Student Selection and Retention at the University of Asmara, Eritrea

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1

Introduction and overview

1.1 The nature of the problem

Eritrea is a new nation in the horn of Africa with a population of approximately 4.3 million. The modern history of Eritrea dates back to the period of colonization, by Italy during more than 50 years (1890-1941) and later for about ten years under the administration of Great Britain. Eritrea was federated with Ethiopia in 1952 by United Nations' resolution. During the period 1952-1962, the Ethiopian regime undermined the federation and ultimately annexed Eritrea as one of the provinces of Ethiopia without the United Nations taking action to defend its own resolution or the people of Eritrea. In 1961, an armed struggle for liberation began and lasted for thirty years. On 24 May 1991 the thirty-year war concluded with a victory of the Eritrean people. In May 1993, Eritrea declared its independence following an internationally supervised referendum.

Under the colonial administrations, educational opportunities for Eritreans were very limited and focused on colonial cultures and social experiences. Policymakers generally agree that the most important factor in the process of socio-economic development is the training of all-round skilled manpower which involves appropriate skills, knowledge, attitudes, motivations and resourcefulness to bring about improvements in quality of production, services, technology and management. Accordingly, since independence, Eritrea has focused on the education of its people, which is a vital element in the process of rebuilding its shattered social and economic infrastructure.

1.1.1 Selection of students

Institutions of higher learning cater for high-level human resources that are needed by the economy of a new nation. The University of Asmara, which is open to only a small fraction of the Eritrean student population, has been the only institution of higher education in the country until very recently. As in the case of most countries, university entrance in Eritrea is based on a national examination. This seems to be the right approach provided that the examinations are fair in identifying the right students, and presupposes that the entrance examinations are prepared in an objective and scientific manner. Therefore, university entrance requirements need to be objectively set so that students with low ability levels, little potential and less motivation are not selected and students with high ability are not rejected.

The university entrance examination in Eritrea, known as the Eritrean Secondary Education Certificate Examination (ESECE), is administered at specified centers throughout the country at the same time annually. University entrance

examination is highly competitive and not all those who are eligible are selected. Besides being an entrance requirement for the university, ESECE results are also required for possible scholarship and fellowship awards on a competitive basis, for employment opportunities, for joining the Teachers' Training Program and other post-secondary education, as well as for some short term training. This renders the ESECE an important hurdle that the youth of the country must take to proceed to higher level jobs.

If the ESECE constitutes an important national examination, questions relating to the quality of the examinations ought to be addressed scientifically.

1.1.2 Attrition of students at the University of Asmara

Discontinuation by a student of his/her studies for any reason is called attrition. One might expect attrition to be exceptional, because during their stay at the university, students are exposed to uniformly good living conditions including free education, free boarding for students coming from outside of Asmara, free cafeteria services, and use of library facilities and books free of charge.

Although university entrance selection criteria are highly competitive – the top 6% to 12% as indicated by success in ESECE of the candidates who completed the Nation's Secondary Schools are admitted–, the attrition rate at the university is substantial at about 35% on average every year at freshman level. The attrition rate for both freshman and non-freshman remained fairly stable at about 35% and 15% respectively while the overall stayed at about 23% through the years 1991/92 to 1996/1997. Table 1 gives the attrition rate on a semester basis for entrants of the years 1993-1995 taken together. The total number of students is 1213. It can be inferred from these data that as the years progress from the second semester of the second year program, more balanced results are attained with a slight deviation during the second semester of the third year program.

Table 1 Attrition of students (cohorts 1993-1995)

Year	Semester	Number of students	Attrition	Attrition rate
1	1	1213	306	25.2%
	2	907	83	9.2%
2	1	830	81	9.8%
	2	767	22	2.9%
3	1	736	9	1.2%
	2	706	30	4.2%
4	1	555	6	1.1%
	2	500	0	0.0%

Both the high level of attrition (about 23% between 1991/92-1996/97) and the fact that this level is not reduced over time indicate the need to investigate the selection processes and students' performance at the university in order to be able to initiate improvement measures.

1.2 Research questions

There are several factors that can cause high attrition rates at institutions of higher learning in Eritrea. First, the entrance examinations may not be as good as they should be or there may be other factors that negatively influence the performance of students. In that case, ways and means of improving the selection procedure should be sought to make it more scientific and practical. Better methods of preparing examinations, better methods of screening and selection will then have to be introduced. Second, for the students who are admitted to the university, it may be possible to identify some factors that affect the performance of students in order to raise the students' retention rate. Accordingly, key problems to be addressed are:

(a) *To what extent does the ESECE test the ability of students in a satisfactory way?*

(b) *What are the important factors that affect the students' performance levels at the university?*

Addressing these key problems requires scientific research in the effectiveness of testing and in the analysis of students' performance factors. Since there are various possible combinations of electives in the ESECE taken by different groups of students, the study of question (a) concentrates only on the compulsory subjects, which are English and Mathematics.

It is hoped that the outcome of this study will make an important contribution towards all-round improvement in all administrative and academic spheres of activity and organizational matters.

1.3 Significance of the study

With the initiation of this study, it may be possible to identify suitable plans that not only help minimize the problems in the system but may also lead to higher academic standards at various levels in the Eritrean educational system. If this is accomplished, then capable students who join institutions of higher learning may be expected to be able to complete their university studies successfully and with little attrition. This will in turn reduce waste of resources earmarked for the development of skilled manpower. Consequently, it will also lead to better utilization of

expenditures on developing human resources. The conclusions and recommendations obtained from the study may be of much help to Eritrea and neighbouring countries with similar problems in their education systems for comparison purposes.

1.4 Structure of the study

The study has two main parts. Chapter 3 focuses on the internal structure of the ESECE. Chapters 4-6 are about the effects of ESECE results and other factors on performance at the university. In Chapters 4-6, the study focuses, respectively, on the first and second semesters of the freshman program, the first semester of the second year program, and the graduation of students. The main reasons for concentrating on these parts are the highly competitive selection and admission criteria, the relatively high attrition rates during the first three semesters at the university, and the importance given to the graduation of students as one of the primary output indicators of the university.

The review of the historical and institutional background information is based on secondary sources, descriptive in nature, whereas the studies on the entrance examinations and performance of students at the university are based on statistical analysis of data collected specifically for the purpose of this study.

Chapter 2 presents an overview of the historical and institutional background information of the educational system in Eritrea with focus on the University of Asmara. It also gives a description of students' admission profile, the university's programs and its implementation procedures, students' services, the recurrent budget, the achievements or outcomes obtained in terms of graduation of students, research publications, academic versus non-academic staff ratio, and success ratio of students.

Chapter 3 turns to the analysis of the ESECE. In this chapter, an attempt is made to get insight into the selection procedures of the university. The reliability and validity of the compulsory subjects in the entrance examinations of the year 1998 are investigated to check the internal consistency, a crucial aspect of whether or not the examinations did measure what they are supposed to measure. Some parts of the study related to internal validity are presented in Chapter 3, whereas predictive validity is discussed in Chapter 4.

Chapter 4 presents the investigation of the influence of the pre-university academic, admission and person-related characteristics on the performance of freshmen students by means of linear regression models.

Chapter 5 presents the analysis of some of the student-level characteristics that influence the Grade Point Average (GPA) of students in the first semester of their second year. Since the placement of students in various academic departments has been processed immediately after their completion of the freshman program, this

chapter also gives insight in the differences between academic departments. Multilevel analysis is used in order to gain insight in the differences between academic departments.

Chapter 6 deals with the investigation of some of the characteristics that influence the graduation of students. For this purpose, logistic regressions based on different sub-groups of variables and various categories of students are used.

Chapter 7 includes general and comprehensive discussions on the entire study and gives recommendations.

2

The historical and institutional background of the University of Asmara and its recent developments

As a general background to the entire study, this chapter describes the main characteristics of the University of Asmara and its recent developments. Next to information about the University's organization, facilities, and staff development, special attention is given to student admission and achievement, as these will be treated further in the next chapter. The chapter starts with a short account of the history of Eritrea and its consequences for education.

2.1 A brief overview of the history of Eritrea and its education

Eritrea is a semi-arid country with a total area of 12.1 million hectares and a population of approximately 4.3 million. The gross national income (GNI) per capita of Eritrea for the year 2001 was estimated to be about US$ 160 (World Development Indicators, World Bank, Washington D.C. 2003). Comparing this indicator with the average per capita income for other countries, Eritrea is considered among the poorest countries in the world. The average GNI per capita for sub-Saharan countries is US$ 460.

The modern history of Eritrea dates back to the Italian colonization (1890 – 1941). During the Italian colonial period the formal European style of education was introduced in Eritrea. The schools were meant for the Italians and the medium of instruction was Italian. The educational opportunities for Eritreans were very limited, providing them with Italian political, cultural and social experiences. In 1941, after the defeat of the Italians by the British, the country came under a British caretaker administration. The traditional British colonial policies were introduced, with the main objective of the British educational structure being to train Eritreans as functionaries in the administration, to force Eritreans into a wage economy and to stimulate the break-up of tribal solidarity.

Eritrea was federated with Ethiopia in 1952 by a United Nations resolution. During the period 1952-62, the Haile Selassie (King of Ethiopia) regime violated the terms of the federation and annexed Eritrea as the 14th province of Ethiopia in 1962. In this period, many new schools were opened in an attempt to advance education. The armed struggle for liberation of Eritrea began in 1961 and lasted for about 30 years. Approximately 65,000 Eritreans were killed and a much higher number were wounded and/or disabled.

As of 1963, the medium of instruction in the elementary schools was Amharic, the national language of Ethiopia. Many private schools were opened and

the number of students increased. However, the influence of the Ethiopian government on education remained dominant.

The war ended in May 1991. A referendum was conducted under UN observation in April 1993 in which the Eritrean people voted 99.8% in favor of independence. In May 1993, Eritrea was declared an independent state. After independence, Eritrea has been engaged in all-out efforts to rebuild its war-shattered social and economic infrastructure. One of the vital programs in the campaign for national rehabilitation has been in the field of education, which mainly focused on training skilled personnel for such understaffed vocations as teaching, law, medicine and administration. A rapid improvement in educational facilities has been achieved. Reports from the Statistics Department of the Ministry of Education indicate that the number of high schools increased from 19 to 43 between the academic years 1990/91 to 2000/01. The number of students in the high schools increased from 27,627 to 63,951 between the academic years 1991/1992 to 2000/2001. From the reports of the National Examinations and Assessment Department of the Ministry of Education, it can be seen that the overall percentage of youth joining high schools was about 55% in the years 2001 and 2002.

2.2 The University of Asmara

2.2.1 Historical background

The University of Asmara was, until very recently, the only institution of higher education in the country. The Registrar's office and university catalogues provide a description of the main points of the history of the University of Asmara. The University of Asmara was founded on December 20, 1958 as the "Holy Family" University Institute by the Missionary Congregation *"Piae Matres Nigritiae"* (Camboni sisters), with Italian as medium of instruction. At that time it was the second university in Ethiopia. The plan was to prepare students to earn the "Laurea" at one of the universities in Italy. The main objective of the university was to provide educational opportunities for Ethiopian youth while meeting the international standard of Education. In 1959, the university was recognized by the then Eritrean Government. In 1960, the university was recognized by the Superior Council of the Italian Universities ascertaining the international academic standard according to the Conventions of Geneva. In 1964, English was adopted as a medium of instruction in addition to Italian.

In 1968, with the aim of stimulating and encouraging private initiatives in the field of education to supplement the efforts and activities of the Government, the university was granted a charter. The university was established as "a body politic and corporate in name and deed, to have perpetual existence with a common seal which may be adopted, changed or varied at the pleasure of University of Asmara". In 1975, English was adopted as the sole medium of instruction. In 1977, the

university came under the umbrella of the Commission for Higher Education. The change of administration from a private university to a government institution resulted in an increase in the number of students. In 1990, due to loss of control in many areas of Eritrea, the Ethiopian Government dismantled the university, with its staff and movable property such as computers and books, and moved it to Ethiopia.

After Eritrean victory in the war of independence, in 1991, the university was re-established with an autonomous status by the Provisional Government of Eritrea. Concerted efforts were taken to rehabilitate, restructure and revitalize it as a center of higher learning and applied research. In the beginning, the university had to start its programs with no facilities at its disposal. It was in a start-up phase with severe shortages of facilities and staff.

According to the Office of the President of the University of Asmara, the university was re-established with the following objectives:

"(*i) The gathering and dissemination of knowledge (higher education) and the provision of training so as to generate the skills and know-how required for national reconstruction and socio-economic development.*

(ii) Enhancing the quality of higher education, expanding its scope and increasing its accessibility through a standard system composed of three integral Programs, namely, Regular, Extension and Correspondence.

(iii) Conducting basic, applied and developmental research involving joint efforts with both Eritrean and non-Eritrean institutions and scholars.

(iv) Spearheading the rehabilitation and development of Eritrea's human resources as the country is undergoing transition from the ravages of war to the task of peaceful reconstruction and development.

(v) Contributing to the restoration and improvement of Eritrea's ruined ecology through applied, developmental, agricultural and environmental research."

The University of Asmara resumed its academic work on October 10, 1991 with five faculties: Natural Sciences, Social Sciences, Agriculture, Law, and English. An evening extension program offering Bachelor of Arts degrees as well as undergraduate diplomas in the same subjects started functioning to supplement the regular four-year program.

Since the independence in 1991, the Eritrean society has been mobilized to construct the war-ravaged country, to build new political and social institutions, and to rehabilitate and develop the national economy. As in many other universities, the mission of the University of Asmara is the discovery, generation and dissemination of knowledge in the service of society. Therefore, the university has been expected

to contribute as much as possible to face these challenges. In order to achieve its goals, the university emphasized the need for reviewing the academic programs and the curriculum. To this effect, in 1992, a Standing Committee consisting of more than thirty representatives from the various departments of the university, ministries, and institutions was established. As an extension of that effort, again in the year 1992, the University of Asmara organized an International Symposium to revise its curricula, in which many Eritrean scholars living and working abroad participated. One of the first achievements in this direction is the introduction of the so-called Students National Service Program, where students spend one academic year before graduation to provide services to local communities. The main purpose of the program is to enhance students' understanding of local community needs, problems and development, and to participate in all capacities requiring the use of special skills developed in the university. The university's National Service Program is a national obligation as well as one of the university's requirements. In the future, the year of National Service will be incorporated into the university's curriculum to serve as an internship year in which students will be engaged in a well-defined, supervised and evaluated program of practical training after they complete their course work.

2.2.2 Establishment of linkage programs

Since 1995, a 10-year strategic plan has been in effect, the aim of which is to rebuild the University of Asmara. The main focus of the plan is on relevance and quality of education, and sustainability of the programs.

The issue of relevance of the university's education was tackled by making formal links between the university and the relevant Eritrean public and private sectors through the formation of a joint steering group. The functions of the steering group include identification of the problems of the public and private sectors, determination of the level of skill needed to realistically handle the problems, and drafting appropriate curricula aimed at developing the desired level of skills. The functions of the Committee further included coordinating and facilitating joint research efforts through freely sharing the information facilities and personnel, and serving as an internal quality control mechanism to regulate the functional standards of the various programs.

The building of local partnership was considered a prerequisite to the building of external partnership, intended to address the quality of education at the university. In this way a linkage model was set up, where each faculty has been linked to one or at most two advanced institutions in Europe, America, Australia, etc. In the opening address on the 30th graduation ceremony of the university, the President of the university paid special tribute to some institutional and development partners for contributing their facilities and experience. These include several universities in the Netherlands (among which Groningen), Sweden, Norway, Italy, the United States of America, Zimbabwe, and India.

External task forces consisting of senior professors from the linkage institutions have been involved in the external partnership. The University of Asmara, the local steering group, and the external partners define the goals based on the functions of the steering group described above. Visiting professors from the linkage institutions have been seconded to the University of Asmara for a duration of six months to two years. They assist the University of Asmara in teaching and problem identification in all spheres including research activities. In order to guarantee sustainability, a commercial farm was set up in the Faculty of Agriculture and Aquatic Sciences, as well as an industrial materials testing center in the faculty of Engineering. In addition, summer programs were organized to upgrade the skills of public and private employees.

The planning and management of the projects is based in Asmara through the assistance of the linkage institutions. The main purpose is to encourage the university to work on its own instead of entirely depending on linkage institutions.

2.2.3 Facilities

The University of Asmara has been underfacilitated for a long time, with respect to availability of teaching materials, classroom conditions, and student accommodation. Some specifics are given in this section.

Library and bookstore

The library has been suffering from a shortage of relevant reference books. The University of Asmara Library was founded in 1960 and accommodates about 400 readers. As a report of the library indicates, much attention towards its improvement was given during 1972/73 - 1998/99. In general, it could be said that the Library has been functioning with insufficient books, shortage of shelving and reading space, and lack of professional librarians. In 1990, when the university was dismantled and transferred to the southern part of Ethiopia, most of the basic library collections were also taken. In the year 2003, the library contains about 80,000 volumes.

The bookstore contains a number of books that are lent to students on a semester basis. Students can borrow textbooks from the center every semester free of charge. Whenever the number of books for a particular course is less than the number of students taking that course, two or more students are made to share a single book. In the years 1991 to 1994, basic textbooks were in an acute short supply with the ratio of students to a textbook being as high as 15:1.

Classroom conditions and laboratories

The congestion in the classrooms has been very severe. The number of students in the classrooms has exceeded the normal capacity of the lecture halls due to the increase of the student body. In general, the frequency and occupancy rates of the classrooms are high. The capacities of the laboratories are increased to

accommodate more students than the normal capacities. Three additional laboratories were constructed in the 1997/98 academic year. Recently, a new auditorium that can accommodate 300 students was built and new blackboards were installed in the classrooms.

The university has 24 classrooms on the main campus. Ten of these have an average normal capacity of about 70 students each. The remaining 14 have a normal capacity of only 30 students each. These classrooms now accommodate 100 and 55 students, respectively. Furthermore, there is one large classroom with a capacity of 100 students, which is to accommodate 140, and an auditorium with a capacity of 150 (now 200) students.

Student services

The student accommodations consist of dormitories, a cafeteria serving free meals to all students in the day program, and the university clinic where outpatient medical health services are provided to the regular students of the university. In the so-called Health Station student patients are examined, diagnosed and treated on a regular basis. If necessary, the Health Station also performs follow-ups, advises patients who need prolonged treatment, and arranges referrals for patients who require admission to more specialized hospitals.

Most of the dormitories were built for classroom use or other purposes. Dormitories have been provided only to the students coming from outside Asmara. Although new dormitories, which can accommodate about 1050 students, were constructed in the academic year 1997/98, the number of students in the day program reached 2948 while the capacity of the dormitories was less than 1300.

Table 2.1 Dormitory accommodation for day students

Academic Year	Male	Female	Total	Percentage housed
1991/92	608	151	759	45
1992/93	1300	150	1450	68
1993/94	626	122	748	33
1994/95	770	84	854	36
1995/96	757	84	841	32
1996/97	892	87	979	35
1997/98	1123	158	1281	43
1998/99	1242	184	1426	36
1999/00	1280	184	1464	35
2000/01	1300	180	1480	32
2001/02	1317	180	1497	27
2002/03	1328	180	1508	25

Source: Office for students' affair

Table 2.1 presents the growth that was attained over the period 1991/92 through 2002/2003 in terms of dormitory facilities to male students. These figures show an increase of about 200% in terms of dormitory residents. The academic year 1992/93 was an exception since classrooms were also used as dormitories to minimize problems. The female students' dormitory facility position remains stagnant. Because of the increasing number of students, additional dormitories are under construction. Furthermore, the table indicates a clear need for increased dormitory facilities because currently only about 29% of the total number of students are being accommodated.

2.2.4 Academic staff

The shortage of academic staff has been strongly felt in the university. Some departments had only two regular staff members. The shortage of academic staff has been one of the major constraints in the process of revitalization.

In the 1992/93 academic year, the university had only 13 Ph.D.s and 59 M.A.s or M.Sc.s as teaching staff.The situation has been improving over the years as is shown in Table 2.2. Furthermore, the table indicates that the number of teachers at the university has increased four times in the period between 1991/92 and 2002/2003, out of which an increase of fourteen times is observed in Ph.D. staff. Table 2.3 gives a detailed account of the academic staff by rank. Under the staff development program, the main emphasis has been on training academic staff members for Master's or Ph.D. degrees. With the exception of some staff members, most of them have been trained in linkage institutions. As a matter of principle, the majority of the staff members who have had the training opportunity have been

working on research topics related to Eritrea. There has been an initiative to grant short term research leaves or sabbatical leaves for academic staff members so that they could improve their research capabilities in linkage institutions or other universities. The training of staff members is expected to meet the demand for additional staff due to the growing number of academic departments and programs. With the increasing number of staff members, they will be expected to work not only in the teaching component but also in research. Since 1994, a total of 215 staff members have been sent for further training. By the end of 2001, and since 1994, the total number of trained staff was 23 at the Doctoral and 62 at Masters levels.

Table 2.2. Academic staff degrees from 1991 through 2003

Academic year	Academic staff		
	Ph.D.	M.A./M.Sc.	B.A./B.Sc.
1991/92	8	38	16
1992/93	13	59	15
1993/94	14	48	25
1994/95	31	57	29
1995/96	49	56	43
1996/97	62	56	65
1997/98	94	64	79
1998/99	95	67	69
1999/00	97	81	72
2000/01	102	77	67
2001/02	121	61	74
2002/03	112	74	58

Table 2.3 indicates that the number of female teachers at the university has increased four times in the period between 1991/92 and 2002/2003. The number of male teachers increased about four times during 1991/1992 through 2002/2003. Academic versus administrative staff ratio of about 1:5 in the academic year 1992/93 dropped to about 1:1.5 in the year 2002/2003. The ratio of female academic to female administrative staff increased slightly from 1:61 in the year 1991/92 but dropped to 0.8 in 2002/2003.

Table 2.3 Academic and administrative staff profile

Academic year	Academic staff					Administrative staff		Staff ratio		
	Professor	Lecturer	Assistant	Total				Academic: Administrative		
	Fem./Tot.	Fem./Tot.	Fem./Tot.	Female	Total	Female	Total	Female	Male	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(5):(7)	[(6)-(5)]:[(8)-(7)	(6):(8)
1991/92				3	62	183	305	1:61	1:2.1	1:4.9
1992/93	3/19	3/57	0/11	6	87	196	326	1:33	1:1.6	1:3.7
1993/94	4/19	2/45	2/23	8	87	192	303	1:24	1:1.4	1:3.5
1994/95	4/41	3/50	2/26	9	117	184	291	1:20	1:1.0	1:2.5
1995/96	4/44	5/61	7/43	16	148	77	159	1:5	1:0.6	1:1.1
1996/97	7/62	9/56	11/65	27	183	80	159	1:3	1:0.5	1:0.9
1997/98	11/101	5/59	10/77	26	237	80	154	1:3	1:0.4	1:0.7
1998/99	7/95	3/28	15/108	25	231	58	139	1:2	1:0.4	1:0.6
1999/00	7/97	4/81	14/72	25	250	192	331	1:7.7	1:0.6	1:1.3
2000/01	9/102	4/77	13/67	30	246	198	352	1:6.6	1:0.7	1:1.4
2001/02	10/121	5/61	16/74	31	256	198	352	1:6.4	1:0.7	1:1.4
2002/03	10/112	5/74	18/58	33	254	224	372	1:6.8	1:0.7	1:1.5

Source: Office of the Director of Administration of the university

An optimistic plan of action program is given in Table 2.4. There will be much progress in terms of quantity and quality of academic staff by the end of 2004. This progress will be achieved through recruitment of qualified staff, introducing training programs to upgrade the qualification of staff, and the introduction of relatively better salary scales as compared to employees in other institutions.

In addition to the recruitment of qualified and experienced staff members, graduate assistants have been recruited who are to be further trained and the dependence on expatriate academic staff will be minimized. They have also been assigned to assist in tutorials and laboratory work before they leave to continue their further studies.

Table 2.4 Projected academic staff by colleges (2004)

College	2004
Agriculture	46
Arts and Social Sciences	81
Business and Economics	83
Education	25
Engineering	46
Health Sciences	37
Law	24
Science	70
Total	412

Source: Research and Human Development Department of the University of Asmara

Furthermore, the university has been hosting senior academic staff members from linkage institutions from various countries. They have made important contributions, focusing on teaching and the identification of postgraduate research areas for junior academic staff.

One of the most important incentives for the retention of staff members is the salary level. The government has made a substantial salary increment to all employees in government institutions. The salary increment for university staff with Ph.D. qualifications has been relatively higher than that of other employees in other institutions with the same qualification. Table 2.5 indicates that there has been a substantial salary increment for all academic staff in the years 1995-1996 and 1997-

2001. During the years 1991 to 2001, the country was more stable as regards the currency. However, after 2001, the impact of war made vast differences in the rates of exchange and it was not suitable for analysis.

Table 2.5 Salary per academic rank (1991-2001)

Academic rank	Year					
	1991-1994		1995-1996		1997-2001	
	Nakfa	USD	Nakfa	USD	Nakfa	USD
Professor			3500	485	4300-4700	596-652
Associate Professor	1365	189	3200-3400	444-472	3800-4100	527-569
Assistant Professor	1200	166	2600-2930	361-406	3100-3550	430-492
Lecturer	650-850	90-118	1800-1880	250-261	2300-2400	319-333
Assistant Lecturer	---	---	---	---	2200	305
Graduate Assistant	500-600	69-83	800-1000	111-139	1500-1650	208-229

1 US$ is equivalent to 7.21 Nakfa.

2.2.5 Research

Lack of facilities and shortage of academic staff in some departments and their pre-occupation with teaching assignments have restrained the initiation of scientific research in the university. Lack of access to recent and relevant scientific journals has been another serious problem. The absence of post-graduate studies has also minimized the opportunity to do research. Although the university has planned for research to be intensified in the plan period 2000 to 2004, which would entail academic staff members being involved in both research and teaching, it appears that much emphasis is still given to the teaching component. An office was established in the year 1998 with the main aim of coordinating the research activities of the university. According to the report of this office, the major research themes that have been functioning are in GeoPhysics, Medicinal Plants, and Materials Science. The other research-related activities are the individual research projects conducted by graduating students as part of the graduation requirement. It has also been planned that staff members on study leave conduct their research in areas that have been deemed relevant to the needs of the society.

2.2.6 Sources of income

The major source of income of the university is formed by government budgetary allocations. The amount obtained is used to cover staff salaries, contractual obligations, maintenance and running costs. Currently, the university covers costs of boarding of all the regular students and provides accommodation to almost thirty percent of them. In Table 2.6, the government expenditure per student is given,

taking the year 1995 as base. The recurrent budgets in the various fiscal years were adjusted with regard to inflation. In 1995 and 1996, the currency was in Ethiopian Birr and it was equivalent to that of Nakfa of Eritrea until 2001. The student intake remained more or less the same over 1995 through 1997.

Table 2.6 Profile of government expenditure per student (1995-2001)

Year (t)	Number of students (1)	Annual Funding (Recurrent) (2)	Expenditure per student in Nakfa (3) = (2)/(1)	Index Numbers students (1995 base) (4)	Index numbers Funding (1995 base) (5)
1995	2600	6,871,280	2423	100	100
1996	2726	11,931,700	4377	105	174
1997	2663	10,646,940	3998	102	155
1998	3224	13,919,940	4318	124	203
1999	3912	14,913,920	3812	150	217
2000	4135	15,583,984	3769	159	227
2001	4628	17,791,023	3844	178	259

One US$ is equivalent to 7.21 Nakfa.

Comparing the index numbers in columns (4) and (5), it is clear that the trend in funding well matches the increase in student enrollment. In addition to the government budget allocations, NUFFIC in the Netherlands, the Italian Government, the World Bank, the UNDP, SAREC SIDA-Sweden, USAID-USA, DANIDA-Denmark, NORAD-Norway, and AUS-AID from Australia made substantial financial contributions to the University.

2.3 Academic programs and student admission

The University of Asmara used to include two different teaching divisions for the day and the evening programs, respectively. The entrance requirements and all other academic regulations were the same for both divisions. The day programs were planned for unemployed full-time students. The evening programs were mainly meant for employed students who were unable to pursue university studies earlier. In exceptional cases employed applicants could be enrolled in the day programs. Programs in both divisions lead to the Bachelor's Degree, Diploma or Certificate. Degree programs leading to the Bachelor of Arts, Bachelor of Science, or Bachelor of Law usually require 4 to 5 years of full-time study. The Diploma programs usually have a 2 to 3 year span of full-time study and Certificate programs require 1 year of full-time study. The study in the evening program normally takes twice as long as the day program study. Due to the shortage of staff and facilities, new

admission to the evening programs was terminated in the academic year 1994/95. The academic year consists of two semesters of sixteen weeks each. The first starts in September and ends in December. The five colleges, with a range of departments, used to prepare students for eleven degree and two diploma programs. Since 1992, several new departments and units have been established. In the 1998/99 academic year, the departments prepared students for 27 degree programs, 13 diploma programs and 6 certificate programs. This expansion in teaching programs has been made possible by the increase from 12 departments in 1998/99 to 31 in 1992/93.

Since the 1992/93 academic year, the students have been organizing some recreational programs and other extra-curricular activities such as drama, music, poetry and sports. The main purpose has been to help students understand the patterns of Eritrean society with a view to extending their scope of culture. In general, no adequate attention was paid to such activities.

Table 2.7 Current programs (as of 2002/2003 academic year)

College	B.A./B.Sc.	Diploma	Certificate
Science	Biology	-	-
	Chemistry	-	-
	Computer Science	-	-
	Geology	-	-
	Mathematics	-	-
	Marine Biology & Fisheries	-	-
	Physics	-	-
Social Sciences	Anthropology & Archaeology	-	-
	Geography	-	-
	History	-	-
	Political Science	-	Political Science
	Sociology & Social Works	-	Sociology & Social W.
	Statistics & Demography	-	-
Arts	English	-	-
	Journalism & Mass Comm.	-	-
Law	Law	-	Law
Business & Economics	Accounting	-	Accounting
	Business Management	-	Archives & Records
	Economics & Finance	-	Human Resource Mgt.
	Public Administration	-	Public Administration
	-	-	Project Management
Agriculture	Agricultural Engineering	-	-
	Animal Science	-	-
	Land Resource & Environment	-	-
	Plant Science	General Agriculture	-
Engineering	Civil Engineering	-	-
	Electrical Engineering	-	-
	Mechanical Engineering	-	-
Health Science	Clinical Laboratory Science	-	-
	Nursing	-	-
	Pharmacy	-	-
Education	Educational Administration	-	-
	Educational Psychology	-	-
	Biology	-	-
	Chemistry	-	-
	Mathematics	Mathematics	-
	Physics	Science Education	-
	English	English	-
	Geography	Geography	-
	History	History	-

Source: Statistics and programming office of the University

2.3.1 Student admission procedure

The University of Asmara centrally administers the Eritrean Secondary Education Certificate Examinations (ESECE). Both the University of Asmara and the Ministry of Education are represented in the ESECE board whose tasks are to provide guidelines for the routine activities of ESECE and to forward fresh initiatives with the aim of developing the center into a strong and competent institution. No educational experts from different areas are available to advise the Testing Center. The questions for the ESECE are set by the academic staff members, who are selected by the President of the University of Asmara.

In administering the ESECE, center representatives and invigilators have been assigned to conduct examinations in the various centers. The topmost officials to organize the examinations are the center representatives, and they are mainly University staff members. The invigilators are selected from the professionals at the University of Asmara, the secondary schools and other educational institutions. Examinations have been conducted at 28 centers, 13 in Asmara and 15 in other towns. The entrance examination, which usually lasts for three days, requires the candidates to take two compulsory examinations, English and Mathematics. Candidates also have to take at least three more elective subjects from Biology, Chemistry, Physics, General Science, Geography, History, Economics, Bookkeeping, Agriculture and general knowledge. All the tests consist of multiple-choice questions. A special examination in Arabic was started in 1994 for the subjects Biology, Chemistry, Physics, Geography, History, English, Mathematics, statistics, Arabic, philosophy and logic, and Islamic religion education. The examinations in Arabic are of the subjective (written) type. The English examination consists mainly of multiple-choice items. To minimize possible cheating during the examinations special seating arrangements of the candidates are planned ahead of time. The staff members of the Computer Unit or College of Engineering of the University handle scanning the answer sheets and converting the raw marks into grades. All the answer sheets for the multiple-choice type of questions are evaluated with a scantron.

Grade points are computed for Mathematics, English and three elective courses on a scale ranging from 0 to 4. The minimum GPA required for the selection of students varies from year to year. The raw marks are submitted to the President of the University, who, together with the Minister of Education, determines the cut-off points. Figure 2.1 depicts the development in the number of ESECE candidates and the number of admitted students from 1992 to 2002. A steep fall followed by a steady rise in the number of candidates taking the ESECE may be observed. Every academic year, the number of students taking the national examination or the University's entrance examination was at least 5000. The percentage of admitted students during the years 1992 to 1994 is less than 10%. However, an increase from about 10% to about 19% during the period 1995 to 2002 may be noticed.

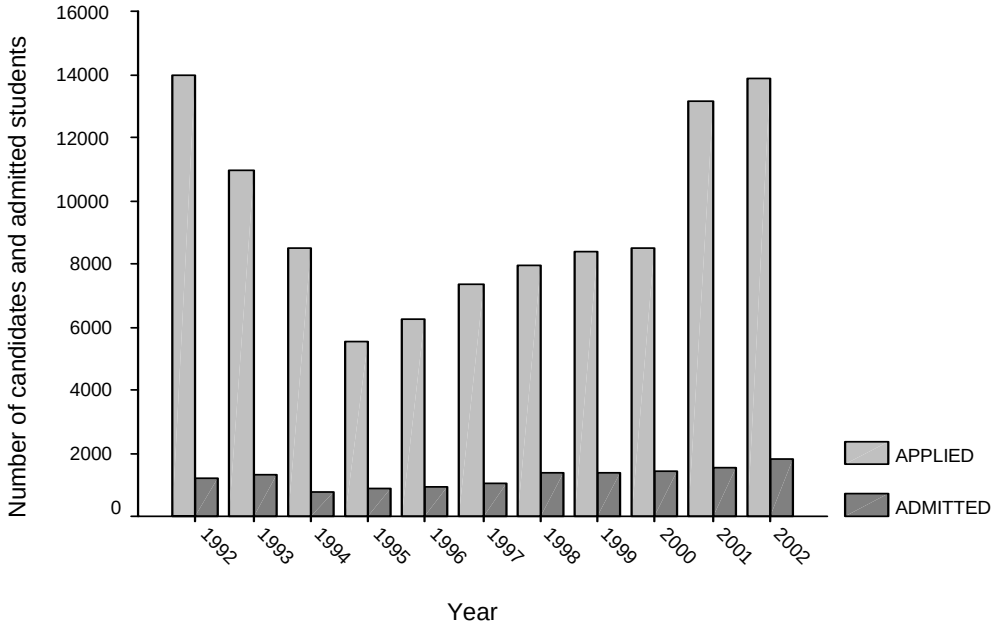


Figure 2.1 Number of candidates and admitted students (1992-2002)

In the year 1992, immediately after the liberation of Eritrea, the first ESECE was conducted in which ex-fighters as well as students from Sudan and Ethiopia took the examination. The number of ESECE candidates steadily declined during (1993-1994). However, there was an annual rise in the number of candidates from 1995 to 2002. This increase may be attributable to the establishment of more high schools and the return of many Eritrean refugees from other countries.

Scholarship awards

The University of Asmara implemented a program of Scholarship Awards to outstanding and needy students to pursue their studies without being hampered by financial constraints. The first objective of the scholarship award has been to encourage gifted female students to pursue their University studies without being hampered by financial considerations. The second objective was to encourage veteran students (ex-fighters) in their readjustment to University life. The third objective was to intensify the University's search for competent and meritorious students. All full-time students in the day program of the University with a semester grade point average of 2.5 and above at the University and in need of financial assistance can be considered for these scholarships. The orders of priorities are: female, veteran ex-fighters, and other students. One of the duties and responsibilities of the Scholarship Awards Committee is to ensure that no qualified applicants are excluded from availing themselves of the scholarship screening process. The second duty is to ensure that the University's opportunities for this scholarship reach the deserving students who are selected on the basis of equality.

Three different scholarship awards are available at present: the Memhir Emmanuel's Scholarship Award, World University Service Scholarship Award, and

Association of Eritreans for Peace and Democracy Scholarship Award. From 1994 to 1999, an amount of Nakfa 860,000.00 was awarded to 3164 deserving students chosen on a semester basis.

2.3.2 Student enrollment

Table 2.8 gives the numbers of students that entered the University of Asmara since 1991. There was an increase of about 152% in student enrollment in the academic years (1991-92) and (2002-2003). For female students in particular the number increased about four times during the academic years 1991/1992 through 2002/2003. The yearly enrollment of female students has been, on average, 11.5% as compared to the total number of students. However, there has been a slight increase in the proportion of female students from the academic years 1996/1997 to 2002/2003. Incentives such as less stringent admission criteria and scholarship awards were intended to encourage female students to pursue their studies at the University could be some of the motivating factors for this increase. Female students have been admitted with a grade point average of 0.2 lower than the male students since 1995 (grade points are computed on a scale of 4.0).

Table 2.8 Student enrollment

Academic year	Enrollment of students			
	Day		Evening	
	Female	Total	Female	Total
1991/92	195	1683	382	1259
1992/93	243	2141	286	1192
1993/94	254	2268	186	881
1994/95	298	2392	124	689
1995/96	274	2611	78	427
1996/97	242	2835	62	324
1997/98	365	2948	31	188
1998/99	531	3956	15	130
1999/00	592	4135	-	-
2000/01	661	4628	-	-
2001/02	739	5506	-	-
2002/03	773	5934	-	-

As regards the enrollment of students in the evening programs, a sharp decrease has been manifested since 1992/93. Taking into account the shortage of qualified staff, and inadequate teaching facilities, the University decided not to admit new students to the evening programs in order to maintain the standards in education.

Student-Staff ratio

Considering all Eritrean and expatriate academic staff members, as a report of the President of the University indicates, the student-staff ratio of some departments was as low as 5:1 during the start-up phase. However, in other departments it was as high as 109:1. As a matter of principle, as the departments stabilize, the University plans to attain a student-staff ratio of about 30:1 or at least 20:1. In the year 2001, the student-staff ratio ranged from 6:1 to 109:1 (taking into account staff on ground and on study leave). A careful interpretation and implementation of the use of student-staff ratio may be worth noting. If the student-staff ratio is very low, the departments will not function in a cost-effective manner, unless academic staff are involved in research or other productive activities. On the other hand if student-staff ratio is very high, the standard of education may be compromised. However, the University has already become conscious of this and has started taking care of both staff recruitment and development programs.

2.3.3 Student output

In Chapter 1, it was mentioned that the selection of students to the University has been highly competitive and about 6% to 10% have been allowed to continue their studies. At freshman level the attrition rate is at about 35% on average every year. The attrition rate for second year and above is about 15%. These indicate that the attrition at the University is very high. Table 2.9 gives the numbers of graduates in the various programs since 1991. It can be noted that the number of degree holders increased about eleven times (from 58 in 1991 to 620 in 1998). The number of degree graduates in the year 1998 is relatively low since the number of admitted students in the year 1994 was relatively low as shown in Figure 2.1. The growth picture with regard to female students is about 16 (in 1991) to 74 (in 2002). With respect to diploma holders an anti-climax type of situation is observed. This can be explained by the decrease in enrollment in the evening program as shown in Table 2.8. Table 2.9 also shows the initiation of the establishment of certificate programs. The table presented here is a summary of the extended tables B1-B3 in Appendix B.

Table 2.9 Number of graduates per college in Degree, Diploma and Certificate Programs, respectively

College/		1991-1995		1996		1997		1998		1999		2000		2001		2002		Total	
Department	Program	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T
Science	*Degree*	6	110	20	159	12	128	8	116	13	122	10	102	10	96	3	115	82	948
Art & Social	*Degree*	-	10	7	40	5	23	5	32	13	79	10	79	15	158	24	113	79	534
Sciences	*Diploma*	6	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	12
	Certificate	-	-	-	-	-	-	8	26	7	47	13	44	2	15	16	65	46	197
Business &	*Degree*	63	303	21	130	15	132	11	99	30	253	14	102	18	80	15	69	187	1168
Economics	*Diploma*	132	352	15	35	16	62	1	7	-	7	-	-	-	-	-	-	164	463
	Certificate	-	-	2	36	9	33	2	30	10	42	24	60	34	139	55	266	136	606
Law	*Degree*	-	-	-	-	-	-	1	27	2	36	1	18	2	19	3	19	9	119
	Diploma	23	144	5	24	-	-	-	-	-	-	-	-	-	-	-	-	28	168
	Certificate	-	-	-	-	-	-	-	-	13	54	-	-	-	-	1	47	14	101
Agriculture	*Degree*	1	20	8	94	3	83	8	51	4	62	3	44	4	44	8	48	39	446
&AquaticSc.	*Diploma*	-	-	-	-	-	-	-	-	-	-	-	-	4	15	-	20	4	35
Engineering	*Degree*	-	-	-	-	-	-	-	-	-	-	-	-	2	77	1	67	3	144
	Diploma	-	-	-	-	-	-	2	48	2	53	1	59	7	82	-	-	12	242
Health Sci.	*Degree*	-	-	-	-	11	36	-	-	-	-	4	28	1	19	6	59	22	142
	Diploma	-	-	-	-	-	-	-	-	-	9	1	14	1	15	5	10	7	48
Education	*Degree*	-	-	-	-	-	-	-	-	-	2	-	5	15	93	14	130	29	230
	Diploma	-	-	-	-	1	27	1	14	-	30	8	104	2	50	1	98	13	323
Total	*Degree*	70	443	56	423	46	402	33	325	62	554	42	378	67	586	74	620	450	3731
	Diploma	184	652	20	59	17	83	4	69	2	96	10	177	14	172	6	128	257	1436
	Certificate	-	-	2	36	9	33	10	56	30	143	37	104	36	154	72	378	196	904

Source: Statistics and Programming Office of the University

2.4 Discussion

In this chapter, it has become apparent that the University has been focusing entirely on teaching activities. The University has witnessed rapid improvement in terms of increasing the number of academic programs, the enrollment of students, increasing number of staff, and staff development programs. However, some major challenges remain that should be given due consideration.

The first important issue is the need to promote research activities in all academic and administrative departments of the University. With present technological advances and the rapid expansion of knowledge, the need of research to guarantee the relevance and quality of education is unquestionable.

Another point of continuing worry is the student admission procedure. The high attrition rate at the University makes the preparation and grading of examinations extremely important. The quality assessment of examinations is a permanent concern. This can be illustrated from the meetings of the Academic Senate and the resulting guidelines from the Office of the President of the University. In the year 1997, the Academic Senate, expressed its concerns regarding the way the University examinations were being conducted. The observations included that some examinations were too easy while others were too difficult. Some examinations represented only a small or narrow portion of the syllabus covered. Marking schemes varied a great deal between individual lecturers; a great deal of authority was left to the individual lecturer and a definition of what the marks represented was not clear. The need to maintain a uniform and standard procedure in the handling and management of examinations, thereby making it possible to monitor or regulate academic standards at the University or faculty or department level, was stressed. With the aim of handling examinations carefully and properly and recognizing the need to create a standardized system of conducting examinations, the office of the President of the University also distributed guidelines on examinations through its letter of 2 March 1998. Apart from rules for examination marking or weighting schemes, for durations of examinations, and for syllabus coverage, the guideline includes the establishment of departmental committees.

In the next chapter, the ESECE examinations for Mathematics and English will be investigated by means of a detailed analysis of their results.

3

Analysis of the 1998 English and Mathematics ESECE examinations

The main aim of this chapter is to examine the results of the examinations in Mathematics and English of the ESECE for the year 1998. The extent of their accurate functioning is studied. A second aim is to provide feedback with regard to the items that need to be revised and to give recommendations on the subject that may be improved. Taking into account the complex nature of the construction of tests, the grading system that is used, the University's current situation, and the data available, the following research question is formulated:

To what extent do the English and Mathematics examinations test the ability of students in a satisfactory way?

An answer to this question will be sought by first exploring the problem in some detail, in Section 3.1, and next by introducing several methods available for investigation of the performance of examinations in Section 3.2. These methods will be applied to data from English and Mathematics 1998 ESECE examinations in the third section. In the final section, a motivated answer to the research question will be provided.

3.1 Introduction

As mentioned in Sections 1.1 and 2.3, the University bases its admission on the highly competitive ESECE. It was shown in the previous chapter that, despite due consideration to education by the Eritrean government, the number of students who are admitted to the University is low: only about 10% of the candidates pass the ESECE, which means that the other 90% are not admitted to the University. This is due to poor results on the ESECE examinations, on which many candidates score less than 50% correct, especially in science subjects such as Mathematics and Physics. The results seem not to have improved over the past few years. Specific figures for the 1998 ESECE English and Mathematics examinations are given in Section 3.3.

Although various reasons, such as the curriculum, shortage of staff, teaching-learning facilities, and lack of motivation of students, could be given for this disturbing outcome, another possibility is that the examinations are suboptimal. This is not altogether unlikely, in view of the absence of professional training for the staff

members who prepare national examinations, and of mechanisms to minimize the probability of making erroneous decisions.

Therefore, the ESECE examinations require further attention. Two of them, Mathematics and English examinations are analyzed in depth in this chapter. Taking into account their severe consequences, tests should be evaluated in a scientific way. In this chapter well-known measures form classical test theory will be used for this evaluation. These measures include item difficulty, item-rest correlation, index of item discrimination, reliability, and several validity measures. Validity is one of the main considerations in the evaluation of an examination. An examination is said to be valid if it measures what it is supposed to measure. Item Response Theory (IRT) is not used since the assumptions made in IRT may be too strong for the data available. For the research questions considered here, classical test theory, a more global approach, is well-suited.

This is the first application of such an analysis for Eritrean education. This does not mean, however, that concern about the admission procedures of students to institutions of higher learning, is not an issue in other countries. On the contrary, many countries are in the process of developing and refining their test admission procedures. In the Netherlands for instance, the use of test ratings, such as theoretical basis and soundness of the test development procedure, norms, reliability, and validity, have been introduced with the purpose of informing test users about the quality of tests and giving feedback to test authors. Evers (2001b) found that the results of 18 years (1982-2000) of test ratings in the Netherlands show that there is an increase in test quality due to the update of the test data bank and the maintenance and revision of existing tests. Keeves (1994) notes that the approach and conduct of national examinations vary from one country to the next depending on the stage of development and the historical contexts of the respective countries, where reference points may differ between developed countries. This makes comparisons to or adaptations of procedures from different countries difficult. This point is even more severe in the case of Eritrea, not only a developing country, but also a country that declared its independence only recently. Therefore, the focus of this chapter is limited, aimed at initiating and encouraging future studies.

Due to the high number of candidates who take national examinations, in many countries mainly multiple-choice items are given. Multiple-choice tests have generally been recognized as an acceptable and useful type of examination, the underlying assumption being that multiple-choice items can measure both understanding and knowledge levels. Gronlund (1968) stated that the multiple-choice test is adaptable to most subject-matter content and can measure a variety of learning outcomes from simple to complex. Burton, Sudweeks, Merrill, and Wood (1991) noted that although multiple-choice tests can be used to measure a great variety of educational objectives, it is inappropriate to use poorly written test questions as a basis of evaluating student achievement since such questions give

scores of doubtful value. Haladyana and Downing (1998b) also described that the reliability and validity of a test decrease when irrelevant material is included in the item stem. They remarked that the extent to which students have achieved educational objectives could be determined using well-written multiple-choice test questions. According to Evers (2001a), studies indicate that, although there were negative attitudes towards tests for a short period of time, the positive attitude seems to prevail.

Since an examination is a measurement, it has uncertainty or errors, like any other test. Universities or other institutions that take decisions based on test results either accept or reject candidates' request for admission. The decision whether to accept or reject candidates based on tests is not an easy task. The consequences of rejecting candidates are of great concern to the individuals in particular and to society in general. The possible errors are to mistakenly reject students who are eligible for admission or to mistakenly accept students who are not eligible for admission. The decisions taken in conducting examinations and the consequences of such decisions are explained in Figure 3.1, which is taken from Nitko (1983).

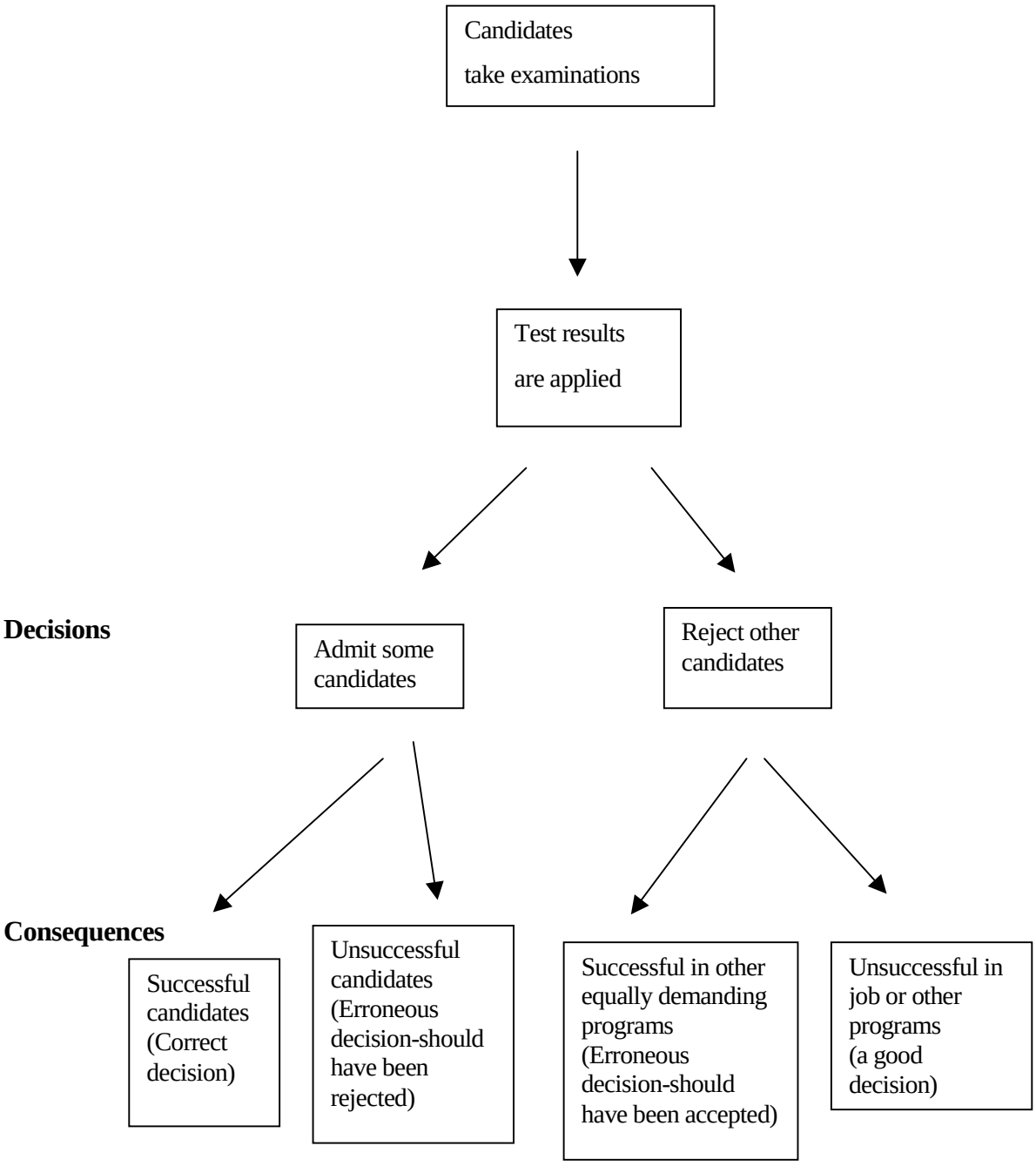


Figure 3.1. Examination decision diagram adapted from Nitko (1983)

Various authors have commented on the difficulty of examination quality assessment, due to the imperfect measurement of candidates' abilities on the basis of test grades. Evers (2001a) notes that one of the important points to be checked in order to assess the quality of a certain test is to examine whether or not the scoring system has been designed in such a way that errors can be avoided. Ebel and Frisbie (1986) stated that it has been a difficult exercise to use grades to measure students' achievement. It may not be possible to make grading easy, painless and to the satisfaction of many of the candidates. Assignment of grades is the most fundamental decision. Such decisions should not be made arbitrarily. McDaniel

(1994) indicated that a big shift in percentile or grade equivalent scores could be made with a small amount of change in the raw score.

The problem of grading was recognized by the University of Asmara, also in response to the concerns about the quality of the University examinations expressed by the Academic Senate. In 1997, the Academic Senate of the University of Asmara made several serious observations about the examinations: some were too easy, while others were too difficult; some represented only a small portion of the covered literature; marking schemes varied a great deal between individual lecturers; a great deal of authority was left to the individual lecturer; and the definition of the grades (A-F, corresponding to grade point 4-0, respectively) was not clear.

3.2 Methods

In this section the quality measures applied to the ESECE examinations are discussed. First, three types of validity are distinguished for the investigation of the quality of an examination. Next, several measures from classical test theory are introduced.

Predictive validity deals with the degree to which a test can predict future performance. One of the main aims of the ESECE is to select candidates who will be admitted to the University. Therefore the main focus is on how well the ESECE predicts a candidate's performance at the University.

Face validity is the expression of a logical relationship between the instrument used and its purpose. It is a measure of appearance, which indicates whether the instrument seems to measure the ability it is supposed to measure. This should be based on well-informed common sense or on expert opinion. In this study, it is defined as the attitude of the teachers about the overall preparation of the examination. Some of the high school teachers and University lecturers of the respective subjects under study were asked to express their evaluation of the level of difficulty and clarity of the Mathematics and English examinations for the year 1998.

Content validity is a judgment as to whether the set of items gives a balanced representation of the different parts taught in the curriculum. It is a study of the test items to investigate whether the test represents a reasonable sample of the relevant content. This approach is used to check whether the materials covered in the high schools were fairly reflected in the test. This is done by comparing the number of periods/hours allotted to the different sections in the subjects (based on the curriculum) with the corresponding number of items in the tests.

Item difficulty, a concept from classical test theory, denoted by p_i, is defined as the proportion of candidates who answer an item correctly. Therefore, somewhat rather counter-intuitively, the higher the item difficulty, the easier the item is.

Under a binomial distribution assumption, the item variance is given by $\sigma^2 = p_i \times q_i$ where $q_i = 1 - p_i$. That means, $\sigma^2 = p_i \times (1 - p_i)$, which is a polynomial with its maximum 0.25 at $p_i = 0.5$.

The *item-rest correlation* is defined as the correlation between an item and the total score without this item. It is used to select items with relatively large correlation values. If the set of items provides a consistent test of a given ability of the examinees, these correlations should be high. Verstralen, Bechger, and Maris (2001) noted that the use of item-rest correlation is preferred to item-total correlation, which is usually high since it includes the item itself.

Traub (1994) noted that, in general, it is desirable to achieve an increase of reliability without an increase of test length. This can be achieved by only including items with a good item-rest correlation. An item is labeled as bad if its inclusion reduces the internal consistency of the examination. It is found that including items with item-rest correlations less than 0.2 has a negative effect on the reliability coefficient of the scale. When these items are deleted the reliability coefficient of the scale formed by the remaining items increases.

Following Crocker and Algina (1986), the concept of *index of item discrimination, D(i)*, is introduced to evaluate the power of an item to discriminate between poor and good students. To this purpose, two groups of examinees are formed, an upper (about 27%) and a lower (about 27%) class, depending upon the total scores they earned for the ESECE tests of Mathematics and English separately. Then the item difficulties denoted by the probabilities $p_u(\text{i})$ and $p_l(\text{i})$ respectively are computed for the upper and lower classes of the i^{th} item. The index of item discrimination is defined as $D(i) = p_u(i) - p_l(i)$. If $D(i) > 0$, then the item discriminates in favor of the upper group, but if $D(i) < 0$, then it discriminates in favor of the lower group, which is counter to the purpose of including the item in the test. The following operational rule is suggested based on the rationale explained above (Ebel 1965, and Crocker and Algina 1986).

1. If $D(i) \geq 0.40$, the item is satisfactory.
2. If $0.30 \leq D(i) < 0.40$, little or no revision of the item is required.
3. If $0.20 \leq D(i) < 0.30$, revision of the item is necessary.
4. If $D(i) < 0.20$, the item is to be eliminated or should be thoroughly revised.

Reliability of a test scale formed by a set of items is defined as the ratio of the true score variance to the observed score variance, based on the model assumption that the observed score is the sum of the true score and a random error. It is a measure of internal consistency or homogeneity based on correlation, which is used to check whether items measure the same concept. Hence, a test is said to be reliable if it measures true scores accurately. Low reliability coefficients indicate that observed

scores are relatively unstable (McDaniel, 1994). The most used method used to assess reliability is Cronbach's alpha.

The correlations between the subtests in the various subjects under discussion are considered for the subjects separately. McDaniel (1994) describes that the instruments used by researchers in estimating the correlation between two scores may result in underestimation due to imperfect reliabilities. In order to estimate the correlation between two scores without the errors of measurement, researchers frequently correct for attenuation due to unreliability in the following way. Let X_1, X_2 be the observed scores, and T_1, T_2 the corresponding true scores. Then the *correlation for attenuation* is given by:

$$\rho(T_1, T_2) = [\rho(X_1, X_2)]/[r_1 \times r_2],$$

where r_1 and r_2 are the square roots of the reliabilities of the two measures (i.e. $r_1 = \sigma T_1 / \sigma X_1$ and $r_2 = \sigma T_2 / \sigma X_2$, where σ denotes the standard deviation). This formula yields a consistent estimator for the correlation between the true scores. True score correlation is a more meaningful estimated parameter than observed score correlation. However, the attenuation-corrected correlation has the disadvantage that it is a more unstable estimator than the correlation of the raw scores; in some cases it can even become larger than 1, in which case the value must be truncated to 1. Such results are possible, since the coefficients in the denominator of the attenuation formula may be influenced by certain sources of error, while the coefficients in the numerator are not influenced by such errors, and vice versa. Sireci, Thissen, and Wainer (1991) showed that if subtests are not dealt with explicitly, the reliability could be overestimated. However, the present study is aimed at finding a rough estimate of the reliability coefficient of the examination in order to provide a preliminary guidance in the preparation of future tests that may be expected to be a more refined test format.

3.3 Results

All candidates who took English and Mathematics examinations in the year 1998 are considered for the study. For English, Algebra and Geometry, and Algebra and Commercial Mathematics, data are available for 7948, 7412, and 432 candidates, respectively. For candidates in the natural science and arts streams, the Mathematics examination is composed of Algebra and Geometry and for those from the commercial stream it is composed of Algebra and Commercial Mathematics. The data were collected from the ESECE office. For each item, the candidates' answers - correct or wrong – were recorded. The English examination consists of 80% multiple-choice and 20% subjective type of questions. This study considers the 80 multiple-choice questions only. The examinations of Mathematics contain only multiple-choice questions. The first 35 questions formed the Algebra section and

they are the same for all students. The last 15 items are on Geometry for the first group, and on Commercial Mathematics for the second.

In Section 3.3.1, descriptive statistics are employed to describe the distribution of scores and the grade categories, as well as of item difficulties and item-rest correlations. Next, validity measures are investigated in Section 3.3.2. In Section 3.3.3 the indices of discrimination are computed and analyzed. The reliabilities of the examinations and their subtests are presented in Section 3.3.4, before and after the deletion of 'bad' items (identified in Section 3.3.3). Finally, in Section 3.3.5, the impact of the deletion of these bad items on the examination grades is investigated.

3.3.1 Distributions of grade scores, item difficulties, and item-rest correlations

For comparability purposes, all the results in the Mathematics and English examinations are converted to a scale of 100, with 0 corresponding to all false and 100 to all correct.

In Table 3.1 some general descriptive measures for the three examinations are given.

Table 3.1: Descriptive measures for the ESECE examinations

	Mean	Median	Mode	Standard deviation	Range
English	44.8	43.75	36.25	14.66	1.25 –100
Algebra and Geometry	35.44	32	24	17.38	0 – 100
Algebra and Commercial Maths	30.06	26	22	13.61	6 – 88

The scores of the students taking the Algebra and Geometry examination have a wider range and a larger variance than the scores of the Algebra and Commercial Mathematics candidates. This may be due to the fact that these data concern 7412 examinees, whereas only 432 students took the Algebra and Commercial Mathematics examination. At high school level, students who aim at joining courses in the natural sciences and arts stream have probably more ability in, and concentration on Mathematics as compared to those who opt to go to the commerce section.

The histograms of the distribution of scores of the examinations for English and for Algebra and Geometry for the year 1998 are given in Figure 3.2. The histogram for Algebra and Commercial Mathematics with far fewer candidates, not shown here, resembles the shape of the histogram of the Algebra and Geometry examination scores.

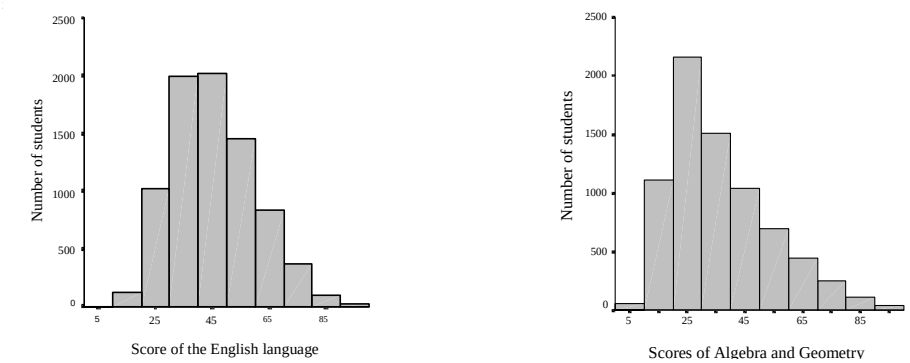


Figure 3.2 Histograms of the distribution of scores for the examinations of English and of Algebra and Geometry (1998)

From both Table 3.1 and Figure 3.2, it can be observed that the exam scores are skewed to the right, with the distribution of the Mathematics scores being much more skewed. This leads to the poor results with more than half of the students scoring less than 50% (see also Table 3.2).

Table 3.2 shows the grade distribution of the candidates by subjects. Based on the scores earned in the examinations, corresponding grades, ranging from 0 to 4, were assigned. The letter grades A, B, C, D and F correspond to the grade points 4, 3, 2, 1 and 0, respectively. It can be observed that more than 60% of the candidates earned grades below the middle grade C in the English examination, whereas these percentages are 79% and 89% for Algebra and Geometry, and Algebra and Commercial Mathematics, respectively.

Table 3.2 Score intervals and percentage of students by grade category for the ESECE (1998)

Subject	Number of candidates	Score interval out of 100	Grade category	Percentage by grade category
English	7912	≥ 75	A	4
		65-74	B	8
		50-64	C	27
		40-49	D	27
		≤ 39	F	34
Algebra & Geometry	7387	≥ 75	A	3
		65-74	B	4
		50-64	C	14
		40-49	D	14
		≤ 39	F	65
Algebra & Commercial Mathematics	438	≥ 75	A	1
		65-74	B	2
		50-64	C	8
		40-49	D	10
		≤ 39	F	79

Source: Consultancy, training and testing center of the University

A frequency table for the distribution of proportions of correct responses, referred as item difficulties, for the English and Mathematics examinations of the ESECE, for the year 1998 is given in Table 3.3. The item difficulties for all items are given in Appendix C.

The item difficulties all are less than or equal to 0.9, 0.7, and 0.6 for the English, Algebra and Geometry, and Algebra and Commercial Mathematics examinations, respectively. The distribution indicates that the examination of Algebra and Commercial Mathematics consisted for large part of difficult questions. Compared to the other two examinations, the English examination consisted mostly of items with medium difficulty.

Table 3.3 Frequency distribution of the item difficulties for the English and Mathematics examinations

Item Difficulty	Number of items (total)		
	English (80)	Algebra and Geometry (50)	Algebra and Comm. Maths (50)
0.0	1	0	0
0.1	1	0	1
0.2	10	10	16
0.3	12	17	19
0.4	17	12	9
0.5	12	8	4
0.6	15	2	1
0.7	7	1	0
0.8	4	0	0
0.9	1	0	0
1.0	0	0	0
Mean	0.45	0.35	0.30

The examinations of Algebra and Geometry, and Algebra and Commercial Mathematics have 35 items in common, of which the final two concern statistics. A comparison of the item difficulties of each of the first 33 items show that students who took Algebra and Geometry score consistently better than those who took Algebra and Commercial Mathematics, which leads to higher individual mean scores as well. For the last two items, items 34 and 35, which are questions about statistics, the Algebra and Commercial Mathematics examinees scored better.

The correlations of every item with the rest of the items are determined in order to assess the internal consistency of the examinations. Some of these item-rest correlations appear in Tables 3.4 through 3.7. The item-rest correlations for all items are given in Appendix C. A short summary is given here.

For the items of the English examination, the item-rest correlations range from -0.07 to 0.49, with 20 items having an item-rest correlation lower than 0.2. The corresponding results of the Algebra and Geometry and Algebra and Commercial Mathematics examinations are: range 0.03-0.55, and –0.10-0.51, respectively, with 10 and 18 items, respectively, having an item rest correlation lower than 0.2. The numbers of items with item-rest correlation less than 0.15 for English, Algebra and Geometry, and Algebra and Commercial Mathematics are 14, 7, and 14, respectively.

3.3.2 Validity

Unfortunately, it was impossible to link the examination data to the later performance of the candidates, which means that it was impossible to study the predictive validity of the examinations.

Face validity

For the study of the face validity of the English examination, 25 high school and University teachers responded to a questionnaire about the quality of the items. For the examinations of Algebra and Geometry, and Algebra and Commercial Mathematics examinations, 27, respectively 24 teachers participated in the questionnaire.

The English examination consists of several subsections. With the exception of a section on paragraph writing with essay-type questions, the examination contained seven subsections with multiple-choice questions, namely: Reading comprehension 1, Grammar in context 1, Sentence in comprehension, Structure and usage, Grammar in context 2, Grammar in context 3, and Reading comprehension 2. Several reading passages were provided for the sections of reading comprehension and grammar in context. Among the subsections on grammar in context, all ten items from the first subsection were presented to the teachers regarding the clarity or vagueness of the items. The response of the teachers was coded as clear (1), or vague (0). The proportions of teachers finding the items clear are given in Table 3.4, together with the item difficulties and item-rest correlations.

Table 3.4 Item difficulties, item-rest correlations and proportions of teachers' opinions of the 10 items of the Grammar in context 1 subsection of the 1998 English ESECE examination.

Item	Item difficulty	Item-rest correlation	Teachers' opinion		
			Proportion item is clear		
			All teachers	University	High school
Q25	0.10	0.00	0.63	0.40	0.68
Q16	0.20	-0.07	0.33	0.60	0.26
Q24	0.22	0.35	0.75	0.80	0.74
Q23	0.25	-0.07	0.54	0.80	0.47
Q22	0.45	0.29	0.58	0.80	0.53
Q18	0.46	0.30	0.58	0.60	0.58
Q17	0.55	0.42	0.92	1.00	0.89
Q21	0.55	0.32	0.83	1.00	0.79
Q19	0.63	0.24	0.92	1.00	0.89
Q20	0.65	0.34	0.88	1.00	0.84

Items 16 and 23 have the lowest percentages of high school teachers rating them as clear, 26% and 47%, respectively. Their item difficulties are 0.20 and 0.25; the corresponding item-rest correlations are low, both -0.07. Item 16 was the item that was rated least clear by the high school teachers. Item 25 was rated lowest by the University teachers, of whom only 40% claimed that the item was clear; the item difficulty is 0.10 and the item-rest correlation is 0.0. It may be interesting to note that as the item difficulties increase, the percentages of respondents from the University who claimed that the items are clear also tend to increase. With the exception of item number 16, the average ratings for the clarity of the items by the University staff were higher than that of the high school teachers. The item difficulties and the item-rest correlations are positively correlated.

As a second part of the face validity study, nine items from the other four subsections of the English examination were selected with varying levels of difficulty. From both the Mathematics examinations, also nine items with different levels of difficulty were selected. For each of these three sets of nine items, the opinions of the teachers of these subjects were asked with respect to the difficulty of these items for poor and for good students. The answers were coded as very easy, easy, medium, difficult, and very difficult, which were dichotomized by joining the categories difficult and very difficult as well as the categories easy and very easy. The medium category was left out. In Tables 3.5 through 3.7 the results of these analyses are presented, including the item difficulties and item-rest correlations. In all analyses, the responses of the teachers were in reasonable agreement with the

corresponding item difficulty level and the lowest item-rest correlations. The item difficulties of the six most difficult items of the nine selected from the English examination (31, 40, 48, 46, 47 and 50), presented in Table 3.5, range from 0.47 to 0.85. Their item-rest correlations range from 0.26 to 0.65.

Table 3.5 Item-difficulties, item-rest correlations, and teachers' opinions of nine selected items of the 1998 English ESECE examination.

Items	Item difficulty	Item-rest correlation	Teachers' opinion			
			Poor students		Good students	
			% difficult	% easy	% difficult	% easy
Q38	0.19	0.23	58.3	12.5	0.0	79.2
Q34	0.22	0.10	95.8	0.0	16.7	50.0
Q39	0.23	0.41	62.5	4.2	4.2	83.3
Q31	0.47	0.49	75.0	8.3	0.0	91.7
Q40	0.55	0.45	56.0	12.0	0.0	91.7
Q48	0.56	0.43	75.0	4.2	0.0	87.5
Q46	0.65	0.65	28.0	24.0	4.3	95.7
Q47	0.71	0.31	66.7	12.5	0.0	96.0
Q50	0.85	0.26	41.7	8.3	0.0	96.0

The percentage of staff members who claimed that these items were easy for the good candidates ranges from 87.5% to 96%, whereas there was almost no one who claimed that the items were difficult for the good students. In contrast, 4.2% to 24% of the teachers claimed that the items were easy for the poor students, and 28% to 75% thought the items to be difficult for them. For the three easiest items the opinions of the teachers with respect to the poor students are similar, whereas fewer of them rate them as easy for the good students. Item 34 is thought to be most difficult, both for poor students (95.8%) and for good students (16.2%).

With respect to the Algebra and Geometry examination, presented in Table 3.6, there is a clear distinction between items 34, 48, and 50 on the one hand, and 2, 3, 16, 20, and 41, on the other hand. Items in the second group have higher item difficulties and higher item-rest correlations, and are found by the teachers to be easy for good students whereas for the poor students, 14.8% to 25.9% of the teachers find them easy and 22.2% to 40.7% find them difficult. These can be considered good items. In contrast, the items in the first group have low item difficulties and low item-rest correlations, only 66.7 to 77.8 of the teachers find them easy for good students, and 70.4 to 85.2 of the teachers find them difficult for poor students. Item 7 is an intermediate case.

Table 3.6 Item-difficulties, item-rest correlations, and teachers' opinions of nine selected items of the 1998 Algebra and Geometry ESECE examination.

Items	Item difficulty	Item-rest correlation	Teachers' opinion			
			Poor students		Good students	
			% difficult	% easy	% difficult	% easy
Q48	0.16	0.12	85.2	3.7	11.1	70.4
Q50	0.16	0.06	81.5	11.1	3.7	66.7
Q34	0.20	0.03	70.4	3.7	3.7	77.8
Q7	0.46	0.33	85.2	0.0	0.0	74.1
Q41	0.46	0.47	40.7	14.8	3.7	96.3
Q20	0.49	0.46	40.7	18.5	0.0	100
Q2	0.57	0.38	29.6	25.9	0.0	100
Q16	0.64	0.37	22.2	25.9	0.0	100
Q3	0.65	0.36	29.6	25.9	0.0	100

In Table 3.7 the pattern of item difficulties, item-rest correlations and teachers' responses to the Algebra and Commercial Mathematics examinations is similar to that of Algebra and Geometry in Table 3.6.

Table 3.7 Item-difficulties, item-rest correlations, and teachers' opinions of nine selected items of the 1998 Algebra and Commercial Mathematics ESECE examination.

Items	Item difficulty	Item-rest correlation	Teachers' opinion			
			Poor students		Good students	
			% difficult	% easy	% difficult	% easy
Q46	0.14	0.08	62.5	12.5	0.0	91.7
Q30	0.15	-0.10	70.8	8.3	12.5	66.7
Q34	0.24	0.09	75.0	4.2	8.3	75
Q20	0.42	0.38	41.7	8.3	0.0	100
Q47	0.44	0.17	95.8	0.0	12.5	54.2
Q2	0.48	0.26	29.2	20.8	0.0	100
Q16	0.50	0.31	33.3	33.3	0.0	100
Q3	0.54	0.40	37.5	25.0	0.0	100
Q45	0.61	0.24	33.3	12.5	0.0	87.5

Content validity

To study the content validity of the ESECE examinations, the composition of the set of items with respect to the different topics should be compared to the attention devoted to these topics in the curriculum.

The main objective of the English curriculum has been to develop the students' listening, speaking, reading and writing ability. In most parts of the textbooks, reading paragraphs are provided. From these reading paragraphs, topics related to grammar, structure and usage, listening, and writing and vocabulary, were included. It was, however, not possible to determine the time allotted to the different subsections in the examination. In general, it can only be said that all subsections covered by the items in the English examination were treated in the learning and teaching process.

For the Mathematics examinations, more information is available. Table 3.8 gives information on the time allotted (i.e., number of periods assigned to each topic), up to 1998, to all topics taught in the senior high school curriculum (grades 8 through 11), and the distribution of items to these topics in the examination of Algebra and Geometry. The expected number of questions is proportional to the time.

Table 3.8 Distribution of the topics and the corresponding number of items for the 1998 ESECE examination of Algebra and Geometry

Topic	Time allotted* Grade					Expected Number of Questions	Number of Items in Exam.
	8	9	10	11	Total		
Solving equations and inequalities	73	30	0	0	103	7	11
Relations and functions	0	65	72	0	137	10	6
Trigonometry	30	0	0	36	66	5	9
Logarithms	21	6	6	0	33	2	5
Statistics	0	0	0	54	54	4	4
Geometry	35	41	72	60	208	15	15
Proportions	15	0	0	0	15	1	0
(Ir)rational exponents	24	33	0	0	57	4	0
Sequences and series	0	0	36	0	36	3	0
Total	198	175	186	150	709	50	50

* The time allotted is given in lecture hours or periods (1 lecture hour=1 period=40 minutes).

From Table 3.8 it can be observed that the topics Solving equations and inequalities, Trigonometry, and Logarithms were given more weight in the examination as compared to the time allotted in the curriculum. On the other hand, the topic Relations and functions was given less weight in the examination in relation to the

time allotted in the curriculum. The topics Sequences and series, and Rational and irrational exponents were not considered in the examination although these topics made up about 14% of the curriculum of Mathematics.

Another way of evaluating the content validity would be to consider only the curriculum taught in the last two grades, 10 and 11. In that case, no question should have been included from the topic Equations and inequalities, as this was taught in previous grades. However, 22% (11 items) of the examination consisted of items from the topic on Equations and inequalities. On the other hand, the number of items from Statistics, entirely taught in grade 11, would then be considered as underrepresented in the examination. Similarly, the topic Relations and functions would still be underrepresented. The portions on Logarithms would be regarded as getting more emphasis in the examination compared to the time allotted to them in the curriculum. The topic Sequences and series was not given any weight in the examination although it received 10% of the allotted time in grades 10 and 11. The portions on Geometry then also seem to be given less weight in the examination. The curriculum of Algebra and Commercial Mathematics is similar to that of Algebra and Geometry except that the topic on Geometry is replaced by Commercial Mathematics. Again, if only grades 10 and 11 are considered, the portion on Commercial Mathematics is underrepresented in the examination.

Summarizing the findings about validity, it can be said that the overall face validity of the ESECE examinations, as judged by the high school and University teachers, is reasonably good. The content validity of the English examination could only be evaluated superficially, yet seemed to be fair as well. The content validity of the two Mathematics examinations seems to give rise to most criticism. Some rather large discrepancies between time allotted in the curriculum and weight given in the ESECE examinations were observed. It was not possible to investigate the predictive validity.

3.3.3 Indices of discrimination, and relation with item difficulties and item-rest correlations

Based on the methodology presented in Section 3.2, an upper and lower class of examinees is formed. Next, values for p_u and p_l for the items of English and Mathematics examinations in the year 1998 are calculated, and thus the indices of item discrimination, or *D(i)* values, can be computed. The distribution of these indices is given in Table 3.9.

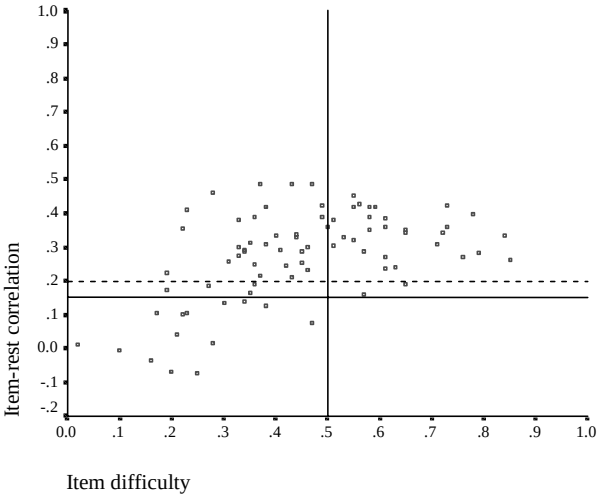
Table 3.9 Distribution of indices of item discrimination of the 1998 ESECE examinations

Examination	% of items with			
	$D(i) < 0.20$ bad	$0.20 \leq D(i) < 0.30$ revision necessary	$0.30 \leq D(i) < 0.40$ no revision required	$D(i) \geq 0.40$ satisfactory
English	17.5	11.25	23.75	47.5
Algebra and Geom.	16	10	16	58
Algebra and Commercial Maths	24	22	26	28

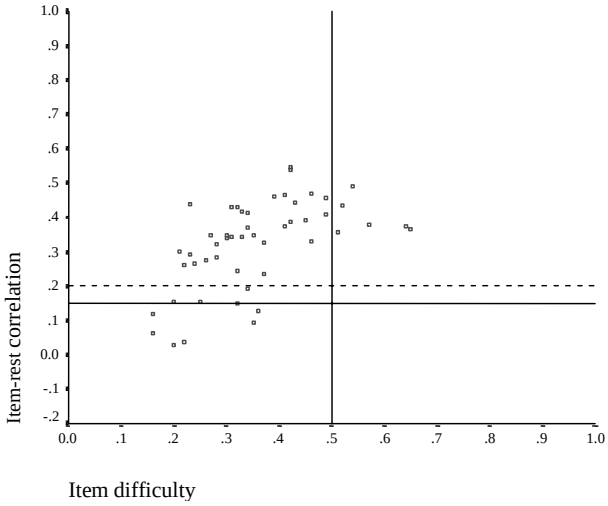
The percentages of items to be deleted or thoroughly revised for the subjects of English, Algebra and Geometry, and Algebra and Commercial Mathematics are 17.5%, 16% and 24%. The percentages of good items are 47.5, 58% and 28%, respectively. Lowering the criterion of a good item to an index value of at least 0.30 improves especially the number of acceptable items for the Algebra and Commercial Mathematics examination.

Tables of the indices of item discrimination of all three examinations are given in Appendix C, together with their item numbers and item difficulties. They contain the data on which the scatterplots given in Figures 3.3 and 3.4 are based. Figure 3.3 shows the relationships between item difficulty and item rest-correlation for the three examinations; Figure 3.4 shows the relationship between item difficulty and index of discrimination. Figure 3.3 confirms the finding in Table 3.2 that the item difficulties of the two Mathematics examinations are lower than of the English examination. Most of the items with item-rest correlations less than 0.2 and even less than 0.15 (the dotted, respectively solid, lines in the figure), have item difficulties lower than the corresponding overall mean item difficulties in the examination (0.45, 0.35, and 0.30, not shown in the figure). Some of these items were also identified as vague by the teachers (cf. Tables 3.4-3.6).

English



Algebra and Geometry



Algebra and Commercial Mathematics

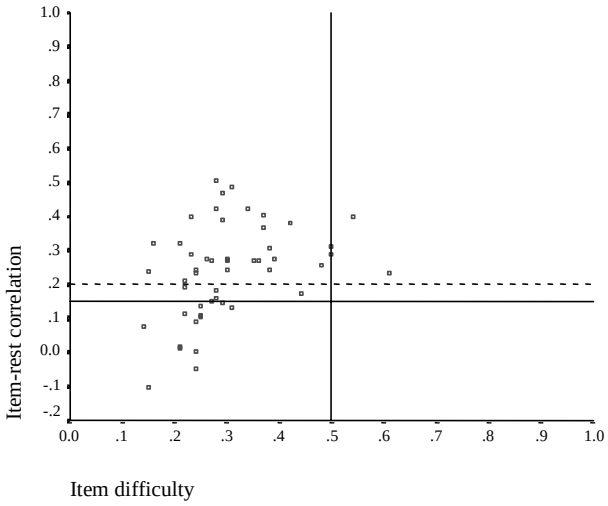
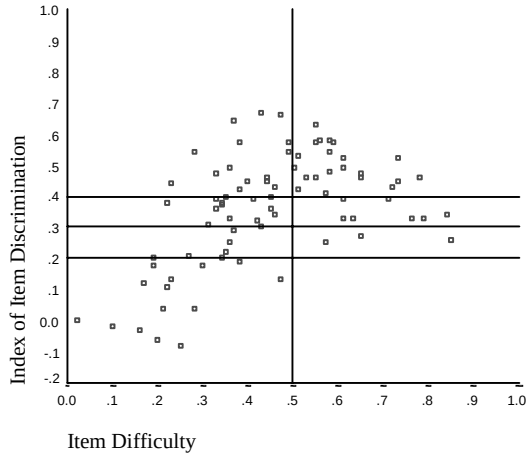
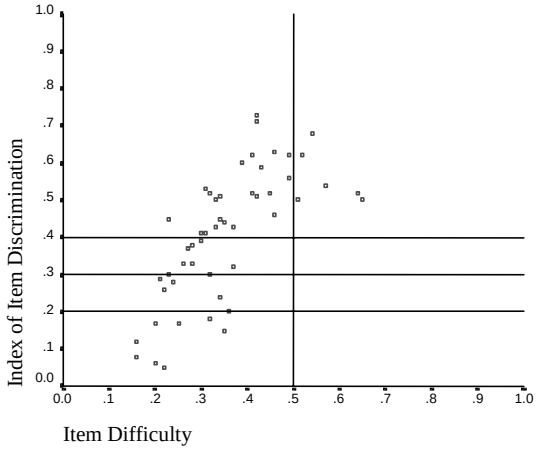


Figure 3.3 Item-rest correlation by item difficulty for the 1998 ESECE examinations

English



Algebra and Geometry



Algebra and Commercial Mathematics

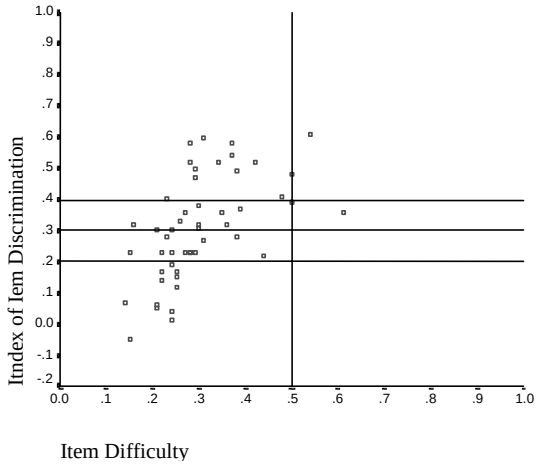


Figure 3.4 Index of item discrimination by item difficulty for the 1998 ESECE examinations

In Figure 3.4, solid lines are drawn for index of item discrimination values of 0.2, 0.3, and 0.4, respectively, indicating the different qualifications for the items, also represented in Table 3.9. A positive relation between item difficulty and index of discrimination is observed for all three examinations. For the English examination, it can be observed that most of the items with *D(i)* values approximately less than 0.3 correspond with item difficulties less than 0.4. As the item difficulty increases from 0 to 0.5, the index of item discrimination also increases. When the item difficulties increase from about 0.5 to about 0.85, however, then the *D(i)* values tend to decrease. In other words, easier items tend to discriminate less. This phenomenon is less clear (and may be absent) for the two Mathematics exams, since the item difficulties are mostly lower than 0.5. Thus, only the increasing relationship between item difficulty and index of discrimination is observed. Again, most of the values lower than 0.3 correspond to item difficulties lower than 0.4. Some of the *D(i)* values for English and Algebra and Commercial Mathematics are negative. This means that some of the items discriminated in favor of the poor students.

3.3.4 Reliability and estimation of correlation between the subtests

In order to determine the consistency of the candidates' performance across items or subsets of items on each of the examinations, functions of the correlation between the separately scored subtests are used. The assumption made in estimating the reliability of the examinations is that the items are independent, and conditional on the candidate's ability. Since such an assumption is difficult to obtain from an examination that involves sections such as Reading comprehension in the English examination, the reliability coefficient may well be overestimated.

Table 3.10 gives the estimated reliability coefficients for the entire examination and for the subtests, before and after deletion of the bad items, i.e., items with an index of item discrimination smaller than 0.2 for the English examination. This table further presents the number of remaining items after deletion of the bad items and the mean scores on the tests before and after deletion.

Table 3.10 Estimated reliabilities (Cronbach's coefficient α), number of items (N) and item means for the 1998 ESECE English examination and its subtests, for all items, and after deletion of bad items *(in Italics)*.

Section	Topic	*N*	α	mean	*N*	*α*	*mean (% change)*	
All	X1-X7	80	.89	.45	*60*	*.90*	*.50*	*(11.1)*
X1	Reading 1	15	.74	.56	*14*	*.75*	*.59*	*(5.4)*
X2	Grammar 1	10	.41	.41	*7*	*.52*	*.50*	*(22.0)*
X3	Sentence	10	.51	.41	*6*	*.60*	*.45*	*(9.8)*
X4	Structure	15	.72	.47	*14*	*.72*	*.46*	*(-2.1)*
X5	Grammar 2	10	.35	.45	*5*	*.42*	*.61*	*(35.6)*
X6	Grammar 3	10	.45	.38	*6*	*.47*	*.46*	*(21.1)*
X7	Reading 2	10	.59	.39	*8*	*.61*	*.43*	*(10.3)*

If all items are considered conditionally independent, then Cronbach's α increases slightly, from 0.89 to 0.90. If the items recommended for revision, i.e. items for which *D(i)* is smaller than 0.3, are also excluded, then an increase in α is observed.

The number of items recommended for revision are one from Reading comprehension 1, three from Grammar in context 1, four from Sentence in comprehension, one from Structure and usage, five from Grammar in context 2, three from Grammar in context 3, and one from Reading comprehension 2. The highest percentage of the number of bad items is from subsection Grammar in context 2. All subtests on Grammar in context together had 12 items to be eliminated or to be revised, which constitute 40% of the total items under these subtests.

When only the bad items are deleted, the subtests on Grammar in context 1, Sentence in comprehension and Grammar in context 2 show a substantial increase of coefficient α, but they are still rather low. Among all subtests, the sections on Grammar in context have the lowest coefficient α. The subtests Sentence in comprehension and Reading comprehension have a relatively higher reliability with considerably lower number of items. In general, it can be seen that the reliability coefficients in all sections are rather low.

The overall test mean increases by 11.1 % (from 0.45 to 0.50) after the deletion of bad items. The highest percentage increases of item means are in the sections of Grammar in context, ranging from 21.1% to 35.6%. There is a slight decrease of about 2.1% in the section consisting of Structure and usage after deletion of the bad items, probably due to the deletion of a relatively easy item.

Table 3.11 Raw correlations of the observed scores between the subtests for the examination of English for all items (X1-X7) in the lower triangle, correlations corrected for attenuation (T1-T7) in the upper triangle, for all items and after deletion of bad items *(in Italics)*.

	X1\T1	X2\T2	X3\T3	X4\T4	X5\T5	X6\T6	X7\T7
X1\		0.327	0.313	0.252	0.381	0.298	0.269
T1		*0.377*	*0.368*	0.*269*	0.*481*	0.*387*	0.*309*
X2\	0.099		0.344	0.344	0.379	0.314	0.301
T2	*0.145*		*0.502*	*0.383*	*0.607*	*0.470*	*0.388*
X3\	0.118	0.072		0.332	0.382	0.312	0.396
T3	*0.166*	*0.157*		*0.383*	*0.620*	*0.495*	*0.413*
X4\	0.133	0.102	0.123		0.405	0.310	0.280
T4	*0.145*	*0.143*	*0.168*		*0.482*	*0.397*	*0.313*
X5\	0.097	0.054	0.068	0.101		0.360	0.345
T5	*0.149*	*0.130*	*0.156*	*0.145*		*0.596*	*0.507*
X6\	0.098	0.058	0.072	0.100	0.056		0.317
T6	*0.136*	*0.115*	*0.141*	*0.136*	*0.117*		*0.445*
X7\	0.117	0.073	0.093	0.119	0.070	0.084	
T7	*0.141*	*0.123*	*0.153*	*0.139*	*0.129*	*0.129*	

Table 3.11 indicates that the correlation coefficients between the different subtests, given in the lower triangle in regular font, are quite low. The subtest on Structure and usage (X4) has a relatively closer relationship with the other subtests with a correlation of about 0.1 on average. After deletion of the bad items, an increase of correlation coefficients, now given in italics below the raw correlations, was observed, to a general level of approximately 0.15 for all subtests. After correcting for attenuation it can be seen that there is a rather large increase in the correlation coefficients, given in the upper right triangle in regular font. After deletion of the bad items, again a general increase of correlation coefficients was observed. Subtests on Grammar in context 1 (T2), Grammar in context 2 (T5), Grammar in context 3 (T6), and Sentence in comprehension (T3) are relatively highly correlated, all 0.47 or higher, and with a maximum correlation of 0.60 between two grammar subtests (T5 and T6). Taking into account that for short subtests coefficient α and correlation corrected for attenuation have large standard errors, and that the corrected correlations are still rather low, the implication is that the corresponding tested abilities are quite different.

Next, the reliabilities, means, and correlations for the Algebra and Geometry examination are investigated. The results are given in Tables 3.12 and 3.13.

Table 3.12 Estimated reliabilities (Cronbach's coefficient α), number of items (N) and item means for the 1998 ESECE Algebra and Geometry examination and its subtests, for all items, and after deletion of bad items *(In Italics).*

Section	Topic	*N*	α	mean	*N*	*α*	*mean (% change)*	
All	X1-X7	50	.88	.35	*40*	*.89*	*.38*	*(8.6)*
X1	Solving	11	.70	.44	*11*	*.70*	*.45*	*(2.3)*
X2	Relations	6	.63	.40	*6*	*.63*	*.41*	*(2.5)*
X3	Trigonometry	9	.57	.35	*8*	*.58*	*.42*	*(20.0)*
X4	Logarithms	5	.41	.37	*4*	*.43*	*.40*	*(8.1)*
X5	Statistics	4	.24	.26	*3*	*.30*	*.27*	*(3.8)*
X6	Geometry (2D)	11	.49	.32	*5*	*.61*	*.41*	*(28.1)*
X7	Geometry (3D)	4	.39	.24	*3*	*.41*	*.22*	*(-8.3)*

The coefficient α of the total Algebra and Geometry examination is 0.88, whereas coefficient α varies from 0.24 to 0.71 among the subtests, assuming that the items are conditionally independent. When the bad items are deleted, coefficient α is raised to 0.89. Similarly, a slight increase of α was observed in all the subtests, except for a rather large increase of coefficient α for the subtests on Statistics (X5) and Geometry two-dimensional (X6) of about 25%. After deletion ofthe bad items, the overall mean increases from 0.38 to 0.38, with the means of all subtests except for Geometry (three-dimensional) increasing also.

Table 3.13 Raw correlations of the observed scores between the subtests for the examination of Algebra and Geometry for all items (X1-X7) in the lower triangle, correlations corrected for attenuation (T1-T7) in the upper triangle, for all items and after deletion of bad items *(in Italics).*

	X1\T1	X2\T2	X3\T3	X4\T4	X5\T5	X6\T6	X7\T7
X1\		0.426	0.365	0.541	0.816	0.337	0.540
T1		*0.427*	*0.382*	*0.565*	*0.742*	*0.441*	*0.562*
X2\	0.188		0.435	0.655	0.944	0.360	0.654
T2	*0.188*		*0.464*	*0.712*	*0.925*	*0.565*	*0.710*
X3\	0.147	0.156		0.536	0.804	0.337	0.553
T3	*0.155*	*0.167*		*0.592*	*0.789*	*0.479*	*0.615*
X4\	0.155	0.167	0.125		0.960	0.426	0.691
T4	*0.169*	*0.189*	*0.145*		*1.057*	*0.736*	*0.819*
X5\	0.136	0.140	0.109	0.093		0.615	0.963
T5	*0.156*	*0.173*	*0.136*	*0.134*		*0.476*	*0.529*
X6\	0.116	0.110	0.094	0.085	0.071		0.439
T6	*0.188*	*0.215*	*0.167*	*0.190*	*0.175*		*0.788*
X7\	0.148	0.160	0.123	0.110	0.089	0.084	
T7	*0.161*	*0.181*	*0.144*	*0.142*	*0.131*	*0.195*	

Table 3.13 indicates that the correlation coefficients between the different subtests are not very high, although slightly higher than for the English examination. The subtests Solving equations or inequalities (X1) and Logarithms (X4) seem to be relatively highly correlated with the other subtests. After correction for attenuation, the short subtest on statistics was relatively highly correlated with the other subtests with an average correlation coefficient of 0.85. After deletion of the bad items, the correlation coefficients between the subtests are higher, but still rather low. After correction for attenuation, the subtests on Statistics (T5) and Logarithms (T4) are again highly correlated with an average correlation coefficient of 0.835. Note that the correlation coefficient of T4 and T5 has become greater than 1. If the attenuation correction for correlations leads to values greater than 1, this clearly is an error, which may be random or a result of the use of assumptions that are not quite satisfied. In any case, such an outcome does suggest that the true score correlation is quite high.

In the examination of Algebra and Commercial Mathematics 18 of the 50 items were found to be bad. The subtests considered in the examination of Algebra and Geometry could not be used again in the Algebra and Commercial Mathematics since many items were found to be bad in some of the subtests. That means, few

items were left and so the analysis becomes unreliable. Therefore, a different set of subtests was chosen for this examination.

Table 3.14 Estimated reliabilities (Cronbach's coefficient α), number of items (N) and item means for the 1998 ESECE Algebra and Commerical Mathematics examination and its subtests, for all items, and after deletion of bad items *(in Italics)*.

Section	Topic	*N*	α	mean	*N*	*α*	*mean (% change)*	
All	X1-X3	50	.80	.30	*32*	*.83*	*.33*	*(9.7)*
X1	Solving, Logs, Statistics	20	.67	.30	*14*	*.69*	*.33*	*(9.8)*
X2	Relations, Trigonometry	15	.45	.28	*8*	*.58*	*.31*	*(13.2)*
X3	Commercial Mathematics	15	.60	.32	*10*	*.64*	*.34*	*(8.5)*

From Table 3.14 it can be seen that, for the total test, coefficient α was 0.80. For the subtests, the range of coefficient α was from 0.45 to 0.67. After deletion of the bad items, there was an increase of coefficient α in each of the subtests. The subtest on Relations and functions, and Trigonometry showed an increase of about 30% coefficient α after deletion of the bad items. For the total test, coefficient α was raised from 0.80 to 0.83. Table 3.14 shows that after deletion of the bad items, there is an increase of item means for the subtests X1, X2, and X3. The overall percentage increase of item means is about 9.7%.

Table 3.15 Raw correlations of the observed scores between the subtests for the examination of Algebra and Commercial Mathematics for all items (X1-X7) in the lower triangle, correlations corrected for attenuation (T1-T7) in the upper triangle, for all items and after deletion of bad items *(in italics)*.

	X1\T1	X2\T2	X3\T3
X1\		0.245	0.204
T1		*0.345*	*0.307*
X2\	0.074		0.221
T2	*0.138*		*0.351*
X3\	0.083	0.060	
T3	*0.137*	*0.130*	

In Table 3.15, without deletion of the bad items, it can be seen that the subtests are not highly correlated. Although the correlation coefficients are not very high, the correlations of the subtests corrected for attenuation are higher. After deletion of the bad items, both the raw and the corrected correlations increase, although both remain rather low.

3.3.5 Effect of deleting bad items on candidates' grades

It may be relevant to check the consequences on the grading if bad items are excluded. A change in grades may affect the admission of some students to the University or the placement into the streams in the freshman program. The threshold used for grading are as indicated in Table 3.1. For the English examination the remaining 20 points come from the subjective type of questions for which data are not available. The effect of deleting bad items on candidates' grade for the English examination can therefore not be considered. The grade changes after deletion of the bad items in both Mathematics examinations are presented in Tables 3.16 and 3.17

Table 3.16 Changes in grades for the Algebra and Geometry 1998 ESECE examination after deletion of bad items.

New Grade	Old Grade				
	A	B	C	D	F
A	235	251	34	0	0
B	0	0	392	0	0
C	0	0	556	486	0
D	0	0	5	529	415
F	0	0	0	22	4420

When the bad items are deleted it can be observed that there are many changes in the new grade category, even though the majority of the grades do not change (on the diagonal 5740 candidates (77.4%) are found). Most of the changes are in favor of the students. Only 27 candidates earn lower grades than before. Especially the 486 changes from D to C can be considered quite important. No changes from F to C (failing to passing) were observed.

The findings for the Algebra and Commercial Mathematics examination are more or less the same. Here, 76.9% of the grades do not change. All of the changes are in favor of the students; 27 grades change from D to C, whereas there are 2 students whose grades increase from F to C.

Table 3.17 Changes in grades for the Algebra and Commercial Mathematics 1998 ESECE examination after deletion of bad items.

New Grade	Old Grade				
	A	B	C	D	F
A	2	8	13	0	0
B	0	0	15	2	0
C	0	0	6	27	2
D	0	0	0	14	33
F	0	0	0	0	310

3.4 Conclusions

The aim of this chapter was to examine to what extent the items in the English and Mathematics examinations of the ESECE for the year 1998 functioned accurately in view of the highly competitive admission procedures at the University of Asmara.

It was found that the distribution of scores for the examinations of English and Mathematics was skewed to the right, with most of the students scoring below the average 50%. The grade distributions also indicate that the vast majority in all the examinations scored below the middle grade C, particularly in Mathematics. Of the total group of candidates who took the examinations of Mathematics with Geometry and Commercial Mathematics, about 79% and 89%, respectively, earned grades below C.

The evaluations of the study indicate that the examinations contain rather many difficult items and items that do not differentiate between poor and good students, and that some of the items are inconsistent with the remaining items. The item difficulties reveal that 42.5%, 64% and 86% of the items of English, Algebra and Geometry, and Algebra and Commercial Mathematics, respectively, were each answered correctly by less than 40% of the candidates. On average, the items in Algebra and Commercial Mathematics proved relatively more difficult to the candidates than the other two subjects. Under typical situations, Verstralen, Bechger, and Maris (2001) note that items with 0.50 difficulty level are preferable. Traub (1994) stated that a test is expected to yield unreliable scores if the tests are composed of either difficult or easy questions. He also indicated that if items are of middle difficulty, it is possible for the test to have good reliability. This opinion is shared by Nunnally and Bernstein (1994), who noted that the contribution of items with middle difficulty (30 to 80 percent correct responses) to test reliability is likely to be important. An item that is answered by less than 10% or more than 90% of the candidates may not contribute much to test reliability. These findings suggest that

the high degree of difficulty of these examinations may be associated with a rather low reliability.

Based on standard criteria for the item discrimination power of the items, it was found that approximately half of the items were good. The items of the Algebra and Commercial Mathematics examination were functioning somewhat worse. Around 20% of the items could be recommended for thorough revision, where again the Algebra and Commercial Mathematics were somewhat worse. Kehoe (1995) found that items answered correctly or incorrectly by more than 85%, show a marked reduction in their power of discrimination, and that items with an item difficulty of about 0.5 have more discrimination power than the other items. This supports the conclusion that the degree of difficulty of the examinations is not conducive to high reliability. Nunnally and Bernstein (1994) indicated that the more the items are discriminating, the more it is likely that the items will have higher test reliability.

It was also studied whether or not the examinations measured what they were supposed to measure. For the face validity, a combination of difficult, medium and easy questions were selected and distributed to some University lecturers and high school teachers for their judgments. The results indicated that the opinions of the staff were in reasonable agreement with those of the corresponding item difficulties and item-rest correlations. In studying the content validity, the results indicated that the curriculum was not appropriately represented in the Mathematics examination. The results showed that some subtopics were either totally ignored or not given proportional weight in the examinations. This might have negatively influenced the reliability of the examinations.

The deletion of the bad items as indicated by the analysis using the index of item discrimination showed a difference in the internal consistency of the tests and in the proportion of passing students. For some subtests, the exclusion of poor items led to higher reliabilities with a considerably lower number of items. It was found that the ranges of the coefficients of reliability of the subtests of all the examinations were wide. However, since the number of items varies per subtest, the direct comparison of their reliability coefficients may not be meaningful. The correlation between the subtests showed a marked increase when the bad items were deleted. Kehoe (1995) noted that tests are more reliable if they include more homogeneous items. According to Ebel and Frisbie (1986), the reliability coefficient of educational achievement, constructed by experts, is usually 0.90 or higher. Evers (2001a) recommended that if the tests are for the use of important decisions then reliability between 0.8 and 0.9 is sufficient. Omitting the bad items led to an approximate 10% increase of the mean scores in all the examinations. In particular, the item mean of the English examination was raised to about 0.5, which is the level of middle difficulty. The results of the Mathematics examinations indicate that the grades change when the bad items are deleted. These changes are, with the exception of very few candidates, in favor of many students. This in turn points out that candidates who should have been admitted to the University may well have

been rejected due to erroneous decisions. On the other hand, some candidates, who were probably not eligible for admission, were admitted to the University.

Items labeled as bad might have been answered correctly by some of the examinees. It may seem unethical to cancel these items and penalize those examinees that have answered them correctly. Kehoe (1995) argues, however, that since the purpose of testing is to determine the examinees' rank, the accuracy of the ranking could be jeopardized if unsatisfactory items are included.

It can thus be concluded that the examinations are not quite satisfactory. They can and should be improved. Even though the predictive validity of the ESECE examinations could not be tested due to a lack of data, the performance of first year students will be studied in the next chapter, investigating the relation between performance and several student characteristics.

4

Performance of first year students

4.1 Introduction

In the previous chapter, it was investigated to which extent the items of the compulsory subjects in the ESECE, which regulate admission to the University, consistently test the ability of the students. Attention now turns to the possible factors that affect the performance of students in the freshman program of the University. Since the reopening of the University of Asmara in September 1991 after the liberation, studies on factors influencing students' results have never been conducted.

From Figure 2.1 of Chapter 2, it can be seen that admission to the University is highly competitive with the top 6% to 12% of the students who apply (or take the ESECE) being admitted. However, the attrition rate at the University is substantial, at about 35% and 25% on average, at freshman and non-freshman levels respectively (cf. Table 1.1). Besides dropout due to personal reasons, students are dismissed for academic reasons: if their Grade Point Average (GPA) is below 1.5 (out of a scale of 0-4) they are not allowed to continue their studies. Therefore, it is important to check whether and how the first year performance of the students at the University varies by ESECE results, admission-related information, and personal characteristics of the students. With this information it may be possible to identify students who are likely to complete their studies at freshman level, and to identify some factors which contribute to a successful completion of their studies.

The aim of this chapter is to explain the academic achievement of students in their first and second semester studies of the freshman program at the University. Based on information before entry to the University, factors possibly affecting the performance of students at the University will be examined. This means a predictive approach is taken: how well can student progress be predicted from pre-university information?

First a short overview of the literature on factors influencing academic achievement is given. Based on this, hypotheses for the Eritrean situation are formulated, which are tested on the available freshman data using multiple linear regression analysis. A description of the data is given, followed by the results of the regression analysis. The chapter is concluded with a discussion of the results.

4.2 Theoretical background

The problem that students drop out from school or university before completing their degrees is of deep concern to educational administrators, policymakers and society at large (Willett and Singer, 1991). For one thing, attrition is generally considered to be not economical. The social investment in human resource development of the country is being wasted (Blaug, 1985). Moreover, dismissal or non-completion of studies means a lot for students at the University. Many people consider university education an important road to success in life. Therefore, students may be affected psychologically by the non-completion of their studies. They may develop feelings of hopelessness, guilt and shame of leaving the university without meaningful results that could be used in their future career (Johnes, 1990).

The work of Tinto (1975, 1987, and 1993) has been important in the study of undergraduate retention. In 1975, Tinto postulated his first model to explain dropout from higher education. This model was based on an interactionalist theory of college departure. Tinto states that students enter college with various individual characteristics that affect the dropout process. These entry characteristics include family background factors such as socioeconomic status, parental educational level, and parental expectations; individual attributes such as academic ability and gender; and precollege schooling such as students' secondary school and record of high school achievement. The model predicts that student pre-entry characteristics will influence students' commitment to an institution and their social and academic integration.

In later years Tinto elaborated on his theory from economic, organizational, psychological and sociological perspectives, a development supported by other researchers such as Berger and Milem (1999) in view of the internal consistency of Tinto's theoretical model.

A wide body of research is known in which Tinto's theory or parts of his theory are tested. Although this research has mainly focused on developed countries, some parts of it are so general that they are most likely applicable to the Eritrean situation. Some interesting research findings on the relationships between achievement and ability, achievement and involvement, achievement and students' demographic characteristics, and achievement and environmental factors are reported in the next section.

4.2.1 Ability

It goes without saying that ability, as measured before entry into university, will be of great influence on achievement in university education. For example, Larose, Robertson, Roy and Lgault (1998) indicated that, according to some studies, high school rank predicts success in college; and success in basic disciplines such as English and mathematical aptitudes at high school are important predictors of

academic performance in college. In a study on student progress in six disciplines in Natural as well as Social Sciences, Jansen (1996) showed that there was an association between grades on the final exam of secondary education and study progress in university. Johnes (1990), in his statistical analysis of a sample of 1979 entry cohort to Lancaster University, indicated that the likelihood of completion is influenced by various characteristics, one of them being the students' academic ability (as reflected by A level results). In studies of the relationship between high school and college performance, high school grade point average was found to be a powerful predictor (Hess 1984, Lindblom-Ylänne, Lonka, and Leskinen 1999, Van der Hulst and Jansen 2002, Bruinsma, 2003). In some cases contradictory findings are reported. For example, Seelen (2002), Ayaya (1996) and Van Zyl Smit et al. (1993) reported a significant negative relationship between the English test scores on the COSC (Cambridge Overseas School Certificate) and academic performance in the context of Southern Africa.

4.2.2 Involvement

Milem and Berger (1997) considered the interaction of student behavior and perception in their study of the influence of the development of academic and social integration. In their revised model of undergraduate persistence in an analysis of first year retention, Berger and Milem (1999) used independent variables such as student background characteristics, initial commitment, involvement measures, academic and social integration, and subsequent commitment. Their results indicated that involvement in both academic activities and activities with peers have a powerful positive impact on students' performance. Students who feel involved in their studies spend more time at studying and show more work discipline (Jansen & Bruinsma, 2003). According to Carroll (1963) and Creemers (1994) time on task is one of the important predictors of achievement.

Furthermore, according to McInnis, Hartley, Polesel and Teese (2000), wrong choice of course or subject has been one of the prominent reasons for non-completion. A wrong choice does not motivate students and results in less involvement and poor academic achievement.

4.2.3 Demographic characteristics

According to Johnes (1990) the age of a student on entry to the university can have two different and opposite effects. If a student leaves his/her job to continue his/her studies, such maturity and dedication may positively influence the academic performance of the individual. On the contrary, it could be argued that older students might have forgotten the academic life and they may be in a difficult position to adjust. Studies conducted by Jansen (1996), and Van der Hulst and Jansen (2002) showed younger students to have better study progress than older students indicating that higher age is an indicator of lower ability. Other studies

have shown that younger students dropped out less often than older students (McInnes et al., 2000; Murthaugh, Burns and Schuster, 1999). However, Trueman and Hartley (1996) found older students to perform equally well or sometimes better than younger students. According to Trueman and Hartley this fact might be mediated by time-management skills. Older mature students were better in time management. Furthermore, according to McInnes, James and MacNaught (1995) mature students have rather clear career orientation and lower integration needs. Therefore they will likely achieve higher results.

Even though other studies found that female students showed better progress than male students did, (Jansen 1996, Shah and Burke 1999, Van der Hulst and Jansen 2002), Johnes (1990) observed that an examination of attrition amongst males and females separately identifies striking differences between the two groups in the characteristics associated with non-completion. However, Johnes (1990) noted that the effect of gender on the probability of non-graduating is uncertain. In a study on "Inventory and Analytic overview of Africa Education sector Studies, Analyses, Agendas, and priorities for Education in Africa" by UNESCO, reviewing the education in Africa for the years 1990-1994, it was reported that higher rates of attrition were found among females than among male students. Parental attitudes, parents' levels of education, and household responsibility were some of the causes mentioned for the high attrition rate.

4.2.4 Environment

Fejgn (1995) noted that parents' education and income, and private school attendance explained the advantage of one group of students in Mathematics scores. It has also been shown that factors such as life stress, which may include family responsibilities for older students and environmental factors, have enhanced integration and persistence (Napoli and Wortman, 1998).

Besides environmental factors in the private life of students, the academic environment plays an important role. In the prediction of the performance of students at higher institutions, the type of course plays an important role (Clarke, Burnett, and Dart 1994). According to McClelland and Kruger (1993), there is a stronger relationship between the high school results of science and the performance at higher institutions than between performance in the humanities at high schools and the performance at higher institutions. Furthermore, a wide body of research on the effects of classroom variables on academic achievement is available (Carroll, 1963; Creemers, 1994; Slavin, 1995). Because these classroom variables differ between stream and departments, stream effects or department effects are to be expected. These will be explored in Chapter 5 for the University of Asmara.

In the next section some possible factors that influence performance at the University of Asmara are described. Based on the literature review and on the specific features of the Eritrean situation, a number of hypotheses are formulated.

4.3 Possible factors of attrition and performance in the freshman program at the University of Asmara

The brief review of literature from other institutions in other countries given in the previous section indicates that there is a wide range of factors influencing the performance of students at a university. Given the situation at the University of Asmara, however, it was not possible to obtain data for all these factors. This section considers only factors for which data were available.

Effects of the following variables were studied in view of the recognition of the high attrition rate at the University, the existing admission policy and the related socio-economic conditions. For each variable a testable hypothesis about its effect is formulated.

4.3.1 High school performance

The grades obtained on the ESECE are an important pre-entry measure of ability. Both the GPA for the elective subjects and the results of the compulsory subjects, Mathematics and English, are expected to be important indicators of success or failure at the University. Higher grade point averages in the elective subjects, Mathematics, and English are expected to predict success at the University. This means that students with lower a GPA in these subjects will have a higher probabilitiy of dropping out or be dismissed for academic reasons.

Hypothesis (4.1)	*The higher the grades earned in the university entrance examinations, the better a student's performance in the freshman program.*

4.3.2 Students with previous post-secondary education

Immediately after the liberation of Eritrea, many students who were previously attending classes in post-secondary institutions in other countries returned to Eritrea and were admitted to the university. Some of these were students in the evening (extension) programs who started their studies in the regular day program. Other students discontinued their university studies for various reasons. Students from the extension programs or those with previous post-secondary education have had the opportunity to be acquainted with the working procedures of the university and therefore stand a good chance to continue their studies with fewer adjustment problems than first-time students.

Hypothesis (4.2)	*Students who were previously admitted to higher education institutions perform better than students without previous post-secondary education.*

4.3.3 Type of examination

Students are admitted to the university either through the ESECE or through exams from other countries, mainly Ethiopia, the Sudan, and the Middle Eastern countries. For some students, the grade computation for their university entrance examinations was based on percentages. At the time of admission to the University of Asmara, their previous average percentages of the entrance examinations were converted into a scale of 0-4 (i.e. New GPA = (previous average score) × 4/100). No general knowledge is available on the quality of the foreign examinations, whereas we do know that students taking the ESECE pass through highly competitive procedures. Furthermore, students coming from other countries may have some external constraints in adjusting to a new environment.

Therefore, it is expected that students who did not take the ESECE but are admitted through results from other countries are less likely to succeed in their studies at the university than those admitted on the basis of the ESECE.

Hypothesis (4.3)	*Students who took the ESECE perform better than students admitted through other results.*

4.3.4 Admission to Natural and Social Sciences streams according to preference

Students do not pay for their educational or living expenses. The government determines the intake capacities of the streams and departments. A placement procedure is employed to assign students to streams (in the freshman year) and to departments (in the second year) which takes the students' preferences into account only to the extent that places are available. This means that admission to streams and departments is not necessarily based on students' preferences. For the freshman year, the motivation of students is expected to be better if they were placed in streams according to their own preference.

Hence, students who are admitted to a stream according to their desire are more likely to succeed than the other students at freshman level.

Hypothesis (4.4)	*Students who are admitted to the streams of their preference perform better.*

4.3.5 Admission category (Regular/Private)

Regular students are those who have been admitted to the university immediately after completing their high school study without interruptions. Students admitted on a private basis have been either extension students, previously employed, or students who completed their high school study some years before the year of admission. Some of the private students could be those who failed to be admitted in previous years because of low grade point average on the ESECE. For others, the interruption

may also lead to problems of readjustment to the academic environment, or be an indicator of other complicating circumstances. Therefore, it is expected that private students are less likely to succeed in the freshman program than the regular students.

Hypothesis (4.5) Regular students perform better than private students.

4.3.6 Readmitted or newly admitted students

Some students discontinue their university studies for various reasons. When such students are re-admitted after a while, it may be appropriate to investigate their performance as compared to the newly admitted students. These students may have the advantage of solving their previous problems and weaknesses and work on capitalizing their strengths. Therefore, it is likely that such students perform better than the newly admitted students.

Hypothesis (4.6) Re-admitted students perform better than newly admitted students.

4.3.7 Natural sciences and Social Sciences streams

At the University of Asmara, the effects of various variables may also differ between streams. Streams have different requirements for their students' abilities resulting in a different composition of student bodies. At high school level, students have different academic backgrounds: Social Sciences, natural science, commercial section, technical school, or Agriculture. There has been a common understanding at the Admission and Placement Committee level of the University of Asmara that a student with a Social Sciences or commercial section background at high schools cannot be placed in the Natural Science stream.

One of the consequences is that students with a natural science background at high schools wanting to be placed in the Social Sciences stream oftentimes cannot be accommodated.

Yet another important fact about the stream choice mechanism is that new fields of specialization are very popular. Whenever a new field of specialization was started in one of the streams, which students assumed would lead to a better future career, there was a tendency for students to choose the stream with that particular field of specialization irrespective of the field of specialization at high schools. This phenomenon applies in particular to students with a natural science background. On the one hand, it shows the dedication and interest of the students to complete their study and ambition to have a better future career. On the other hand, it indicates that some students are joining streams while giving scant regard to their previous field of specialization at high schools. This phenomenon may also influence the performance of students between streams.

Hypothesis (4.7)	*Social Sciences students perform better than students in the natural sciences.*

4.3.8 Gender

In Eritrea, the distribution of female and male students at elementary schools (grades 1-7) is about equal. However, as the data of the academic years 1994/1995 and 1995/1996 in Table 4.1 reveal, the proportion of female students decreases constantly.

Table 4.1 Student Enrolment by sex - Grades 1-11 for the Academic Years 1994/1995 and 1995/1996

Year	94-95			95-96		
	Female	Total	% of Female	Female	Total	% of Female
Grade						
1-7	115428	259282	44.5	123508	276091	44.7
8	6703	15265	43.9	6257	14544	43.0
9	4255	10528	40.4	4526	11282	40.1
10	2549	7183	35.5	3237	8441	38.3
11	1124	3752	30.0	1455	4884	29.8

Source: Annual report of the Ministry of Education, Eritrea.

The percentage of female students decreases from about 45% to about 30%, from grades 1-7 to grade 11. The yearly decrease of the percentage of female students is probably due to early marriage, attitudes of society, and the parents' expectation for their daughters to work in the household. Although the government encourages female participation in almost all aspects of life including political positions, and laws have been set up to that effect, it seems that the problem still exists. Many people in Eritrea still believe that a family whose first child is a female, has a blessing from God. This is simply the consequence of the expectation that the girl will assist in home affairs. Taking into consideration that female students face higher hurdles, it seems likely that female students will tend to perform less well than male students do in universities as elsewhere.

Hypothesis (4.8)	*Female students perform worse than male students.*

4.3.9 Age

Admission to the university is based on competition. For the younger students who are coming directly from the high schools, there is a continuity of study habits. In particular, for older students in the natural science stream, it might not be easy to recall the mathematical formulae and computational techniques developed at earlier stages. It is, therefore, expected that younger students perform better than older students.

Hypothesis (4.9) Younger students perform better than older students.

4.3.10 Interaction effects and control variables

Students in the natural sciences could be in a relatively better position because many of the courses given at high school level are also given at freshman level in the university. This is not the case for the other students. For instance, for commercial section students, Bookkeeping is compulsory at high school level but is not offered at freshman level in the university. Therefore, it is possible that the effect of the ESECE differs between streams.

The effect of age might also differ between streams. As far as computational skills are concerned, younger students could be more competent than the relatively older students. This implies that older students placed in the natural science stream might face problems in their performance as compared to the younger students. However, the effect of age in the Social Sciences stream might not be so strong, as the need for computational skills is smaller in this stream.

The effect of the Mathematics grade on the ESECE might be more important in the natural science stream than in the Social Sciences stream, due to the reason stated above. The effect of the English grade on the ESECE might be more significant in the Social Sciences stream than in the natural science stream, since the Social Sciences stream probably demands a higher degree of English language proficiency.

Private students have been admitted to both the Natural and Social Sciences streams. Being away from the school environment, and having experiences in other environments, could decrease the main skills needed in the natural sciences but is expected to have no, or a weaker, effect on skills especially needed for the Social Sciences. Therefore, it could be relatively difficult to adjust for private students placed in the natural science stream as compared to those private students in the Social Sciences stream, since most of the private students were out of the school system for some time.

The same type of conjectures also leads to the expectation that there will be differences between students who enter the university with previous post-secondary education and those who do not have this experience.

Hypothesis (4.10)	*The effect of academic, personal and admission-related variables differs between the natural and Social Sciences streams and between students with and without previous post-secondary education.*

The study deals with students admitted to the University during the years 1993 through 1997. The yearly entrance examinations may have their own weaknesses and strengths related to the change of curriculum, the difficulty level of examinations, etc. Also circumstances at the university may have changed somewhat over the years. Therefore, the effect of the academic years (1993 to 1997) on the performance of students is included in order to control for time trends in the investigation of the effects of the various explanatory variables.

4.4 Data

Grade point averages of semesters 1 and 2 of the freshman year were collected from both the files of students in the Registrar's office of the university and from questionnaires distributed to students, for a period covering the years 1993 to 1997, of as many students as possible. Also collected were data on the pre-university entrance examination and several other personal and admission-related variables as presented in the previous section. Moreover, it was attempted to include other explanatory variables such as educational background of students at high schools, parents' education, parents' profession, family income, employment status, perceived institutional support, perceived peer support, satisfaction of academic experience, and learning-teaching experience. By distributing questionnaires to students, a data-collection effort was made. At the same time when the study was conducted, some officials of the university hinted to the students that the current practice of free tuition fees, free services of food and dormitories might not continue in the future. It was pointed out that introducing cost-sharing mechanisms where students had to cover some of their expenses was a possibility. After this incident, some of the students did not fill in their responses related to the above variables or it seems that students were not frank enough to tell the facts regarding family background, financial circumstances, and other variables stated above. As a consequence, this data collection did not lead to reliable information that could be used in this chapter.

Data were obtained for 2412 students, although complete data (i.e. data on all variables) were not obtained for each student. For 2302 students a GPA score for the first semester was available. A first investigation considering the differences in characteristics between the 2029 students with complete data in the first semester and the 383 students with missing data showed that the differences between pre-university results were negligible. The differences between the average ESECE GPAs were less than 0.1 point. For the second semester with a total of 1910 students

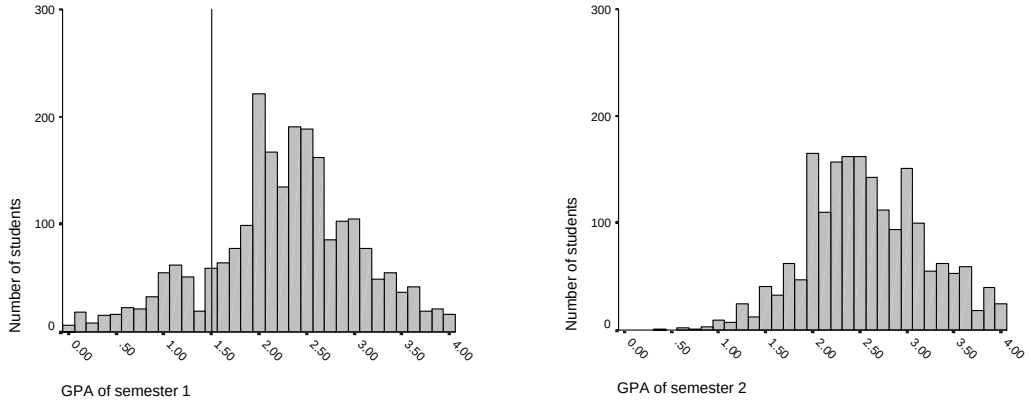
available, the differences increased somewhat between the 1673 students with complete data and the 237 students with missing data, probably due to selection after the first semester. The students with complete data had better GPAs on average (approximately 0.25 points). No gender differences were found.

In the remainder of this section first a graphical description of the GPAs in the first and second semester of the freshman year is given, as well as the relation with the ESECE examination results for all students in the freshman year, and for the social and natural sciences separately. Next, a description of the variables characterizing potential other influential factors is given. These variables will be called the predictors, because they are used as predictor variables in the regression analysis. In view of the expected differences between groups of students, descriptive statistics are also reported for the first year students in the natural sciences stream and in the Social Sciences separately, and for the students with and without previous post-secondary education separately.

4.4.1 First and second semester Grade Point Averages and their relation with ESECE GPAs

The distributions of the grade point averages of the first and second semester are given in Figure 4.1.

Figure 4.1 Distribution of grade point averages of semesters 1 and 2



The minimum passing grade point average at the end of the first semester of the freshman program was 1.5 in a scale out of 4.0. Therefore, all students with grades to the left of the line Y = 1.5 were dismissed for academic reasons.

The right hand panel of Figure 4.2 represents the distribution of grade point average of the second semester only. The minimum passing cumulative grade point average, mean GPA of both semesters 1 and 2, at the end of the second semester of the freshman program is 1.75 on a scale from 0 to 4.0. Students who earn a semester grade point average of less than 1.5 are also subject to dismissal.

Figures 4.2a and 4.2b present the mean GPA of semesters 1 and 2 respectively versus the ESECE.

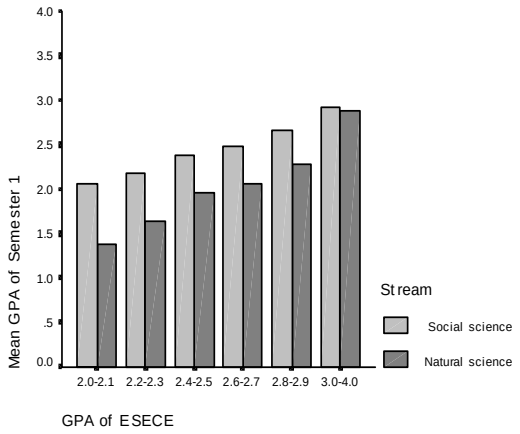


Figure 4.2a Mean GPA of semester 1 Versus GPA of ESECE

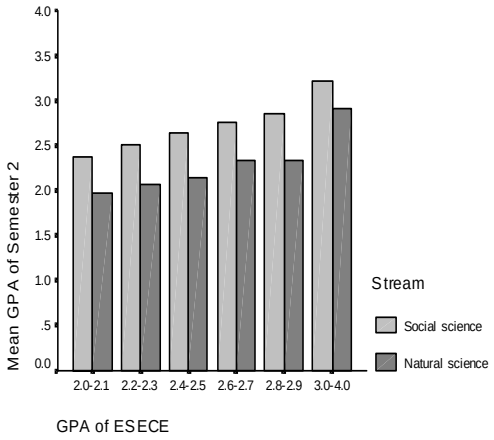


Figure 4.2b Mean GPA of semester 2 Versus GPA of ESECE

From Figures 4.2a and 4.2b, it can be observed that as the mean grade point average of the ESECE increases the mean grade point average of semesters 1 and 2 also increases for both Natural and Social Sciences students. In all grade intervals, the mean grade point average of semester 2 is slightly greater than that of semester 1. For students with mean grade point average in between 2.0 and 2.3, the corresponding mean grade point average in semester 1 is less than 2.0 for the Natural Sciences students but greater or equal to 2.0 for the Social Sciences. For both streams, the mean grade point averages in the second semester are greater than or equal to 2.0 for all corresponding grade intervals on the ESECE. This restriction of range is due to the fact that students who dropped out or who were dismissed for academic reasons during the first semester were not allowed to continue their studies in the following second semester. In other words, some of the students with lower grade point average during the first semester could not attend classes in the following second semester. For each grade category of the ESECE results, the mean GPA of the Natural Sciences students is less than the corresponding mean GPA for the Social Sciences students in both semesters 1 and 2.

In order to give insight into not only the averages but also the distribution of the GPA, Figures 4.4a and 4.4b represent scatter plots of the GPA of the first semester versus the GPA of the ESECE for the Natural and Social Sciences respectively. Figures 4.4c and 4.4d represent scatter plots of the second semester versus the GPA of the ESECE for the Natural and Social Sciences respectively.

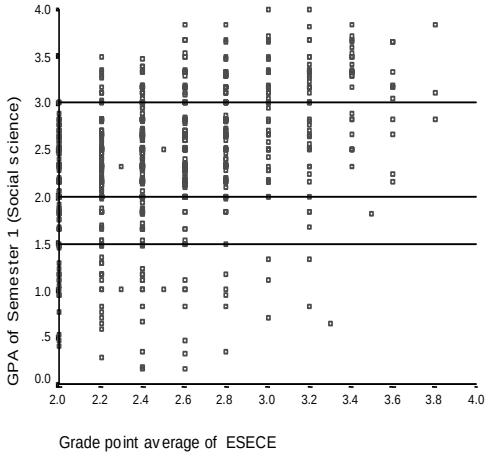


Figure 4.4a Mean GPA of Semester 1 Versus GPA of ESECE for Natural Sciences

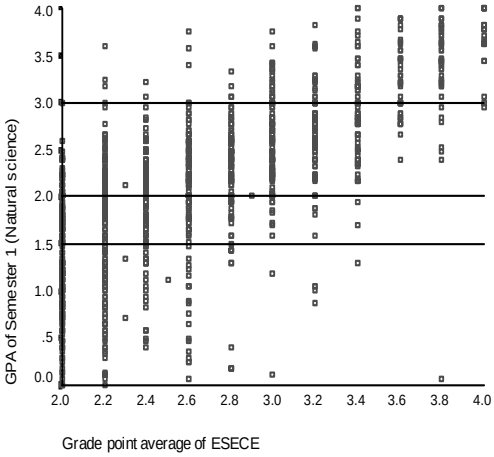


Figure 4.4b GPA of Semester 1 Versus GPA of ESECE for Social Sciences

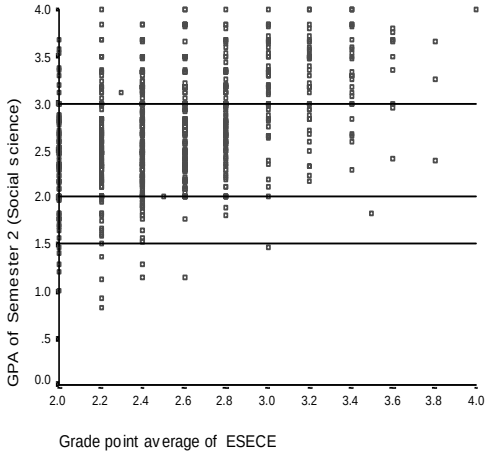


Figure 4.4c Mean GPA of Semester 2 Versus GPA of ESECE for Natural Sciences

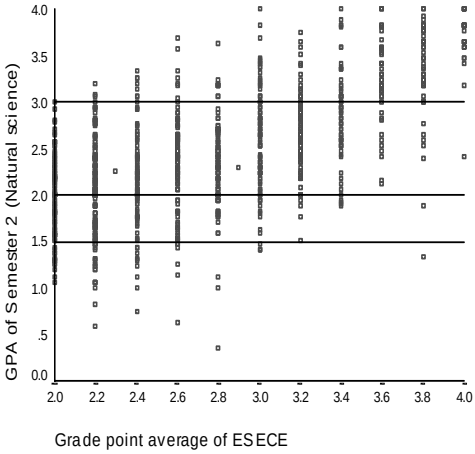


Figure 4.4d GPA of Semester 2 Versus GPA of ESECE for Social Sciences

Figures 4.4a and 4.4b indicate that almost all students with an ESECE GPA greater than 2.8 had a semester GPA greater than or equal to 1.5.

In Figures 4.4c and 4.4d, displaying the second semester results of the freshman program, it can be observed in Figure 4.4d that there were relatively many students earning a semester GPA greater or equal to 3.0 for students in the Social Sciences with a GPA of the ESECE equal to 2.0 or 2.2. Figure 4.4c indicates that a similar achievement was almost not possible for the Natural Sciences students. It appeared that as the GPA of the ESECE increased the number of students earning a semester GPA greater or equal to 3.0 also increased steadily. However, in Figure 4.4d, the increment of the semester GPA to a level of greater or equal to 3.0 did not seem to follow such a pattern. Students with a lower GPA of the ESECE could also

manage to earn a higher GPA in the freshman program. Again, there are relatively more dismissals in the Natural Sciences than in the Social Sciences.

In Appendix D, similar figures can be found for the relation between the mean GPA on the elective subjects, and the grades on the (compulsory) English and Mathematics ESECE examinations.

4.4.2 Description of the predictor variables

In Table 4.2 the names, the hypothesis number, and a description of the predictor variables are given, as well as a classification of continuous (together with the range) or binary (where 1 is used to indicate that condition is present, and 0 that condition is not fulfilled). In the two final columns, the mean (for continuous variables) or the percentage (for the binary variables) is given for both semesters of the freshman year. The number of students in the first and second semesters was 2302 and 1910 respectively. From Table 4.2 it can be inferred that approximately half the students had previous post-secondary education and that the placement into the two streams is about even as well. Relatively few students are not admitted to the stream they desire. A minority of the students is re-admitted to the university, or enters through a different examination than the ESECE and/or as private students.

Descriptive data, including mean grade point averages for the academic variables and standard deviations, are given in Table 4.3. It indicates that the mean GPA for the electives, that of Mathematics for the students in the Natural Sciences were slightly higher than the corresponding mean GPAs for the students in the Social Sciences. The mean GPAs for English for the Natural and Social Sciences students were more or less equal, with the GPA for Social Sciences being slightly higher than that of the Natural Sciences. The overall means GPA for both semesters in the Natural Science were less than the corresponding mean GPA in the Social Sciences. The mean grade point averages of Mathematics on the ESECE were less than 2.0 for all groups of students.

Table 4.2 Names and description of the variables and their means (or percentages) and numbers.

Variable Name (Hypothesis)	Description	Type of variable and range	Semester 1 Mean (SD)	Semester 2 Mean (SD)
Academic				
Elective (4.1)	Grade point average for elective subjects	Continuous (0-4)	2.72 (0.61) n=2237	2.79 (0.60) n=1854
Mathgpa (4.1)	Grade point average for Mathematics in ESECE	Continuous (0-4)	1.86 (0.87) n=2267	1.88 (0.87) n=1881
Enggpa (4.1)	Grade point average for English in ESECE	Continuous (1-4)	2.92 (0.86) n=2280	3.00 (0.84) n=1895
Admission and person-related				
Postedu (4.2/4.10)	Post-secondary education (yes/no)	Binary (1/0)	0.40 n=2302	0.45 n=1910
Examtype (4.3)	Admission through ESECE or others (yes/no)	Binary (1/0)	0.97 n=2302	0.97 n=1910
Destream (4.4)	Desired stream (yes/no)	Binary (1/0)	0.90 n=2255	0.94 n=1866
Admcateg (4.5)	Admission category (Regular/Private)	Binary (1/0)	0.84 n=2220	0.86 n=1837
Readmn (4.6)	Re-admitted/ Newly admitted	Binary (1/0)	0.07 n=2302	0.08 n=1910
Stream (4.7/4.10)	Natural Sciences/ Social Sciences	Binary (1/0)	0.57 n=2260	0.53 n=1868
Sex (4.8)	Man/Woman	Binary (1/0)	0.85 n=2302	0.86 n=1910
Age (4.9)	Age of the student at admission	Continuous (16 – 41 in years)	19.6 (2.54) n=2182	19.4 (2.42) n=1808
Control				
Cohort	Year of admission; 1993 is reference year	Dummy variables for year 1994 through 1997	0.19 0.19 0.24 0.27	0.17 0.19 0.25 0.28

Table 4.3 Mean grade point averages (and standard deviations) for the academic variables by stream.

Variable	Mean GPA of students		
	All	Natural Sciences	Social Sciences
Electives	2.72 (.61)	2.77 (.67)	2.66 (.51)
Mathematics on ESECE	1.87 (.87)	1.99 (.88)	1.70 (.84)
English on ESECE	2.93 (.85)	2.90 (.85)	2.98 (.86)
Semester 1	2.26 (.77)	2.11 (.83)	2.44 (.64)
Semester 2	2.58 (.62)	2.45 (.65)	2.73 (.57)

N.B.: The numbers in brackets are standard deviations.

In Tables D.1 and D.2 in the Appendix, the mean semester GPAs for the various types of students are given: for all students together, separately for the Natural Sciences and Social Sciences students, and for the students with and without previous post-secondary education. From these tables it can be seen that there is a tendency to increasing GPA scores over the years for all students. The GPAs in the second semester are generally higher than in the first semester, due to selection. Few mean GPAs lower than 2.0 are observed, and these are typically observed for female and/or private Natural Sciences students and/or students without previous post-secondary education, who were not admitted to their stream of preference.

For the dichotomous independent variables, independent samples *t*-tests were used to compare the means of the two groups in each independent variable, which are reported in Appendix D. The results are given here without much detail or further discussion, because these bivariate relations are meant mainly as a descriptive background to the multivariate analyses in the next section.

Considering the results of the first semester, it was found that there were significant differences between the mean GPA of the groups formed according to all variables, and all in the expected direction. Considering the GPA of the second semester, the mean GPAs of all groups were higher, due to selection. For the same reason probably, the difference between the students who were admitted through the ESECE and those who took a different type of examination was now smaller, and not significant anymore, which is also due to the relatively large variation among the non-ESECE students.

The difference between men and women reduced considerably in the second semester and is not significant anymore, probably due to selection. The shift in the difference between the groups of re-admitted and newly admitted students is remarkable. In the second semester, the newly admitted students performed better. For all other groups the differences were significant and in the expected direction.

Next, the results of the first semester for students in the Natural Sciences were considered. All groups are significantly different, except for the groups formed

according to the type of examinations, again due to the large variation in the group of students who did not take the ESECE. In the second semester the differences remain, also between men and women. Again, it is observed that now the newly admitted students performed better than the re-admitted students.

Considering the results of the two semesters for the Social Sciences students, it was found that the mean GPA of the groups in the variables previous post-secondary education and type of examinations were significantly different, which differences disappear in the second semester. In both semesters newly admitted students performed significantly better than re-admitted students, which difference is significant only in the second semester.

Considering the GPA of the first semester of the freshman program for students with post-secondary education, there were significant differences between the mean GPA of the groups formed according to the variables: type of examination, new admission or readmission, stream and gender, all in the expected direction. These differences disappear in the second semester, except for the difference between Natural Sciences and Social Sciences students. Also, for students with post-secondary education, newly admitted students performed better than re-admitted students in the second semester.

For the students without post-secondary education, larger differences are observed in the first semester, for all groupings. In the second semester, the difference between students admitted according to and not according to preference remains. Here too, newly admitted students performed better than re-admitted students.

In Table 4.4 the correlation coefficients of the continuous predictor variables with the semester GPAs are reported.

Table 4.4 Pearson's correlation coefficients for various combinations of the dependent variables and the predictor variables.

	All students		Natural Sciences		Social Sciences	
	Semester 1 GPA	Semester 2 GPA	Semester 1 GPA	Semester 2 GPA	Semester 1 GPA	Semester 2 GPA
GPA	.51	.43	.77	.53	.31	.45
Electives GPA	.22	.20	.37	.47	.08	-.02
Mathematics GPA	.41	.35	.45	.43	.35	.27
English						
Age	-.18	-.08	-.27	-.15	-.10	-.04

The relationship between the grade point averages for both semesters and the elective subjects was positive and of medium to high size. The Mathematics grade

point averages on the ESECE were positive and of medium size, with the strongest relationship between Mathematics and the GPAs for students in the Natural Sciences, especially in the second semester. The correlations between the English ESECE and GPAs are all positive and of medium size, although generally higher than the correlations between Mathematics and the GPA. They seem to be smaller in the second semester. The relationship between age and the semester GPAs is mildly negative.

In Table 4.5 the correlations between the academic variables are given for all students, and for students in the Natural and Social Sciences.

Table 4.5 Pearson's correlation coefficients for various combinations of the predictor variables.

	All students			Natural Sciences			Social Sciences		
	Age	Elect.	Math	Age	Elect.	Math	Age	Elect.	Math
GPA Electives	-.133			-.189			-.059		
GPA Mathematics	-.067	.233		.073	.310		-.033	.035	
GPA English	-0.55	.217	.102	-.102	-.321	.207	-.066	.063	-.043

It can be observed from Table 4.5 that the correlations between the semester GPAs and the ESECE results are all higher for students in the Natural Sciences than for students in the Social Sciences. The correlations for all students are more or less the means of the two correlations for the separate groups. Only for the Natural Sciences there may be some incidence of mild multi-collinearity between the three academic variables.

After this description of the dependent and predictor variables, the regression analysis is discussed in detail.

4.5 Regression analysis

To obtain insight into the simultaneous effect of the various explanatory variables, linear regression analyses were carried out. Separate analyses were performed with the grade point averages of both semesters 1 and 2 as dependent variables for all students together, the Natural Sciences students, the Social Sciences students, students with previous post-secondary education, and students without previous post- secondary education.

Different regression models were estimated, based on the distinction between three types of predictor variables: academic, admission, and person-related

variables. First a model was estimated including only the academic variables. Next, the personal and admission-related variables were added. This turned out to always lead to a significant increase in the explained variance, with small changes in the estimated regression coefficients of the academic variables. The third step consisted of the investigation of all interaction effects (as formulated in hypothesis 4.10). In addition, some non-linear effects of the academic variables were tested. Only few interactions proved to be significant, with no significant increase of the explained variance.

In Table 4.6 an overview is given of the R^2-measures (explained variance) of the various models. It can be observed that the explained variance of the model with only the academic predictor variables is lower in the second semester for all groups, except for the Social Sciences, implying that the predictive power of the academic variables diminishes for the second semester. The explained variance is highest for the group of Natural Sciences students, followed by the group of students without previous post-secondary education. Academic variables explain a great deal of variance, admission and person-related characteristics have a relatively lower contribution to the explained variance.

Table 4.6 Explained variance (R^2) measures for all estimated models

		All students		Natural Sciences		Social Sciences		Previous Education		No previous Education	
Model	Semester	1	2	1	2	1	2	1	2	1	2
Academic		0.37	0.27	0.53	0.45	0.21	0.25	0.31	0.21	0.42	0.31
+ Personal +		0.50	0.38	0.59	0.48	0.27	0.36	0.39	0.30	0.52	0.43
Admission-related + Interaction effects		0.50	0.39	0.60	0.49	0.27	0.36	0.40	0.33	0.52	0.43

Here, only the results of the second model, with academic and personal and admission-related variables are presented, in Table 4.7 for the first semester and in Table 4.8 for the second semester. In Appendix E, the results of the first and third regression analysis are given for both semesters, respectively.

First the results of the first semester are interpreted, separately for all students and for the different groups of students, followed by a similar section for the second semester results.

4.5.1 Results of the first semester of the freshman program for all students

In Table 4.7, it can be observed that the GPA for the elective subjects was a significant predictor of the performance of students in the first semester of the

freshman program and consistently so. An additional unit of GPA in the elective subjects adds on average a GPA of 0.47 in semester 1 of the freshman program.

Mathematics is a significant predictor of the performance of students in semester 1 of the freshman program in all models. An additional unit of grade in Mathematics adds, on average, a grade point average of 0.18 to the results of the first semester. Likewise, an additional unit of grade for English, also a significant effect in all models, adds, on average, a grade point average of 0.27 in semester 1. Students with previous post-secondary education had, on average, a 0.21 higher GPA than those without such experience. Students who were admitted to the university through the ESECE were likely to score, on average, 0.38 higher than those who did not take the ESECE. Students admitted to streams of their preference score, on average, 0.22 higher than those admitted without desire. Re-admitted students score, on average, 0.12 higher than those newly admitted. Social Sciences students score, on average, 0.39 higher than those in the Natural Sciences stream. Male students were likely to score, on average, 0.12 higher than female students. All these estimated effects are calculated under the assumption that the other mentioned variables remain constant. The admission category was not a significant predictor of the performance of students in the first semester of the freshman program.

4.5.2 Results of the first semester for students in the Natural Sciences

The effects of the electives, Mathematics, English, previous post-secondary education, admission based on preference, new admission or readmission, sex, and age for students in the Natural Sciences were more or less similar to those for all students, both in magnitude and direction. The effects of desired stream and readmission were stronger for the Natural Sciences as compared to all students. Students admitted to the stream according to desire score, on average, 0.28 higher than those admitted to the stream without desire. Readmitted students score, on average, 0.27 lower than those newly admitted. The effects of types of examination and admission category were not significant predictors of the performance of Natural Science students in the first semester of the freshman program.

4.5.3 Results of the first semester for students in the Social Sciences

The effects of the electives, Mathematics, English, previous post-secondary education, and age for students in the Social Sciences were more or less similar to the model estimates for all students, both in magnitude and direction, except for the effect of readmission. The effect of English on students' performance in the first semester of the freshman program was higher than the effect when all students were considered, the effect of electives and Mathematics were lower. Students who were admitted to the university based on the ESECE results had, on average, a 0.48 higher GPA than those admitted using other entrance examinations. Such an effect was not found for the students in the Natural Sciences.

Table 4.7 Linear Regression of semester 1 GPA for all students, Natural and Social Sciences, students with and without post-secondary education, unstandardized regression coefficients with *t* values in parentheses.

Predictor variable	All students	Natural Sciences	Social Sciences	Previous Education	No Previous Education
Constant	-.03	-.04	.04	.56	-.04
	(-.19)	(-.16)	(.14)	(2.40)*	(-.15)
Electives	.47	.52	.36	.38	.51
	(18.85)*	(15.98)*	(8.95)*	(12.48)*	(14.15)*
Mathgpa	.18	.20	.11	.14	.19
	(11.29)*	(10.27)*	(4.19)*	(6.96)*	(8.42)*
Enggpa	.27	.24	.30	.22	.30
	(17.05)*	(11.03)*	(13.33)*	(10.92)*	(13.17)*
Postedu	.21	.21	.20	-	-
	(8.02)*	(5.97)*	(5.07)*	-	-
Examtype	.38	.21	.48	.31	.43
	(4.89)*	(1.91)	(4.47)*	(3.53)*	(3.71)*
Destream	.22	.28	-.11	.02	.24
	(5.14)*	(5.70)*	(-1.32)	(.22)	(4.38)*
Admcateg	.01	.05	-.04	-.10	-.02
	(.31)	(1.00)	(-.79)	(-2.02)*	(-.37)
Readmn	-.12	-.27	.10	.17	-.27
	(-2.10)*	(-3.68)*	(1.19)	(2.53)*	(-3.31)*
Stream	-.39	-	-	-.32	-.41
	(-14.64)*	-	-	(-9.57)*	(-10.84)*
Cohort94	.05	-.05	.17	-.03	-.11
	(1.05)	(-.75)	(2.27)*	(-.42)	(1.73)
Cohort95	.12	-.06	.29	.02	.16
	(2.44)*	(-.94)	(3.82)*	(.36)	(2.35)*
Cohort96	.07	.01	.12	-.08	.13
	(1.52)	(.12)	(1.55)	(-1.20)	(2.10)*
Cohort97	.18	.14	.18	-.06	.29
	(3.50)*	(2.23)*	(2.17)*	(-.92)	(4.10)*
Sex	.12	.12	.10	.13	.11
	(3.39)*	(2.27)*	(1.85)	(2.80)*	(2.23)*
Age	-.03	-.04	-.02	-.02	-.04
	(-6.21)*	(-5.37)*	(-2.60)*	(-2.64)*	(-5.48)*
R^2_{adj}	.498	.591	.270	.393	.519
(N)	2029	1169	860	807	1222

*$p < .05$

The effects of admission to streams according to desire, admission category, readmission or new admission and sex were insignificant for the results of the first semester of the freshman program.

4.5.4 Results of the first semester for students with and without previous post-secondary education

For students with previous post-secondary education, the effects of the electives, Mathematics, English, type of examinations, readmission, and gender were positive and significant. The effects of admission category, stream, and age are more or less similar to that of all students. The effect of admission, however, is opposite for the students with previous post-secondary education: re-admitted students scored 0.17 higher than newly admitted students. The effect of admission to streams of preference was stronger for all students as compared to those students with previous post-secondary education (.39 versus .32).

For students without previous post-secondary education, the effects of the electives, Mathematics, English, type of examinations, admission to streams of preference, and sex were positive and more or less similar to those of all students. Readmitted students scored .27 lower than newly admitted students. The effects of cohort 95, cohort 96, and cohort 97 were found to be significantly positive. The effects of electives, Mathematics, English, type of examinations, admission to streams of preference, and stream were stronger for students with previous post-secondary education than those without such kind of experience.

4.5.5 Results of the second semester of the freshman program for all students

In Table 4.8, it can be seen that the GPA for the elective subjects is a significant predictor of the performance of students in the second semester of the freshman program. One additional unit in the GPA for the electives adds, on average, 0.39 to the GPA of the second semester of the freshman program. An additional unit in the grade for Mathematics adds, on average, 0.15 to the GPA of semester 2. An additional unit in the grade for English adds, on average, 0.19 to the GPA of semester 2. Students with previous post-secondary education had, on average, a GPA of semester 2 higher by 0.07. Students who were admitted taking the ESECE examinations scored, on average, 0.17 higher than those admitted with other results. Social Sciences students scored, on average, 0.43 GPA points higher than Natural Science students. The effects of variables related to admission to streams according to desire, admission category, new admissions or readmission, year of admission, sex, and age were insignificant.

Table 4.8 Linear Regression of semester 2 GPA for all students, Natural and Social Sciences, students with and without post-secondary education, unstandardized regression coefficients with *t* values in parentheses.

Predictor variable	**All students**	**Natural Sciences**	**Social Sciences**	**Previous Education**	**No Previous Education**
Constant	.70	.52	.25	1.03	.51
	(3.81)*	(2.11)*	(.95)	(3.85)*	(2.04)*
Electives	.39	.43	.38	.35	.43
	(15.87)*	(13.37)*	(10.72)*	(10.07)*	(12.20)*
Mathgpa	.15	.23	.08	.10	.18
	(9.53)*	(11.37)*	(3.48)*	(4.39)*	(8.37)*
Enggpa	.19	.19	.19	.17	.20
	(11.70)*	(8.32)*	(8.97)*	(7.50)*	(8.85)*
Postedu	.07	.08	.03	-	-
	(2.87)*	(2.58)*	(1.10)	-	-
Examtype	.17	.07	.40	.06	.31
	(2.25)*	(.62)	(4.00)*	(.59)	(2.62)*
Destream	.05	.11	-.10	.01	.07
	(1.00)	(1.68)	(-1.27)	(.18)	(1.09)
Admcateg	.03	.05	-.01	-.01	.03
	(.71)	(.93)	(-.14)	(-.25)	(.55)
Readmn	.00	-.10	.15	.14	-.10
	(-.07)	(-1.40)	(2.00)*	(1.84)	(-1.47)
Stream	-.43	-	-	-.38	-.45
	(-16.21)*	-	-	(-10.15)*	(-12.45)*
Cohort94	.04	-.02	.23	-.03	.10
	(.79)	(-.24)	(3.51)*	(-.36)	(1.49)
Cohort95	.01	-.15	.27	-.02	.04
	(.26)	(-2.36)*	(3.97)*	(-.29)	(.65)
Cohort6	-.03	-.17	.15	-.12	.04
	(-.64)	(-2.83)*	(2.35)*	(-1.67)	(.64)
Cohort97	.11	-.27	.65	.08	.10
	(2.13)*	(-4.40)*	(9.14)*	(1.14)	(1.45)
Sex	.02	-.01	.09	.06	-.02
	(.54)	(-.17)	(1.91)	(1.11)	(-.34)
Age	-.01	-.02	.00	-.06	-.01
	(-1.44)	(-2.15)*	(-.33)	(-.80)	(-1.37)
R^2_{adj}	.379	.477	.357	.302	.431
(N)	1673	892	781	765	908

* $p < .05$

4.5.6 Results of the second semester for students of the Natural Science stream

In Table 4.8, the effects of English and previous post-secondary education are more or less similar for the Natural Sciences students and for all students taken together. The effects of the electives and Mathematics are stronger for the Natural Sciences students. Younger students score higher than older students. The effects of cohort 95, cohort 96 and cohort 97 are significant and negative. The variables admission on preference, types of examinations, admission category, readmission, cohort 1994, and gender are not significant predictors of the performance of Natural Sciences students in the second semester of the freshman program.

4.5.7 Results of the second semester for students of the Social Sciences stream

The effects of the electives and English are about the same for all the Social Sciences students and for all students taken together. The effect of Mathematics on students' performance in the second semester of the freshman program is lower for the Social Sciences students as compared to those of all students. The effect of the type of examinations is much higher for the Social Sciences students than for all students. Students who were admitted to the university based on the ESECE results had, on average, 0.40 higher GPA than those admitted using other entrance examinations. Newly admitted students score higher than readmitted students. The effects of admission on preference, previous post-secondary education, admission category, sex, and age are insignificant.

4.5.8 Results of the second semester for students with and without previous post-secondary education

For students with previous post-secondary education, the effects of the electives, Mathematics, English, and stream are all significant and similar to, or slightly weaker than the corresponding effects for the group of all students. The effects of type of examinations, admission to streams of preference, admission category, readmitted or newly admitted, and gender are insignificant.

For students without previous post-secondary education, again, the effects of the electives, Mathematics and English, and stream are all significant and similar to, but now somewhat stronger than the corresponding effects for the group of all students, and thus also for the group of students with previous post-secondary education. The type of examination is significant and of comparable size to that for the group of Social Sciences students. All other predictor variables are insignificant.

4.6 Conclusions

The aim of this chapter was to investigate some of the possible factors that affect the performance of freshman students based on pre-university characteristics. The results of the two semesters of the freshman program are used as separate dependent variables. The results of the multiple linear regression analyses derived from estimating the models for the freshman students confirmed many hypotheses. The results for all variables, except for age, are summarized in Table 4.9. A parameter estimate of 0.40 or higher is considered a strong effect, a parameter estimate between 0.15 and 0.40 a medium effect, and a parameter estimate smaller than 0.15 a small effect. The hypothesis (4.9) that younger students perform better than older students was not rejected in most models, its effect is mostly small however, considering an age difference of 5 years.

Table 4.9 Summary of effects of variables on the performance of students in the freshman program of the university.

Hypothesis	**Strength of predictor variable**	**All students**		**Natural Sciences**		**Social Sciences**		**Students with post sec. edu.**		**Students without post sec. edu**	
	Semester	1	2	1	2	1	2	1	2	1	2
Academic											
4.1	GPA for electives	+++	++	+++	+++	++	++	++	++	+++	+++
4.1	GPA for Mathematics	++	+	++	++	+	+	+	+	++	++
4.1	GPA for English	++	++	++	++	++	++	++	++	++	++
Academic/person-related											
4.2/4.10	Post-secondary education	++	+	++	+	++	0				
4.3	Admission through ESECE	++	++	0	0	+++	+++	++	0	+++	++
4.4	Desired stream (Yes/No)	++	0	++	0	0	0	0	0	++	0
4.5	Regular admission category	0	0	0	0	0	0	+	0	0	0
4.6	Readmission	-	0	--	0	0	+	++	0	--	0
4.7/4.10	Social Sciences stream	++	++					++	++	+++	+++
4.8	Men	+	0	+	0	0	0	+	0	+	0
Explained variance		.50	.39	.60	.49	.27	.36	.40	.33	.52	.44

+++/--- = Absolute value of positive/negative parameter estimate higher than .40

++ = Absolute value of positive/negative parameter estimate between 0.15 and 0.40

+ = Absolute value of positive/negative parameter estimate less than 0.15

0 = Not significant

4.6.1 Conclusions for the two semesters of the freshman program presented separately

In all models, most of the variation of the first semester is explained by the academic results of the ESECE. The electives and English are consistenty significant predictors of medium to large size of the performance of all students, Natural and Social Sciences considered separately. The effect of Mathematics is significant, too, but somewhat weaker, especially for students in the Social Sciences and for students with previous post-secondary education. Students with higher ESECE GPAs score, on average, higher results in the first semester of the freshman program, which confirms hypothesis 4.1. Effects that range between small and medium are found for all other hypotheses, except for a strong effect for admission through the ESECE for the Social Sciences students and for stream in the category of students without post-secondary education.

For all students and for students with and without post-secondary education, stream came out as a significant predictor of the performance of students in both semesters, with students in the Social Sciences likely to earn better grades than those in the Natural Sciences. Some evidence was found for differential effects of the variables between the streams, especially for the effect of GPA electives and admission to desired stream, both with a stronger effect for the Natural Sciences students. Most remarkable was the effect of readmission, which was postulated to be positive. A positive effect was only found for students with previous post-secondary education and for students in the Social Sciences stream in the second semester. A negative effect, however, was found for Natural Sciences students and students without previous post-secondary education.

Moreover, the explained variance of the Natural Sciences stream is higher than that of the Social Sciences stream, indicating that the variables better explain student performance in the natural Sciences stream than in the Social Sciences stream. Similarly, the variables better explain student performance for students without post-secondary education than for the students with post-secondary education.

In the second semester, generally speaking, the same results are found. The effect of the Mathematics GPA is reduced as well as the effect of age, which is possibly due to the selection effect of the students who passed the first semester. The effects of the independent variables are already present during the first semester, while during this semester students are getting accustomed to the university's environment, rules and regulations, and efficient use of the existing facilities. In general, it could be said that they are relatively well settled in semester 2 after about four to five months study and experience at the university.

The effect of the ESECE admission has become stronger for the Social Sciences students. Students who took the ESECE are mainly those who followed the curriculum in the high schools of Eritrea. Most of the high school courses, especially in the Natural Sciences stream, are related to the courses in the university.

The background of those admitted through other criteria could probably be unrelated to the courses offered in the university. In addition, for most of them, the medium of instruction in their previous high schools was Arabic. This might have contributed to their low performance in the Social Sciences stream in the university.

4.6.2 The freshman program considered as a whole

In both semesters, the prominent factors positively influencing student performance uniformly are the entrance examinations, which include the elective subjects, Mathematics, and English. Stream of specialization and previous post-secondary education also play a very important role in explaining the performance of students at freshman level. In both semesters, the explained variance is higher in the Natural Sciences than in the Social Sciences stream indicating that success in the former is better explained by the available variables than in the latter. Also, the explained variance is higher for students without previous post-secondary education than for students with that experience. As a general remark, it could be said that the variables put together explain to an important extent the dependent variables in both semesters.

In Section 3.5 of Chapter 3, regarding the predictive validity of the entrance examinations, it was stated that the 1998 entrants would not be considered for this particular study, since results of the 1998 entrants are not available. However, using the data of the 1993 to 1997 entrants and the above results, it can be concluded that the high predictive power of the entrance examinations is a positive indicator of its validity. It may be important to note that the presence of bad items decreases the validity and reliability of an examination, but it does not reduce the validity to zero as far as there are also good items. The predictive validity is caused by the presence of good items.

The next step is to check what influences the performance of those students who have completed the freshman program and who are able to continue their studies at second year level. This will be discussed in the following chapter.

5

The impact of departments on students' performance

5.1 Introduction

Besides the university entrance examinations, the final exams of the two semesters of the freshman program were difficult hurdles for students to take to be admitted to the second year program. In Chapter 4, some of the characteristics affecting the performance of students during their stay in the freshman program were investigated.

For students who were promoted to the second year program with a cumulative GPA between 1.75 and 2.00, the first semester of the second year program is challenging. Such students have to earn a cumulative GPA of 2.00 at the end of the first semester of the second year program in order to be admitted to the next stage. That means they have to work hard in order to make up for their deficiencies of the freshman program. Students who manage to complete the freshman program and those who are otherwise promoted to the second year, are placed in a department by the Admission and Placement Committee, consisting of academic staff members, which processes the placement of the first year students in the departments, with final approval by the President of the University. Students in the Natural Sciences stream are placed in the various departments in the Colleges of Agriculture and Aquatic Sciences, Engineering, Science and Health Sciences. Similarly, students in the Social Sciences stream are placed in the different departments in the Colleges of Arts and Social Sciences, Business and Economics, and Law.

A problem is that the preferences of students do not match the available places. One of the most important points to have been considered by the Admission and Placement Committee in processing the placement of students has been the far-reaching effect of current placement procedures on students' career structure and future employment prospects. The second point has been the students' right to go to departments of their preference as much as conditions permit. However, the implementation has always been rather difficult because of the placement limitations in all departments.

One of the recommendations adopted by the Admission and Placement Committee has been the placement of students according to their first preference as far as the number of first choices is less than, or equal to, the number of spaces available in the department. Whenever the number of places available in a department has been smaller than the number of first preferences, students have been placed on the basis of their cumulative grade point averages. Thus, students with a higher GPA in the freshman program have had the advantage of being placed

in departments according to their choice. The remaining students have been placed in departments of their second, third, etc. preferences on the basis of the availability of vacancies, choice, and cumulative grade point averages. As a matter of principle, students were not placed in departments that offer courses for which they earned a grade of "F".

Table 5.1, showing the percentage of students placed in the departments according to their preference, hints at the seriousness of the problem. The table indicates that in most of the departments, part or all of the students were placed in the department against their desire. It is worst in the departments of English and Educational Psychology, in which not a single student was placed according to preference. In some departments placement of students was a combination of according to and against their preference. Placements in the departments of Marine Biology, Civil Engineering, Accounting, Economics, Management, Law, Political Science, Pharmacy, Geology, Statistics and Demography, however, were always according to students' preferences.

Some departments are not included in the list of Table 5.1. These are new departments in the college of Education, where students are supposed to take extra educational courses to be trained as future high school teachers. All students assigned to these departments in the year 1996 did not desire to study there.

Table 5.1 Percentages of students placed in departments according to preference

Natural Science Department	%	Social Sciences Department	%
Geology	100	Accounting	100
Marine Biology	100	Economics	100
Pharmacy	100	Management	100
Civil Engineering	100	Political science	100
Nurse Practitioner	86	Law	100
Chemistry	41	Statistics & Demography	100
Animal Science	37.4	Journalism & Mass Communication	95
Biology	35	Archaeology	88.9
Plant Science	33,5	Geography	77.8
Mathematics	25	Sociology & Anthropology	75
Physics	22	History	42.9
Soil & Water Conservation	7	Educational Psychology	0
		Educational Administration	0
		English	0

It is to be expected that, from the moment of placement, the departments will have an influence on a student’s progress. With respect to attrition rates over the four years of university study the first semester of the second year program has been third, after the two freshman semesters. Therefore, as was done for the freshman program, it is relevant to examine some pre-university explanatory variables that may affect the performance of students in the first semester of the second year

program. Here, the proposed approach will be slightly different since it is expected that extra insight will be obtained by considering not only student characteristics, but also differences between departments. Two important reasons can be given for these differences: general differences between students because of the required abilities or skills for certain departments (for instance Mathematics for Natural Sciences departments), but also differences due to the placement policy of the University of Asmara. Therefore, with respect to performance of the second year students, it is appropriate to ask (1) what are the factors that explain differences in performance among students, as we did for the freshmen year; and to pose the additional question, (2) are there factors that explain differences in performances among departments?

A review of the literature reveals that some evidence of the importance of departmental factors is found. Van der Hulst and Jansen (2002) found that study progress depends on both student characteristics and organization of the curriculum, which differs per department. Morgan, Flanaghan and Kellaghan (2001), in their study of non-completion in undergraduate university courses, noted that institutes differ in both the overall completion rates and the size of the differences in the various fields of study. They also found effects of the field of study and the particular institute attended on the extent of gender differences in performance. Porter (2000) examined the impact of academic departments on students' satisfaction. After controlling for individual characteristics, he found that variables such as size of departments, faculty contact with students, research emphasis, and proportion of female undergraduates had an impact on satisfaction with education in the major. This in turn affected performance in their studies.

For the University of Asmara, there is reasonable evidence that academic performance of students does differ between departments, as is illustrated in Figure 5.1 showing the mean ESECE GPA as well as the mean GPA of the first semester in the second year for the various departments.

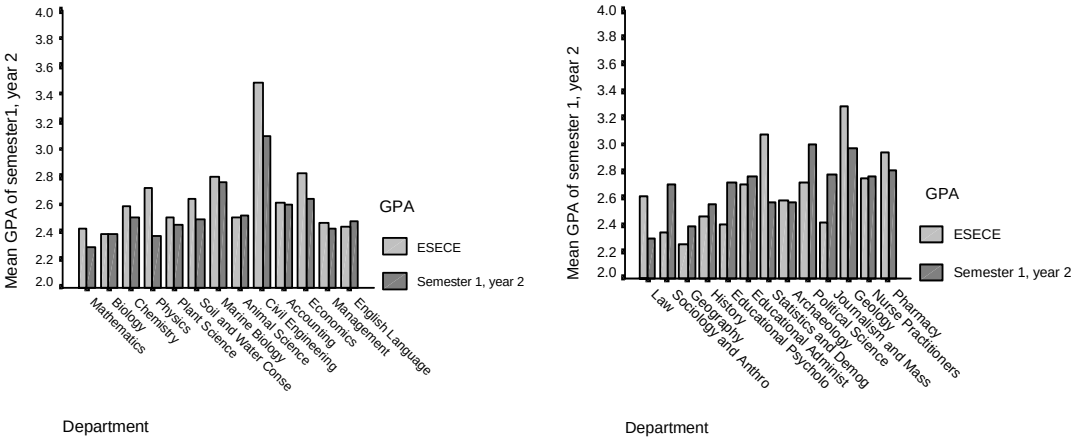


Figure 5.1 Mean GPA of the first semester of second year program and ESECE by Departments

It is the aim of this chapter to answer the two research questions stated above. As in Chapter 4, regression analysis is used. For the second question, dealing with differences between departments, a special type of regression analysis, multilevel analysis, has to be used. The ideas and assumptions of multilevel analysis are explained in the next section, together with the hypotheses to be tested. In Section 4, the data are described, that are analyzed in Section 5 with both ordinary and multilevel regression analysis. A discussion of the results concludes the chapter.

5.2 Methods and hypotheses

The research questions imply investigations of the differences between students and between departments. To answer the first question 'what are the factors that explain differences in performance among students' ordinary regression analysis can be used. This analysis is used as a first step in preparation of the multilevel analysis. It is meaningful to include results of the freshman program in addition to the pre-university characteristics to investigate their effect on the performance of students in the first semester of the second year program. Lack of academic integration, often measured as results after a certain period of time, according to theories on college dropout (Spady, 1971; Tinto, 1987; Pascarella, 1980), is one of the most important predictors of dropout. Therefore, in addition to the expected effects of student characteristics mentioned in Chapter 4, the following hypothesis has been formulated:

Hypothesis (5.1)	*Grade point average in the freshman program has an effect on the performance of students in the first semester of the second year program.*

However, the freshmen results play a different role among the explanatory variables than the student characteristics known before the start of the first year and the department characteristics, because they cannot be used for a prediction of success at the moment of entry into the university. Therefore, separate investigations will be made of the effects of the variables excluding, and including, the freshmen results.

To answer the second research question 'are there factors that explain differences in student performance among departments', multilevel analysis has to be used. In a multilevel model, which can be viewed as a special type of linear regression model, the fact that the data concern performance of students who are grouped together in departments is explicitly taken into account (see, e.g., Bryk & Raudenbush, 1992, Goldstein, 1995, and Snijders & Bosker, 1999). That is, differences between the students but also differences between the departments are modeled by including error terms for both students at the so-called level 1 (here: students) as well as at level 2 (here: the department). The multilevel model derived its name from the fact that it distinguishes more than one level of dependence, with the first level always being the lowest level, i.e., the level of the dependent variable (here student performance). The data need to have a clear hierarchical dependence structure, that is level 1 units have to be neatly grouped (or nested) in level 2 units, which implies here that each student belongs to one department.

This statistical model implies that the performances of students in the same department are not assumed to be independent. This seems to be a sensible assumption, since the students in one department were selected by the same criteria, follow the same curriculum, and are taught by the same professors. They may be interacting more with each other than with students from other departments, and they may have further known and unknown similarities. Thus, the performances of students in one department are influenced by the same factors, which do not influence the performances of students in a different department.

The multilevel model was developed in the context of educational data, taking into account the hierarchical data structure (pupils nested in classes). Thus, it can answer questions about the influence of pupil characteristics on pupil outcomes, as well as the influence of instruction methods, and school or teacher characteristics (see the textbooks mentioned). Rumberger (1995) noted the importance of the perspective that focuses on the school or class level in addition to that of the student or individual level. Using a student-level analysis only, by employing the standard linear regression model, to study multilevel phenomena may result in misleading conclusions. Several software packages are available to carry out multilevel analyses. Here, the program MLwiN (Rasbash et al., 2000) was used.

The unbalanced composition of students resulting from the placement procedures is likely to have contributed to differences in student performance between the departments. Since whether placement was according to desire is not known at the individual level in the available data set, this variable can only be used at the department level. Moreover, possible differences in the methodological

aspects of the teaching-learning process, the facilities, grading systems, and the adequacy and competence of academic staff members in the various departments are also likely to cause differences between departments. These influences, however, are not reflected in this study by measured department-level variables, and therefore they are expected to lead to unexplained performance differences between the departments. A department-level variable that can, however, be computed from the available data is the average GPA of the ESECE, or its three constituents, per department. It is likely that the average GPA reflects the average ability of the department's students, which is expected to have an influence on individual student performance, in addition to the individual student-level ability itself. In multilevel analysis, the distinction between the effect of level-one predictors and of their derived level-two predictors is known as the difference between within-group and between-group regressions (Snijders & Bosker, 1999, p. 53).

Thus, the following hypotheses on department level are formulated:

Hypothesis (5.2)	*There is variability among departments not explained by student characteristics.*
Hypothesis (5.3)	*The larger the number of students placed against their desire the lower the performance of students in a department.*
Hypothesis (5.4)	*The higher the average GPA in Mathematics, English, and elective subjects on the ESECE, the higher the performance of students in a department.*

It should be noted that hypotheses (5.2) to (5.4) will not be tested separately from the first hypothesis. That is, the student-level characteristics that hypothesis (5.1) pertains to, will be included in the multilevel model. Consequently, the multilevel analysis will provide tests for all hypotheses, in addition to the ordinary regression analysis testing the first hypothesis.

5.3 Data

Data were collected from both the files of students in the Registrar's office of the University and from questionnaires distributed to students. The data were from the entrants of the years 1993 through 1996. Without considering students with missing values, the number of students was approximately 1000 (this depends on the model used). The number of departments was $N = 26$. In the original data the numbers of students per department ranged from 8 to 132. However, in the data used for the analyses in this chapter, the numbers of students per department ranged from 5 to 106 since some cases were not considered due to missing data. Descriptive figures and tables are based on all available data. The dependent variable was the GPA of students in semester 1 of the second year program. Its distribution is presented in Figure 5.2.

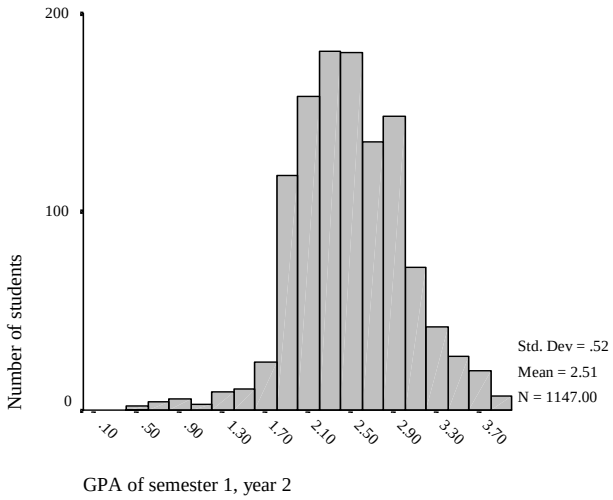


Figure 5.2 Distribution of GPA of students for the first semester of the second year program

For the student level, the explanatory variables considered in Section 4.3 were employed. However, since in preliminary analyses some of them were found to be insignificant predictors of the performance in semester 1 of the second year program, they were not included in this particular study. The variables included are the GPA for the elective subjects, the GPA for Mathematics, the GPA for English, stream of specialization in the freshman program, admission category (private/regular), and age at admission, divided into 6 categories (16/17, 18/19, 20/21, 22/23, 24/25, and older than 25). In a second analysis, the GPA of the freshman year was also considered as an explanatory variable.

Table 5.2 shows the differences in ESECE results, academic performance in the freshman program and the first semester of the second year by department.

Table 5.2 Mean grade point average for results of the ESECE, freshman program, and first semester of year 2, by departments

Department	*N*	Mean GPA of students						
		English	Math.	Electives	ESECE	Sem.1 Year 1	Sem.2 Year 1	Sem.1 Year 2
Mathematics	102	2.73	2.21	2.45	2.52	2.27	2.29	2.29
Biology	82	2.83	1.60	2.46	2.48	2.01	2.10	2.38
Chemistry	79	2.82	1.95	2.67	2.63	2.26	2.42	2.51
Physics	66	2.96	2.12	2.72	2.73	2.30	2.30	2.36
Plant Science	61	3.03	1.85	2.54	2.55	2.22	2.37	2.46
Soil & Water Conservation	49	2.82	1.97	2.68	2.62	2.43	2.51	2.48
Marine Biology	32	3.07	2.07	3.00	2.90	2.53	2.66	2.76
Animal Science	47	2.53	1.78	2.63	2.51	2.19	2.20	2.52
Civil Engineering	22	3.69	2.94	3.59	3.52	3.31	3.25	3.10
Accounting	101	3.09	1.96	2.64	2.62	2.86	3.01	2.61
Economics	91	3.28	2.09	2.88	2.83	3.05	3.17	2.63
Management	97	2.99	1.69	2.54	2.49	2.58	2.81	2.41
English	132	2.89	1.77	2.49	2.44	2.27	2.33	2.48
Law	63	3.42	1.67	2.63	2.68	2.81	2.84	2.29
Sociology & Anthropology	58	3.01	1.54	2.37	2.37	2.31	2.54	2.71
Geography	58	2.39	1.63	2.41	2.33	2.19	2.45	2.38
History	22	2.93	1.08	2.60	2.44	2.42	2.56	2.55
Educational Psychology	12	2.81	1.44	2.58	2.43	2.28	2.37	2.72
Educational Administration	10	2.84	1.42	2.90	2.65	2.59	2.85	2.77
Statistics & Demography	22	3.34	2.00	3.17	3.00	2.85	3.11	2.56
Archaeology	8	3.06	1.13	2.83	2.58	2.52	3.03	2.57
Political Science	13	3.75	1.35	2.74	2.77	2.89	3.06	3.00
Journalism & Mass Comm.	10	3.83	0.94	2.37	2.49	2.50	2.62	2.77
Geology	31	3.43	2.51	3.48	3.29	3.07	3.03	2.96
Nurse Practitioner	8	3.44	1.94	2.88	2.94	2.57	2.69	2.76
Pharmacy	15	3.65	2.16	3.07	3.17	2.86	2.95	2.81

Table 5.2 indicates that there was considerable variation in the performance of students in the different departments. The departments' mean GPA of the results of the first semester of year 2 varied from 2.29 to 3.10. The lowest mean GPA values were from the departments of Mathematics and Law. The highest mean GPA was from the department of Civil Engineering. The range of the mean GPA of the ESECE of the departments varied from 2.33 to 3.52. The departments of Geography and Civil Engineering had the lowest and the highest mean GPA of the ESECE, respectively. It can be observed that the mean GPA of students in the Civil Engineering department was the highest in the Mathematics ESECE, elective subjects, and the overall ESECE. The mean GPA of the ESECE in the departments of Mathematics, Chemistry, Physics, Soil and Water Conservation, Civil

Engineering, Economics, Law, Statistics and Demography, Geology, and Pharmacy was higher than the corresponding mean GPA of the results of year 2. The mean GPA of the ESECE in the departments of Sociology and Anthropology, Educational Psychology, and Political Science was lower than the corresponding mean GPA for the results of the first semester of the second year program. The mean GPA of both the ESECE and the results of the first semester of the second year program were more or less equal for the departments of Animal Science, Accounting, and Archaeology.

5.4 Results

In this section, first the linear regression analyses investigating the effects of student characteristics and especially the effect of their first year performance on the GPA of the first semester in the second year are presented. These analyses can be viewed as a preliminary analysis for the multilevel analysis that will be presented in Section 5.4.2.

5.4.1 Linear regression: Which factors explain differences in performances between students?

In Table 5.3 the results of two linear regression models are presented. The presentation differs slightly from the one in Chapter 4. In view of the multilevel analysis presented in the next section, standard errors of the parameter estimates are given instead of t-values.

In the first model it is found that the pre-university academic results are significant predictors of the GPA in the first semester of the second year. Stream is also an important variable. Its negative regression coefficient implies that the GPA of Natural Sciences students in the first semester of the second year is, on average, 0.088 point lower than that of Social Sciences students who have the same ESECE results, the same age and the same admission category. Older students are somewhat less likely to score higher than younger students. Although its effect is not significant at the 0.05 level, but close to it, admission category is kept in the model, indicating that regular students score on average 0.077 point higher than private students. All other variables were found to be insignificant predictors of the performance of students of the first semester of the second year program and are left out of the model. The explained variance is lower than in the models predicting the first year performance.

Table 5.3 Linear regression of GPA of students in the first semester of the second year program

Predictor	Model 1		Model 2	
	B	*S.E.*	*B*	*S.E.*
Constant	1.427*	0.109	0.849*	0.111
Academic				
Electives	0.244*	0.029	0.096*	0.030
Mathgpa	0.042*	0.021	-0.016	0.021
Enggpa	0.145*	0.018	0.097*	0.018
Sem2gpa			0.454*	0.035
Admission and person-related				
Stream	-0.088*	0.031	0.005	0.030
Admcateg	0.077	0.044	0.074	0.041
Age (category)	-0.040*	0.015	-0.029*	0.014
Adjusted R^2	0.16 (N = 1009)		0.29 (N = 985)	

**Significant at .05 level*
B Unstandardized regression coefficient
S.E. Standard error

From Table 5.3, in Model 1, it can be seen that the GPA for the elective subjects had a higher predictive power than the other characteristics. Considering Model 1, for one unit increase of the GPA in the elective subjects, there was, on average, an increase of a GPA of 0.244 in the first semester of the second year program. For one unit increase of the GPA in English, there was, on average, an increase of a GPA of 0.145 in the first semester of the second year program. Students in the Social Sciences stream were more likely to score better in the first semester of the second year program as compared to the students in the Natural Sciences stream. Note that unlike for the prediction of the first and second semester GPA of the first year found in Chapter 4, no effect of previous secondary education is found. Apparently, the effect is limited to the first year.

As a next step, the freshman results are included in the regression model to predict the GPA in the first semester of the second year. It is to be expected that more recent academic results are relevant. The GPAs of the first and second semesters of the first year are used to measure these results. Of course this analysis is about a prediction possible only after finishing the first year, whereas the first model of Table 5.3 indicates prediction possibilities at the moment of admission to the freshman year of the university.

The analysis is presented as Model 2 in Table 5.3. It is found that the includion of the GPA of the second semester of the first year improves the adjusted R^2 considerably to 0.29. The GPA of the first semester does not improve the model any further due to the large collinearity between the results of the two semesters. Model 2 shows that the first year results have the strongest effect. Of the ESECE results, the Electives and English retain significant effects, although these are

weaker than in Model 1. The GPA for Mathematics is negatively effected, but this is not significant and therefore this result does not merit attention. The effect of Stream also loses its significance. It can be concluded that an important part of the effects of the ESECE results are mediated by the first year results: the ESECE results have an effect on the first year results, and these in turn have an effect on the second year results. For students with the same GPA in the freshman year the effect of the ESECE GPA on Electives and English remains, although it is much smaller than when the freshman year GPA is not controlled for.

The negative effect of Mathematics may seem strange at first sight, but can only be interpreted by taking into account the fact that this effect is obtained in a model that controls for the first year GPA (i.e., the latter variable is held constant), and the first year GPA itself is positively affected by the GPA for the Mathematics ESECE. At this moment no interpretation is given; since a multilevel analysis, as will be carried out later in this chapter, is more appropriate. In the multilevel analysis, different and better interpretable results are found, as will be explained in the next section. Note that the other pre-university academic results (Electives and English) have not lost their predictive power, notwithstanding their decreased regression coefficients. No other significant interaction effects were found.

In the next section these findings will be compared to the results found by means of a multilevel analysis.

5.4.2 Multilevel analysis: Which factors explain differences in performances between students and between departments?

In this section, the results of the multilevel analysis of student performance in the first semester of the second year are presented. Several models are presented, with increasing complexity. Ample attention will be paid to the explanation and interpretation of the models. The presentation of the multilevel models in tables is somewhat different from that of the ordinary regression models, due to the necessity to present the two sources of variance: between students (level 1) and between departments (level 2). Some concepts from multilevel analysis are discussed below. They are further explained in textbooks such as Snijders and Bosker (1999). A distinction is made between so-called fixed effects, the regression coefficients, and the random effects, also called variance components. In multilevel models, the so-called intercept denotes the constant in the regression equation. The deviance reported in the tables is the logarithm of the likelihood value, multiplied by –2. The overall improvement of the model obtained by including extra effects may be tested by the decrease in deviance. The difference in deviance between two nested models, e.g., a smaller model with m variables and a larger model with the m variables from the smaller model plus p additional effects, is asymptotically χ^2 distributed with p degrees of freedom under the null hypothesis that the simpler model is true.

Model 0: the empty model

The so-called empty model is a model without student-level or department-level variables. In the empty model, the dependent variable Y_{ij} is modeled as

$Y_{ij} = \gamma_{00} + U_{0j} + R_{ij}$,

where index i denotes the student, and index j the department. The intercept is denoted by γ_{00}, and the terms U_{0j} and R_{ij} denote the deviations at the department and the student level with variances τ_0^2 and σ^2, respectively. The empty model can also be viewed as a random effects model with independent factors having effects U_{0j} and R_{ij}, randomly varying with mean zero and variances τ_0^2 and σ^2.

With the information of this model it is possible to partition the variance in the outcome variable between variances at the student level and at the department level. Thus, the differences between departments can be investigated. Table 5.5 presents the results.

Table 5.4 Estimates for the empty model (Model 0)

Effect		Parameter estimate	*S.E.*
Fixed	γ_{00} = Intercept	2.586	0.042
Random		Variance component	S.E
Level-two variance:	τ_0^2 = var (U_{0j})	0.255	0.012
Level-one variance	σ^2 = var (R_{ij})	0.035	0.012
Deviance		1428.8	

The intra-class correlation coefficient, or the relative amount of variance in the dependent variable explained by the departments, is given by:

$$\rho_I(Y/X) = \frac{\tau_0^2}{\tau_0^2 + \sigma^2} = \frac{0.035}{0.035 + 0.255} = 0.12 .$$

Snijders and Bosker (1999) define the intra-class correlation as the correlation between two randomly drawn individuals in one randomly drawn group. Another definition is the fraction of total variability that is due to the group level. They also note that intra-class correlations in educational research of this nature commonly range between 0.05 and 0.20. The result obtained here lies in this interval. Finding that the department level accounts for 12% of the variability of second year results is substantial but not extremely high. For the overall distribution of the grade point averages, the estimated mean grade point average is 2.59 with a standard deviation of

$\sqrt{0.035 + 0.255} = \sqrt{0.290} = 0.54.$

Therefore, the expected grade point average at the level of the second year, semester one, for a random student in a randomly drawn department is 2.59 with a standard deviation of 0.54. These parameter estimates are close to the raw mean, 2.51 with standard deviation 0.52. The estimated variance of the intercept term is 0.035 and significant, suggesting variation or differences between departments.

Model 1: the random intercept model

The next step is the estimation of the random intercept model, with explanatory variables being added to the empty model. Here the student-level academic variables and admission and person-related variables are added, as well as the department-level variable Stream, plus a so-called cross-level interaction variable (i.e., the product of a level 1 and level 2 variable). To obtain a usefully interpretable intercept, the academic variables are centered around the middle value of their range. This means that the range for the English GPA now is from -1.5 to 1.5; for Mathematics GPA the range is from -2 to 2; for the Electives GPA it is from -1.33 to +1.33. In the following tables a distinction is made between various types of explanatory variables, at level one (e.g., age), at level two (e.g., stream), and cross-level interactions (e.g., the interaction between stream and the GPA for Mathematics on the ESECE).

The results of the multilevel analysis of the model comparable to Model 1 in Table 5.3 are presented in Table 5.5. Comparing these results to the analogous regression results of Table 5.3, it can be observed that there are almost no differences for the estimated regression coefficients estimated in the first model.

Table 5.5 Estimates for the random intercept model (Model 1) and the random intercept model with between- and within-regression effects (Model 2)

	Model 1		Model 2	
Effect	Parameter	*S.E.*	Parameter	*S.E.*
Fixed				
Constant	2.588*	0.074	2.652*	0.109
Level 1				
Academic				
Electives	0.253*	0.031	0.245*	0.032
Mathgpa	0.007	0.029	0.056*	0.022
Enggpa	0.148*	0.019	0.150*	0.019
Admission and person-related				
Admcateg	0.065	0.044	0.064	0.045
Age (category)	-0.046*	0.015	-0.046*	0.015
Level 2				
Stream	-0.118*	0.063	-0.080	0.068
% Dedept			-0.100	0.100
Mean Electives			0.343*	0.171
Mean Mathgpa			-0.364*	0.137
Mean Enggpa			-0.074	0.121
Cross-level interaction				
Int[1]	0.103*	0.045		
Random				
Level-two variance	0.019	0.007	0.014	0.006
Level-one variance	0.216	0.010	0.217	0.010
Deviance	1263.8	(*N*=943)	1261.5	(*N*=943)

* *Significant at .05 level*
S.E. Standard error
Int[1] Interaction of stream and GPA (centered) for Mathematics on the ESECE.

The residual level-one variance (σ^2) is lower in the random intercept model than in the empty model since between-students differences were partially explained in the second model. The same is true for the level-two variance (τ_0^2). In the random intercept models the total variance has decreased to 0.235. It is possible to calculate two measures of explained variance, at level one, R_1^2, and at level two, R_2^2 (see Snijders & Bosker, Chapter 7). The level-one explained variance is the most important, and is analogous to R^2 in the linear regression model. It is defined as

$$R_1^2 = 1 - \frac{\sigma_m^2 + \tau_{0m}^2}{\sigma_e^2 + \tau_{0e}^2},$$

where the numerator with subscripts m refers to the variances under the estimated model, and the numerator with subscripts e refers to the variances under the empty model. The value of R_1^2 is equal to 1 – 0.235/0.290 = 0.19 for the model of Table 5.5. This value is close to the value obtained for the linear regression model. This

was to be expected, since explained variance in the multilevel model is defined, like in the regression model, as the proportion of variance explained by the fixed effects only. The overall improvement of the model may be tested using the deviance, given at the bottom of the tables. The difference in deviance between two nested models, e.g., the empty model and the first model from Table 5.5 containing all the effects of the empty model and seven additional effects, is asymptotically χ^2-distributed with 7 degrees of freedom under the null hypothesis that the simpler model (here the empty model) is true. Here, the difference with the empty model is 165.0. Not surprisingly, the model is a significant improvement with regard to the empty model.

The estimated residual intra-class correlation is given by

$$\rho_I(Y/X) = \frac{\tau_0^2}{\tau_0^2 + \sigma^2}$$
$$= \frac{0.019}{0.019 + 0.216} = 0.08 .$$

This result is smaller than the raw intra-class correlation of 0.12. This indicates that relatively more variation between departments has been explained than variation between students.

Model 2: with between- and within regression effects

To test hypotheses 5.2 and 5.3 more department-level variables are added: the percentage of students that are in the department according to their desire (% Dedept), presented in Table 5.1, and the per-department mean academic variables. The level-two average of a level-one explanatory variable is an important type of level-two explanatory variable. Including such variables makes it possible to distinguish within-department regression from between-department regression (cf. Snijders & Bosker, p. 53). (For the moment, interaction effects are not considered, because they are more appropriate when dealing with the random slope models to be treated later in this chapter.) The results of Model 2 are given in Table 5.5.

For a department represented by the subscript j, the multilevel equation for this table is given by

$$\begin{aligned} Y_{ij} = 2.652 + U_{0j} &+0\ .245\ (\text{Electives})_{ij} +0\ .343\ (\text{Mean Electives})_j \\ &+ 0\ .056(\text{Mathgpa})_{ij} - 0.364(\text{Mean Mathgpa})_j \\ &+ 0.150(\ \text{Enggpa})_{ij} - 0.074(\text{Mean Enggpa})_j \\ &- 0.80\ (\text{Stream})_{ij} + 0.064\ (\text{Admcat})_j \\ &- 0.046\ (\text{Age})_{ij} - 0.100\ (\%\ \text{Dedept})_j + R_{ij} \end{aligned}$$

where U_{0j} is a department-dependent deviation with mean 0 and variance .014 and standard deviation 0.12. The within-department deviations about this regression equation, $R_{ij,}$ have mean 0, a variance of 0.217, and standard deviation 0.47.

Of the three ESECE GPA variables, the department mean is significant for Electives and Mathematics, not for English. This means that for Electives and Mathematics, the within-departments regression differs from the between-

departments regression. Let us study the coefficients first for Mathematics. The within-department regression coefficient that expresses the effect of the student's GPA for Mathematics on the ESECE is positive and significant. The effect of the department mean of the Mathematics GPA on the other hand, is significant with a large negative value (–0.364). The between-department regression coefficient is the sum of the two coefficients, (0.056 – 0.364) = –0.308. This means that the effect of Mathematics is much more important on the department level than on the individual level. A student earns, on average, a higher GPA in semester 1 of the second year program if the student is in a department with a lower average GPA in Mathematics; and also if the student has a higher GPA in Mathematics compared to others in his/her own department. Thus, the two effects of Mathematics have opposite signs.

For the Electives GPA, both the individual-level and the department-level effects are significant and positive. This means that students in a department with a higher average Electives GPA tend to have a higher first semester GPA in their second year; but also within departments, the individual students with a higher Electives GPA tend to score higher in the first semester of their second year than those individuals with a lower Electives GPA. For English, the department mean has no significant effect, so the effect of the English GPA can be regarded as a purely individual-level effect.

The percentage of students admitted according to desire in a department, and the stream, do not have significant effects. Apparently, the differences between departments are better explained by mean GPA scores of their student population than by the percentage of students admitted according to desire, or whether they belong to the Natural or Social Sciences.

The inclusion of explanatory variables at the department level has further decreased the level-two variance to 0.014. The proportion of explained variance at level-1 is now 0.20.

Model 3: a random slope model

To study differences between departments with respect to the effects of student characteristics, so-called random slope models were estimated as a next step. This means (cf. Snijders & Bosker, 1999, Chapter 5) that the regression coefficients of student-level variables can depend on the department, or, put differently, may vary over departments. As a first step in this direction, a model was estimated in which all GPA variables for the ESECE have random slopes. The model as a whole was an improvement over model 2 of Table 5.5 (deviance difference 1261.5 – 1229.7 = 31.8, $d.f. = 9$, $p < 0.001$).

Before the results are interpreted, an attempt is made to obtain a somewhat better fitting model. In the first place, the interaction between stream and the GPA for Mathematics on the ESECE (see Table 5.6) is re-introduced. To remain consistent with the distinction between ESECE results as individual-level variables and as departmental means, the interaction effect between stream and departmental mean GPA for Mathematics is also included. It turns out that in this model, several

effects can be excluded because they are far from significant. These are the random slope of the GPA for Mathematics on the ESECE (which is "explained" by the cross-level interaction between stream and the GPA for Mathematics), the percentage of students admitted according to desire, and the department mean GPA for English. The individual GPA for Mathematics, although not significant, is retained as a main effect because it is also included in the interaction effect. The random slope of the English GPA is rather small (slope variance 0.005) but is nevertheless significant (χ^2 = 9.8, *d.f.* = 3, $p < 0.05$). The resulting more parsimonious model (which still contains some non-significant effects) is presented as Model 3 in Table 5.6.

The main conclusions from this model are the following. Within departments, the effect of the GPA for Electives and English is positive, the effect of Electives being stronger. The non-significant main effect of the GPA for Mathematics together with the significant cross-level interaction effect indicate that for the Social Sciences stream, individual-level GPA for Mathematics does not have a significant impact, but for the Natural Sciences stream it does (estimated coefficient 0.017 + 0.093 = 0.110). Admission category does not have a significant impact, but the effect of age is significantly negative. Considering differences between departments, departments with an intake of students with a higher average GPA for Electives, and those with a lower average GPA for Mathematics, have a higher GPA in the first semester of the second year. Even when these intake characteristics are kept constant, the GPA in the Natural Sciences stream is lower than in the Social Sciences.

After controlling for all these effects, unexplained differences between the departments remain, as is reflected by the random intercept variance of 0.035 with corresponding standard deviation 0.19 and the random slope variances. Note that in this random slope model, the department intercept refers to a student with values of 0 on the variables having random slopes; since the GPA variables on the ESECE are centered at the middle values, this means that it refers to students with close to average ESECE results. A random slope implies unexplained variation of the effect of a certain explanatory variable between departments, that is, the effect is not the same over all departments and this is not, or not completely, explained by cross-level interactions. Two variables whose random slope led to a significant improvement of the random intercept model were the GPA for Electives and English; the random slope of the GPA for Mathematics, found in the first random slope model, was sufficiently explained by the interaction with Stream. The estimated random slope variance is largest for Electives, and therefore the interpretation will concentrate on this variable.

The standard deviation of the regression parameter of the GPA for Electives of the second semester in the first year is $\sqrt{0.025}$ = 0.16, implying that the within-department effect of this variable roughly varies between $0.248 - 2\times0.16 = -0.07$ and $0.248 + 2\times0.16 = 0.57$ (the mean plus or minus twice the standard deviation). The lower bound is so close to 0 that its being negative does not seem very

important. The range of the effect of the GPA for Electives does indicate that there are important differences between departments in how the students' academic abilities influence their results.

The correlation between random slope and random intercept for the GPA for Electives is given by

$$\frac{\tau_{01}}{\sqrt{\tau_0^2 \times \tau_1^2}} = \frac{Cov(U_{0j}, U_{1j})}{\sqrt{\text{var}(U_{0j}) \times \text{var}(U_{1j})}}$$
$$= \frac{-0.022}{\sqrt{0.025 \times 0.035}}$$
$$= -0.74.$$

This rather large negative correlation coefficient between random slope and random intercept means that an above average effect of GPA for Electives is more likely in a department with a below average mean GPA in the first semester of the second year. The proportion of explained variance at level 1 can be calculated (cf. Snijders & Bosker, 1999, page 105) from the random intercept model obtained from model RS3 by deleting the random slopes, and is equal to 21%.

To assess the overall improvement in fit compared to the Model 1 of Table 5.5, the decrease in deviance of 33.1 is compared to a chi-square distribution with 8 degrees of freedom (due to 3 additional fixed effects and 5 additional parameters in the random part); this decrease is significant with $p < 0.001$.

Table 5.6 Estimates for the parsimonious random slope model (Model 3) and the random slope model including results of the freshmen year (Model 4)

		Model 3		Model 4
Effect	Parameter	*S.E.*	Parameter	*S.E.*
Fixed				
Constant	2.551*	0.076	3.500*	0.477
Level 1				
Academic				
Electives	0.248*	0.047	0.089*	0.030
Mathgpa	0.017	0.029	0.009	0.020
Enggpa	0.147*	0.025	0.104*	0.017
Sem2gpa			0.542*	0.054
Admission and person-related				
Admcategory	0.070	0.043	0.054	0.039
Age (category)	-0.044*	0.015	-0.036*	0.013
Int[1]			0.051	0.038
Level 2				
Stream	-0.145*	0.052	0.020	0.071
Mean Electives	0.206	0.107	0.239	0.153
Mean Mathgpa	-0.306*	0.118	-0.398*	0.130
Mean Sem2gpa			-0.360*	0.175
Int[2]	0.207	0.195	0.279	0.196
Cross-level interaction				
Int[3]	0.093*	0.045		
Random				
Level-two (intercept) variance	0.035	0.014	0.011	0.005
Electives (slope) variance	0.025	0.014		
Enggpa variance	0.005	0.004		
Electives-intercept covariance	-0.022	0.011		
Enggpa-intercept covariance	-0.015	0.007		
Electives-Enggpa covariance	0.009	0.005		
Sem2gpa (slope) variance			0.029	0.016
Sem2gpa-intercept covariance			-0.009	0.007
Level-one (residual) variance	0.206	0.010	0.169	0.008
Deviance	1229.7	(N = 943)	1044.0	(N = 943)

**Significant at .05 level*
S.E. Standard error
Int[1] Interaction of GPA (centered) in second semester of freshman year and GPA (centered) of Mathematics on the ESECE.
Int[2] Interaction of stream and department average GPA for Mathematics.
Int[3] Interaction of stream and GPA (centered) of Mathematics on the ESECE.

Model 4: a random slope model including results of the freshman year

As a final step, similar to the linear regression analysis in Section 5.3.2, the effect of the GPA obtained in the second semester of the freshman year at university is included. The model indicates how the predictive possibilities are modified or mediated by the information conveyed by the student performance in the first year at university. Given the results of Section 5.3.2, a first model was fitted combining the effects in Models 2 of Table 5.3 and Model 3 of Table 5.6, with a random slope for the freshman GPA. It turned out that in this model, the interaction effects of GPA of the second semester of the first year with stream, and of GPA for Mathematics on the ESECE with stream, were very weak (absolute value of estimated effect less than one standard error). Therefore, these effects were deleted. In line with the earlier multilevel analysis approach, to allow for differences between the between-department and within-department regressions, the department average of the GPA obtained in the freshman year was added to the model. A check of the significance of the fraction of students admitted according to desire, and of the department mean of the GPA for English on the ESECE, indicated that these variables had no significant effect (absolute value of estimated effect less than one standard error), and therefore they were further excluded. In this model, the ESECE GPA variables did not have significant random slopes, which consequently were left out. The estimates of the model resulting from all these operations are presented as Model 4 in Table 5.6.

The resulting model has a much lower deviance than the earlier presented models, and a smaller level-one residual variance, reflecting that the results obtained in the first year of the university strongly increase the possibility to predict the students' results in their second year. The fraction of explained variance at level 1, calculated again for the model from which the random slope is omitted, is equal to 35%. The individual-level GPA in the second semester of the freshman year has a very strong effect. The individual-level effects of GPA for Electives and English are much weaker than in Model 3, but still significant. The GPA now mediates their effects in the second semester of the freshman year, acting as an intervening variable. For the level-two effects, it should be noted that these refer to differences between the departments controlling for the level-1 effects; in other words, they refer to differences between expected results of students with the same GPA on the ESECE and in the second semester of the freshman year. In this comparison, departments with a relatively high average freshman GPA and with a relatively high average GPA for Mathematics on the ESECE obtain comparatively lower average grades in the second year. The interpretation is again that these departments have relatively difficult curricula. With respect to the effect of the average GPA for Mathematics, its interaction effect with stream should also be taken into account, which suggests that its negative between-departments effect holds mainly in the Social Sciences, and much less strongly in the Natural Sciences, where the between-departments effect is –0.398 + 0.009 + 0.279 = –0.110. The between-departments effect of the freshman GPA is positive: 0.542 – 0.360 = 0.182, implying that the

within-department effect is stronger than the still positive between-department effect.

Comparing the results of Models 3 and 4 with the conclusions of Model 2, it can be concluded that the separation of the Mathematics effect in an individual-level within-department effect, and a department-level effect (the difference between the between- and within-department effects) makes clear that the negative effect of the Mathematics GPA operates only at the department level, not at the individual level. Departments with a student intake of average higher performance in Mathematics presumably have more difficult curricula and therefore their students get comparatively lower grades. Within departments, the GPA for Mathematics hardly leads to any differences in performance between students. To put it differently (and more positively): a higher ESECE Mathematics GPA (given that the GPA for Electives and for English is constant) gives a student a better chance of being admitted in a department with a more difficult curriculum, but not a better chance of obtaining a higher GPA in the second year within a certain department.

To give a graphical representation of the random slope model, the *MLwiN* software was used to make a graph of predicted regression lines of the second year GPA on the Electives GPA for the ESECE, the lines being specific for each department. To make the clearest possible model, a slightly modified version of Model 3 (Table 5.6) was used, in which the Maths and English GPA variables were omitted, in order to let the Electives GPA capture as much as possible of their effects. The other individual-level variables were retained and for the figure were set equal to their overall mean values. Figure 5.3 gives the prediction lines for the second year performance as a function of the Electives GPA on the ESECE, controlled for the age and the admission category of the students.

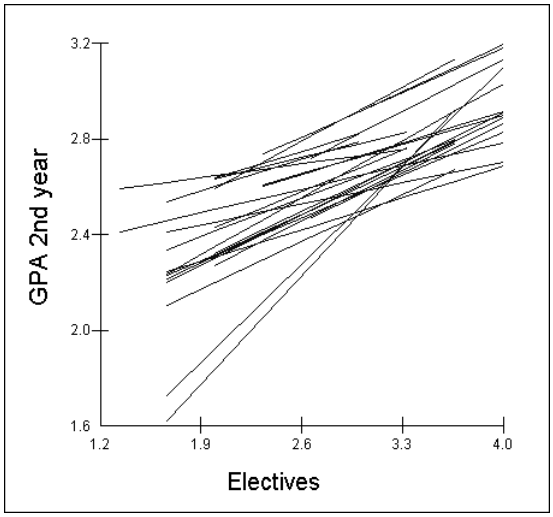


Figure 5.3 Graph of the department-wise predicted GPA in the first semester of the second year, as a function of the Electives GPA on the ESECE.

Figure 5.3 shows a picture of a quite diverse dependence of the second year GPA on the ESECE Electives GPA. The two departments with the steepest regression lines are the Physics department and the Law department. These departments differ most strongly from the others in the sense that they have an especially low second year performance of those students who have a low Electives GPA on the ESECE. An explanation may be that the subjects taught by these departments are difficult and therefore only students with a high ability (as measured by Electives GPA) are successful.

The departments with the least steep lines are the departments of Economics and of Sociology and Anthropology. Performance in these departments depends least strongly on the ESECE Electives GPA. An explanation may be that these departments offer mostly new subjects, not taught at high school, and that therefore the relation with the Electives GPA is weak. Three departments show to have high grades on the Electives and also high GPA in the second year, even when related to the already high performance in the Electives, and therefore exhibit lines in the upper right corner; these are the departments of Civil Engineering, of Archeology, and of Political Science. These departments are attractive to students (in view of the favorite career opportunities) and only admit students with high GPAs.

5.5 Conclusions

In this chapter, the prediction of the grade point average in the first semester of the second year program was investigated. Because of the admission of students to the various departments after completion of the freshmen year and the large variation of student performance over the departments, not only student characteristics, such as academic, personal and admission-related variables, were taken into account, but also department characteristics, such as the department mean of academic variables and the percentage of students admitted to the department according to desire. Ignoring the dependence of student performance within departments, by using ordinary linear regression, may render unclear and potentially misleading results. The separation between the individual and department variation by the use of multilevel models gives clearer results. For instance, in a provisional regression analysis, unexpected results with negative coefficients of the GPA for Mathematics led to difficulties in the interpretation. The multilevel analysis, including the mean GPA of the academic variables, resolved this problem. Table 5.7 summarizes the effects found in the multilevel analysis. A small positive effect is indicated as +, a medium positive effect as ++, and a strong positive effect as +++. In de same way negative effects are indicated by a minus. If there was no significant effect, a 0 is recorded in the table. An x indicates that the effect was not tested.

Table 5.7 Summary of the conclusion in relation to the hypotheses

Hypothesis	*Effect of*	*Student-level*	*Department-level*
Academic			
5.1/5.4	GPA Electives	+	0
5.15.4	GPA Mathematics	0	---
5.1/5.4	GPA English	+	0
5.1/5.4	GPA Freshmen year	+++	---
Admission/person-related			
5.1	Admission through ESECE	0	x
5.1	Regular admission category	0	x
5.1/5.3	Desired stream (yes/no)	0	0
5.1	Post-secondary education	0	x
5.1	New admittance	0	x
5.1	Men	0	x
5.1	Younger age	++	x
5.1	Social Sciences stream	-	0
5.2	Explained variance	0.35	

x: not tested

When only pre-university characteristics are considered, the GPA for Electives has a positive effect at both student and department level, as expected and also found in the analysis of the first year performance presented in Chapter 4. It is significant at student level but insignificant at department level. This means that the department mean of this variable does not have an additional effect next to its individual value. Students with a higher GPA in the electives are likely to score better in the first semester of the second year program than those with a lower GPA. Among the academic variables, the GPA for the elective subjects has the highest predictive power.

Considering the main effect of the Mathematics GPA on the student level (within departments) together with the interaction effect, the within-department effect of the GPA for Mathematics is significant for the Natural Sciences, while it is insignificant for the Social Sciences. The effect of the department average of GPA for Mathematics is negative and significant, implying that students in departments with a lower average GPA for Mathematics tend to have higher GPA in the first semester of the second year. Put differently: suppose we compare two students with the same characteristics, including their GPAs on Mathematics and both in the same stream. One of them is admitted to a department with a high mean GPA for Mathematics (e.g., Geography), and the other is admitted to a department with a low

mean GPA for Mathematics (e.g., Journalism and Mass Communication). The model predicts that the student in the Geography department will have a lower GPA in the first semester of the second year than the student in the Journalism and Mass Communication department. This phenomenon is probably due to the fact that the departments taking students with a higher average GPA in Mathematics are more competitive and, therefore, give a lower average GPA in the first semester of the second year program. The result rejects the hypothesis that the average GPA in Mathematics has a positive effect on the performance of students in the department and even contradicts it. Of students with the same results on the ESECE, those admitted to a more competitive department will get a lower GPA in the first semester of the second year.

The effect of GPA for English is positive and significant at student level but insignificant at department level. In agreement with the hypothesis, students with higher GPA in English score higher in the first semester of the second year program.

In line with the expectations, when the GPA of the second semester of the freshman program is included, it is found that the GPA of the freshman program has a positive and significant effect at student level. At the individual level, the effect of the GPA of the second semester of the freshman program has the strongest effect as compared to the pre-university characteristics. The GPA of the second semester of the freshman program strongly increases the possibility to predict the students' results in their second year. The effect of the average GPA of the second semester of the freshman program may be given a similar explanation as was given to the effect of the average GPA for Mathematics stated above. The mean GPA in the freshman program has an effect on the performance of students in the first semester of the second year program, which is in accordance with the hypothesis.

The individual-level effects of the GPA for Electives and English are positive and significant with less strong predictive powers in comparison to when pre-university variables are only used. This supports the hypothesis that the GPA for the Electives, English, and the freshman program have effects on the performance of students in the first semester of the second year program. However, since these effects are partly mediated by the GPA of the second semester in the first year, they are smaller when the latter variable is held constant. The effect of Mathematics has the same pattern as discussed above while considering pre-university variables only.

The effect of age is negative and significant, which implies that younger students score higher than older students do in the first semester of the second year program. The effects of other variables are insignificant. Rather strikingly, the percentage of admitted students according to desire in a department does not have a significant effect. It may be concluded that the effects of placement according to desire are, for this outcome variable, taken over by department characteristics reflecting the average grades of students on the ESECE and in the first year. Confirming hypothesis 5.2, the multilevel models explained more variation between departments than between students only. After controlling for the GPA of the

second semester of the freshman program, the explained variance increased considerably.

Overall we may conclude that the selection in the freshman program is functioning in a satisfactory way, even though there is quite some variation between departments. Students with lower ability, that is, with lower GPA scores on the ESECE-exams as well on the freshman exams receive lower scores in the second year as well, and are thus possible candidates for dropping out.

6

Logistic regression analysis for the graduation of students

6.1 Introduction

So far, some of the characteristics affecting the performance of students with a focus on the university entrance (national) examinations, the freshman program, and semester 1 of year 2 were identified. Also some insight into the differences between the academic departments at second year level was obtained. Although students have to pass all these barriers to successfully complete their studies, the current chapter serves to identify some of the possible pre-entry characteristics influencing the eventual graduation of students. Thus, it is investigated whether the ability/academic performance, admission-related information, and personal characteristics found to predict success in the freshman year have a long-term predictive value.

Whether and how performance in the national examinations and other admission or person-related characteristics are related to actual graduation at the University of Asmara has not been investigated so far. Under normal conditions, all degree students of the university should complete their studies within four or five years. Some preliminary observations indicate that many students do not graduate at all or do not graduate in time. A student admitted to one of the degree programs at the University of Asmara has been regarded as non-graduate if he/she does not complete his/her studies in at most six years after the year of admission. In other words, if t is the year of admission, then t+6 will be the maximum limit for timely graduation.

6.2 Possible factors influencing graduation

Since non-graduation is regarded as non-completion of studies, the pre-university explanatory variables that are assumed to influence the graduation of students can be taken to be identical to those stated in Section 3 of Chapter 4. All the discussions related to the explanatory variables are, therefore, applicable to the current analyses. Based on those discussions, the following hypotheses were formulated, again distinguishing academic, personal and admission-related factors of influence.

Hypothesis (6.1) *The higher the grades earned in the Elective subjects, Mathematics and English, the higher the probabilitiy of graduating.*

Hypothesis (6.2) *Students who were previously admitted to higher institutions have a higher probabilitiy of graduating than newly admitted students.*

Hypothesis (6.3) *Students who took the ESECE are more likely to graduate than students admitted through other results into the freshman program.*

Hypothesis (6.4) *Students admitted to streams according to their preference have a higher probability of graduating.*

Hypothesis (6.5) *Regular students have a higher probabilitiy of graduating than private students.*

Hypothesis (6.6) *Re-admitted students have a higher probabilitiy of graduating than newly admitted students.*

Hypothesis (6.7) *Social Sciences students have a higher probabilitiy of graduating than students in the natural sciences.*

Hypothesis (6.8) *The effects of pre-university scores, personal and admission-related variables on the probability of graduating differ between the natural and Social Sciences.*

Hypothesis (6.9) *Female students are less likely to graduate than male students.*

Hypothesis (6.10) *The younger, the higher the probabilitiy of graduating.*

Hypothesis (6.11) *The effects of pre-university scores, personal and admission-related variables on the probability of graduating differ between the students with and those without post-secondary education.*

Immediately after the liberation of Eritrea, many students of higher institutions came back to their country from abroad and started their education afresh. Many evening students from the University of Asmara also discontinued their studies and joined the day program in order to join new departments, to be exempted from tuition fees and to complete their studies in a relatively short period. These students, constituting the major part of those with previous post-secondary education, have had very different experiences from those who entered the University of Asmara directly after graduating from high school. It is possible that these experiences also have an influence on the eventual graduation. Now that this trend seems to be over, the focus

of the study on those without previous post-secondary education is probably more appropriate.

As in Chapter 4, the possible effect of cohort is investigated by defining dummy variables for the years 1994 and 1995, using 1993 as the year of reference.

6.3 Data

Similar to Chapter 4, data were collected from both the files in the office of the Registrar and through a questionnaire distributed to students. For those students who left the university, data were collected from their personal files in the Registrar's office. For the students who were attending classes, data were collected both from the questionnaires and the student files in the Registrar's office. The years of admission considered are 1993-1995. For the analyses, 1213 subjects, all degree students, were considered. Among the 1993 entrants, about 500 ex-fighters withdrew from the university due to government regulations. These students are not included in the study.

6.3.1 General description

Table 6.1 shows the numbers of graduates and non-graduates considered for the study of students who joined the university in the years 1993–1995. Of the 1213 students included in this study, 516 (42%) did not graduate within six years as of their admission to the university. Table 6.2 presents the distribution of the mean ESECE GPA for the Elective subjects, of English and of Mathematics for all students, graduates, and non-graduates, as well as their GPAs in the first and second semester of the freshman year. A more detailed overview of the difference between graduated and non-graduated students is given in Table 6.3.

Table 6.1: Distribution of graduates and non-graduates by year of admission (1993-1995)

Cohort	Number of graduates	Number of Non-graduates
1993	188	117
1994	257	197
1995	252	202

Table 6.2 Mean grade point average distribution for graduates and non-graduates by subjects or semesters

Semester or Subject	Mean grade point average (and standard deviation)		
	Overall	Graduates	Non-Graduates
Electives ESECE	2.50 (.53)	2.57 (.52)	2.39 (.52)
Mathematics ESECE	2.01 (.60)	2.06 (.62)	1.94 (.58)
English ESECE	2.53 (.57)	2.59 (.55)	2.46 (.60)
Semester 1 GPA	2.09 (.83)	2.48 (.49)	1.58 (.89)
Semester 2 GPA	2.49 (.59)	2.60 (.48)	2.20 (.74)

From Table 6.2, it can be seen that the grade point average of graduates in all subjects and in the two semesters of the freshman program were larger than the corresponding grade point averages of the non-graduates. The differences in the ESECE subjects are relatively small. The difference between the mean grade point averages of the graduates and the non-graduates in the first semester was 0.90. This indicates that most of the non-graduates performed low during the first semester in the freshman program. On the other hand, the difference between the mean grade point averages of the graduates and non-graduates during the second semester of the freshman program was 0.42, which is much less than that of the first semester. This is due to restriction of range, because some of the non-graduates were already dismissed during the second semester period.

Table 6.3 presents the percentages of students graduating for each category of the independent variables under consideration. As the GPA for the Elective subjects increases from the lowest category to 3.2, the corresponding percentage graduating also increases from 42.9% to 73.4%. This means that the higher the GPA for the elective courses, the higher the percentage graduating. When the GPA for the elective subjects was greater or equal to 3.2, the percentage graduating dropped from 73.4 to 65.8%. The effect of the GPA for the electives ranging from the lowest to 2.59 on the results of the freshman program seems to be stronger than the effects of the other categories. From the four categories of the results of English, it can be seen that as the grades for English increase from "F or D" to A, the percentage graduating also increases from 40.4% to 69.4%. For Mathematics, as the grade for Mathematics increases from "F" to "B", the percentage graduating also increases from 45.5% to 68.7%. However, when the grade for Mathematics is an "A", the percentage graduating drops to 65.2%. It should be noted, however, that only 23 students of the 1194 students earned a grade "A". Most of them will have gone to other countries with scholarships and will have graduated, but not at the University of Asmara. The percentages graduating of students with and without previous post-secondary education were 79.7% and 45.3%, respectively. For the students admitted to streams according to preference, the percentage graduating was 61.2% and for those who were admitted not according to preference, it was 31.1%. The percentages graduating for students in the Social and Natural Sciences were 73.3%

and 44.2%, respectively. The percentages graduating for the regular and private students were 60.3% and 46.4%, respectively. From the age groups of students, it can be observed that as the age increases, the percentage graduating decreases.

Table 6.3 Distribution of graduates and non-graduates

	Categories	Non-Graduates		Graduates		Total
		Number	%	Number	%	Number of
GPA for Electives	<= 2.29	224	57.1	168	42.9	392
	2.30-2.59	109	38.7	173	61.3	282
	2.60-2.89	82	38.1	133	61.9	215
	2.90-3.19	37	26.6	102	73.4	139
	>=3.20	50	34.2	96	65.8	146
	Total	502	42.8	672	57.2	1174
GPA for English	1 (F or D)	28	59.6	19	40.4	47
	2 (C)	219	47.1	246	52.9	465
	3 (B)	183	42.9	244	57.1	427
	4 (A)	78	30.6	177	69.4	255
	Total	508	42.5	686	57.5	1194
GPA for Mathematics	0 (F)	12	54.5	10	45.5	22
	1 (D)	90	47.6	99	52.4	189
	2 (C)	336	44.3	423	55.7	759
	3 (B)	63	31.3	138	68.7	201
	4 (A)	8	34.8	15	65.2	23
	Total	509	42.6	685	57.4	1194
Previous post-secondary education	No	429	54.7	355	45.3	784
	Yes	87	20.3	342	79.7	429
	Total	516	42.5	697	57.5	1213
Admission to streams according to preference	Yes	392	38.8	618	61.2	1010
	No	115	68.9	52	31.1	167
	Total	507	43.1	670	56.9	1177
Stream	Natural Sc.	374	55.8	296	44.2	670
	Social Sc.	136	26.7	374	73.3	510
	Total	510	43.2	670	56.8	1180
Cohort	1993	117	38.4	188	61.6	305
	1994	197	43.4	257	56.6	454
	1995	202	44.5	252	55.5	454
	Total	516	42.5	697	57.5	1213
Admission category	Private	140	53.6	121	46.4	261
	Regular	364	39.7	552	60.3	916
	Total	504	42.8	673	57.2	1177
Age at admission	16	4	14.8	23	85.2	27
	17	34	27.0	92	73.0	126
	18	93	34.4	177	65.6	270
	19	74	40.9	107	59.1	181
	20	98	47.1	110	52.9	208
	21	74	50.3	73	49.7	147
	22	40	54.1	34	45.9	74
	>=23	75	61.0	48	39.0	123
	Total	492	43.3	644	56.7	1136

6.4 Logistic regression analysis results

Logistic regression of the dichotomous (1/0) variable "graduation yes/no" is used to test the statistical significance of the explanatory variables by predicting the probability that a student with given characteristics graduates, and by estimating the corresponding parameters. This method is based on the logit transformation of the probability of success, which converts non-linear to linear relationships by transforming the variables' scales. The logit transformation is specified in Appendix F.

The logistic regression analyses were conducted in three steps. First, single estimates for all the independent variables were computed considering all students in the study. Second, two models were tested to examine the effects of academic, admission and person-related characteristics for all students. Third, separate models were estimated for the Natural Sciences stream, Social Sciences stream, students admitted to streams of their preference, students with previous post-secondary education, and students without previous post-secondary education. The reason for conducting analyses for these subgroups separately is that this is a convenient way of finding interactions of these grouping variables with all other explanatory variables.

The results of the univariate logistic analysis for all students are given in Table 6.4 and those of multiple logistic regression are shown in Tables 6.5 -6.7. The values shown in the tables are the transformed coefficients exp(β). These transformed coefficients are known as the odds [P_i /(1- P_i)] ratios. They represent the ratio of the predicted odds of graduating with one unit increase in the independent variable, to the predicted odds of graduating without the one unit increase. Note that the predicted probability of graduation associated with any single independent variable depends on the values of the other variables in the model.

Denote the probability of graduating for a student with the one unit increase by P_j, for a student without this increase by P_i. Then the odds ratio is

$$\exp(\beta) = [P_j / (1 - P_j)] / [P_i / (1 - P_i)] = [P_j (1 - P_i)] / [P_i (1 - P_j)]$$

Conversely, when comparing the student with the lower value to the student with the higher value on the independent variable, the odds ratio is the reciprocal of the earlier ratio,

$$\exp(-\beta) = [P_i / (1 - P_i)] / [P_j / (1 - P_j)]$$

A value $\beta = 0$ is equivalent to $\exp(\beta) = 1$ and to $P_i = P_j$, i.e., the independent variable has no effect on the probability of graduation. A value $\beta > 0$ implies that graduation becomes more likely as the independent variable increases; $\beta < 0$ implies that graduation then becomes less likely.

6.4.1 Single logistic regression models for the graduation data

The summary of the results of the univariate logistic regressions is given in Table 6.4. From this table it can be seen that most of the variables considered are significant predictors of the graduation of students at the university. All academic-related characteristics have a positive association with the dependent variable. Regarding the electives, it may be more meaningful to consider changes of the GPA for the elective subjects as multiples of 0.33 (1/3) since each change of grade in one of the three subjects in the electives will change the GPA for electives by 0.33. This is expressed by the odds ratio (1/3) = exp(1/3 × .680) = exp (.227) = 1.25. This indicates that for every increase of a grade point average of 0.33 for the electives, there is a 25% increase of the odds of graduation. Students with higher grade point average for electives are more likely to graduate than those with lower grade point average in electives. Students with a higher grade point average for Mathematics and English have, on average, higher odds of graduation by 35%, and 40% respectively, compared to those with one unit lower grade point average.

Table 6.3 Single logistic regression models for the graduation of students

Variable	β	S.E.	Exp (β)
Academic			
Electives	.680*	.119	1.974
Mathgpa	.298*	.087	1.347
Enggpa	.399*	.072	1.403
Admission and person-related			
Admcat	.562*	.141	1.755
Postedu	1.558*	.140	4.750
Destream	1.249*	.179	3.486
Stream	-1.246*	.127	.288
Examtype	-.763	.443	.466
Readmn	-.305	.196	.737
Sex	-.015	.169	.985
Age	-.170*	.027	.843
Cohort94	-.056	.120	.946
Cohort95	-.128	.120	.880

**Significant at .05 level.*

Among the personal and admission-related characteristics, there is an indication that previous post-secondary education and desired fields of study are positively associated with the graduation of students. Students with previous post-secondary education are more likely to succeed than those without. Students admitted to streams according to desire are more likely to succeed than those who were not admitted according to their desire. The negative coefficient of stream means that

being a student in the Natural Sciences decreases the odds of graduation of students by 71% compared to those of Social Sciences students. Students in the Natural Sciences were less likely to graduate than those in the Social Sciences. Regular students, on average, have higher odds of graduation by 76% in comparison to the private students. Among the personal characteristics, age is negatively associated with the graduation of students. Being an older student decreases the odds of graduation of students compared to younger students. The changes in ages are easily interpretable if they are considered as multiples of 5. The estimated odds ratio is then exp (5 × -0.17) = 0.43. Thus, for a difference of 5 years in age, the graduation of students is about one half as likely to occur among those older students than among those younger students.

The univariate associations between the graduation of students and the variables type of examination, newly admitted or readmitted, sex and cohort were low and insignificant. For the type of examinations, the number of the non-standard category was small. In a trial model fit, these variables were also found to be insignificant and they were eliminated from the model. There were no associations between the graduation of students and these variables and hence they were further not included in the current study. With the variables and information above, the fitting of the multiple logistic regression model is discussed below.

6.4.2 Multiple logistic regression models

In the multiple logistic regression analysis, the academic performance variables were first entered in the model. Next, the personal and admission-related variables were added. In this way, both the direct effects of academic performance and their effects controlled for other characteristics were studied. In a third step, it was examined whether it was necessary to include interaction effects. Models were fitted adding interactions and quadratic effects of numerical variables. No interactions at all were found to be significant, but the quadratic effect of the electives was found to be significant and it was included. In Table 6.4, this model is presented for all students, and separately for the different streams, and for the students with and without previous post-secondary education.

The impact of the electives of the graduation of students varies according to the values of the electives since it involves a polynomial function. Therefore, the interpretation is as follows. Let the GPA for the electives be denoted by X. Then the polynomial regression for all students is given by:

$$0.696X - 0.850(X - \overline{X})^2,$$

where $\overline{X}$ is the mean GPA for the electives, equal to 2.5. The graph of the polynomial is a parabola, opens downward and it has a maximum point. The maximum point is determined by taking the first derivative of the polynomial with respect to X. Taking the first derivative and equating it to 0 we get:

$$0.696 - 2 \times 0.850(X - 2.5) = 0.$$

This implies that $X = 2.91$, and the polynomial attains its maximum at $X = 2.91$. Therefore, it can be concluded that as the GPA for the electives increases from 1.33 (the minimum GPA) to 2.91, the odds of graduation also increase. As the GPA for the electives increases from 2.91 to 4.00, then the odds of graduation decrease.

In the model for all students, an increase of one grade point in Mathematics increases, on average, the odds of graduation by 36%. English was found to be a significant predictor of graduation in all models. An increase of a grade in English increases, on average, the odds of graduation by 36%.

The results indicate that students admitted to streams of their preference have, on average, two times higher odds of graduation compared to those admitted without their desire. Students with previous post-secondary education have, on average, four times higher odds of graduation than those without such experience. Students in the Social Sciences stream have on average, 30% higher odds of graduation than students in the Natural Sciences stream. The age of students also has a negative association with the dependent variable. The estimated odds ratio for an increase of 5 years in age is odds ratio = exp (5×-0.185) = 0.40. For students who differ by 5 years of age, the odds of graduation of the older students are 40% of the odds for the younger students.

Table 6.4 Logistic regression model for the graduation of students with focus on their streams, regression coefficients, standard errors and odds ratio.

Variable	All	N.Sc.	S.Sc.	P[1].	NP[2]
Constant	.780	-.273	.890	4.115*	.391
	(.893)	(1.249)	(1.397)	(1.582)	(1.162)
Academic					
Electives	.696*	1.021*	.293	.094	.918*
	(.168)	(.246)	(.263)	(.320)	(.208)
	2.006	2.776	1.374	1.099	2.504
Enggpa	.309*	.219	.433*	.092	.404*
	(.101)	(.143)	(.151)	(.176)	(.125)
	1.362	1.245	1.541	1.096	1.498
Mathgpa	.310*	.249	.318	.072	.384*
	(.117)	(.161)	(.177)	(.196)	(.148)
	1.364	1.283	1.374	1.075	1.468
Personal and Admission-Related					
Destream	.791*	1.048*	.030	-.022	.890*
	(.218)	(.292)	(.412)	(.582)	(.261)
	2.204	2.852	1.031	.979	2.436
Postedu.	1.387*	1.703*	.944*		
	(.161)	(.222)	(.235)		
	4.002	5.490	2.570		
Stream	-1.190*	-	-	-.629*	-1.351*
	(.153)	-	-	(.275)	(.186)
	. 304	-	-	.533	.259
Cohort 94	-.085	-.346	.321	-.306	.086
	(.207)	(.271)	(.340)	(.438)	(.252)
	.919	.708	1.378	.737	1.090
Cohort 95	-.584*	-1.097*	-.005	-1.157*	-.303
	(.217)	(.300)	(.345)	(.421)	(.265)
	.558	.334	.995	.314	.738
Age	-.185*	-.213*	-.141*	-.115*	-.222*
	(.034)	(.048)	(.044)	(.054)	(.044)
	.831	.809	.869	.892	.801
Interaction/non-linear effects					
Int	-.850*	-1.092*	-.438	-.548	-.806*
	(.237)	(.313)	(.418)	(.401)	(.298)
	.428	.336	.645	.578	.447

** Significant at .05 level.* [c] *Exp (β)*

[a] *Logistic regression* β *Int*[1] *(Electives-* $\overline{\text{Electives}}$ *)*[2]

[b] *S.E.(β), Standard errors in parentheses*

A total of 1213 subjects, all degree students, were considered for the analyses. The number of subjects in the Natural and Social Sciences were 670 and 510 respectively. Students with previous post-secondary education were 429 and those without such experience were 784.

For the Natural Sciences students, it can be concluded that as the GPA for the electives increases from 1.33 (the minimum GPA) to 2.96, the odds of graduation also increase. As the GPA for the electives increases from 2.96 to 4.00, then the odds of graduation decrease due to the quadratic effect. Mathematics and English are significant predictors of graduation when academic variables are considered only. However, after controlling for admission and person-related characteristics, both Mathematics and English lose their significance. Students placed in streams according to their preference have, on average, a three times larger odds of graduation than students placed without their preference. Students with previous post-secondary education have, on average, five and half times larger odds of graduation than students without such experience. The estimated odds ratio for an increase of 5 years in age is exp (5 × -.213) = 0.34. For students who differ by 5 years of age, the graduation of students is about one third as likely among those older students than among those younger students.

In Table 6.4, in which the Social Sciences stream is considered separately, the GPA for the elective subjects and Mathematics are found to be insignificant predictors of graduation. Now it is English which has a significant effect. An increase of one grade point in English increases, on average, the odds of graduation by 54%. Students with previous post-secondary education have, on average, two and half times higher odds of graduation than students without such experience. The estimated odds ratio for an increase of 5 years in age is exp (5 × -.141) = 0.49. For students who differ by 5 years of age, the graduation of students is about one half as likely to occur among those older students than among those younger students.

Students with previous post-secondary education are considered separately. Since this is a smaller group (429 out of 1213 students), the standard errors are expected to be higher and the power to find significant effects is lower. In Model 1, when only the academic variables are considered, all the academic variables are found to be insignificant predictors of graduation. After controlling for admission and person-related variables, it is found that stream, cohort 1995, and age at admission are associated with graduation. Students in the Social Sciences stream have, on average, more than three times higher odds of graduation than the students in the Natural Sciences. For students who differ by 5 years of age, younger students have, on average, two times higher odds of graduation than older students. For students without previous post-secondary education, it is found that after controlling for admission and person-related variables, the same variables are significant as for the group of all students, except for the Cohort 95 effect. The effects are somewhat larger than for the complete group.

6.4 Classification of the correct and incorrect predictions of graduation

One possible way of summarizing the fitted model is to use classification tables and determine the correct and incorrect predictions of success and failure. These tables are aggregates based on the predicted probabilities $\hat{P}_i$, defined as the probability of graduation for student *i* according to the logistic regression model in which the estimated coefficients are used. If $\hat{P}_i$ exceeds a predetermined cut-point, the student is predicted as a successful graduation. The classification table for all students is given in Table 6.5.

Table 6.5 Classification table based on the logistic regression model using a cut-point 0.5

Predicted		**Observed**		
		Graduation		
		0	1	Total
Graduation	0	324	119	443
Graduation 1		154	502	656
Total		478	621	1099

In Table 6.5, if the estimated probability exceeds the cut-point 0.5, then the graduation of students has been predicted to be equal to 1 (success); otherwise it has been set to be equal to 0 (failure). The cut-point 0.5 is the most commonly used (Hosmer and Lemeshow, 1989) and seems to be a good choice here. From Table 6.5 it can be seen that:
Proportion correct classification = ((324 + 502) / 1099) = .75
Proportion incorrect prediction of success = 154/656 = .23.
Proportion incorrect prediction of failure = 119/443 = .27.
Among the 656 students predicted for graduation, 502 were indeed graduates and 154 non-graduates, which are 76.5% and 23.5% respectively.

Using similar methods the correct classification rates, incorrect predictions of success and failure for the other cut-points were also determined. The results are given in Table 6.6.

Table 6.6 Classification rate and incorrect predictions of success and failure.

Cut-point probability	Incorrect prediction of failure	Incorrect prediction of success	Correct classification
.9	.53	.12	0.51
.8	.48	.15	0.60
.7	.41	.19	0.68
.6	.34	.21	0.73
.5	.27	.23	0.75
.4	.19	.27	0.76
.3	.13	.32	0.72
.2	.11	.38	0.65
.1	.11	.43	0.58

Figure 6.1: Incorrect predictions versus estimated probabilities

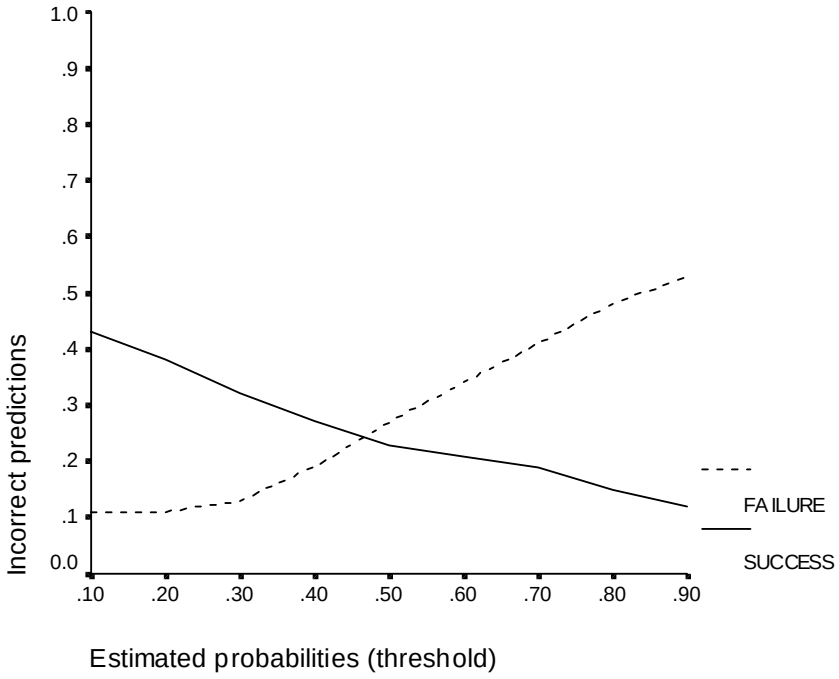


Table 6.6 and Figure 6.1 indicate that the correct classification rate is above 70% for cut-points between 0.3 and 0.6. Within this range, increasing the cut-point leads to a higher number of correct predictions of success which is more or less compensated for by the lower number of correct predictions of failure.

6.5 Conclusions

The aim of this chapter was to identify pre-university characteristics that influence the graduation of students at the University of Asmara.

When all students are considered, the results of the multiple logistic regression models indicate that the entrance examinations for the university have a strong predictive power for the graduation of students. In almost all the analyses that are conducted, grade point averages for the electives, as long as they are less than or equal to 3.0, are found to influence students' graduation at the university positively. However, for grade point averages greater or equal to 3.0, the influence of the elective subjects on students' graduation is negative. One of the main reasons is that during the 1994/95 and 1995/96 academic years, several outstanding students with a very high GPA in both the ESECE and the freshman program were sent to Yemen and Ethiopia on a scholarship basis. There was an exchange of students program resulting from bilateral agreements between the governments of Eritrea and Ethiopia. Since the outcome data of these students were not easily available and they did not graduate at the University of Asmara, they are considered as non-graduates. It may be argued that since they were among the outstanding students in the university and they were transferred to another university in another country based on their merit, they should not be included in the attrition category. On the other hand, from the viewpoint of the University of Asmara, they can be considered as non-completers. The fact that they were selected for scholarships based on merit indicates that their performance at the university was good.

It is also found that students with high results in Mathematics and English are more likely to graduate than students with lower grades, which is in agreement with the hypotheses. Electives have a larger effect than Mathematics and English. Admission to streams according to preference is an important predictor of the performance of students at the university. In line with the hypothesis, students admitted to streams according to desire are more likely to graduate than those without preference. As stated in the formulation of the hypothesis in Chapter 4, students are probably better motivated to concentrate on their studies since they were placed in streams according to their preference. The hypothesis that students in the Social Sciences stream are more likely to graduate than students in the Natural Sciences is confirmed. This is probably due to the fact that the Natural Sciences stream requires more computational skills and more time is spent in laboratories which in general implies a more demanding curriculum. Students with previous post-secondary education have higher odds of graduation than those students without such experience. This result is in line with the hypothesis. Students with previous post-secondary education are probably well prepared and have better experience to tackle the problems related to their studies. It could be an indication that the experience that they had at tertiary level institutions prior to their admission to the University of Asmara has contributed positively to their adjusting to the university environment. It is also possible that the courses they took prior to their

admission to the university are similar to courses offered at the university. This might have helped them to obtain better grades, to develop confidence and consequently to adjust well to the university environment. The age at admission is also a significant predictor of the graduation of students. Older students have considerably lower odds of graduation than the younger students, which is in agreement with the hypothesis. The effects of admission to the university through the ESECE or other certificates, admission category (regular/private), gender, and new admission or readmission as predictors of graduation have not been confirmed, nor has the hypothesis about the differential stream effects since none of the interaction effects was found to be significant.

In both streams, the students with previous post-secondary education have higher odds of graduation than students without this experience. It is interesting to note that placement according to desire and previous post-secondary education have larger effects in the Natural Sciences than in the Social Sciences. English has an effect in the Social Sciences, whereas the Electives and Mathematics have a positive effect in the Natural Sciences, with the largest effect for the Electives, of similar size as for all students. The electives consist of three subjects and most of them are related to courses offered in the freshman program of the university. On the other hand, most of the subjects taken as electives by students joining the Social Sciences stream are not related to the courses offered at the university at freshman level.

Table 6.7 Overview of results of hypotheses tested in Chapter 6.

Hypoth.	Positive effect of	All students	Natural Sciences	Social Sciences	Previous	Non-previous
Academic						
6.1	GPA Electives	+++	+++	0	0	+++
6.1	GPA Mathematics	++	+	0	0	++
6.1	GPA English	++	0	++	0	++
Admission/person-related						
6.2	Post sec. education	+++	++++	+++	x	x
6.3	Admission ESECE	0	0	0	0	0
6.4	Desired stream (y/n)	+++	+++	0	0	+++
6.5	Regular admission	0	0	0	0	0
6.6	New admittance	0	0	0	0	0
6.7	Soc. Science stream	+++	x	x	++	+++
6.8	Diff. effect Stream	0	x	x	0	0
6.9	Men	0	0	0	0	0
6.10	Age	--	--	--	---	---
6.11	Diff. effect Postedu	0	0	0	x	x

The large effect of previous post-secondary education as a predictor of graduation is even higher in the Natural Sciences than in the Social Sciences stream. Students with previous post-secondary education who were admitted to the Natural Sciences stream were probably better equipped with the necessary computational skills. Older students are less likely to graduate than younger students in both streams. Placement of students in streams according to preference has a positive influence as regards the graduation of students for the Natural Sciences students. For the students in the Social Sciences, admission on preference is not relevant since almost all students in the Social Sciences are placed in this stream according to their preference.

When students with previous post-secondary education are considered separately, only stream and age at admission are significant predictors of graduation. For students without previous post-secondary education, the electives, Mathematics, English, admission to streams according to preference, stream and age at admission are significant predictors of graduation. The effects of gender, new admissions or re-admissions, and type of examinations on graduation are found to be insignificant. These results are similar to the results for all students.

The fact that fewer predictors are significant for the group with previous secondary education cannot be attributed completely to the smaller sample size, since the effect sizes as reflected by the parameter estimates are also considerably

smaller. An explanation may be that this was a selected group with a relatively high ability and motivation, resulting in better performance. Apparently, the lack of success for 20% of these students depended on other factors than those considered here.

In order to provide the reader with more insight into the results of this study, the probability of graduation in the Natural and Social Sciences streams based on various categories of admission on desire, age and the GPA for electives are shown in Table 6.8. These probabilities are for students without previous post-secondary education.

Table 6.8: Probability of graduation in the streams based on selected categories of admission on desire, age and GPA for electives

Admission on desire	Age	GPA for Electives			
		Natural Science Stream		Social Sciences Stream	
		2.0	4.0	2.0	4.0
Yes	18	.23	.49	.62	.71
Yes	23	.09	.25	.45	.55
No	18	.08	.23	.62	.71
No	23	.03	.09	.45	.55

Table 6.8 shows that, when keeping the other variables as constant, the GPA for the Electives has an effect on the probability of graduation in both streams, especially in the Natural Sciences stream, where the probabilitiy of graduation is extremely low for students with a minimal GPA for the Electives. It can be seen that a high Electives GPA cannot compensate the negative effect on the probabilitiy of graduation for an older student who was placed unwillingly in the Natural Sciences stream. The negative effect of age is quite strong, again stronger for students in the Natural Sciences stream, where older age means that the probabilitiy of graduation is only a third for the students with a low GPA for the Electives, and about half for the students with a high GPA. The effect of admission according to desire is comparable to the age effect for students in the natural Sciences, whereas it is absent for students in the Social Sciences.

Table 6.8 demonstrates quite clearly that the effects of the various explanatory variables are not the same for all types of students. It also demonstrates that there are some long-term effects of pre-university characteristics, especially of the academic variables. This makes a good selection procedure for students to be admitted to university even more important.

7

Summary and conclusions

This chapter presents a summary of the study. The purpose of the research, research questions, and design are summarized in 7.1 and 7.2. Conclusions are given in 7.3. The recommendations are given in 7.4. The last section, 7.5, is on directions for further research.

7.1 The purpose of the research

Eritrea is a new and developing country in East Africa that was declared independent in May 1993. Since independence, Eritrea has been engaged in all-out efforts to rebuild its war-shattered social and economic infrastructure. One of the vital programs in the campaign for national rehabilitation has been in the field of education, which has mainly focused on training skilled personnel for such understaffed vocations as teaching, law, medicine and administration. A rapid improvement in educational facilities has been achieved. The University of Asmara, which was the only institution of higher education in the country, has been engaged in fulfilling the high level human resources that the country needs. Much like many other universities, the mission of the University of Asmara is the discovery, generation and dissemination of knowledge in the service of society. Therefore, the university has been expected to contribute as much as possible to face these challenges. In order to achieve its goals, the university has emphasized the need for reviewing the academic programs and the curriculum.

Admission to the university is based on a national examination, which is called the Eritrean Secondary Education Certificate Examination (ESECE). Both the University of Asmara and the Ministry of Education are represented in the ESECE board whose task it is to provide guidelines for the routine activities of the ESECE and to forward fresh initiatives with the aim of developing the center into a strong and competent institution. The entrance examination, which usually lasts for three days, requires the candidates to take two compulsory examinations, English and Mathematics. Candidates also have to take at least three more elective subjects from Biology, Chemistry, Physics, General Science, Geography, History, Economics, Bookkeeping, Agriculture and general knowledge. The criterion for entrance to the university is based on the average grade point average for Mathematics, English and three other elective courses. Due to the high number of applicants for admissions to the university, the selection processes are usually highly competitive. Until 1994 about 10% and from 1995 through 2002 about 19% of the candidates were admitted

to the university. The low percentage of students that pass the ESECE examinations justifies the need to investigate the quality of the ESECE

During their stay at the university, students are provided with free education, free meals and free medical services. Dormitories are also provided freely to students coming from outside the central region where the university is located. However, in spite of all these free student services and the very competitive selection processes, the attrition rate at freshman level is about 35% on average every year. The attrition rate for second year and above is about 15%. These figures indicate that the attrition at the university is very high and results in a low proportion of graduates. Therefore, the high attrition rate at the university justifies the need to investigate the factors at student and department levels that influence the performance of students during their university career. This implies also that research on the predictive validity of the ESECE is very important.

7.2 Research questions and design

Based on the problems the University of Asmara encounters, the key problems addressed in this research are:

(a) To what extent does the ESECE test the ability of students in a satisfactory way?

(b) What are important factors that affect the students' performance levels at the university?

Materials and methods

For the study of the quality of the ESECE tests, the items of the English and Mathematics examinations of the year 1998 were used. The data were collected from the ESECE office and include all candidates. They are for 7948, 7412 and 432 candidates who took English, Algebra and Geometry, and Algebra and Commercial Mathematics, respectively. For each question, the data include each candidate's correct or wrong answer. Competent experts on these subjects, university and high school teachers (27 teachers for each subject) were asked to fill in questionnaires designed to get insight into the quality and appropriateness of some selected questions.

Three types of validity were used to investigate the quality of the examinations: predictive validity, face validity, and content validity. Furthermore, based on measures from classical test theory, the examination questions were analyzed in terms of the proportion of students who correctly answered them, the power of these questions to discriminate between poor and good students, and the association of each question with remaining questions.

The study on the performance of students at the university focused on the results of the freshman program and the results of the first semester of the second year program. Furthermore, the study dealt with the graduation of students in view of its importance as an indicator of outcome and performance. For the study of the performance of students at freshman level, the data cover the entrants of the years 1993 to 1997 for a total of 2412 students. Data were collected from the files of students in the Registrar's Office of the university and from questionnaires distributed to students. The explanatory variables include both academic and non-academic characteristics. The academic variables include results of three elective subjects, Mathematics, and English of the university's entrance examinations. The available admission and person-related variables include previous post-secondary education, placement of students to streams according to preference, stream of specialization, type of entrance examinations, admission category, whether the student was newly admitted or readmitted, cohort, gender, and age of students at admission. The dependent variables are grade point averages of the first and second semesters of the first year program. Linear regressions were used to identify the factors that influence the performance of students in the freshman program.

The performance of students is not only influenced by student-level characteristics but also by other factors that include university curriculum and organization. Some department-level variables are, therefore, also included in this study. For the study of the performance of students of the first semester of the second year program, the student-level characteristics are the same as those considered for the study of performance in the freshman program, and complemented by the recent results of the freshman program. Department-level variables are the average grades of the student population of each department obtained on the university entrance examination and in the freshman program. Students are placed in departments after their completion of the freshman program. The placement is based on the academic merit of students, intake capacity of departments and students' preference. This means that some students are not placed in departments according to their preference. Therefore, the percentage of the students placed to departments according to preference is also included as a department-level variable. Data are available for 969 entrants of the years 1993 to 1996. Most of the data are the same as those collected for the study of the freshman program. The data on the percentage of students' placement according to their preference was collected from the Office of the Freshman Program. The number of departments under study is 26. Linear regression was used as a preliminary step to identify the characteristics that influence the performance of students in the first semester of the second year program. In order to get insight into the differences between departments, multilevel analysis was used.

Furthermore, as the main and final outcome or performance indicator, a study on graduation of students is included. This study deals with a total of 1213 subjects who are entrants of the years 1993-1995. The data are those collected for the study of the performance of students in the freshman program. The dependent variable is

the graduation of students. The explanatory variables are the pre-university characteristics considered also for the study of the results of the freshman program. Logistic regressions were used in order to analyze the factors that influence the graduation of students

Limitations

In order to study the internal consistency of the ESECE, the proportions of candidates who correctly answer each item of the examinations are needed. The data of the years 1993-1997 are not available in a form that can be used for the study of the internal consistency of the items. Due to this handicap, the data of the year 1998 are used since this year is the latest in which students took the examinations in a relatively stable situation. For the study of the validity of the ESECE, an external criterion, such as the grade point average at the university is required. Unfortunately, the grade point averages of the students at the university for the 1998 entrants are also not easily available. For the external validity of the examinations, the ESECE results of the years 1993-1997 are used. Thus, the internal consistency and external validity of the ESECE are investigated based on two independent data sets, which is a limitation of the possibilities of obtaining insight into the overall structure of the examinations.

The working procedures and record keeping of the university are not computerized and hence data were collected manually from the personal records of the students. This made it extremely difficult for follow-up data collection since access to such data is strictly restricted to the employees of the Registrar's Office. The responses of students in the questionnaires were also found to be unreliable since the students were not frank enough to give correct information for fear of the data being used by the university administration to reconsider the current practice of free tuition fees and catering services. For these reasons, many personal and family-related characteristics that might have been important predictors of the performance of students at the university were not included in the study.

7.3 Conclusions

7.3.1 The quality of the ESECE

The first research question, about the extent to which the ESECE tests in a satisfactory way the ability of students in English and Mathematics, is answered in Chapter 3. Three main conclusions of this chapter will be summarized here: about the degree of difficulty of the examinations, about the quality of the examination questions to discriminate between the better and the poorer students, and about how well the examination questions reflect the curriculum taught at schools.

In the first place, it can be concluded that the examinations are difficult, particularly the Mathematics exam, and indeed most of the individual examination

questions are difficult. The investigation of the ESECE for the year 1998 reveals that most of the candidates scored below 50% in the examination of Mathematics and English. Most questions are quite difficult, e.g., the proportion of questions answered correctly by less than 40 % of the candidates, was 43% in English, 64% in Algebra and Geometry, and 86% in Algebra and Commercial Mathematics. It is known from psychometric theory and practical experience in test construction, that questions that are either very easy or very difficult are less informative about the candidate's ability and hence provide a smaller contribution to the reliability of a test.

This is in line with the second conclusion, about the power of the examination questions to discriminate between poor and good students. There were quite a number of examination questions that did not discriminate between the good and poor students. Using standards for item quality that are conventional in psychometric test construction, it was found that only approximately half of the questions were of good quality. From the questions of the various examinations, 18% of the questions of the English exam, 16% of the Algebra and Geometry exam, and 24% of those in Algebra and Commercial Mathematics exam were indicated as having to be deleted or thoroughly revised because of their lack of discriminating quality. Most of these questions were relatively difficult also.

A third conclusion can be given about the quality of the examination questions as evaluated by competent experts, in this case, a number of high school teachers and university lecturers. They identified some of the questions as being too vaguely formulated. For Mathematics, it was found that the curriculum was not appropriately represented in the examination, some subtopics being either totally ignored or not given appropriate weights. The questions that were indicated by the experts as being of sub-standard quality also tended to have a low discriminating quality as found in the psychometric analyses. Thus, there was converging evidence from two different sources as to the unsatisfactory quality of a number of the examination questions. Since the sub-standard questions also tended to be difficult, an improvement of the quality of the examinations may be expected to lead, on average, to higher grades for the students. This suggests that some candidates who should have been admitted to the university might well have been rejected due to erroneous decisions. Deleting the bad items from the 1998 Algebra and Geometry exams should have resulted in better grades for almost a quarter of the candidates. All candidates with a grade B would have received a grade A. On the other hand, some candidates may also have been admitted to the university who were probably not eligible for admission, but this number may be assumed to be much lower than the number of those who erroneously were not admitted. However, for the 1998 cohort this would have been the case for only one percent of the applicants.

7.3.2 Factors that influence the performance of students

The second research question, which is about the identification of important factors that affect the students' performance levels at the university, is answered in Chapters 4-6. The summaries of the conclusions in this chapter have three main parts; namely, identification of important factors that affect the performance of students in the freshman program, the performance of students in the first semester of the second year program, and the graduation of students. The freshman program is considered separately using the results of the students in the two semesters. A summary of the conclusion whether or not the examinations of Mathematics and English that are part of the ESECE measured what they were supposed to measure is also given here.

For the first case, in the identification of important factors that affect the performance of students in the freshman program, the analysis reveals that the results obtained for the electives, Mathematics, and English on the ESECE were important predictors of the performance in the freshman program of the university for all students, and also when natural science students, Social Sciences students, or students with or without previous post-secondary education were considered separately. The percentage of variance in the first semester GPA explained by the ESECE variables for all students is 38%, which is reasonably high. In part because of the stringent selection during the first year for going from the first to the second semester, the average GPA after the second semester is higher than after the first semester, and the predictive value of the ESECE results is lower for the performance in the second than for the performance in the first year (the so-called "restriction of range" phenomenon). This is illustrated by Table 7.1 which reveals how strongly the success ratio of students in the freshman program increases as a function of the GPA of the ESECE.

Table 7.1: Percentage of students by performance on the ESECE and the university

Performance at the university	**ESECE GPA**		
	2.0 – 2.2	**2.4 – 2.8**	**3.0 – 4.0**
Semester 1 GPA ≥ 2.0	44%	86%	91%
Semester 2 GPA ≥ 2.0	74%	86%	94%

The effect of the ESECE outcomes is not equally strong for all subgroups of students. The focus here is on the GPA for the electives, this being the strongest influence among the three ESECE outcomes considered.

The effect of the GPA for the electives is stronger for the Natural Sciences than for the Social Sciences. Its effect is also stronger for students without post-secondary education than for those with such experience. Students who were previously admitted to higher institutions perform better, and show a weaker effect of the ESECE electives, than those without post-secondary education experience. More or less similar results are observed in the second semester. The effects of the

Mathematics GPA on the ESECE are lower in the second semester than the first semester.

Other variables also contribute to the prediction of the freshman results. It is especially useful to represent their effects as effects estimated in a linear regression, because then they are controlled for each other and for the ESECE results. Of the various results presented in Chapter 4, Table 7.2 represents the regression coefficients representing significant effects on the GPA obtained for the first semester in the freshman program. For the continuous variables (ESECE GPA variables, age), these coefficients are the average increase in the first semester GPA that may be expected from one unit increase in the explanatory variable. The other variables are dichotomous, and the coefficient gives the average difference between the category mentioned and the other category.

Table 7.2. Significant effects of explanatory variables on the GPA after the first semester of the freshman year.

Electives GPA	.47
English GPA	.27
Maths GPA	.18
Stream (Nat. Sci.)	-.39
Examination type (ESECE)	.38
Desired stream	.22
Previous post-secondary education	.21
Readmission	-.12
Sex (M)	.12
Age (years)	-0.03

The importance of the ESECE results has been discussed above. On avergage, students in the Social Sciences score higher than those in the natural Sciences. Those who were admitted to the university through the ESECE examination score higher on average than those admitted through other exams. Placement in a stream according to preference results in a higher GPA in the first semester. Earlier experience with higher education on average leads to a higher GPA in the first semester. Those readmitted score higher than those newly admitted. Male students score higher than female students. All these effects are valid when all other variables mentioned are kept constant; in particular, since the ESECE exams have such an important effect, it must be stressed that these effects obtain when students are compared who have equal ESECE grades. This is important, e.g, for the effect of sex, because the raw difference between the first semester GPA of male and female students is 0.16, higher than the effect of 0.12 found here. It can be concluded that part of the difference in performance between male and female students can be explained from the better preparation of male students in high school.

The variables mentioned in Table 7.2 explain 50% of the variance in the first semester GPA, which may be considered a high proportion of explained variance. When subgroups of students are considered separately, it turns out that the prediction is better for the students in the Natural Sciences (59% explained variance) than in the Social Sciences (27% explained variance), and also better for those without previous post-secondary education (52% explained variance) than for those with such experience (39% explained variance).

For the second semester, the results are similar but weaker for almost all variables. The percentage of variance in the second semester GPA explained by the ESECE variables alone is 27%, while it is 38% when all variables are considered. The effects of the variables mentioned already in Table 7.2, but now for the second semester, are reported in Table 7.3; effects indicated by * are significant at the 5% level, so it can be concluded that 4 out of the 10 variables in Table 7.2 have lost their significance. It can be concluded that these four variables exert their effect mainly, or completely, during the first semester, and their effect on later university success is mediated by the selection process and the admittance into the second semester of the freshman year. The remaining variables with significant effects are the three ESECE results, experience with post-secondary education, examination type, and stream.

Table 7.3. Effects of explanatory variables on the GPA after the second semester of the freshman year.

Electives GPA	.39*
English GPA	.19*
Maths GPA	.15*
Stream (Nat. Sci.)	-.43*
Examination type (ESECE)	.17*
Desired stream	.05
Previous post-secondary education	.07*
Readmission	.00
Sex (M)	.02
Age (years)	-0.01

As regards the validity of the examinations, it can be concluded that the high predictive power of the Mathematics and English ESECE examinations is a positive indicator of their external validity. The fact that Chapter 3 suggests that improvements in these examinations are possible, as summarized in Section 7.3.1, implies, however, that it may be possible to further improve the predictive power of the ESECE examinations.

The second conclusion of this section deals with the role of the departments in the explanation of study outcomes in the first semester of the second year program, which was studied in Chapter 5. In this chapter, the same student-level characteristics were considered as presented in the previous section; in separate analyses, these characteristics were supplemented by the GPA obtained in the first

year of university. The effects of the ESECE results are similar to those reported above. It turns out that, in addition, there are important differences between departments; the influence of placement according to desire, which was found to be important in the first analysis, turns out to be mediated by these department differences. To students who obtained the same grades on the ESECE, departments in the Natural Sciences give lower grades in the second university year than departments in the Social Sciences; departments that have an intake of students who obtained higher grades in Mathematics on the ESECE, also give lower grades in the second university year; and departments that have an intake of students who obtained higher grades in the electives on the ESECE, give higher grades in the second university year. Thus, there is an intricate combination of effects at the individual and departmental levels, especially for the ESECE results in Mathematics, which have a positive effect when only the individual level is considered, but a negative effect at the department level. A likely explanation is that the departments that have an intake of students who are good in Mathematics are also those departments that are more competitive, and that set high requirements for the students with respect to their computational and related abilities. When the results of the first university year are also taken into account, the ESECE results lose much of their effect; this implies that, for those admitted to the second year, their earlier ESECE results are of secondary importance compared to their more recent freshman results. Here also it can be seen that departments with a better intake with respect to average GPA obtained in the first year, students with the same first year GPA obtain lower second year grades than departments with an intake with a lower average first year GPA. Again, this can presumably be explained by a more competitive nature of the study in the former departments.

Taking everything together, variation between departments explained more than variation between students.

The third conclusion is about the effects of students' pre-entry characteristics on their graduation. It is found that those students with high results in Mathematics and English, students admitted to streams according to preference, students in the Social Sciences stream, students with previous post-secondary education, and younger students have higher odds of graduation than their counterparts.

The effects of the variables differ in the Natural and Social Sciences. The effects of age, placement into streams according to desire, and of previous post-secondary education are larger in the Natural Sciences than in the Social Sciences. Of the ESECE results, in the Social Sciences the effect of the English GPA is most important, whereas in the Natural Sciences, the effect of the electives is by far the greatest.

The effects of the variables also differ when students with previous post-secondary education and without previous post-secondary experience are considered separately. The electives, Mathematics, English, stream, placement of students to streams according to desire, and age are important predictors of graduation of

students without previous post-secondary education. For students with previous post-secondary education, only stream and age are significant predictors of graduation.

7.4 Recommendations

Quality assurance has been one of the main concerns of the university since 1995, when the 10-years strategic plan of the university was prepared with the main objective to regulate the functional standards of the various programs. Since then, the university has started building both local and external partnership with different institutions and has set up a "Linkage Model". The local partnership includes relevant Eritrean public and local sectors, and the external partnerships are with several universities in the Netherlands, Sweden, Norway, Italy, the United States of America, Zimbabwe, and India. The University Academic Senate set up rules and regulations regarding examinations. Recently, an evaluation and monitoring office has been established at the university. These developments indicate that quality assurance has been a crucial concern of the university.

One of the major policy issues at the university should be the unacceptably high attrition of students. The study reveals that students with high grades on the ESECE perform better than those with lower grades. This means that the selection of students based on the ESECE is meaningful and indicates that monitoring the quality of tests and examinations would be of great importance. However, the questions for the ESECE clearly can be improved, which may be expected to further improve the selection, based on the merit of future university students. The setting up of a division under the educational testing center that monitors the quality of the ESECE may be advantageous. The establishment of close contacts between the university, the Curriculum Department of the Ministry of Education, teachers of high schools, and other relevant institutions should be institutionalized so that all will have a common understanding of the curriculum and evaluation mechanisms.

Students admitted through the ESECE, tend to show better performance as compared to those with other examinations. Students who do not take the ESECE are Eritreans coming from outside Eritrea. These are students with diverse backgrounds and experiences, which is also reflected in their retention at the university. Taking into consideration the large number of Eritrean refugees, it may be wise to expect applicants from other countries. A mechanism has to be introduced which allows such students to take the ESECE with the other regular candidates or pass other additional entrance examinations. The arrangement of an extended special preparatory program, which is a supplement to the current English language support for those with low proficiency in English, is helpful.

The results of this study show that students admitted to streams of preference have a higher chance of success than those admitted without preference. It is true that as to certain aspects, studies in Natural Sciences disciplines are harder than

those in the Social Sciences. The former departments perhaps should make an extra effort to become more attractive to students, and thereby attract more excellent students to their studies. Departments, especially in the Natural Sciences, must boost the attractiveness of their programs for good students by presenting clear goals and expectations, and improving the quality of information.

The performance of female students in the first semester of the university is lower than the performance of male students. The steps taken by the university to encourage female students to improve their performance by granting scholarship awards should be strengthened. Additional assistance such as tutorials or other supplemental instruction may be introduced. However, the performance of female students in the ESECE is clearly lower than the performance of male students, and it seems that the disadvantage for female students is caused more in the period before university than during university. Therefore, more effort should be spent at primary and high school levels to improve opportunities and results of female pupils.

Results indicate that younger students tend to perform better than older students during their university studies. However, it may not be ethical to use age as one of the admission criteria to the university. It is not fair to deprive older students of the right to join the university. It is equally unfair to simply grant them admission if it is known that they have a low chance of succeeding in their studies. Age may be taken into consideration in the placement of students in streams and departments.

Quality assurance focuses not only on entrance tests but also on the performance of the university on several aspects. For example, an indication of the quality of teachers and courses is very important. Regular evaluations of the pedagogical aspects and courses will contribute to an improvement of the performance of the university. The current practice of having linkage programs with European or Australian universities has to be encouraged and further developed. For example, it may be advantageous to establish linkages with institutes, such as the Institute for Teaching and Learning of the University of Sydney or the Learning & Teaching Support Network on these topics. The existing policies of staff development programs have to be strengthened.

The assessment of modern trends and standards in the quality of tests is essential for maintaining the quality of education. In the current 2003/2004 academic year and in previous years, various Ministries established new institutions of higher learning. These include the Medical College, the Institute of Science and Technology, and the Asmara Commercial College. Currently all of these, including the University of Asmara, are functioning independently, using different admission criteria. Since these are government institutions, the establishment of a Commission for Higher Education in Eritrea is appropriate for maintaining standards by introducing clear and transparent examination and admission policies and finally creating a basis for accreditation of programs both nationally and internationally. According to Lawrence and Pharr (2003), one of the means of maintaining the quality of academic programs and their pool of students is by employing admission standards.

The collection of data for the study was an extremely difficult exercise due to a lack of accessibility, incomplete information, and students' doubts on the confidentiality of the information they would provide. The university should include the collection of data as an important task in its plan. These data have to be collected in such a way that they are easily accessible and interpretable. It is important that data on the ESECE examinations and the results of the students who have been admitted during their study career are registered in such a way that the data can be linked at student level, while respecting confidentiality. This requires the training of staff and procurement of necessary facilities. Joining Associations for Institutional Research may also be useful for the exchange of experiences.

7.5 Directions for further research

The selection and retention of students is of crucial concern to the students, their families and parents, the university, and the country at large. From this study it has become apparent that there is a need for further investigation of the selection and retention of students at the university. Due attention must be paid to making the selection more reliable and to minimize the attrition rate of students at the university. In order to address these issues the need for research is unquestionable.

The study reveals that male students have a somewhat higher chance of performing at the university than female students. An investigation of the knowledge of the influence of culture and traditions, the role of guidance and counseling services, and the advantage of introducing educational support systems to improve the performance of female students is highly recommended.

Previous post-secondary education plays a significant role in the students' achievement at the university. The fact that previous post-secondary education has such a positive influence in the performance of students indicates the need for an investigation to establish a sort of preparatory program prior to university education to strengthen the academic background of students.

Regular surveys and studies must be conducted to minimize attrition. The attitudes of students, the understanding of staff members regarding whether or not attrition is desirable, and the university processes in general need a careful and continuous study. Much can be learnt from the experiences of the various institutions in the USA, Europe, etc. One of the tasks of the proposed division under the educational testing center is to investigate on a regular basis the tests for the ESECE and the tests used in the university, focusing on the importance of scientific soundness and relevance.

Previously, students dismissed for academic reasons had to leave the university for one year and could apply again for readmission. Re-admission was then granted based on their GPA and availability of space. The university has recently introduced re-sit examinations which allow students to take some examinations again. This has reduced the number of re-admitted students

substantially. However, the strengths and weaknesses of this new regulation have to be continuously investigated.

In this study, due to a lack of data, it has been possible to investigate a limited number of variables that affect the performance of students at the university. Further studies are needed investigating student and department level factors that have been found important in other studies (cf. Chapter 4) including ability, commitment, academic and social integration, demographic characteristics, social circumstances (housing, family responsibilities, etc.), classroom variables, etc.

Quality assurance has to be based on continuous research related to the quality of the examinations, the selection processes, the curriculum, the pedagogical aspects, and the motivation of students and/or teachers to determine what might make the difference, especially for the Natural Sciences with high attrition rates. Correct decisions regarding the selection and retention of students at the university could then be taken based on the results.

Finally, one of the pertinent issues that have to be addressed is the lack of consistent data. Data have to be collected regularly at university level for the analysis of trends over time. These data must be longitudinal so that they are a reflection of the total picture of a student starting from the time of admission until graduation so that all the possible hurdles and their causes may be identified. As new universities and colleges are being established, such data should also be collected at national level. Qualified personnel should investigate the type of data and the implementation procedures.

Appendices

Appendix A

Table A1 Sub-tests and corresponding item numbers for the examination of English on theESECE (1998)

Section	Topic	Item Number
X1	Reading Comprehension 1	1 - 15
X2	Grammar in Context 1	16 - 25
X3	Sentence in Comprehension	26 – 35
X4	Structure and Usage	36 – 50
X5	Grammar in Context 2	51 – 60
X6	Grammar in Context 3	61 – 70
X7	Reading Comprehension 2	71 - 80

Appendix B

Table B1 Number of graduates-Degree programs

College/Department	1991-1995		1996		1997		1998		1999		2000		2001		2002		Total	
	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T
Science	6	110	20	159	12	128	8	116	13	122	10	102	10	96	3	115	82	948
Biology	3	10	5	34	2	35	4	24	6	26	3	17	1	15	1	22	25	183
Chemistry	1	33	7	27	2	31	1	34	2	28	2	16	4	16	1	23	20	208
Geology	-	-	-	-	-	-	-	-	-	3	3	22	2	20	-	24	5	69
Marine Science	-	10	1	24	-	-	-	-	1	14	-	6	2	15	1	14	5	83
Mathematics	-	26	6	52	6	45	-	36	2	36	1	24	-	14	-	18	15	251
Physics	2	31	1	22	2	17	3	22	2	15	1	17	1	16	-	14	12	154
Health Science	-	-	-	-	11	36	-	-	-	-	4	28	1	19	6	59	22	142
Nursing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clinical Laboratory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	18	1	18
Science	-	-	-	-	11	36	-	-	-	-	4	28	1	19	3	26	19	109
Public Health & Clinical Sc. Pharmacy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	15	2	15
Art & Social Sciences	-	10	7	40	5	23	5	32	13	79	10	79	15	158	24	113	79	534
Archaeology	-	-	-	-	-	-	-	-	-	-	-	-	2	16	3	10	5	26
English	-	10	7	40	5	23	5	30	8	40	9	36	2	37	3	12	39	228
Geography	-	-	-	-	-	-	-	-	-	6	1	26	1	16	4	18	6	66
History	-	-	-	-	-	-	-	-	-	1	-	2	1	12	3	15	4	30
Journalism & Mass. Comm.	-	-	-	-	-	-	-	-	-	-	-	2	3	9	4	14	7	25
Political Science	-	-	-	-	-	-	-	-	-	-	-	-	2	18	1	9	3	27
Sociology & Anthropology	-	-	-	-	-	-	-	2	5	32	-	2	2	18	5	14	12	68
Statistics & Demography	-	-	-	-	-	-	-	-	-	-	-	11	2	32	1	21	3	64
Law Programme	-	-	-	-	-	-	1	27	2	36	1	18	2	19	3	19	9	119
Business & Economics	63	303	21	130	15	132	11	99	30	253	14	102	18	80	15	69	187	1168
Accounting	44	150	12	50	8	50	9	41	10	89	8	35	7	26	7	18	105	459
Business Management	11	85	4	35	4	38	1	25	9	107	1	30	2	26	-	17	32	363
Economics & Finance	8	68	5	45	3	44	1	33	11	57	5	37	6	22	8	26	47	332
Public Administration	-	-	-	-	-	-	-	-	-	-	-	-	3	6	-	8	3	14
Agriculture & Acquatic Sci.	1	20	8	94	3	83	8	51	4	62	3	44	4	44	8	48	39	446

Animal Science	-	-	-	-	-	-	-	-	1	20	1	14	1	13	4	21	7	68
Plant Science	-	8	6	44	-	36	6	25	1	26	1	17	1	15	2	13	17	184
Soil & Water Conservation	1	12	2	50	3	47	2	26	2	16	1	13	2	16	2	14	15	194

Table B1 (continued) Number of graduates-Degree programs

	1991-1995		1996		1997		1998		1999		2000		2001		2002		Total	
College/Department	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T
Engineering	-	-	-	-	-	-	-	-	-	-	-	-	2	77	1	67	3	144
Civil Engineering	-	-	-	-	-	-	-	-	-	-	-	-	2	37	1	33	3	70
Electrical Engineering	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	18	-	39
Mechanical Engineering	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	16	-	35
Education	-	-	-	-	-	-	-	-	-	2	-	5	15	93	14	130	29	230
Educational Administration	-	-	-	-	-	-	-	-	-	-	-	1	1	14	1	15	2	30
Educational Psychology	-	-	-	-	-	-	-	-	-	2	-	1	1	11	1	11	2	25
Science Education																		
Biology	-	-	-	-	-	-	-	-	-	-	-	-	5	12	4	19	9	31
Chemistry	-	-	-	-	-	-	-	-	-	-	-	1	2	9	1	16	3	26
Mathematics	-	-	-	-	-	-	-	-	-	-	-	1	-	10	-	12	-	23
Physics	-	-	-	-	-	-	-	-	-	-	-	1	1	5	1	9	2	15
Social Sciences Education																		
English	-	-	-	-	-	-	-	-	-	-	-	-	2	10	3	14	5	24
Geography	-	-	-	-	-	-	-	-	-	-	-	-	1	9	-	20	1	29
History	-	-	-	-	-	-	-	-	-	-	-	-	2	13	3	14	5	27
Total	70	443	56	423	46	402	33	325	62	554	42	378	67	586	74	620	450	3731

Table B2 Number of graduates-Diploma programs

College/Department	1991-1995		1996		1997		1998		1999		2000		2001		2002		Total	
	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T
Business & Economics	132	352	15	35	16	62	1	7	-	7	-	-	-	-	-	-	164	463
Accounting	93	225	14	26	10	36	-	2	-	2	-	-	-	-	-	-	117	291
Management	39	127	1	9	6	26	1	5	-	5	-	-	-	-	-	-	47	172
Law	23	144	5	24	-	-	-	-	-	-	-	-	-	-	-	-	28	168
Arts & Social Sciences	6	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	12
French	6	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Education Program	-	-	-	-	1	27	1	14	-	30	8	104	2	50	1	98	13	323
Biology	-	-	-	-	-	1	-	11	-	7	2	4	-	2	-	-	2	25
Chemistry	-	-	-	-	-	-	-	-	-	3	1	8	-	-	-	-	1	11
Mathematics	-	-	-	-	-	9	-	1	-	6	1	7	1	10	-	7	2	40
English	-	-	-	-	-	-	-	-	-	-	1	16	1	4	-	20	2	40
Geography	-	-	-	-	-	9	-	1	-	6	2	35	-	8	-	26	2	85
History	-	-	-	-	1	8	1	1	-	8	1	23	-	6	1	24	4	70
Science Education	-	-	-	-	-	-	-	-	-	-	-	11	-	20	-	21	-	52
Faculty of Engineering	-	-	-	-	-	-	2	48	2	53	1	59	7	82	-	-	12	242
Civil	-	-	-	-	-	-	1	23	2	23	1	28	3	37	-	-	7	111
Electrical	-	-	-	-	-	-	1	13	-	17	-	17	4	26	-	-	5	73
Mechanical	-	-	-	-	-	-	-	12	-	13	-	14	-	19	-	-	-	58
Health Science	-	-	-	-	-	-	-	-	-	9	1	14	1	15	5	10	7	48
Medical Lab. Technician	-	-	-	-	-	-	-	-	-	9	1	14	1	15	5	10	7	48
Agriculture & Aqua. Sc.	-	-	-	-	-	-	-	-	-	-	-	-	4	15	-	20	4	35
General Agriculture	-	-	-	-	-	-	-	-	-	-	-	-	4	15	-	20	4	35
Total	161	508	20	59	17	89	4	69	2	99	10	177	14	162	6	128	234	1291

Source: Statistics and programming office of the university

Table B3 Number of graduates-Certificate programs

College/Department	1991-1995		1996		1997		1998		1999		2000		2001		2002		Total	
	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T
Law Programme	-	-	-	-	-	-	-	-	13	54	-	-	-	-	1	47	14	101
Arts & Social Sciences	-	-	-	-	-	-	8	26	7	47	13	44	2	15	16	65	46	197
Archaeology	-	-	-	-	-	-	-	-	2	22	-	-	-	-	-	-	2	22
Journalism	-	-	-	-	-	-	8	26	-	-	-	-	-	-	-	-	8	26
Social Work	-	-	-	-	-	-	-	-	5	25	12	29	1	2	12	41	30	97
Political Science	-	-	-	-	-	-	-	-	-	-	1	15	1	13	4	24	6	52
Business & Economics	-	-	2	36	9	33	2	30	10	42	24	60	34	139	55	266	136	606
Accounting	-	-	-	-	-	-	-	-	-	-	-	-	7	22	19	66	26	88
HRM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	29	1	29
Library & Information Studies	-	-	-	-	-	-	-	-	-	-	13	25	8	24	17	31	38	80
Project Management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	37	3	37
Public Administration	-	-	2	36	9	33	2	30	10	42	11	35	19	93	15	103	68	372
Total	-	-	2	36	9	33	10	56	30	143	37	104	36	154	72	378	196	904

Source: Statistics and Programming Office of the University

Appendix C

Table C.1 Item difficulties, item discriminations and item-rest correlation for the English

Item number	Item difficulty	Item discrimination	Item-rest correlation	Item number	Item difficulty	Item discrimination	Item-rest correlation
1	0.33	0.39	0.301	41	0.37	0.64	0.488
2	0.59	0.57	0.417	42	0.38	0.42	0.309
3	0.41	0.39	0.293	43	0.31	0.31	0.256
4	0.72	0.43	0.344	44	0.28	0.54	0.463
5	0.49	0.57	0.423	45	0.33	0.47	0.380
6	0.76	0.33	0.272	46	0.65	0.47	0.350
7	0.51	0.42	0.303	47	0.71	0.39	0.308
8	0.17	0.12	0.104	48	0.56	0.58	0.429
9	0.73	0.52	0.422	49	0.58	0.54	0.388
10	0.78	0.46	0.397	50	0.85	0.26	0.264
11	0.51	0.53	0.379	51	0.47	0.13	0.075
12	0.73	0.45	0.361	52	0.79	0.33	0.285
13	0.61	0.49	0.361	53	0.35	0.40	0.313
14	0.61	0.33	0.236	54	0.84	0.34	0.336
15	0.45	0.36	0.253	55	0.35	0.22	0.163
16	0.20	-0.06	-0.070	56	0.34	0.20	0.140
17	0.55	0.57	0.420	57	0.23	0.13	0.106
18	0.46	0.43	0.301	58	0.02	0.00	0.012
19	0.63	0.33	0.242	59	0.61	0.39	0.270
20	0.65	0.46	0.343	60	0.49	0.54	0.388
21	0.55	0.46	0.323	61	0.42	0.32	0.245
22	0.45	0.40	0.286	62	0.36	0.25	0.191
23	0.25	-0.08	-0.074	63	0.30	0.18	0.137
24	0.22	0.38	0.354	64	0.16	-0.03	-0.037
25	0.10	-0.02	-0.004	65	0.19	0.18	0.175
26	0.38	0.57	0.419	66	0.43	0.30	0.213
27	0.43	0.67	0.486	67	0.40	0.45	0.335
28	0.61	0.52	0.386	68	0.37	0.29	0.214
29	0.34	0.38	0.290	69	0.57	0.41	0.288
30	0.57	0.25	0.160	70	0.58	0.58	0.419
31	0.47	0.66	0.487	71	0.58	0.48	0.351
32	0.28	0.04	0.015	72	0.34	0.37	0.289
33	0.38	0.19	0.125	73	0.50	0.49	0.358
34	0.22	0.11	0.100	74	0.46	0.34	0.234
35	0.44	0.46	0.341	75	0.33	0.36	0.273
36	0.44	0.45	0.330	76	0.36	0.33	0.248
37	0.65	0.27	0.189	77	0.27	0.21	0.186
38	0.19	0.20	0.225	78	0.21	0.04	0.044
39	0.23	0.44	0.409	79	0.36	0.49	0.388
40	0.55	0.63	0.452	80	0.53	0.46	0.330

Table C.2 Item difficulties, item discriminations and item-rest correlation for the Algebra and Geometry

Item number	Item difficulty	Item discrimination	Item-rest correlation	Item number	Item difficulty	Item discrimination	Item-rest correlation
1	0.28	0.38	0.324	26	0.45	0.52	0.392
2	0.57	0.54	0.379	27	0.34	0.24	0.193
3	0.65	0.50	0.364	28	0.37	0.32	0.237
4	0.42	0.71	0.537	29	0.32	0.30	0.244
5	0.31	0.53	0.429	30	0.30	0.41	0.347
6	0.27	0.37	0.346	31	0.28	0.33	0.282
7	0.46	0.46	0.331	32	0.26	0.33	0.276
8	0.42	0.73	0.547	33	0.33	0.43	0.343
9	0.54	0.68	0.489	34	0.20	0.06	0.028
10	0.51	0.50	0.359	35	0.23	0.30	0.293
11	0.24	0.28	0.266	36	0.36	0.20	0.128
12	0.25	0.17	0.153	37	0.35	0.15	0.092
13	0.30	0.39	0.339	38	0.20	0.17	0.155
14	0.34	0.45	0.368	39	0.41	0.62	0.463
15	0.37	0.43	0.326	40	0.41	0.52	0.375
16	0.64	0.52	0.374	41	0.46	0.63	0.467
17	0.52	0.62	0.435	42	0.34	0.51	0.412
18	0.35	0.44	0.348	43	0.22	0.05	0.039
19	0.39	0.60	0.459	44	0.43	0.59	0.442
20	0.49	0.62	0.456	45	0.21	0.29	0.301
21	0.42	0.51	0.385	46	0.23	0.45	0.438
22	0.32	0.52	0.430	47	0.32	0.18	0.149
23	0.33	0.50	0.416	48	0.16	0.12	0.122
24	0.49	0.56	0.408	49	0.22	0.26	0.262
25	0.31	0.41	0.345	50	0.16	0.08	0.063

Table C.3 Item difficulties, item discriminations and item-rest correlation for the Algebra and Commercial Mathematics

Item number	Item difficulty	Item discrimination	Item-rest correlation	Item number	Item difficulty	Item discrimination	Item-rest correlation
1	0.15	0.23	0.240	26	0.30	0.32	0.242
2	0.48	0.41	0.257	27	0.29	0.23	0.145
3	0.54	0.61	0.402	28	0.31	0.27	0.131
4	0.29	0.50	0.468	29	0.28	0.23	0.160
5	0.21	0.06	0.018	30	0.15	-0.05	-0.102
6	0.24	0.04	0.004	31	0.21	0.05	0.014
7	0.38	0.49	0.310	32	0.21	0.30	0.323
8	0.28	0.58	0.505	33	0.28	0.23	0.182
9	0.37	0.58	0.407	34	0.24	0.19	0.092
10	0.39	0.37	0.276	35	0.26	0.33	0.275
11	0.22	0.14	0.116	36	0.29	0.47	0.391
12	0.25	0.15	0.135	37	0.30	0.38	0.271
13	0.22	0.17	0.192	38	0.30	0.31	0.277
14	0.24	0.30	0.242	39	0.16	0.32	0.322
15	0.27	0.36	0.270	40	0.36	0.32	0.269
16	0.50	0.48	0.315	41	0.50	0.39	0.288
17	0.34	0.52	0.423	42	0.25	0.17	0.105
18	0.27	0.23	0.149	43	0.24	0.01	-0.046
19	0.28	0.52	0.424	44	0.31	0.60	0.486
20	0.42	0.52	0.383	45	0.61	0.36	0.235
21	0.38	0.28	0.242	46	0.14	0.07	0.079
22	0.23	0.40	0.400	47	0.44	0.22	0.174
23	0.24	0.23	0.235	48	0.23	0.28	0.289
24	0.35	0.36	0.273	49	0.37	0.54	0.367
25	0.22	0.23	0.211	50	0.25	0.12	0.107

Appendix D

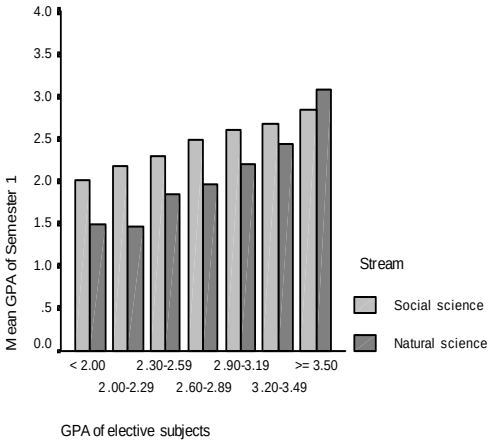


Figure D.1: Mean GPA of Semester 1 versus GPA for elective subjects

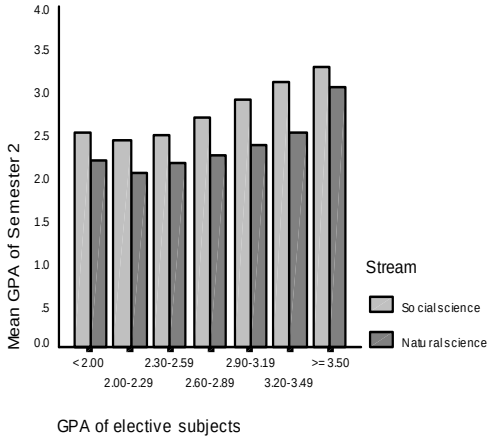


Figure D.3: Mean GPA of Semester 2 versus GPA for elective subjects

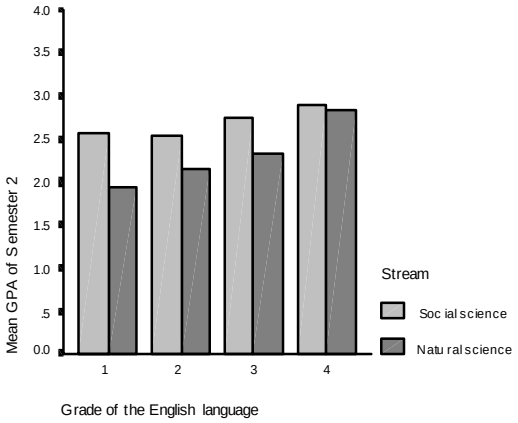


Figure D.2: Mean GPA of Semester 1 versus the grades for English

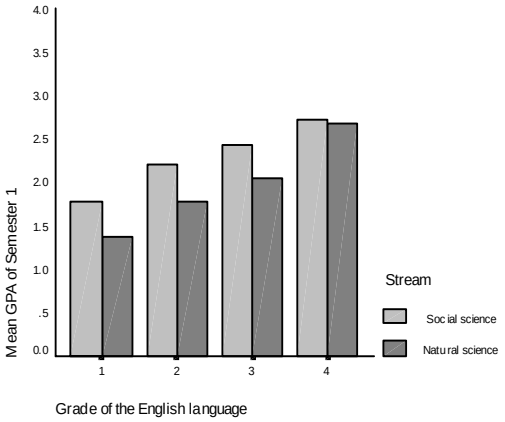


Figure D.4: Mean GPA of Semester 2 versus the grades for English

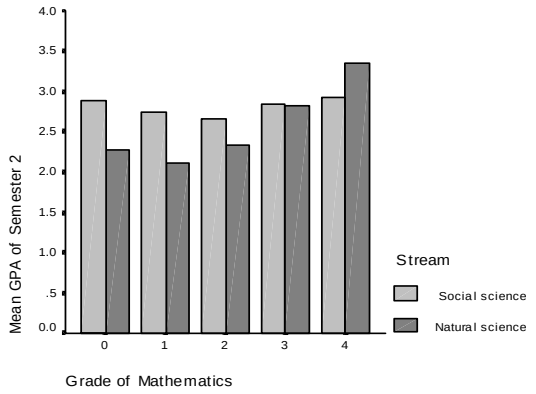


Figure D.5: Mean GPA of Semester 1 versus the grades for Mathematics

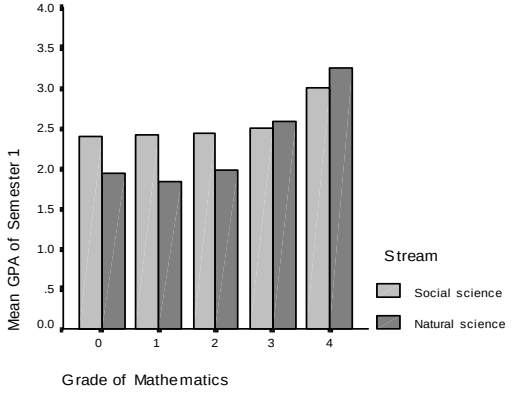


Figure D.6: Mean GPA of Semester 2 versus the grades for Mathematics

Table D.1 Mean GPA (and standard error) of the first and second semester for all students, and students in the Natural and Social Sciences streams (in italics the non-significant differences are indicated)

Categories	All Students		Natural Sciences		Social Sciences	
	Semester 1	Semester 2	Semester 1	Semester 2	Semester 1	Semester 2
Post sec.edu.	2.44 (.019)	2.62 (.015)	2.34 (.029)	2.48 (.028)	2.55 (.024)	2.75 (.027)
No post edu.	2.13 (.023)	2.54 (.021)	1.99 (.031)	2.43 (.029)	2.35 (.033)	2.70 (.027)
ESECE	2.26 (.016)	*2.58 (.015)*	*2.12 (.027)*	*2.45 (.021)*	*2.45 (.021)*	*2.73 (.019)*
No ESECE	2.07 (.074)	*2.50 (.073)*	*1.94 (.110)*	*2.37 (.091)*	*2.20 (.103)*	*2.66 (.114)*
Preference	2.32 (.016)	*2.59 (.015)*	2.23 (.024)	2.47 (.022)	*2.44 (.021)*	*2.73 (.020)*
No Pref.	1.64 (.056)	*2.33 (.054)*	1.37 (.051)	2.07 (.057)	*2.53 (.097)*	*2.73 (.073)*
Regular	2.29 (.018)	2.59 (.016)	2.18 (.025)	2.48 (.023)	*2.45 (.023)*	*2.74 (.029)*
Private	2.03 (.045)	2.50 (.040)	1.69 (.061)	2.28 (.060)	*2.40 (.054)*	*2.66 (.051)*
Re-admitted	2.29 (.050)	2.45 (.044)	2.20 (.069)	2.36 (.059)	*2.37 (.079)*	2.55 (.073)
Newly adm.	2.25 (.017)	2.59 (.015)	2.10(.024)	2.45 .022	*2.45 (.021)*	2.74(.020)
Female	2.12 (.041)	*2.53 (.036)*	1.84 (.060)	2.29 (.054)	*2.36 (.050)*	*2.69 (.044)*
Male	2.28 (.017)	*2.58 (.016)*	2.15 (.025)	2.46 (.022)	*2.46 (.023)*	*2.73 (.021)*
Year 1994	1.95 (.040)	2.47 (.033)	1.58 (.050)	2.28 (.048)	2.41 (.048)	2.62 (.043)
Year 1995	2.23 (.040)	2.50 (.031)	2.01 (.062)	2.39 (.054)	2.44 (.046)	2.60 (.036)
Year 1996	2.34 (.031)	2.56 (.027)	2.25 (.044)	2.52 (.039)	2.47 (.044)	2.63 (.037)
Year 1997	2.50 (.025)	2.74 (.029)	2.52 (.034)	2.48 (.039)	2.47 (.036)	3.09 (.033)

Table D.2 Mean GPA (and standard error) of the first and second semester for students with or without previous post-secondary education (in italics the no-significant differences are indicated).

Categories	Students with Post-secondary education		Students without Post-secondary education	
	Semester 1	Semester 2	Semester 1	Semester 2
ESECE	2.45 (.019)	*2.62 (.020)*	2.40 (.024)	*2.55(.021)*
No ESECE	2.20 (.094)	*2.60 (.111)*	1.96 (.108)	*2.39 (.091)*
Preference	*2.45 (.019)*	*2.63 (.020)*	2.23 (.024)	2.57 (.022)
No Pref.	*2.36 (.083)*	*2.51 (.076)*	1.44 (.060)	2.23 (.071)
Regular	*2.45 (.020)*	*2.62 (.021)*	2.19 (.026)	*2.57 (.023)*
Private	*2.45 (.060)*	*2.62 (.059)*	1.84 (.055)	*2.41 (.053)*
Re-admitted	*2.24 (.083)*	2.41 (.077)	2.33 (.033)	*2.48 (.051)*
Newly adm.	*2.10 (.024)*	2.63 (.020)	2.12 (.024)	*2.55(.022)*
Natural sc.	2.34(.029)	2.48(.028)	1.99 (.031)	2.43 (.029)
Social Sc.	2.55(.024)	2.75(.028)	2.35 (.033)	2.70 (.027)
Female	2.33(.057)	*2.57 (.056)*	2.01 (.054)	*2.51 (.048)*
Male	2.46 (.019)	*2.63 (.021)*	2.15 (.026)	*2.55 (.023)*
Year 1994	2.42 (.044)	2.57 (.045)	1.72 (.050)	2.39 (.046)
Year 1995	2.47 (.045)	2.59 (.043)	2.08 (.056)	2.44 (.044)
Year 1996	2.47 (.034)	2.56 (.030)	2.23 (.049)	2.55 (.045)
Year 1997	2.43 (.037)	2.78 (.046)	2.56 (.033)	2.73 (.021)

Standard errors are in parentheses.

Appendix E

Table E.1 Pearson's correlation coefficients for various combinations of some independent variables (All students). *N* = 2327

Variable	GPA for the Electives	GPA for Mathematics	GPA for English	Age at admission
GPA for the Electives	1.000			
GPA for Mathematics	.161**	1.000		
GPA for English	.215**	.057**	1.000	
GPA for the Electives	-.141**	-.047*	-.059**	1.000

** Correlation is significant at 0.05 level*
*** Correlation is significant at 0.01 level*

Table E.2 Pearson's correlation coefficients for various combinations of some independent variables (Natural Science Stream). *N* = 1303

Variable	GPA for the Electives	GPA for Mathematics	GPA for English	Age at admission
GPA for the Electives	1.000			
GPA for Mathematics	.242**	1.000		
GPA for English	.318**	.182**	1.000	
GPA for the Electives	-.195**	-.054	-.110**	1.000

** Correlation is significant at 0.05 level*
*** Correlation is significant at 0.01 level*

Table E.3 Pearson's correlation coefficients for various combinations of some independent variables (Social Sciences Stream). *N* = 974

Variable	GPA for the Electives	GPA for Mathematics	GPA for English	Age at admission
GPA for the Electives	1.000			
GPA for Mathematics	-.018	1.000		
GPA for English	.063*	-.095**	1.000	
GPA for the Electives	-.059	-.016	.005	1.000

** Correlation is significant at 0.05 level*
*** Correlation is significant at 0.01 level*

Table E.4 Pearson's correlation coefficients for various combinations of some independent variables (Students with post-secondary education). *N* = 942

Variable	GPA for the Electives	GPA for Mathematics	GPA for English	Age at admission
GPA for the Electives	1.000			
GPA for Mathematics	.115**	1.000		
GPA for English	.133**	.018	1.000	
GPA for the Electives	-.121**	-.046	-.005	1.000

** Correlation is significant at 0.05 level*
*** Correlation is significant at 0.01 level*

Table E.5 Pearson's correlation coefficients for various combinations of some independent variables (Students without post-secondary education). *N* = 1385

Variable	GPA for the Electives	GPA for Mathematics	GPA for English	Age at admission
GPA for the Electives	1.000			
GPA for Mathematics	.192**	1.000		
GPA for English	.264**	.084**	1.000	
GPA for the Electives	-.153**	-.049	-.095**	1.000

** Correlation is significant at 0.05 level*
*** Correlation is significant at 0.01 level*

Table E.6 Linear Regression of semester 1 GPA for all students, Natural and Social Sciences, students with and without post -secondary education, Unstandardized regression coefficients with *t* values in parentheses. (For the academic variables only).

Independent variable	**Model 2**				
	All	**N.Sc.**	**S.Sc.**	**P**	**NP**
Constant	-.30[u]	-.83	.54	.65	-.70
	(-4.03)[t*]	(-9.96)*	(4.12)*	(6.99)*	(-7.59)*
Electives	.55	.66	.38	.33	.63
	(23.24)*	(24.34)*	(9.51)*	(11.88)*	(21.04)*
Mathgpa	.12	.20	.09	.12	.12
	(7.52)*	(9.76)*	(3.69)*	(6.18)*	(5.83)*
Enggpa	.28	.25	.25	.23	.31
	(17.05)*	(11.60)	(11.04)*	(11.98)*	(14.46)*
R^2_{adj}	.38	.53	.21	.31	.42
(*N*)	2236	1254	939	894	1341

p < .05

Table E.7 Linear Regression of semester 2 GPA for all students, Natural and Social Sciences, students with and without post-secondary education, Unstandardized regression coefficients with *t* values in parentheses. (For the academic variables only).

Independent variable	**Model 2**				
	All	**N.Sc.**	**S.Sc.**	**P**	**NP**
Constant	.81[u]	.34	.97	1.01	.61
	(11.14)[t*]	(4.04)*	(8.24)*	(10.52)*	(6.63)*
Electives	.36	.36	.49	.33	.39
	(15.73)*	(13.45)*	(13.70)*	(10.48)*	(13.09)*
Mathgpa	.09	.25	-.01	.05	.10
	(5.82)*	(13.12)*	(-.42)	(2.15)*	(5.16)*
Enggpa	.19	.18	.15	.18	.21
	(11.87)*	(8.47)*	(7.36)*	(8.30)*	(9.74)*
R^2_{adj}	.27	.45	.25	.21	.31
(N)	1853	961	849	839	1013

** p < .05*

Table E.8 Linear Regression of semester 1 GPA for all students, Natural and Social Sciences, students with and without post-secondary education, with interactions and quadratic effects. Unstandardized regression coefficients with *t* values in parentheses.

Independent variable	**Model 2**				
	All	N.Sc.	S.Sc.	P	NP
Constant	.12	-.07	.04	.68	.03
	(.63)	(-.31)	(.14)	(2.68)	(.11)
Electives	.45	.50	.38	.36	.52
	(17.67)*	(15.44)*	(9.11)*	(11.19)*	(13.77)*
Mathgpa	.17	.19	.09	.13	.19
	(10.46)*	(9.52)*	(3.52)*	(6.50)*	(8.04)*
Enggpa	.26	.23	.30	.21	.30
	(16.36)*	(10.88)*	(12.48)*	(10.39)*	(12.73)*
Postedu	.21	.21	.20	-	-
	(8.03)*	(6.08)*	(5.00)*	-	-
Examtype	.35	.19	.50	.31	.45
	(4.59)*	(1.76)	(4.58)*	(3.50)*	(3.84)*
Destream	.19	.29	-.12	.01	.24
	(4.43)*	(5.75)*	(-1.37)	(.16)*	(4.29)*
Admcateg	.01	.04	-.04	-.11	.01
	(.15)	(.80)	(-.80)	(-2.12)*	(.24)
Readmn	-.12	-.27	.10	.17	-.27
	(-2.21)*	(-3.68)*	(1.21)	(2.55)*	(-3.29)*
Stream	-.38	-	-	-.31	-.41
	(-14.16)*	-	-	(-9.48)*	(-10.34)*
Cohort94	.03	-.05	.16	-.02	.11
	(.73)	(-.86)	(2.14)*	(-.27)	(1.74)
Cohort95	.09	-.06	.29	.03	.16
	(1.86)	(-.93)	(3.76*	(.41)	(2.37)*
Cohort96	.04	-.01	.11	-.07	.13
	(.92)	(-.11)	(1.51)	(-1.18)	(2.11)*
Cohort97	.14	.16	.18	-.08	.30
	(2.85)*	(2.45)*	(2.22)*	(-1.16)	(4.20)*
Sex	.12	.11	.09	.13	.11
	(3.35)*	(2.15)*	(1.83)	(2.80)*	(2.23)*
Age	-.03	-.04	-.02	-.04	-.02
	(-6.04)*	(-4.51)*	(-2.62)*	(-2.64)*	(-5.62)*
Int^1	.21	-	-	.03	-.02
	(4.50)*	-	-	(.80)	(-.45)
Int^2	.01	.03	-.03	.04	-.01
	(1.20)	(2.21)*	-1.87	(2.86)*	-.31
Int^3	.03	.07	.01	.01	.03
	(2.48)	(3.79)*	(.50)	(.83)	(1.51)
R^2_{adj}	.504	.597	.272	.398	.519
(*N*)	2029	1169	860	806	1221

* $p < .05$

Int^1 = (GPA for electives - Mean GPA for electives)^2
Int^2 = (Grade for Mathematics - Mean grade for Mathematics)^2
Int^3 = Product interaction term of cohort 1997 and age of students at admission

Table E.9 Linear Regression of semester 2 GPA for all students, Natural and Social Sciences, students with and without post-secondary education, with interactions and quadratic effects. Unstandardized regression coefficients with *t* values in parentheses.

Independent variable	**Model 2**				
	All	**N.Sc.**	**S.Sc.**	**P**	**NP**
Constant	**.81**	**.55**	**.46**	**1.50**	**.74**
	(4.43)*	(2.13)*	(1.67)	(5.28)*	(2.79)*
Electives	.36	.41	.38	.32	.38
	(13.68)*	(12.74)*	(10.42)*	(8.87)*	(10.29)*
Mathgpa	.13	.21	.07	.08	.15
	(7.93)*	(10.18)*	(3.02)*	(3.58)*	(6.83)*
Enggpa	.17	.17	.19	.16	.18
	(10.59)*	(7.76)*	(8.75)*	(6.89)*	(8.03)*
Postedu	.08	.10	.03	-	-
	(3.12)*	(3.10)*	(.98)	-	-
Examtype	.17	.06	.42	.07	.29
	(2.21)*	(.53)	(4.23)*	(.67)	(2.45)*
Destream	.05	.13	-.09	-.07	.08
	(.96)	(2.03)*	(-1.28)	(-.09)	(1.26)
Admcateg	.02	.04	-.01	-.02	.03
	(.58)	(.78)	(-.25)	(-.35)	(.56)
Readmn	-.01	-.09	.13	.13	-.11
	(-.17)	(-1.31)	(1.82)	(1.73)	(-1.57)
Stream	-.42	-	-	-.37	-.47
	(-16.18)*	-	-	(-9.85)*	(-12.68)*
Cohort94	.04	-.02	.22	-.02	.09
	(.83)	(-.29)	(3.30)*	(-.22)	(1.46)
Cohort95	.02	-.13	.26	-.02	.05
	(.37)	(-2.02)*	(3.88)*	(-.25)	(.76)
Cohort96	-.04	-.17	.15	-.12	.03
	(-.81)	(-2.84)*	(2.26)*	(-1.74)	(.52)
Cohort97	.09	-.29	.64	.06	.08
	(1.82)	(-4.61)*	(8.89)*	(.84)	(1.17)
Sex	.02	-.07	.09	.06	-.01
	(.66)	(-.01)	(1.93)	(1.15)	(-.12)
Age	-.07	-.02	.00	-.02	-.01
	(-1.26)*	(-2.00)*	(-1.55)	(-2.69)*	(-1.58)
Int^1	.09	.11	.03	.06	.11
	(2.57)*	(2.62)*	(.55)	(1.29)	(2.43)*
Int^2	.05	.05	-.01	.07	.05
	(4.77)*	(3.61)*	(-.55)	(3.99)*	(2.64)*
Int^3	.04	.01	-.04	.06	.02
	(3.65)*	(.50)	(2.56)*	(4.01)*	(.99)
R^2_{adj}	.393	.488	.361	.328	.438
(*N*)	1673	892	781	764	907

* $p < .05$

Int^1 = (GPA for electives - Mean GPA for electives)^2
Int^2 = (Grade for Mathematics - Mean grade for Mathematics)^2
Int^3 = Product interaction term of cohort 1997 and age of students at admission

Appendix F

The logit transformation

Let

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \quad .$$

Then

$$Z = \beta_0 + \sum \beta_j X_{ji} .$$

Let P_i be the probability that the j^{th} student is graduating, given the characteristics $X_{1i}, X_{2i}, \ldots, X_{ni}$.

Thus

$$P_i = 1/(1 + e^{-Z}) ,$$

$$1 - P_i = 1 - 1/(1 + e^{-Z}) = e^{-Z}/(1 + e^{-Z}) .$$

Then,

$$P_i / (1 - P_i) = [(1/(1 + e^{-Z}))/(e^{-Z}/(1 + e^{-Z})] = 1/e^{-Z} = e^{Z} .$$

Taking the logarithm of the ratio, we get

$$\log [P_i / (1 - P_i)] = \log e(e^{Z}) = Z .$$

Therefore,

$$\log [(P_i / (1 - P_i)] = \beta_0 + \sum \beta_j X_{ji} .$$

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Samenvatting

1. Doel van het onderzoek

Eritrea is een jonge natie in Oost Afrika die zich in 1993 onafhankelijk verklaarde. Na de onafhankelijkheid is alle aandacht in Eritrea gericht op de wederopbouw van de sociale en economische infrastructuur. Een belangrijk aspect van de wederopbouw is onderwijs, met in eerste instantie het doel staf op te leiden voor vitale functies in onderwijs, rechtspraak, de medische en de administratieve sector. De infrastructuur voor onderwijs in het land heeft een enorm snelle ontwikkeling doorgemaakt. De Universiteit van Asmara, als enige instelling voor hoger onderwijs in het land, heeft als missie te voorzien in de nationale behoefte aan hoger opgeleid personeel. Het voorzien in deze maatschappelijke behoefte heeft de hoogste prioriteit en vereist onder andere dat onderwijsprogramma's kritisch geëvalueerd en verbeterd worden.

Toelating tot de universiteit gebeurt op grond van een nationaal examen, het z.g.n. Eritrean Secondary Education Certificate Examination (ESECE). In het bestuur van de ESECE zijn zowel de universiteit van Asmara als het ministerie van onderwijs vertegenwoordigd. Het bestuur stelt de richtlijnen vast voor de reguliere ESECE activiteiten en initieert nieuwe initiatieven die tot doel hebben de ESECE organisatie tot een sterke en deskundige instelling te maken.

Het toelatingsexamen neemt gewoonlijk drie dagen in beslag en omvat twee verplichte onderdelen, namelijk een examen in de engelse taal en in wiskunde. Kandidaten moeten bovendien examen doen in minimaal drie keuzevakken, te kiezen uit: biologie, scheikunde, natuurkunde, algemene natuurwetenschap, geografie, geschiedenis, economie, administratie, landbouwwetenschap en algemene kennis. De toegang tot de universiteit is gebaseerd op de gemiddelde score van de twee verplichte en drie keuzevakken. Vanwege het grote aantal aanmeldingen is het selectieproces zeer competitief; tot 1994 werd ongeveer 10% van de kandidaten toegelaten, van 1995 tot 2002 19%.

Het lage percentage studenten dat het ESECE examen haalt rechtvaardigt een grondig onderzoek naar de kwaliteit van de ESECE test. Daarnaast geeft toegang tot de universiteit recht op gratis onderwijs, gratis voeding en medische verzorging. Studenten van buiten de centrale regio waar de universiteit is gelegen krijgen bovendien gratis accommodatie op de campus. Ondanks deze goede voorzieningen en het competitieve selectieproces is het uitvalpercentage in het eerste studiejaar gemiddeld 35%. In de volgende jaren is dat percentage ongeveer 15 %. Deze cijfers geven aan dat het uitvalpercentage zeer hoog is en bij gevolg het percentage afgestudeerden laag. Dit hoge uitvalpercentage noodzaakt een onderzoek naar alle mogelijke factoren, zowel op student niveau

als op studierichting- en instellingsniveau, die van invloed zijn op de prestaties van studenten. Het hoge uitvalpercentage vormt zo een tweede rechtvaardiging voor een onderzoek naar de voorspellende waarde van het ESECE examen.

2. Vraagstelling en onderzoeksopzet

Het onderzoek richt zich op de volgende vragen:

1. In welke mate is de ESECE een effectieve test voor het niveau van studenten?
2. Wat zijn de belangrijkste factoren die de prestaties van studenten aan de Universiteit van Asmara bepalen?

Data en methode

Het voorliggende onderzoek naar de kwaliteit van het ESECE examen is gebaseerd op gegevens over de examens in engelse taal en wiskunde in het jaar 1998. De data werden verzameld bij het ESECE bureau en betreffen alle kandidaten. Het gaat om 7948, 7412 en 432 kandidaten in resp. de vakken engelse taal, algebra en meetkunde, en algebra en handelsrekenen. De gegevens omvatten voor elke examenvraag het goede of foute antwoord van de kandidaat. Deskundigen in elk van de vakken, 27 universitaire of middelbaar onderwijs docenten per vak, zijn gevraagd vragenlijsten in te vullen met betrekking tot de kwaliteit en geschiktheid van een aantal geselecteerde examenvragen. De kwaliteit van de examens werd beoordeeld aan de hand van drie typen validiteit, namelijk “predictive validity”, “face validity”, en “content validity”. Daarnaast werden examenvragen geanalyseerd met methoden van de klassieke test theorie:het percentage studenten dat deze correct beantwoordde, de mate waarin de vragen goede van slechte studenten konden onderscheiden en de samenhang van elke vraag met de rest van de vragen.

Het onderzoek naar de prestaties van studenten aan de universiteit was gericht op het eerstejaars programma en de resultaten van het eerste semester van het tweede jaar programma. Daarnaast betrof het onderzoek gegevens over het afstuderen als indicator voor uiteindelijke studieprestaties. De gegevens van studieprestaties in het eerste jaarsprogramma betroffen de jaren 1993 tot 1997, in totaal 2412 studenten. De bronnen voor deze gegevens waren de studentenadministratie van de Universiteit van Asmara en vragenlijsten voor studenten. De verklarende variabelen betreffen zowel academische als niet-academische kenmerken. Academische variabelen zijn de resultaten van de verplichte vakken engelse taal en wiskunde en van de drie keuzevakken van het ESECE toelatingsexamen, evenals gegevens over eerdere ervaring in het hoger onderwijs van studenten, toewijzing van studenten in de studierichting van voorkeur, specialisatierichting, type toelatingsexamen, toelatingscategorie, of studenten nieuw of opnieuw werden ingeschreven, de jaargang, geslacht en leeftijd

bij toelating. De afhankelijke variabelen waren de gemiddelde cijfers in de eerste twee semesters van het eerste jaar.

De factoren die studentenprestaties beïnvloeden werden geïdentificeerd met behulp van lineaire regressie-analyse. De prestaties van studenten worden niet alleen bepaald door studentgebonden kenmerken maar ook door factoren als het universitaire curriculum en organisatie. Daarom zijn sommige facultaire of studierichtingvariabelen ook in beschouwing genomen.

Voor het onderzoek naar prestaties van studenten in het eerste semester van het tweede studiejaar werden dezelfde studentgerelateerde kenmerken gebruikt als voor het eerste jaar, naast de studieresultaten behaald in het eerste jaar. Faculteitgerelateerde variabelen werden gespecificeerd in het gemiddelde cijfer in hun toelatingsexamen en eerstejaars examen voor de studentenpopulatie per studierichting. Studenten worden aan studierichtingen toegewezen na het eerste studiejaar op basis van behaalde cijfers, capaciteit van elke studierichting en voorkeur van de student. Dit betekent dat sommige studenten niet in de studierichting van hun voorkeur kunnen studeren. Daarom is het percentage studenten dat volgens hun voorkeur in een studierichting geplaatst is ook als verklarende variabele meegenomen. Er zijn gegevens van 969 tweedejaars studenten in 26 studierichtingen geanalyseerd over de jaren 1993 tot 1996. Als eerste stap werden de gegevens geanalyseerd met lineaire regressieanalyse. Multi-niveau analyse is gebruikt om verschillen tussen de studierichtingen te analyseren.

Tenslotte zijn afstudeerresultaten onderzocht. Het onderzoek betreft hier 1213 personen die in de jaren 1993 tot 1995 hun studie startten. De gegevens werden verzameld in dezelfde categorieën als in het onderzoek naar de resultaten in het eerste jaar. De afhankelijke variabele is het afstuderen van de student. De verklarende variabelen zin dezelfde als bij het onderzoek naar de resultaten het eerste studiejaar. Logistische regressie-analyse is gebruikt om de factoren die het afstuderen bepalen te analyseren.

3. Conclusies

De kwaliteit van het ESECE examen

Hoofdstuk 3 behandelt de vraag naar de validiteit van het ESECE examen in engelse taal en in wiskunde. Dit leidt tot drie conclusies: over de moeilijkheidsgraad van de examens, over de mate waarin de examenvragen een effectief onderscheid maken tussen goede en slechte studenten, en over de mate waarin de examenvragen een afspiegeling zijn van het schoolcurriculum.

De eerste conclusie is dat de examens moeilijk zijn, met name het wiskunde-examen, en dat de meeste items van het examen moeilijk zijn. In 1998 scoorde de meerderheid van de studenten minder dan 50% op de vakken engelse

taal en wiskunde. De meeste vragen waren ook moeilijk. Het percentage vragen dat door minder dan 40% van de kandidaten correct beantwoord werd bedroeg 43% voor engelse taal, 64% voor algebra en meetkunde, en 86% voor algebra en handelsrekenen. Het is bekend uit de psychometrische theorie en uit praktische ervaring in testconstructie dat vragen die zeer moeilijk of zeer makkelijk zijn weinig informatief zijn over de kwaliteiten van de kandidaat en dus weinig bijdragen aan een betrouwbare test.

De tweede conclusie, betreffende de mate waarin de examenvragen een effectief onderscheid maken tussen goede en slechte studenten, gaat in dezelfde richting. Volgens standaarden voor kwaliteit van vragen die gebruikelijk zijn bij de constructie van psychometrische testen bleek ongeveer de helft van de vragen van goede kwaliteit. Van specifieke examenvragen bleek dat 18% van de engelse taal vragen, 16 % van de algebra en meetkunde vragen en 24% van de algebra en handelsrekenen vragen geëlimineerd of sterk aangepast zouden moeten worden vanwege gebrek aan vermogen goede van slechte studenten te onderscheiden. De meeste van die vragen waren juist de moeilijk vragen.

Een derde conclusie betreft de kwaliteit van de examenvragen zoals geëvalueerd door deskundigen, in dit geval middelbare school en universitaire docenten. Verschillende items werden beoordeeld als te vaag geformuleerd. Voor wiskunde werd vastgesteld dat de lesstof uit het schoolcurriculum niet was afgedekt in het examen. De vragen die de deskundigen identificeerden als van slechte kwaliteit waren veelal ook de vragen die volgens de standaarden van psychometrische analyse slecht scoorden. De gebrekkige kwaliteit van een deel van de examenvragen werd dus van twee kanten bevestigd. Omdat de betreffende vragen veelal ook de moeilijker vragen betreft kan verwacht worden dat een hogere kwaliteit van de examenvragen ook tot een hoger slagingspercentage zal leiden. Het ligt dus voor de hand te verwachten dat sommige kandidaten die geschikt waren om te studeren door het examen toch uitgesloten werden. Wanneer de examenvragen van lage kwaliteit in het algebra-examen van 1998 niet waren meegeteld, dan had dit voor een kwart van de kandidaten een beter examencijfer opgeleverd. Alle kandidaten die een B scoorden hadden dan een A gescoord. Aan de andere kant kunnen sommige kandidaten tot de universiteit zijn toegelaten die eigenlijk ongeschikt waren, maar hun aantal zal veel lager geweest zijn dan van hen die ten onrechte niet toegelaten zijn. In het 1998 cohort zou dit voor 1 % van de kandidaten hebben gegolden.

Factoren die de prestaties van studenten beïnvloeden

Hoofdstukken 4 tot 6 behandelen de tweede onderzoeksvraag, naar de factoren die prestaties van studenten aan de universiteit beïnvloeden. De samenvatting van de conclusies betreft drie hoofdpunten: factoren die de prestaties in het eerste jaar beïnvloeden, factoren die prestaties in het eerste semester van het

tweede jaar beïnvloeden en factoren die afstuderen beïnvloeden. In dit kader is ook geanalyseerd in hoeverre scores op het toelatingsexamen voor engelse taal en voor wiskunde voorspellende waarde hadden voor latere studieresultaten.

Wat betreft de prestaties in het eerste jaar bleken resultaten in verschillende vakken in het toelatingsexamen goede voorspellende waarde te hebben, ook wanneer natuurwetenschappen studenten, studenten in de sociale wetenschappen of studenten met eerdere ervaring in het hoger onderwijs apart werden beschouwd. Het percentage verklaarde variantie in het gemiddelde cijfer na het eerste semester dat verklaard wordt door de resultaten op het ESECE-examen bedraagt 38%, hetgeen redelijk hoog is. Het gemiddelde cijfer voor het tweede semester is in het algemeen hoger dan voor het eerste, dit vanwege de strenge selectie aan het eind van het eerste semester. De voorspellende waarde van de resultaten van het toelatingsexamen zijn lager voor het tweede dan voor het eerste jaar (het z.g.n. “restriction of range” fenomeen). In tabel 1 is uitgedrukt hoe sterk het succes van studenten in het eerste jaarsprogramma voorspeld wordt door het ESECE toelatingsexamen.

Table 1: Resultaten van studenten uitgesplitst naar gemiddelde ESECE-score

Reultaat op universiteit	**Gemiddelde ESECE score**		
gemiddeld cijfer	**2.0 – 2.2**	**2.4 – 2.8**	**3.0 – 4.0**
Semester 1 ≥ 2.0	44%	86%	91%
Semester 2 ≥ 2.0	74%	86%	94%

De voorspellende waarde van het ESECE is niet even sterk voor alle subgroepen van studenten. Het effect van het gemiddelde cijfer van de keuzevakken is het sterkste van de ESECE-examens. Het effect is sterker voor de natuurwetenschappen dan voor de sociale wetenschappen. Het effect is ook groter voor studenten zonder eerdere ervaring in hoger onderwijs dan voor wie dat wel heeft. Deze laatste groep heeft betere studieresultaten en hun resultaten worden minder goed voorspeld door hun score in de keuzevakken van het toelatingsexamen. De resultaten in het tweede semester van het eerste jaar zijn vergelijkbaar, waarbij de gemiddelde score voor wiskunde in het ESECE minder voorspellend is in het tweede semester dan in het eerste.

Andere variabelen dragen ook bij aan de voorspelling van eerstejaars resultaten. Hun effect kan vooral in een lineaire regressie goed naar voren gebracht worden omdat ze dan gecontrolleerd worden ten opzichte van elkaar en van de ESECE resultaten. Tabel 2 geeft enkele resultaten van hoofdstuk 4, namelijk de regressie coëfficiënten die significante effecten weergeven op het gemiddelde cijfer van het eerste semester van het eerste jaar. Voor de continue variabelen (ESECE-cijfers, gemiddelde cijfer en leeftijd) zijn deze coëfficiënten de gemiddelde toename in het gemiddelde cijfer van het eerste semester die verwacht kan worden bij een toename van 1 punt van de verklarende variabele. De andere variabelen zijn dichotoom en de coëfficiënt geeft het gemiddelde verschil tussen de categorie die genoemd wordt en de andere categorie.

Table 2. Significante effecten van de verklarende variabelen op het gemiddelde cijfer na het eerste semester van het eerste jaar.

keuzevakken GPA	.47
Engels GPA	.27
Wiskunde GPA	.18
Richting (Nat. SW.)	-.39
Examen type (ESECE)	.38
Gewenste richting	.22
Eerdere ervaring in hoger onderwijs	.21
Hernieuwde toelating	-.12
Geslacht (M)	.12
Leeftijd (in jaren)	-0.03

Het belang van ESECE resultaten is hierboven besproken. Studenten in de sociale wetenschappen scoren in het algemeen hoger dan die in de natuurwetenschappen. Studenten toegelaten via het ESECE examen scoren in het algemeen hoger dan degenen die via andere examens zijn toegelaten. Wanneer studenten in de studierichting van hun keuze geplaatst worden scoren ze in het algemeen hoger. Studenten die eerder hoger onderwijs volgden scoren gemiddeld hoger in het eerste semester, evenals degenen die al eens eerder toegelaten waren. Mannelijke studenten scoren gemiddeld hoger dan vrouwelijke. Deze effecten gelden wanneer andere factoren constant gehouden worden. Vooral omdat de ESECE resultaten zo een sterk effect hebben, wordt benadrukt dat deze effecten gemeten worden wanneer studenten met gelijke ESECE scores vergeleken worden. Dit is van belang bij bijvoorbeeld het effect van geslacht, omdat het verschil in ruwe scores tussen het gemiddelde cijfer in het eerste semester tussen mannelijke en vrouwelijke studenten 0.16 is, hetgeen hoger is dan de 0.12 die hier gevonden werd. Men kan concluderen dat een gedeelte van het verschil tussen mannelijke en vrouwelijke studenten verklaard kan worden uit een betere voorbereiding in de middelbare school.

De variabelen die in tabel 2 genoemd zijn verklaren 50% van de variantie in gemiddeld cijfer in het eerste semester. Wanneer subgroepen van studenten apart bekeken worden dan blijkt dat de voorspellende waarde beter is voor studenten in de natuurwetenschappen (59% variantie verklaard) dan in de sociale wetenschappen (27% variantie verklaard) en ook beter voor degenen die geen ervaring in hoger onderwijs hadden (52%) dan voor degenen die die ervaring wel hadden (39% variantie verklaard).

Voor het tweede semester zijn de resultaten vergelijkbaar maar voor bijna alle variabelen minder sterk. Het percentage variantie in het gemiddeld cijfer in het tweede semester is voor 27% verklaard door ESECE variabelen en door alle beschouwde variabelen voor 38%. Wanneer de variabelen genoemd in tabel 2

gebruikt worden in de analyse voor het tweede semester (zie tabel 3), dan zijn nog slechts 6 van de 10 variabelen significant op een niveau van 5%. Deze vier variabelen hebben vooral effect in het eerste semester en hun effect op de verdere universitaire opleiding wordt gemedieerd door het selectieproces en de toelating tot het tweede semester van het eerste jaar. Significant blijven de 3 ESECE resultaten, eerdere ervaring met hoger onderwijs, soort toelatingsexamen en studierichting.

Table 3. Significante effecten van de verklarende variabelen op het gemiddelde cijfer na het tweede semester van het eerste jaar.

keuzevakken GPA	.39*
Engels GPA	.19*
Wiskunde GPA	.15*
Richting (Nat. SW.)	-.43*
Examen type (ESECE)	.17*
Gewenste richting	.05
Eerdere ervaring in hoger onderwijs	.07*
Hernieuwde toelating	.00
Geslacht (M)	.02
Leeftijd (in jaren)	-0.01

Geconcludeerd worden dat de grote voorspellende waarde van wiskunde en engelse taal in de ESECE examens een positieve indicatie is voor hun externe validiteit. De verbeteringen in deze examens voorgesteld in hoofdstuk 3 (samengevat in sectie 3.1) geven echter aan dat het zeker mogelijk is de voorspellende waarde van de ESECE nog te verbeteren.

De tweede conclusie betreft factoren die de prestaties van studenten in het eerste semester van het tweede studiejaar beïnvloeden gaat over de rol van studierichtingen. De resultaten zijn besproken in hoofdstuk 5. Hier zijn dezelfde studentgerelateerde factoren geanalyseerd als in de vorige sectie. In een aparte analyse werden deze kenmerken aangevuld met het gemiddelde cijfer in het eerste studiejaar. De effecten van de ESECE resultaten zijn vergelijkbaar met wat hierboven is gerapporteerd. Er blijken echter belangrijke verschillen te zijn per studierichting. De invloed van de plaatsing van studenten naar preferentie blijkt gemedieerd te zijn door verschillen tussen studierichtingen. Studenten die dezelfde cijfers haalden op de ESECE halen lagere cijfers in de natuurwetenschappelijke richting dan in de sociale wetenschappen in het tweede studiejaar. Afdelingen die studenten hebben met gemiddeld hogere cijfers op de ESECE wiskunde geven in het algemeen lagere cijfers in het tweede jaar. Studierichtingen die studenten hebben met gemiddeld hogere cijfers in de keuzevakken in het ESECE examen geven hogere cijfers in het tweede studiejaar. Er is dus een gecompliceerde combinatie van effecten op individueel en studierichtingniveau, vooral voor ESECE wiskunde resultaten. Deze hebben een positief effect als het individuele niveau wordt bekeken,

maar een negatief effect op studierichtingniveau. Een mogelijke verklaring is dat studierichtingen met een hoog percentage studenten die goed zijn in wiskunde ook de meer competitieve departementen zijn die hogere eisen stellen aan vaardigheden in rekenen en daarmee verwante vaardigheden.

Wanneer de resultaten van het eerste jaar in de beschouwing betrokken worden dan verliezen de ESECE resultaten veel van hun voorspellende waarde. Voor het tweede jaar zijn de resultaten van het eerste jaar dus meer voorspellend dan de resultaten van het eerdere toelatingsexamen. Hier kan ook waargenomen worden dat studierichtingen die studenten met een beter eerstejaars gemiddeld cijfer aantrekken, gemiddeld lagere cijfers geven dan studierichtingen met een instroom van studenten met een lager gemiddeld cijfer. Samengevat kan gesteld worden dat variantie tussen studierichtingen hier meer verklaart dan variantie in studenten alleen.

De derde conclusie betreft de effecten van student kenmerken op hun afstuderen. Studenten met een hoge score in wiskunde en engelse taal, studenten toegelaten in de studierichting van hun voorkeur, studenten in de sociale wetenschappen, studenten met een eerdere ervaring in hoger onderwijs en jongere studenten hebben betere kansen op afstuderen. Het effect van deze variabelen verschilt tussen de natuurwetenschappen en de sociale wetenschappen. De effecten van leeftijd, plaatsing in voorkeursstudie en eerdere ervaring in hoger onderwijs zijn groter in de natuurwetenschappen dan in de sociale wetenschappen. Van de ESECE resultaten is het cijfer op engels het meest van invloed binnen de sociale wetenschappen, tegenover het cijfer voor de keuzevakken voor de natuurwetenschappen. De effecten van de variabelen verschillen ook voor de studenten met en zonder eerdere ervaring in het hoger onderwijs. Voor studenten zonder eerdere ervaring in het hoger onderwijs hebben de variabelen scores op wiskunde, keuzevakken en engelse taal, evenals de studierichting, respecteren van studiekeuze en leeftijd een effect op het afstuderen. Voor studenten met ervaring in het hoger onderwijs voorspellen alleen studierichting en leeftijd.