A generic method for distribution and transfer of ECTS grades and other norm-referenced grades within student cohorts

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ABSTRACT

The ECTS grade transfer scale is an interface grade scale to help European universities, students and employers to understand the level of student achievement. Hence, the ECTS grading scale can be seen as an interface, transforming local scales to a common system where A-E denote passing grades. By definition, the ECTS grade transfer scale involves distribution of the passing students into five cohorts representing fixed percentiles.

This paper presents a generic method to distribute students with differentiated passing local grades into differentiated ECTS grade, or any other grading scale, cohorts. It takes into account historic student performance, the percentiles required for the scale in question, and the performance of a student group relative to student groups previously graded in the same course module. The method can handle any number of equally or unequally spaced local grade cohorts of any size and allows direct transfer between local grades in the spirit of ECTS.

Keywords: ECTS;grade;transfer;scale;distribution;mobility

1. INTRODUCTION

The ECTS grade transfer scale is an interface grade scale to “facilitate the understanding and comparison of grades given according to different national systems” (Directorate-General for Education and Culture 2005). It is thus an aid to European universities, students and employers to understand the level of student achievement. Originally, the elements of ECTS were developed to remove obstacles for student mobility. Student mobility may be horizontal, i.e. traditional student exchange within the frame of an educational program. It may also be vertical, such as when a student that has completed a bachelors’ degree at one university transfers at another Higher Education Institution (HEI). A grade transfer system is arguably of most value in the context of horizontal mobility. In the wake of the Bologna process, it is yet to be seen whether there will be a shift from horizontal to vertical mobility among European students, reducing the need for a grade transfer system. However, the Life Long Learning Programme, launched in 2007, strongly supports horizontal mobility, and the goal to reach 3 million Erasmus exchange students by 2012 still persists (European Commission, 2008).

In the field of engineering education, there are strong, cooperative structures in support of horizontal exchange. One example is the double degree program of T.I.M.E., Top Industrial Managers of Europe. Effective since 1989, T.I.M.E. promotes bilateral exchange between 51 leading engineering HEI across Europe, Japan and Brazil (T.I.M.E., 2008). Hence, a reliable grade transfer system will be of particular importance in engineering education where horizontal mobility is very well developed and popular among students. This is particularly important in exchange situations involving students that will get a final grade for their entire qualification, such as in Portugal.

The ECTS grading scale is an interface, transforming local scales deeply rooted in a domestic academic tradition to a common system where A-E denote passing grades, while Fx and F indicate failure. By definition, passing students should be distributed into five cohorts, representing the percentiles 10, 35, 65, 90 and 100 of student performance. Earlier, verbal descriptions were tied to each grade. A summary of the ECTS grade specifications is given in Table 1. The ECTS grading scale was not created with the objective of replacing national grading scales. The various national, or local grading scales exhibit a fascinating variability (Karran 2004). At the time of writing, only Norway has introduced an A-E/Fx-F grading scale as the only scale on national level, but a similar 7-step scale is about to be introduced in Denmark. Several countries maintain highly differentiated national criterion-referenced scales, examples including the 0-10 in the Netherlands, 0-20 in Belgium, France and Portugal, 0-30 in Italy, each with a fixed or flexible level for a passing grade.

In some countries, the practice leans towards less differentiated scales. In Sweden, the grading scale suggested in the Higher Education Ordinance (Ministry of Education and Research 2008) comprises two levels of passing grades. However, in Sweden three levels of passing grades have traditionally been used in the fields of law and engineering (3, 4 and 5), while non-differentiated grades, i.e. Pass/Fail, are normally used in fields related to medicine and education of teachers.

It is clear that across Europe, A-E grading scales is used in several ways that deviate from how the ECTS grade transfer scale is defined (Karran 2004, 2005). At several universities, the local absolute or criterion-referenced local scale of a HEI is directly mapped on the ECTS grading scale without taking the required distribution of grades into account. From a practical perspective, the advantages of adopting this methodology are obvious; no account has to be taken for grades given earlier and students do not have to be ranked. Such schemes are most straightforward if the local grading system is more differentiated than the ECTS grading scale.

This was illustrated in a study covering 20 universities (Karran 2004) who concluded that ”the alignment of ECTS grades varies within nation states and show that, despite the fact that ECTS grading is a norm-referenced system, while national systems are usually criterion-referenced, the ECTS conversion tables provided by universities indicate straight line transference from institutional to ECTS grades”. Obviously common, Grosges and Barchiesi (2007) analyzed the effects of straight transference and proposed a statistically justified, improved method to assign ECTS grades. Their method goes beyond the ambition of the current ECTS grade concept and accounts for the students’ performance relative to the population, as well as the grade distribution of a module relative to a program. Nunes *et al.* (2005) proposed a method to go from a highly differentiated grading scale to ECTS grades, taking the legal restrictions of Portugal into account.

In addition, some HEI have introduced an A-E grading scale as the only grading scale in a manner that does not comply strictly with the ECTS standards, e.g. Hansson and Engström (2006). Although such a scale may be linked to assessment criteria tied to a verbal interpretation of the ECTS grades, the distribution of grades inevitably deviates from the ECTS grade percentiles. In such cases both the local A-E grades and the assigned ECTS grades become absolute or criterion-referenced grades and not norm-referenced grades.

The prescribed norm-referenced nature of the ECTS grading scale may be very uncomfortable in many pedagogic cultures. While student ranking is accepted and commonplace in some countries, notably France, the scepticism towards ranking is deeply rooted in Sweden. For example, Dahlgren and Fejes (2005) argue that ranking counteracts student cooperation and interaction, elements that deserve to be encouraged in order to support deep learning approaches (Biggs 2003). Hence, there is an obvious risk that the lack of stringency in the use of the ECTS grading scale will lead to a decreased rather than an increased understanding of student performance across Europe. While Karran (2005) argues that “justice and fairness … are best upheld by the use of a unified grading system at national and European levels”, an alternative feasible route is to systematically apply a method to map local grades in the ECTS grading scale in a manner that follows the basic principles of the ECTS grading scale.

The objective of this paper is to present a generic method to map any differentiated local grade scale on i) the ECTS grading scale, and ii) any other norm-referenced local grading scale. The output of the method is a matrix specifying the number of students in a group that should get a certain grade, depending on the local grade they have been awarded.

For the first application, the sizes of the ECTS grade cohorts are in accordance with the ECTS grade percentiles, and the method also relates the relative performance of the ”current” student group to the long-term distribution of grades on the course module in question. Thereby, students get full credit for their performance even if they have the ”misfortune” to be a part of a group that over performs in relation to earlier groups graded in the course module.

2. METHOD AND EXAMPLE

The basic principle of the method is to map the cumulative distribution of the local passing grades of the current student group on the cumulative distribution of the long-term distribution of local passing grades. Thereby, the performance of current students can be quantified in relation to long-term performance. This quantification forms the basis for dividing the current student group into the five ECTS grade cohorts. Thereby, it is possible to take into statistical account that the current group of students may be over- or underperforming relative to previous groups of students. Besides the percentile levels of the ECTS grading scale, the proposed distribution method makes use of two sets of input data, the number of local passing grades awarded within the current student group, and the long-term distribution of local passing grades.

The long-term distribution of local passing grades may certainly be difficult to extract at some HEI, while they may be at hand at others. In Sweden, a comprehensive, computerized documentation system (LADOK) has been in place since 1994. Hence, every single student performance and every grade given is available, tied to a course code. Even if the course code has changed, the historic distribution of final passing grades is thus possible to extract in an unambiguous way.

2.1 Example data

At Lund University, Faculty of Engineering LTH, the passing grades are given as 3 (worst), 4 and 5 (best). Hence, there are three cohorts of students that should be divided into the five ECTS grade cohorts. This means that it is almost certain that some students with the local grade 3 should get an E, while others should get D etc.

As a basis for illustration, the description of the method as related to an example case. In a hypothetical group of 100 students, denoted the current group, the example distribution is that 10, 50 and 40 students have been awarded the local passing grades 3, 4 and 5 respectively. This is visualized in Figure 1.

In addition to the grades of the current group, Table 2 includes the hypothetical long-term performance of the students. For illustration, the long-term distribution of grades 3-5 was set to 30%, 50% and 20% respectively. In Table 2, the example data have also been transformed to percentiles. Obviously, the current group is over performing relative to the long-term student performance.

2.2 Calculation of the sizes of the ECTS grade cohorts

Figure 2 shows the long-term cumulative distribution of local passing grades (3, 4 or 5) of the example data set, based on the index of the grade, which is indicated on the horizontal axis. In the figure, the percentile data have been introduced and connected with straight lines. This allows the cumulative distribution to be modelled as three segments in a clear, but arbitrary, way.

As each of the three segments are represented by a straight line, it is possible to calculate the grade index *j* from a given percentile ECTS grade percentile *P,* as well as the opposite. Recognizing that the "break points" of the modelled distribution (Figure 2, solid line) are the discrete values L_i, the generic equation for this calculation is:

$$j = \frac{P - i \cdot L_{i-i} + (i-1) \cdot L_i}{L_i - L_{i-1}} \quad \text{where} \quad L_{i-1} < P < L_i,\ i = 1...n \qquad (1)$$

where n is the number of local grade cohorts. The equation can be seen as the inverse of the "straight line", where the "x-value" (j) is calculated from the "y-value" (P).

Figure 2 demonstrates how Equation (1) works in practice when applied to the example data. Starting at the percentile P=0.35, the horizontal line denoted "a" and the vertical "b" are used to find the corresponding grade index value j. Formally, the value j should be interpreted as "the index of the grade that should render the student a D or lower". Another interpretation of the grade index corresponding to a certain percentile is that it represents the cut-off point between two ECTS grades, i.e. E and D, D and C etc.

Thereafter the value j is inserted into Equation (2), which is an inverse of Equation (1), using the model of the cumulative distribution of the current student group (Figure 2, dashed line) to get the corresponding percentile Q. In doing this, one has to use the correct segment of the cumulative distribution of the current group. Defining the segment in terms of j* as the nearest lower integer of j, we get Q as:

$$Q = j \cdot (C_{1+j*} - C_j^*) + (1+j^*) \cdot C_j^* - j^* \cdot C_{1+j*} \quad \text{where} \quad j^* < j < j^*+1,\ j^* = 0...(n-1) \qquad (2)$$

Referring to Figure 2, one can see that for the percentile P=0.35, corresponding to ECTS grade D or lower, the procedure gives j=1.1. Inserting 1.1 into Equation (2) then gives Q=0.15. This means, that 15% of the current group of students should get ECTS grades D or lower, i.e. a D or an E. In the example, the calculated percentile Q is lower than the original value P. This means that relatively fewer students than normal should receive an E or a D.

Comparing the values of j for P=0.35 and P=0.65, one can see that the grade index for both these percentiles fall in the interval $1 < j < 2$. Since grade index 1 corresponds to local grade 3 and grade index 2 corresponds to local grade 4 (or lower), all students that should receive ECTS grade C or lower (P=0.65) but not D or lower (P=0.35) should be picked from the cohort with a local grade 4.

The algorithm for determining the sizes of the ECTS grade cohorts is:

$$ECTS_i = \text{integer}((N+0.5) \cdot Q_i) - (ECTS_0 + ... + ECTS_{i-1}) \qquad \text{for} \quad i = 1...5 \qquad (3)$$

where N is the number of students and $ECTS_0$=0 by definition. The term 0.5 compensates for an effect that appears when the number of students in the current group is very few. Unless another "half student" was added, there would be a bias towards higher ECTS grades.

Table 3 shows the calculated values of j and Q for each ECTS grade percentile, based on the example data (Table 2).

2.3 Distribution of students into ECTS grade cohorts.

After the sizes of the ECTS grade cohorts have been determined, the current students should be distributed into these five groups. The approach is simply to "fill" the ECTS grade cohorts from below, making the split in a fair way for the students.

As seen in Table 2, the example data includes 10 students with grade 3. Out of these and according to Table 3, 3.3 students should be allocated to ECTS grade E, while the remaining should get a D. Hence, 3 students will get an E and 7 will get a D. As 12 students should get a D, another 5 have to be picked from the current group. These will be selected from the cohort that have received the local grade 4.

In general terms, an output matrix is made. Each ECTS grade cohort is filled by drawing students from the current students group cohorts. Starting at i=1, i.e. ECTS grade E and j=1, i.e. the lowest local grade, the number of students with a local grade j, S_j, that should have ECTS grade i is calculated as min($ECTS_i$,S_j).

Thereafter, the contribution to the next ECTS grade cohort is calculated after a reduction of "available" students. Hence, the number of students with the lowest local grade that should receive ECTS grade D is min($ECTS_2$,($S_1 - ECTS_1$)). This sequence is repeated for all ECTS grades and all local grade cohorts as an inner and an outer loop, respectively. Referring to Table 4, this means that the columns are filled from left to right, going from the top to the bottom. It can also be seen as moving from left to right in Figure 3. Applying this method to the example data, the matrix shown in Table 4 was generated.

2.4 Application to single students

Another, and likely common, way to use the model is to apply for transfer of the grade of a single student. In that case, the method gives on single "true" output. Table 5 shows the outcome of single student grade transfer, applying the grade distribution used. It can be seen that a 3 on the local scale will be translated to a D, which is only "fair" if the student belongs to the top 67% of the students with that local grade. Indeed, it is also interesting to note that translation of a single 4 will result in a B, despite the fact that most students with a B deserve a C.

3. DIRECT CONVERSION OF GRADES

The method presented above can also be used to transfer grades given on one local scale to grades on any other scale. Such direct grade transfer may be useful in exchange situations, where the local grades awarded by the "host" (receiving) HEI need to be transferred to at the local grade of the "home" (sending) HEI. In such situations an ECTS grade has no value in itself. Table 6 shows an example of such direct host-to-home grade translation, where the use of the ECTS grade transfer scale is by-passed but the under-lying principles of the ECTS transfer are fully respected.

In the example, grades on a 3-4-5 scale are transferred to 11 passing grades in the range 10-20, a common scale in engineering education in continental Europe. Applying the method above, using defined percentiles, a student with grade 3 should typically be awarded grade 12, while a 4 corresponds to a 17 and 5 corresponds to 20. However, if the model is used to distribute 100 students each with grades 3, 4 and 5 respectively, the model output will more clearly show the correct statistical distribution of students on the 10-20 grading scale. For example, out of 100 students with a 3, the top 9% should receive a 13 while the remaining 91% should be distributed on 10-12. In a similar fashion a 4 on the 3-4-5 scale may actually correspond to any grade from 13-18, while a 5 could be translated to either 18, 19 or 20 on the 10-20 scale.

4. DISCUSSION

The method presented provides a transparent method to award ECTS grades in accordance with the fundamental principles of the ECTS grading scale. In practice however, it relies heavily on availability of long-term grade data. It should also be recognized that ideally, the current data should be included as a part of the long-term data set.

Numerically, the method is very stable and the method provides useful results even for a single student, provided that a fair amount of historic data is available.

The methodology has the built-in assumption that the distribution of student performance within each local grade is constant. This assumption may be checked only if examination data with a higher resolution than the local grading scale is available. In that case, the cumulative distribution can be made from a set of straight lines. Otherwise, more sophisticated interpolation algorithms could be used. It is likely, however, that this would complicate the use of the proposed method far beyond what is reasonable.

It should also be recognized that a fundamental assumption is that the requirements for a certain grade is stable over time. Realistically however, there are certainly variations between years in the difficulty obtain a certain grade on a certain course. However, this problem cannot be eliminated by any grading scale or transfer method, since such bias could not be distinguished from the actual performance of a given student group relative to the long-term performance of comparable groups.

Dahlgren and Fejes (2005) argue that using the ECTS grading scale for grading introduces two major problems. First, differentiated grades automatically lead to methods for examination that supports a surface oriented learning behaviour. The method proposed here does not address this issue specifically. Possibly, one could argue that the mere existence of a grade transfer methodology could justify the use of local differentiated grading scale, but such an argumentation appears far-fetched. It has been also argued, as in several contributions in Löfgren (2006), that when applying a norm-referenced grading system, or even a norm-references grade transfer scale, student cooperation would be hampered. However, unless the size of the current group is comparable with the total number of students forming the basis for the long-term data, this risk is negligible. Instead, as the proposed method takes long-term data into account it provides a transparent strategy to manage this crucial problem.

If the local grade is Pass/Fail, all students must be ranked if the differentiated ECTS grade transfer scale is to be used, maintaining the ECTS percentiles. It is, in principle, possible to use the proposed method to award differentiated ECTS grades based on the underlying assessment data rather than the grade actually awarded. However there are certainly reasons to bear in mind the recommendation in ECTS USERS' GUIDE that "Where a valid ranking cannot be obtained from the primary assessment data, only an ECTS pass or fail should be recorded."

As clearly shown in Tables 5 and 6, the methodology presented above does not eliminate the intrinsic need for ranking of the students within the cohorts of students with certain local grades. Unless the local grading scale is more differentiated than the ECTS grading scale or "home" scale, original grade cohorts are normally split. Hence ranking must be performed within local grade cohorts to provide arguments for allocating students with the same local grade to different ECTS or “home” grade cohorts. It may be discussed whether ranking within cohorts is easy or difficult, good or bad but it nevertheless appears unavoidable whenever the ECTS grade transfer principles are used strictly.

In many real-life exchange situations, the ECTS grade will only serve as an intermediate link between a “host” and a “home”. In several south European HEI, where grades may given for entire semesters, years or even qualifications, returning exchange students need to have their ECTS grade converted to the local grade of their home HEI. In such cases, a direct conversion between two local grades would be most accurate, effective and fair from a students’ point of view. If the distributions of local grades of the both HEI are set, it is thus possible to overcome many of the problems associated with the ECTS grade transfer scale. Least room for interpretation appears when the grading scale of the “host” HEI is more differentiated than the local method of the “home” HEI.

In conclusion, it could be recommended that, based on bilateral agreements between HEI, the ECTS grade transfer scale should be by-passed and replaced with direct host-to-home grade translation. When such translations are made with the method presented here, it is done in the spirit of ECTS itself, since the final outcome is an individual, norm-referenced grade reducing the impact of one obstacle for student mobility within the European Higher Education Area.

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	ECTS grade	ECTS-percentile of passing grades P_i	Previously recommended verbal description
Passing grades	A	100	Excellent
	B	90	Very Good
	C	65	Good
	D	35	Satisfactory
	E	10	Sufficient
Failure grades	Fx	N/A	
	F	N/A	

Table 1. Summary of characteristics of the ECTS grading scale. Note that the percentiles should relate to the long-term performance of students graded on the course module. The verbal descriptions are no longer recommended as they do not fit with percentage based ranking of the ECTS grade transfer scale.

Grade	Grade index i	Current distribution of local passing grades		Long-term distribution of local passing grades	
		Number S_i	Percentile C_i	Percentage	Percentiles L_i
	0		0.00		0.00
3	1	10	0.10	30	0.30
4	2	50	0.60	50	0.80
5	3	40	1.00	20	1.00

Table 2: Example data set.

ECTS-grade	P	j	Q	% of current students	Number of students out of 100 $ECTS_i$
E	0.10	0.33	0.033	3.3	3
D	0.35	1.10	0.150	11.7	12
C	0.65	1.70	0.450	30.0	30
B	0.90	2.50	0.800	35.0	35
A	1.00	3.0	1.000	20.0	20

Table 3: Distribution of students into the ECTS cohorts for the example data, where the total number of students (N) is 100.

	Local grades j			
ECTS grades i	3	4	5	Sum:
E	3			3
D	7	5		12
C		30		30
B		15	20	35
A			20	20
Sum:	10	50	40	100

Table 4: Output matrix of the grade distribution model, applied to the example data.

Local grade	Long-term distribution of local grades (%)	Corresponding ECTS grade for a single student (A-E)	Probability of transfer from local to ECTS grade
3	30	D	E – 33 % D – 67 %
4	50	B	D – 10 % C – 60 % B – 30 %
5	20	A	B – 50 % A – 50 %

Table 5: Example of transfer from local to ECTS passing grades. The percentages were calculated by using 100 students as the cohort size for each local grade 3, 4 and 5 respectively.

"Host" local grade	Long-term distribution of "host" grades (%)	Corresponding "home" grade (10-20)	Probability of transfer from "host" to "home" grade
3	30	12	10 – 30 % 11 – 30 % 12 – 31 % 13 – 9 %
4	50	17	13 – 12 % 14 – 19 % 15 – 18 % 16 – 18 % 17 – 18 % 18 – 15 %
5	20	20	18 – 9 % 19 – 45 % 20 – 46 %

Table 6: Example of direct transfer from a "host" to a "home" passing grade, where the "home" grading scheme includes 11 passing grades (10-20). The "home" grade is assumed to be norm-references with ideally 100/11% of the students assigned to each of the 11 passing grades.

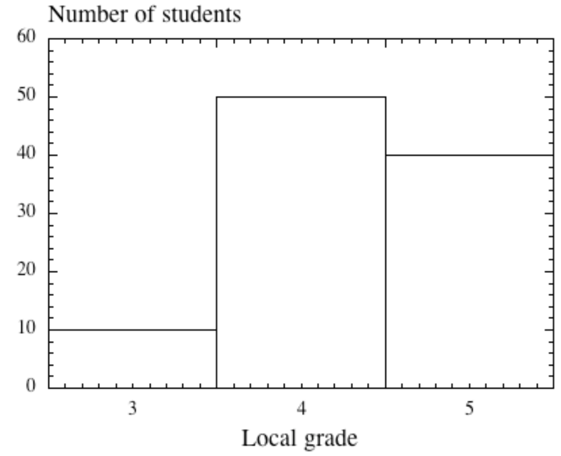

Figure 1

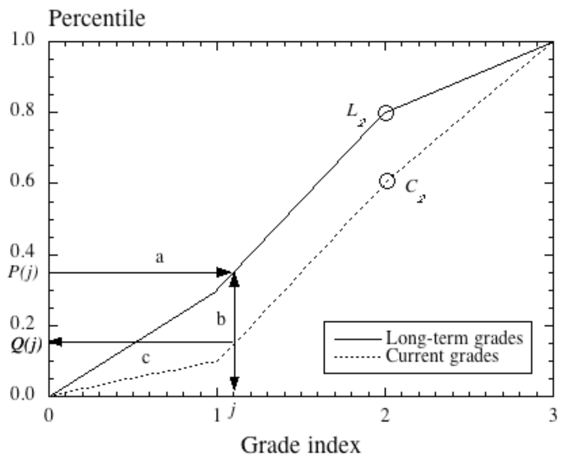

Figure 2

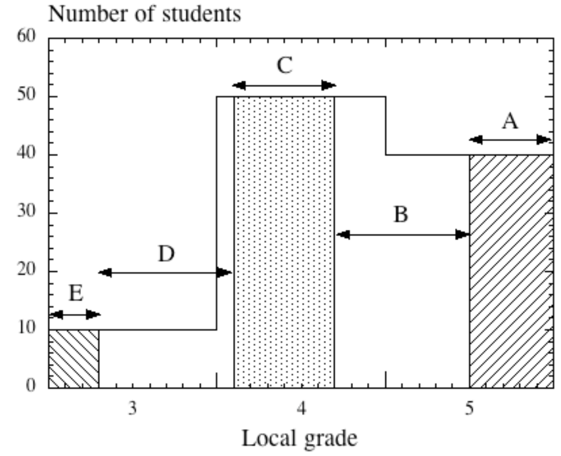

Figure 3

Figure 1.
Example data used to demonstrate the methodology. The local grading scale includes 3 grade scales, 3, 4 and 5 where 5 is the best grade.

Figure 2.
Cumulative distributions of example data referring to long-term data (solid line) and current group data (dashed line). The points L_2 and C_2 are included to illustrate how the long-term grade data (*L)* and the data representing the current group (*C*) are used to model the cumulative distributions.

Figure 3.
Graphical representation of how the cohorts of students with local grades 3, 4 and 5 of the example data are distributed to ECTS grade cohorts E-A. The figure is coherent with the output matrix shown in Table 4.