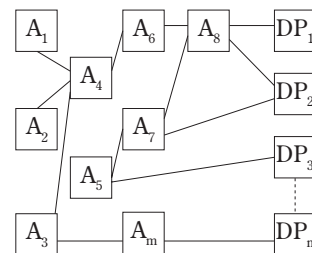
We are studying it as a future subject.

Table 2 to Table 7 are the visual representations of the contents of Table 1. It shows the relationship between each sub-diploma policy (DP$_1$, DP$_2$, DP$_3$,..., DP$_n$) and the subject name (A$_1$, A$_2$, A$_3$,..., A$_m$). With the exception of Type I, it can be seen that many subjects span multiple sub-diploma policies. One subject contributes not only to one sub-diploma policy but to multiple sub-diploma policies. This means that there are multiple ways to meet diploma policy requirements. In other words, in some cases, it is possible to meet the diploma policy requirements without taking the required courses.

3　Problems arising due to the discrepancies

3.1　Problem 1

Let's investigate the problem in more detail using Type V. Table 8 is a generalized version of the Type V curriculum map.

The items of the diploma policy (DP$_1$, DP$_2$, DP$_3$,..., DP$_n$) are arranged on the top horizontally, and the subject names (A$_1$, A$_2$, A$_3$,..., A$_m$) are arranged in the first column. a_{ij} represents the degree of contribution of subject A$_i$ to DP$_j$. The last three lines show the sum of contributions of each diploma policy, the ratio of sub-diploma policy j to total diploma policy, and the diploma policy requirements, respectively.

Denoting that the total DP$_j$ acquired from the passed subjects is G_j, G_j can be written as Eq. (1).

$$G_j = \sum_{i \in P} z_i a_{ij}, \quad j = \{1, 2, 3,..., n\} \tag{1}$$

Table 8　Curriculum map of Type V

Subject	DP					Total
	DP$_1$	DP$_2$	DP$_3$	$\cdots$	DP$_n$	
A$_1$	a_{11}	a_{12}	a_{13}	$\cdots$	a_{1n}	100
A$_2$	a_{21}	a_{22}	a_{23}	$\cdots$	a_{2n}	100
A$_3$	a_{31}	a_{32}	a_{33}	$\cdots$	a_{3n}	100
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
A$_m$	a_{m1}	a_{m2}	a_{m3}	$\cdots$	a_{mn}	100
Total	$S_1 = \sum_{i=1}^{m} a_{i1}$	$S_2 = \sum_{i=1}^{m} a_{i2}$	$S_3 = \sum_{i=1}^{m} a_{i3}$	$\cdots$	$S_n = \sum_{i=1}^{m} a_{in}$	$100m$
ratio	$R_1 = \dfrac{S_1}{100m}$	$R_2 = \dfrac{S_2}{100m}$	$R_3 = \dfrac{S_3}{100m}$	$\cdots$	$R_n = \dfrac{S_n}{100m}$	1
DP requirement	ϕS_1	ϕS_2	ϕS_3	$\cdots$	ϕS_n	$100\phi_m$

where, P means a set of passed subjects. z_i $(0 < z_i \leq 1)$ is the degree of achievement of subject A_i. We expressed the diploma policy requirement for DP_j as ϕS_j, and if the diploma policy requirement for DP_j is satisfied, it becomes Eq. (2).

$$G_j \geq \phi S_j, \quad j = \{1, 2, 3,..., n\} \tag{2}$$

where, ϕ $(0 < \phi < 1)$ is a constant. Since $z_i|_{i \in P} \geq \phi$, it is possible that the left side of Eq. (3) is larger than the right side.

$$\sum_{i \in P} a_{ij} \underbrace{(z_i - \phi)}_{positive} \geq \phi \sum_{i \in P} a_{ij}, \quad j = \{1, 2, 3,..., n\} \tag{3}$$

Interpreting Eq. (3), if the diploma policy of the subjects that could not be taken (right side) can be supplemented from the subjects other than the subjects that could not be taken (left side), the diploma policy requirements can be satisfied. In particular, the larger the number of $i \in P$, the easier it is for Eq. (3) to hold. There are proverbs "Many a little makes a mickle." and "Drop by drop fills the tub." Even students who fully meet the diploma policy requirements will not be able to graduate because they do not meet the graduation requirements if they drop the required courses.

3.2 Problem 2

The DP achievement level can be calculated as Eq. (4). Since the DP achievement is a function of G, it is an increasing (non-decreasing) function of the number of elements in P. In other words, as the number of passed subjects increases, the degree of achievement of DP increases.

$$\text{degree of achievement of DP} = \sum_{j}^{n} \sum_{i \in P} z_i a_{ij}. \tag{4}$$

On the other hand, GPA can be calculated as Eq. (5). GPA is not an increasing function of the number of elements in P. In other words, even if the number of passed subjects increases, the DP may not increase.

$$GPA = \frac{\sum_{i \in P} z_i}{\# \text{ of elements in } P} \tag{5}$$

DP is cumulative and GPA is average. Therefore, a high GPA does not necessarily mean a high DP. Conversely, a high DP does not necessarily mean a high GPA. This inconsistency gives us a question of which students who have a high GPA or a high degree of DP achievement are more in line with the university's educational philosophy.

In the next section, we show that Problem 1 and Problem 2 occur using the Monte Carlo simula-

tion.

4　Simulation

4.1　Simulation method

　We perform four types of simulations - Simulation I, II, III, and IV - with different numbers of courses (m). First, we explain the way of simulation of Simulation I. A curriculum map such as Type V is used for this simulation.

　The simulation is performed using the fictitious values described in Table 9. The university's diploma policy has four sub-diploma policies - DP_1, DP_2, DP_3, and DP_4. And there are 26 courses offered labeled A_1, A_2, A_3,..., A_{25}, and A_{26}. The figures in Table 9 indicate how much the subject contributes to the diploma policy. The sum of contributions (sum of rows) is 100. The sum of the columns can be interpreted as the importance of each sub-diploma policy in the diploma policy. In other words, in the diploma policy, the importance of DP_1 is $R_1 = 41.2\% \left(\frac{1090}{2600} \right)$, the importance of DP_2 is $R_2 = 20.0\% \left(\frac{520}{2600} \right)$, DP_3 is important $R_3 = 20.0\% \left(\frac{520}{2600} \right)$, and the importance of DP_4 is $R_4 = 18.8\% \left(\frac{490}{2600} \right)$.

　To simplify the setting, it is assumed that the students apply for all courses only once and do not retake them. Grades are evaluated in five stages: S, A, B, C, and D. Then, grade points of 4, 3, 2, 1, 0 are assigned corresponding to the different stages and the GPA is calculated on average.[7] Most universities in Japan have introduced such an evaluation method. For this study, we assume that students earning grades S, A, B, C, and D achieve goals of the lessons at 95%, 85%, 75%, 65%, 0%, respectively.[8] For example, a student who receives the grade A from the subject A_2, as shown in Table 9, will acquire DP_1 68 ($= 80 \times 0.85$), DP_2 17 ($= 20 \times 0.85$), DP_3 0 ($= 0 \times 0.85$), DP_4 0 ($= 0 \times 0.85$).

　In another instance, a student who gets grade Cs in all subjects (26 subjects) also obtains credits for compulsory subjects, so the graduation requirements in this case are met. The GPA and DP achievements obtained by this student are used as one of the criteria for judging whether or not to graduate. The student obtains GPA = 1.00 and DP_1 695.5 ($= 1070 \times 0.65$), DP_2 338 ($= 520 \times 0.65$), DP_3 338 ($= 520 \times 0.65$) and DP_4 318.5 ($= 490 \times 0.65$), and is able to graduate. In this case, $\phi = 0.65$. We set the DP achievement level acquired by this student ($DP_1 = 695.5$, $DP_2 = 338$, $DP_3 = 338$ and $DP_4 = 318.5$) as a DP require-

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[7]　Center for Institutional Research, Educational Development, and Learning Support, Ochanomizu University (2014)[1] points out the problems of GPA that is commonly used and proposes functional GPA. Please refer to the following link for details of functional GPA. https://crdeg5.cf.ocha.ac.jp/crdeSite/fgpa1.html and https://www.mext.go.jp/a_menu/koutou/itaku/icsFiles/afieldfile/2014/05/08/1347636_05.pdf

[8]　In this research, we assume that the student who gets a grade of D does not learn anything; hence, the achievement goals is 0%. However, in reality, a student can still learn something; thereby, pushing the inconsistency to likely occur more.

Table 9　Fictitious data

Subject	DP				Total
	DP_1	DP_2	DP_3	DP_4	
A_1	100				100
A_2	80	20			100
A_3	80	20			100
A_4	80		20		100
A_5	80		20		100
A_6	80	10	10		100
A_7	90	10			100
A_8	90	10			100
A_9	90		10		100
A_{10}	90		10		100
A_{11}	30	50	20		100
A_{12}	20	60	20		100
A_{13}	20	70	10		100
A_{14}	20	80			100
A_{15}	10	90			100
A_{16}	30	20	50		100
A_{17}	20	20	60		100
A_{18}	20	10	70		100
A_{19}	20		80		100
A_{20}	10		90		100
A_{21}		10		90	100
A_{22}			10	90	100
A_{23}		10	10	80	100
A_{24}		20		80	100
A_{25}			20	80	100
A_{26}	10	10	10	70	100
Total	1,070	520	520	490	2,600
Ratio	41.2	20.0	20.0	18.8	100.0
DP requirement	695.5	338.0	338.0	318.5	1,690.0

ment. Students will also earn credits for required courses and have a GPA of 1.00 or higher as a gradu-
ation requirement.

In each subject, the probability of getting S, A, B, and C is $\frac{9}{40}$, respectively $\left(\frac{9}{40} + \frac{9}{40} + \frac{9}{40} + \frac{9}{40} = \frac{9}{10} \right)$ and the probability of getting D is $\frac{1}{10}$. In other words, the probability of taking a unit is $\frac{9}{10}$. A Monte Carlo simulation was performed assuming that the number of compulsory subjects is 1 (A_1), 5 (A_1, A_2,..., A_4, A_5),10 (A_1, A_2,..., A_9, A_{10}),15 (A_1, A_2,..., A_{14}, A_{15}). The number of students was 10,000, and the number of repetitions was 1,000.

We arrived at Simulations II, III, and IV by increasing the number of courses offered to twice, thrice, and four times that of Simulation I, respectively. It is assumed that the number of similar subjects will increase. In the case of Simulation II, A_1 to A_{26} are used again as A_{27} to A_{52}. That is $A_i = A_{26+i}$, where, i = {1, 2, 3,..., 26}. The total number of courses offered will then be 52. In the case of Simulation III, A_1 to A_{26} are used two more times as A_{27} to A_{52} and A_{53} to A_{78}. That is $A_i = A_{26+i} = A_{52+i}$, where i = {1, 2, 3,..., 26}. Here, the number of courses offered will become 78. In the case of Simulation IV, A_1 to A_{26} is used three more times as A_{27} to A_{52}, A_{53} to $_{78}$ and A_{79} to A_{104}. That is $A_i = A_{26+i} = A_{52+i} = A_{78+i}$, where i = {1, 2, 3,..., 26}. The number of courses offered will be 104. The curriculum map used in Simulation II (Table 14), III (Table 15) and IV (Table 16) is described in the Appendix. The DP total and DP requirements of Simulation II, III and IV are double, triple and quadruple of Simulation I, respectively. And, the importance of DP of Simulation II, III and IV is the same as the importance of DP of Simulation I.

4.2　Simulation results and solutions

To simplify the description, we first define three groups which are Group A, Group S, and Group F. Group A is a group of students who exceed the DP requirements. Group S is a group of students who exceed the DP requirements and can graduate by earning credits for compulsory courses. Group F is a group of students who cannot graduate because they have exceeded the DP requirements but have not earned credits for compulsory subjects. Group A=Group S $\cup$ Group F.

Table 10 summarizes the results of $\frac{\text{\# of students in Group F}}{\text{\# of students in Group A}} \times 100 (\%)$. In other words, this shows the percentage of students who have met the DP requirements but cannot graduate because they could not pass the compulsory subjects. Comparing the number of compulsory subjects and their ratio, it can be seen that, of course, the larger the number of compulsory subjects, the higher the ratio. And to the number of courses offered as against the ratio, we observe that the higher the number of courses offered, the higher is the ratio.

Next, we compare 1) the top GPA student's GPA, 2) the top GPA student's DP achievement, 3) the bottom GPA student's GPA, 4) the bottom GPA student's DP achievement, 5) the top DP student's GPA, 6) the top DP student's DP achievement, 7) the bottom DP student's GPA, 8) the bottom DP

Table 10 The results of the simulations

number of compulsory subjects	compulsory subjects	Simulation			
		I (26)	II (52)	III (78)	IV (104)
1	A_1	7.143%	8.826%	9.374%	9.683%
5	$A_1, A_2,..., A_4, A_5$	32.67%	37.35%	39.00%	39.80%
10	$A_1, A_2,..., A_9, A_{10}$	57.81%	61.75%	63.28%	64.02%
15	$A_1, A_2,..., A_{14}, A_{15}$	70.26%	75.26%	77.06%	77.98%

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

student's DP achievement within both Group S and Group F. To simplify the description, the above 16 ways are expressed in the format of X_b^a, where X = {GPA, DP}, a = {S, F}, b = {tGPA, bGPA, tDP, bDP}. For example, GPA_{tGPA}^S represents the GPA of the student who obtained the highest GPA in Group S. DP_{tGPA}^F represents the DP achievement of the student who obtained the highest GPA in Group F. GPA_{bDP}^S represents the GPA of the student who obtained the lowest DP in Group S. DP_{bDP}^F represents the DP achievement of the student who obtained the lowest DP in Group F.

Some of the above 16 values are summarized in Table 11. The results of whole calculation are described in Appendix Table 17, Table 18, Table 19 and Table 20. For example, when the number of compulsory subjects for Simulation I is 5, $\frac{DP_{tDP}^F}{DP_{bDP}^S} = 1.224$. In other words, the student who obtained the highest DP in Group F was not able to graduate, even though he/she obtained 1.244 times of DP compared to the student who obtained the lowest DP and was able to graduate in Group S. It can be seen that among the students who cannot graduate, there are students who have obtained more DP than the students who were able to graduate. And the results of $\frac{DP_{tDP}^F}{DP_{bGPA}^S}$ show that these ratios gradually decrease as the number of subjects increases. (1.161 > 1.148 > 1.137 > 1.130), (1.169 > 1.157 > 1.146 > 1.139), (1.160 > 1.155 > 1.145 > 1.137) and (1.157 > 1.151 > 1.143 > 1.135).

In Table 12, we calculate the ratio of $DP_{tDP}^S > DP_{tGPA}^S$, that is, $P_1 = \frac{\text{\# of } (DP_{tDP}^S > DP_{tGPA}^S)}{\text{\# of iteration}}$ and the ratio of $DP_{tDP}^F > DP_{tGPA}^S$, that is, $P_2 = \frac{\text{\# of } (DP_{tDP}^F > DP_{tGPA}^S)}{\text{\# of iteration}}$. And the percentage of students in Group F who got higher GPA and DP than GPA_{bGPA}^S and DP_{bGPA}^S was calculated (P_3). In the case of Simulation I, P_1 is 90 % or more. P_2 is 60 % or more. And P_3 is 80 % or more. It can be seen that as the number of compulsory subjects increases, P_1 and P_2 also increase. On the other hand, P_1 and P_3 decrease as the number of similar subjects increases. There lies the problem when many students cannot graduate even though they have higher GPA and DP than those who can. According to Ogawa (2010)[7], students in many universities take courses only to meet graduation requirements often disregarding the degree of achievement of their educational goals. If students can graduate when they meet the graduation requirements as in

Table 11　The results of the simulations

Simulation	number of compulsory subjects	(10–1) $\frac{\mathrm{DP}^S_{tDP}}{\mathrm{DP}^S_{tGPA}}$	(12–4) $\frac{\mathrm{DP}^F_{tDP}}{\mathrm{DP}^S_{bDP}}$	(12–2) $\frac{\mathrm{DP}^F_{tDP}}{\mathrm{DP}^S_{bGPA}}$
I（26）	1	1.063	1.234	1.161
	5	1.064	1.244	1.169
	10	1.043	1.210	1.160
	15	1.034	1.196	1.157
II（52）	1	1.080	1.218	1.148
	5	1.061	1.228	1.157
	10	1.060	1.225	1.155
	15	1.059	1.219	1.151
III（78）	1	1.070	1.202	1.137
	5	1.057	1.211	1.146
	10	1.057	1.210	1.145
	15	1.055	1.206	1.143
IV（104）	1	1.157	1.191	1.130
	5	1.054	1.200	1.139
	10	1.054	1.198	1.137
	15	1.053	1.194	1.135

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

the current system, it may be rational for them to think only about meeting the graduation requirements rather than aiming for a higher GPA or DP achievement.

Table 13 calculates the correlation coefficient between GPA and DP achievement. Excluding the correlation coefficients of one compulsory subject of Group S of Simulation III and one compulsory subject of Group S of Simulation IV which are 0.580 and 0.676, respectively, the correlation coefficients are about 0.4. Although there are positive correlations, it cannot be said that there is a strong correlation between GPA and DP achievement.

The simulation results confirm that some problems could occur. Such problems can cause students to feel unfair in the graduation system. Based on the simulation results, we propose about four methods to solve the problems. First, since contradictions are more likely to occur the higher the number of subjects get, we propose to streamline the number of subjects by integrating similar subjects. Second, subdivide the DP and consider a DP that cannot be obtained from subjects other than that particular subject. Third, constitutionalize both graduation requirements and DP requirements. Fourth, utili-

Table 12   The results of the simulations

Simulation	number of compulsory subjects	P_1	P_2	P_3
I （26）	1	93.2%	63.2%	84.4%
	5	96.5%	82.4%	80.5%
	10	97.4%	85.6%	80.8%
	15	97.6%	88.8%	82.4%
II （52）	1	89.9%	63.0%	81.0%
	5	96.0%	87.6%	79.0%
	10	97.1%	91.4%	79.1%
	15	98.0%	92.9%	81.0%
III （78）	1	81.6%	49.1%	74.8%
	5	94.5%	86.7%	75.3%
	10	95.7%	91.6%	76.2%
	15	97.1%	93.9%	77.3%
IV （104）	1	68.4%	35.6%	73.9%
	5	92.6%	84.0%	72.1%
	10	94.4%	90.2%	74.5%
	15	96.5%	95.0%	75.5%

The numbers in the parentheses represent the number of subjects.
The values in the Table are the results of averaging 1,000 repetitions of the simulation.

zation of computer simulation or the like in order to anticipate the relationship between the number of discrepancies and the optimal number of subjects and the degree of DP contribution.

5   Conclusions

In this paper, we analyzed the inconsistency that occurs between the graduation requirement and the DP requirement. Eligible students may still not be able to graduate even if they have achieved a higher degree of achievement in the diploma policy. GPA top students and diploma policy top students do not always match. There was also no high correlation between GPA and DP achievement. Such problems can cause students to feel unfair in the graduation system. One of the causes of such discrepancies is that many subjects contribute to the accomplishment of multiple diploma policies that it makes it possible to meet DP requirements without taking compulsory courses. It is not realistic to have les-

Table 13　Correlations between GPA and DP achievement

Simulation	number of compulsory subjects	Group A	Group S	Group F
I （26）	1	0.414	0.424	0.422
	5	0.396	0.401	0.393
	10	0.389	0.393	0.384
	15	0.389	0.391	0.386
II （52）	1	0.414	0.471	0.445
	5	0.396	0.423	0.403
	10	0.389	0.407	0.392
	15	0.389	0.402	0.390
III （78）	1	0.414	0.580	0.469
	5	0.396	0.456	0.411
	10	0.389	0.427	0.397
	15	0.389	0.415	0.394
IV （104）	1	0.414	0.676	0.485
	5	0.396	0.483	0.415
	10	0.389	0.443	0.400
	15	0.389	0.428	0.396

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

son content that does not span multiple diploma policies. As solutions to the problems, we proposed the following: 1) curriculum slimming, 2) subdivision of diploma policy, 3) constitutionalize both graduation requirements and diploma policy, and 4) prior confirmation of discrepancies using simulations. According to the MEXT (2006) [3], 465 universities (66.7%) and 1,063 faculties (58.3%) are reviewing on compulsory subjects and optional subjects. In the future, it will be necessary to consider inconsistencies when reviewing compulsory courses and optional courses, and to pay attention to the construction of an educational system that does not cause discrepancies and does not cause misunderstandings by students.

　This research also examined cases where the diploma policy requirements were met but the graduation requirements were not. According to Ogawa (2010) [7], a lot of university students fail to consider the degree of achievement of their educational goals; rather, they focus only on meeting graduation requirements. Therefore, contrary to the analysis of this paper, it is possible that the diploma policy requirement is not satisfied even if the graduation requirement is fulfilled. We would like to consider

a solution to this problem with the cooperation of pedagogues. This study used fictitious data in the examination process but would be open to conducting another test if actual data becomes available.

References

［1］ Center for Institutional Research, Educational Development, and Learning Support, Ochanomizu University, 2014, Functional GPA, Available at: https://crdeg5.cf.ocha.ac.jp/crdeSite/fgpa1.html

［2］ Education Management Special Committee of the Central Council for Education University Subcommittee, 2019, Notice Concerning Amendment of School Education Law Enforcement Regulations, reference material 2019.9.24, Available at: https://www.mext.go.jp/content/1419954_10.pdf

［3］ MEXT（Ministry of Education, Culture, Sports, Science and Technology）、2006、「大学における教育内容等の改革状況について（平成 16 年度）」、大学教育部会（第 7 回）議事録・配付資料、資料 4-2、Available at: https://www.mext.go.jp/b_menu/shingi/chukyo/chukyo4/015/gijiroku/06101201.htm, https://www.mext.go.jp/b_menu/shingi/chukyo/chukyo4/015/gijiroku/06101201/004/001.htm

［4］ MEXT（Ministry of Education, Culture, Sports, Science and Technology）、2014、「大学における教育内容・方法の改善等について」、「成績評価基準の明示と GPA 制度の活用」、Available at: https://www.mext.go.jp/a_menu/koutou/daigaku/04052801/003.htm

［5］ MEXT（Ministry of Education, Culture, Sports, Science and Technology）、2015、大学教育部会（第 40 回）配付資料、資料 1-2、三つのポリシーの策定と運用に係るガイドライン（骨子の素案）、Available at: https://www.mext.go.jp/b_menu/shingi/chukyo/chukyo4/015/attach/1365326.htm

［6］ MEXT（Ministry of Education, Culture, Sports, Science and Technology）、2017、大学における教育内容等の改革状況について、Available at: https://www.mext.go.jp/a_menu/koutou/daigaku/04052801/1398426.htm, https://www.mext.go.jp/a_menu/koutou/daigaku/04052801/icsFiles/afieldfile/2019/05/28/1398426_001.pdf

［7］ Ogawa, T., 2010, A Study of Systematic curriculum Improvement towards Guaranteeing the Quality of Undergraduate Education: A Curriculum Improvement Trial Based on Faculty Development for Improvement of Undergraduate Education, *Kyoto University Researches in Higher Education*, Vol. 16, pp. 13-24, Available at: https://repository.kulib.kyoto-u.ac.jp/dspace/bitstream/2433/137206/1/02_ogawa.pdf

［8］ Oki, H., 2007, Structure of curriculum policies from the viewpoint of point-by-point instructional objectives, *Ritsumeikan higher educational studies*, Vol. 7, pp. 61-74, Available at: http://www.ritsumei.ac.jp/acd/ac/kyomu/cer/kanko/kiyo7/07_4_oki.pdf

［9］ Oki, H., and Tanaka, H., 2006, The basic concept of designing graduation policy and admission policy at Yamaguchi University, *Journal of higher education*, Vol. 3, pp. 39-55, Available at: http://petit.lib.yamaguchi-u. ac.jp/13700/files/147985

［10］ Walter, W., 1976, Instructional Curriculum Mapping, Paper presented at the Annual Spring Conference of the American Educational Research Association, San Francisco, California, April 21, 1976, Available at: https://files.eric.ed.gov/fulltext/ED141264.pdf

6　Appendix

Table 14, Table 15, and Table 16 represent fictitious curriculum maps for Simulation II, III and IV, respectively. Table 17, Table 18, Table 19, and Table 20 show the results obtained from Simulation I, II, III, and IV, when the numbers of compulsory subjects are 1, 5, 10 and 15, respectively. Table 21 shows how to read Tables 17, 18, 19 and 20.

Table 14　Fictitious data for Simulation II

Subject	DP				Total
	DP_1	DP_2	DP_3	DP_4	
A_1	100				100
A_2	80	20			100
A_3	80	20			100
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	
A_{24}		20		80	100
A_{25}			20	80	100
A_{26}	10	10	10	70	100
A_{27}	100				100
A_{28}	80	20			100
A_{29}	80	20			100
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	
A_{50}		20		80	100
A_{51}			20	80	100
A^{52}	10	10	10	70	100
Total	2,140	1,040	1,040	980	5,200
Ratio	41.2	20.0	20.0	18.8	100.0
DP requirement	1,391	676	676	637	3,380

Table 15　Fictitious data for Simulation III

Subject	DP				Total
	DP_1	DP_2	DP_3	DP_4	
A_1	100				100
A_2	80	20			100
A_3	80	20			100
⋮	⋮	⋮	⋮	⋮	
A_{24}		20		80	100
A_{25}			20	80	100
A_{26}	10	10	10	70	100
A_{27}	100				100
A_{28}	80	20			100
A_{29}	80	20			100
⋮	⋮	⋮	⋮	⋮	
A_{50}		20		80	100
A_{51}			20	80	100
A_{52}	10	10	10	70	100
A_{53}	100				100
A_{54}	80	20			100
A_{55}	80	20			100
⋮	⋮	⋮	⋮	⋮	
A_{76}		20		80	100
A_{77}			20	80	100
A_{78}	10	10	10	70	100
Total	3,210	1,560	1,560	1,470	7,800
Ratio	41.2	20.0	20.0	18.8	100.0
DP requirement	2,086.5	1,014.0	1,014.0	955.5	5,070.0

Table 16　Fictitious data for Simulation IV

Subject	DP				Total
	DP$_1$	DP$_2$	DP$_3$	DP$_4$	
A$_1$	100				100
A$_2$	80	20			100
A$_3$	80	20			100
⋮	⋮	⋮	⋮	⋮	
A$_{24}$		20		80	100
A$_{25}$			20	80	100
A$_{26}$	10	10	10	70	100
A$_{27}$	100				100
A$_{28}$	80	20			100
A$_{29}$	80	20			100
⋮	⋮	⋮	⋮	⋮	
A$_{50}$		20		80	100
A$_{51}$			20	80	100
A$_{52}$	10	10	10	70	100
A$_{53}$	100				100
A$_{54}$	80	20			100
A$_{55}$	80	20			100
⋮	⋮	⋮	⋮	⋮	
A$_{76}$		20		80	100
A$_{77}$			20	80	100
A$_{78}$	10	10	10	70	100
A$_{79}$	100				100
A$_{80}$	80	20			100
A$_{81}$	80	20			100
⋮	⋮	⋮	⋮	⋮	
A$_{102}$		20		80	100
A$_{103}$			20	80	100
A$_{104}$	10	10	10	70	100
Total	4,280	2,080	2,080	1,960	10,400
Ratio	41.2	20.0	20.0	18.8	100.0
DP requirement	2,782	1,352	1,352	1,274	6,760

Table 17　The results of the simulations（the number of compulsory subjects=1）

Simulation		Group S				Group F			
		GPA	ratio	DP achievement	ratio	GPA	ratio	DP achievement	ratio
I （26）	top GPA	3.334	1.000 1.879 1.049 1.390	2090.430	1.000 1.138 0.927 1.210	3.212	0.963 1.810 1.011 1.339	2007.690	0.960 1.093 0.890 1.162
	bottom GPA	1.774	0.532 1.000 0.558 0.740	1837.045	0.879 1.000 0.814 1.063	1.957	0.587 1.103 0.616 0.816	1841.705	0.881 1.003 0.816 1.066
	top DP	3.178	0.953 1.791 1.000 1.325	2256.085	1.079 1.228 1.000 1.306	3.040	0.912 1.713 0.956 1.267	2132.780	1.020 1.161 0.945 1.234
	bottom DP	2.399	0.720 1.352 0.755 1.000	1727.880	0.827 0.941 0.766 1.000	2.466	0.740 1.390 0.776 1.028	1746.595	0.836 0.951 0.774 1.011
II （52）	top GPA	3.088	1.000 1.570 1.068 1.302	4018.835	1.000 1.101 0.926 1.168	3.019	0.978 1.535 1.044 1.273	3946.660	0.982 1.081 0.909 1.147
	bottom GPA	1.967	0.637 1.000 0.680 0.830	3650.890	0.908 1.000 0.841 1.061	2.061	0.668 1.048 0.713 0.869	3651.685	0.909 1.000 0.841 1.061
	top DP	2.890	0.936 1.470 1.000 1.219	4341.835	1.080 1.189 1.000 1.262	2.810	0.910 1.429 0.972 1.185	4190.200	1.043 1.148 0.965 1.218
	bottom DP	2.371	0.768 1.205 0.820 1.000	3440.580	0.856 0.942 0.792 1.000	2.406	0.779 1.223 0.832 1.015	3469.580	0.863 0.950 0.799 1.008
III （78）	top GPA	3.002	1.000 1.472 1.074 1.255	5965.465	1.000 1.094 0.935 1.156	2.928	0.975 1.436 1.048 1.224	5853.660	0.981 1.073 0.917 1.134
	bottom GPA	2.039	0.679 1.000 0.730 0.853	5454.470	0.914 1.000 0.855 1.057	2.118	0.706 1.039 0.758 0.886	5442.155	0.912 0.998 0.853 1.055
	top DP	2.794	0.931 1.370 1.000 1.168	6381.140	1.070 1.170 1.000 1.237	2.729	0.909 1.338 0.977 1.141	6200.690	1.039 1.137 0.972 1.202
	bottom DP	2.391	0.797 1.173 0.856 1.000	5159.915	0.865 0.946 0.809 1.000	2.406	0.801 1.180 0.861 1.006	5195.865	0.871 0.953 0.814 1.007
IV （104）	GPA max	2.938	1.000 1.405 1.074 1.227	7882.550	1.000 1.087 0.939 1.146	2.871	0.977 1.373 1.049 1.199	7755.000	0.984 1.070 0.924 1.127
	GPA min	2.091	0.712 1.000 0.764 0.873	7249.570	0.920 1.000 0.864 1.054	2.158	0.734 1.032 0.789 0.901	7249.965	0.920 1.000 0.864 1.054
	DP max	2.736	0.931 1.309 1.000 1.143	8390.540	1.064 1.157 1.000 1.220	2.692	0.916 1.287 0.984 1.124	8192.605	1.039 1.130 0.976 1.191
	DP min	2.394	0.815 1.145 0.875 1.000	6878.605	0.873 0.949 0.820 1.000	2.411	0.821 1.153 0.881 1.007	6927.565	0.879 0.956 0.826 1.007

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

Table 18　The results of the simulations（the number of compulsory subjects＝5）

Simulation			Group S				Group F		
		GPA	ratio	DP achievement	ratio	GPA	ratio	DP achievement	ratio
I　(26)	top GPA	3.308	1.000	2118.905	1.000	3.298	0.997	2025.505	0.956
			1.851		1.146		1.845		1.096
			1.041		0.939		1.038		0.898
			1.402		1.219		1.397		1.165
	bottom GPA	1.787	0.540	1848.720	0.872	1.847	0.558	1816.060	0.857
			1.000		1.000		1.034		0.982
			0.562		0.819		0.581		0.805
			0.757		1.064		0.783		1.045
	top DP	3.178	0.961	2256.085	1.065	3.147	0.951	2161.320	1.020
			1.778		1.220		1.761		1.169
			1.000		1.000		0.990		0.958
			1.347		1.298		1.333		1.244
	bottom DP	2.360	0.714	1738.060	0.820	2.436	0.736	1729.540	0.816
			1.321		0.940		1.363		0.936
			0.743		0.770		0.766		0.767
			1.000		1.000		1.032		0.995
II　(52)	top GPA	3.088	1.000	4045.110	1.000	3.081	0.998	3960.735	0.979
			1.570		1.104		1.566		1.081
			1.068		0.932		1.066		0.912
			1.302		1.171		1.299		1.147
	bottom GPA	1.967	0.637	3665.010	0.906	1.997	0.647	3633.175	0.898
			1.000		1.000		1.015		0.991
			0.680		0.844		0.691		0.837
			0.830		1.061		0.842		1.052
	top DP	2.890	0.936	4341.465	1.073	2.872	0.930	4242.045	1.049
			1.470		1.185		1.460		1.157
			1.000		1.000		0.994		0.977
			1.219		1.257		1.212		1.228
	bottom DP	2.371	0.768	3454.115	0.854	2.392	0.775	3444.625	0.852
			1.205		0.942		1.216		0.940
			0.820		0.796		0.828		0.793
			1.000		1.000		1.009		0.997
III　(78)	top GPA	2.986	1.000	5990.470	1.000	2.979	0.998	5902.535	0.985
			1.458		1.094		1.454		1.078
			1.070		0.939		1.068		0.925
			1.254		1.157		1.251		1.140
	bottom GPA	2.049	0.686	5474.695	0.914	2.069	0.693	5432.730	0.907
			1.000		1.000		1.010		0.992
			0.734		0.858		0.742		0.852
			0.860		1.057		0.869		1.049
	top DP	2.790	0.934	6379.205	1.065	2.767	0.927	6272.430	1.047
			1.362		1.165		1.351		1.146
			1.000		1.000		0.992		0.983
			1.171		1.232		1.162		1.211
	bottom DP	2.381	0.797	5177.895	0.864	2.397	0.803	5163.770	0.862
			1.162		0.946		1.170		0.943
			0.854		0.812		0.859		0.809
			1.000		1.000		1.007		0.997
IV　(104)	top GPA	2.925	1.000	7902.675	1.000	2.915	0.997	7823.195	0.990
			1.392		1.087		1.388		1.076
			1.071		0.942		1.067		0.933
			1.223		1.145		1.219		1.134
	bottom GPA	2.101	0.718	7272.520	0.920	2.116	0.723	7227.705	0.915
			1.000		1.000		1.007		0.994
			0.769		0.867		0.775		0.862
			0.878		1.054		0.885		1.047
	top DP	2.731	0.934	8385.660	1.061	2.725	0.932	8281.720	1.048
			1.300		1.153		1.297		1.139
			1.000		1.000		0.998		0.988
			1.142		1.215		1.139		1.200
	bottom DP	2.392	0.818	6901.220	0.873	2.404	0.822	6886.075	0.871
			1.138		0.949		1.144		0.947
			0.876		0.823		0.880		0.821
			1.000		1.000		1.005		0.998

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

Table 19　The results of the simulations（the number of compulsory subjects＝10）

Simulation		Group S				Group F			
		GPA	ratio	DP achievement	ratio	GPA	ratio	DP achievement	ratio
I　(26)	top GPA	3.275	1.000 1.811 1.030 1.499	2162.295	1.000 1.155 0.958 1.205	3.324	1.015 1.838 1.046 1.521	2037.520	0.942 1.088 0.903 1.135
	bottom GPA	1.808	0.552 1.000 0.569 0.828	1872.235	0.866 1.000 0.830 1.043	1.809	0.552 1.000 0.569 0.828	1811.615	0.838 0.968 0.803 1.009
	top DP	3.178	0.971 1.758 1.000 1.455	2256.085	1.043 1.205 1.000 1.257	3.190	0.974 1.764 1.004 1.460	2171.925	1.004 1.160 0.963 1.210
	bottom DP	2.185	0.667 1.208 0.687 1.000	1794.620	0.830 0.959 0.795 1.000	2.412	0.737 1.334 0.759 1.104	1726.305	0.798 0.922 0.765 0.962
II　(52)	top GPA	3.062	1.000 1.545 1.060 1.304	4089.375	1.000 1.108 0.942 1.175	3.100	1.012 1.564 1.073 1.320	3979.010	0.973 1.078 0.917 1.143
	bottom GPA	1.982	0.647 1.000 0.686 0.844	3690.430	0.902 1.000 0.850 1.060	1.976	0.645 0.997 0.684 0.842	3629.605	0.888 0.984 0.836 1.043
	top DP	2.888	0.943 1.457 1.000 1.230	4341.000	1.062 1.176 1.000 1.247	2.899	0.947 1.462 1.004 1.235	4263.005	1.042 1.155 0.982 1.225
	bottom DP	2.348	0.767 1.184 0.813 1.000	3480.925	0.851 0.943 0.802 1.000	2.381	0.778 1.201 0.824 1.014	3439.360	0.841 0.932 0.792 0.988
III　(78)	top GPA	2.968	1.000 1.438 1.067 1.251	6024.580	1.000 1.095 0.945 1.157	2.993	1.009 1.450 1.076 1.261	5919.030	0.982 1.076 0.928 1.137
	bottom GPA	2.063	0.695 1.000 0.742 0.870	5502.535	0.913 1.000 0.863 1.057	2.052	0.691 0.994 0.737 0.865	5428.625	0.901 0.987 0.851 1.042
	top DP	2.782	0.938 1.348 1.000 1.173	6376.905	1.058 1.159 1.000 1.225	2.785	0.938 1.350 1.001 1.174	6299.665	1.046 1.145 0.988 1.210
	bottom DP	2.373	0.800 1.150 0.853 1.000	5207.350	0.864 0.946 0.817 1.000	2.395	0.807 1.161 0.861 1.010	5157.920	0.856 0.937 0.809 0.991
IV　(104)	top GPA	2.908	1.000 1.375 1.066 1.215	7939.420	1.000 1.085 0.947 1.144	2.929	1.007 1.385 1.074 1.224	7831.285	0.986 1.071 0.934 1.129
	bottom GPA	2.114	0.727 1.000 0.775 0.883	7314.195	0.921 1.000 0.873 1.054	2.102	0.723 0.994 0.770 0.878	7224.670	0.910 0.988 0.862 1.041
	top DP	2.728	0.938 1.291 1.000 1.140	8381.015	1.056 1.146 1.000 1.208	2.735	0.941 1.294 1.002 1.143	8312.965	1.047 1.137 0.992 1.198
	bottom DP	2.393	0.823 1.132 0.877 1.000	6938.775	0.874 0.949 0.828 1.000	2.399	0.825 1.135 0.879 1.002	6877.415	0.866 0.940 0.821 0.991

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

Table 20　The results of the simulations（the number of compulsory subjects＝15）

Simulation		Group S				Group F			
		GPA	ratio	DP achievement	ratio	GPA	ratio	DP achievement	ratio
I　(26)	top GPA	3.308	1.000	2193.460	1.000	3.331	1.027	2050.695	0.935
			1.785		1.165		1.834		1.089
			1.020		0.972		1.048		0.909
			1.571		1.205		1.614		1.127
	bottom GPA	1.787	0.560	1883.160	0.859	1.804	0.556	1811.575	0.826
			1.000		1.000		0.993		0.962
			0.571		0.835		0.567		0.803
			0.880		1.034		0.874		0.995
	top DP	3.178	0.980	2256.085	1.029	3.213	0.991	2178.020	0.993
			1.750		1.198		1.769		1.157
			1.000		1.000		1.011		0.965
			1.540		1.239		1.557		1.196
	bottom DP	2.360	0.636	1820.405	0.830	2.412	0.744	1726.305	0.787
			1.136		0.967		1.328		0.917
			0.649		0.807		0.759		0.765
			1.000		1.000		1.169		0.948
II　(52)	top GPA	3.088	1.000	4125.720	1.000	3.106	1.022	3989.260	0.967
			1.523		1.111		1.556		1.074
			1.054		0.951		1.077		0.919
			1.304		1.177		1.333		1.138
	bottom GPA	1.967	0.657	3713.080	0.900	1.970	0.648	3631.750	0.880
			1.000		1.000		0.987		0.978
			0.692		0.855		0.683		0.837
			0.857		1.059		0.845		1.036
	top DP	2.890	0.949	4340.475	1.052	2.916	0.959	4273.565	1.036
			1.445		1.169		1.461		1.151
			1.000		1.000		1.011		0.985
			1.237		1.239		1.251		1.219
	bottom DP	2.371	0.767	3504.560	0.849	2.379	0.783	3438.505	0.833
			1.167		0.944		1.192		0.926
			0.808		0.807		0.825		0.792
			1.000		1.000		1.021		0.981
III　(78)	top GPA	2.986	1.000	6052.495	1.000	2.998	1.017	5930.805	0.980
			1.420		1.096		1.444		1.074
			1.062		0.949		1.080		0.930
			1.247		1.156		1.268		1.133
	bottom GPA	2.049	0.704	5523.605	0.913	2.046	0.694	5436.310	0.898
			1.000		1.000		0.985		0.984
			0.748		0.866		0.737		0.853
			0.878		1.055		0.865		1.038
	top DP	2.790	0.942	6374.705	1.053	2.795	0.948	6313.295	1.043
			1.338		1.154		1.346		1.143
			1.000		1.000		1.007		0.990
			1.174		1.218		1.182		1.206
	bottom DP	2.381	0.802	5235.325	0.865	2.392	0.811	5156.690	0.852
			1.139		0.948		1.152		0.934
			0.852		0.821		0.861		0.809
			1.000		1.000		1.012		0.985
IV　(104)	top GPA	2.925	1.000	7958.120	1.000	2.935	1.015	7851.340	0.987
			1.360		1.084		1.380		1.070
			1.062		0.950		1.078		0.937
			1.214		1.141		1.232		1.126
	bottom GPA	2.101	0.735	7340.140	0.922	2.097	0.725	7230.005	0.909
			1.000		1.000		0.986		0.985
			0.781		0.876		0.770		0.863
			0.892		1.053		0.880		1.037
	top DP	2.731	0.941	8376.350	1.053	2.741	0.948	8329.525	1.047
			1.280		1.141		1.289		1.135
			1.000		1.000		1.007		0.994
			1.143		1.201		1.151		1.194
	bottom DP	2.392	0.824	6973.965	0.876	2.398	0.829	6875.355	0.864
			1.121		0.950		1.128		0.937
			0.875		0.833		0.881		0.821
			1.000		1.000		1.007		0.986

The numbers in the parentheses represent the number of subjects. The values in the Table are the results of averaging 1,000 repetitions of the simulation.

Table 21 Guide to reading Tables 17, 18, 19 and 20

	Group S				Group F			
student	**GPA**	**ratio**	**DPachievement**	**ratio**	**GPA**	**ratio**	**DPachievement**	**ratio**
the top GPA student	(1) GPA^S_{tGPA}	(1-1) $\dfrac{(1)\ GPA^S_{tGPA}}{(1)\ GPA^S_{tGPA}}$ (1-2) $\dfrac{(5)\ GPA^S_{bGPA}}{(1)\ GPA^S_{tGPA}}$ (1-3) $\dfrac{(9)\ GPA^S_{tDP}}{(1)\ GPA^S_{tGPA}}$ (1-4) $\dfrac{(13)\ GPA^S_{bDP}}{(1)\ GPA^S_{tGPA}}$	(2) DP^S_{tGPA}	(2-1) $\dfrac{(2)\ DPS_{tGPA}}{(2)\ DP^S_{tGPA}}$ (2-2) $\dfrac{(2)\ DP^S_{tGPA}}{(6)\ DP^S_{bGPA}}$ (2-3) $\dfrac{(2)\ DP^S_{tGPA}}{(10)\ DP^S_{tDP}}$ (2-4) $\dfrac{(2)\ DP^S_{tGPA}}{(14)\ DP^S_{bDP}}$	(3) GPA^F_{tGPA}	(3-1) $\dfrac{(3)\ GPA^F_{tGPA}}{(1)\ GPA^S_{tGPA}}$ (3-2) $\dfrac{(3)\ GPA^F_{tGPA}}{(5)\ GPA^S_{bGPA}}$ (3-3) $\dfrac{(3)\ GPA^F_{tGPA}}{(9)\ GPA^S_{tDP}}$ (3-4) $\dfrac{(3)\ GPA^F_{tGPA}}{(13)\ GPA^S_{bDP}}$	(4) DP^F_{tGPA}	(4-1) $\dfrac{(4)\ DP^F_{tGPA}}{(2)\ DP^S_{tGPA}}$ (4-2) $\dfrac{(4)\ DP^F_{tGPA}}{(6)\ DP^S_{bGPA}}$ (4-3) $\dfrac{(4)\ DP^F_{tGPA}}{(10)\ DP^S_{tDP}}$ (4-4) $\dfrac{(4)\ DP^F_{tGPA}}{(14)\ DP^S_{bDP}}$
the bottom GPA student	(5) GPA^S_{bGPA}	(5-1) $\dfrac{(5)\ GPA^S_{bGPA}}{(1)\ GPA^S_{tGPA}}$ (5-2) $\dfrac{(5)\ GPA^S_{bGPA}}{(5)\ GPA^S_{bGPA}}$ (5-3) $\dfrac{(5)\ GPA^S_{bGPA}}{(9)\ GPA^S_{tDP}}$ (5-4) $\dfrac{(5)\ GPA^S_{bGPA}}{(13)\ GPA^S_{bDP}}$	(6) DP^S_{bGPA}	(6-1) $\dfrac{(6)\ DP^S_{bGPA}}{(2)\ DP^S_{tGPA}}$ (6-2) $\dfrac{(6)\ DP^S_{bGPA}}{(6)\ DP^S_{bGPA}}$ (6-3) $\dfrac{(6)\ DP^S_{bGPA}}{(10)\ DP^S_{tDP}}$ (6-4) $\dfrac{(6)\ DP^S_{bGPA}}{(14)\ DP^S_{bDP}}$	(7) GPA^F_{bGPA}	(7-1) $\dfrac{(7)\ GPA^F_{bGPA}}{(1)\ GPA^S_{tGPA}}$ (7-2) $\dfrac{(7)\ GPA^F_{bGPA}}{(5)\ GPA^S_{bGPA}}$ (7-3) $\dfrac{(7)\ GPA^F_{bGPA}}{(9)\ GPA^S_{tDP}}$ (7-4) $\dfrac{(7)\ GPA^F_{bGPA}}{(13)\ GPA^S_{bDP}}$	(8) DP^F_{bGPA}	(8-1) $\dfrac{(8)\ DP^F_{bGPA}}{(2)\ DP^S_{tGPA}}$ (8-2) $\dfrac{(8)\ DP^F_{bGPA}}{(6)\ DP^S_{bGPA}}$ (8-3) $\dfrac{(8)\ DP^F_{bGPA}}{(10)\ DP^S_{tDP}}$ (8-4) $\dfrac{(8)\ DP^F_{bGPA}}{(14)\ DP^S_{bDP}}$
the top DP student	(9) GPA^S_{tDP}	(9-1) $\dfrac{(9)\ GPA^S_{tDP}}{(1)\ GPA^S_{tGPA}}$ (9-2) $\dfrac{(9)\ GPA^S_{tDP}}{(5)\ GPA^S_{bGPA}}$ (9-3) $\dfrac{(9)\ GPA^S_{tDP}}{(9)\ GPA^S_{tDP}}$ (9-4) $\dfrac{(9)\ GPA^S_{tDP}}{(13)\ GPA^S_{bDP}}$	(10) DP^S_{tDP}	(10-1) $\dfrac{(10)\ DP^S_{tDP}}{(2)\ DP^S_{tGPA}}$ (10-2) $\dfrac{(10)\ DP^S_{tDP}}{(6)\ DP^S_{bGPA}}$ (10-3) $\dfrac{(10)\ DP^S_{tDP}}{(10)\ DP^S_{tDP}}$ (10-4) $\dfrac{(10)\ DP^S_{tDP}}{(14)\ DP^S_{bDP}}$	(11) GPA^F_{tDP}	(11-1) $\dfrac{(11)\ GPA^F_{tDP}}{(1)\ GPA^S_{tGPA}}$ (11-2) $\dfrac{(11)\ GPA^F_{tDP}}{(5)\ GPA^S_{bGPA}}$ (11-3) $\dfrac{(11)\ GPA^F_{tDP}}{(9)\ GPA^S_{tDP}}$ (11-4) $\dfrac{(11)\ GPA^F_{tDP}}{(13)\ GPA^S_{bDP}}$	(12) DP^F_{tDP}	(12-1) $\dfrac{(12)\ DP^F_{tDP}}{(2)\ DP^S_{tGPA}}$ (12-2) $\dfrac{(12)\ DP^F_{tDP}}{(6)\ DP^S_{bGPA}}$ (12-3) $\dfrac{(12)\ DP^F_{tDP}}{(10)\ DP^S_{tDP}}$ (12-4) $\dfrac{(12)\ DP^F_{tDP}}{(14)\ DP^S_{bDP}}$
the bottom DP student	(13) GPA^S_{bDP}	(13-1) $\dfrac{(13)\ GPA^S_{bDP}}{(1)\ GPA^S_{tGPA}}$ (13-2) $\dfrac{(13)\ GPA^S_{bDP}}{(5)\ GPA^S_{bGPA}}$ (13-3) $\dfrac{(13)\ GPA^S_{bDP}}{(9)\ GPA^S_{tDP}}$ (13-4) $\dfrac{(13)\ GPA^S_{bDP}}{(13)\ GPA^S_{bDP}}$	(14) DP^S_{bDP}	(14-1) $\dfrac{(14)\ DP^S_{bDP}}{(2)\ DP^S_{tGPA}}$ (14-2) $\dfrac{(14)\ DP^S_{bDP}}{(6)\ DP^S_{bGPA}}$ (14-3) $\dfrac{(14)\ DP^S_{bDP}}{(10)\ DP^S_{tDP}}$ (14-4) $\dfrac{(14)\ DP^S_{bDP}}{(14)\ DP^S_{bDP}}$	(15) GPA^F_{bDP}	(15-1) $\dfrac{(15)\ GPA^F_{bDP}}{(1)\ GPA^S_{tGPA}}$ (15-2) $\dfrac{(15)\ GPA^F_{bDP}}{(5)\ GPA^S_{bGPA}}$ (15-3) $\dfrac{(15)\ GPA^F_{bDP}}{(9)\ GPA^S_{tDP}}$ (15-4) $\dfrac{(15)\ GPA^F_{bDP}}{(13)\ GPA^S_{bDP}}$	(16) DP^F_{bDP}	(16-1) $\dfrac{(16)\ DP^F_{bDP}}{(2)\ DP^S_{tGPA}}$ (16-2) $\dfrac{(16)\ DP^F_{bDP}}{(6)\ DP^S_{bGPA}}$ (16-3) $\dfrac{(16)\ DP^F_{bDP}}{(10)\ DP^S_{tDP}}$ (16-4) $\dfrac{(16)\ DP^F_{bDP}}{(14)\ DP^S_{bDP}}$