ACTAC
Australasian Conference of Tertiary Admission Centres

Using International Baccalaureate fine-grained data to increase gradations in the combined International Baccalaureate schedule

Executive summary

The conversion from International Baccalaureate (IB) diploma scores (integers from 24 to 45) to an admission rank (potentially ranging from 0.00 to 99.95, at 0.05 intervals) is a complex problem for tertiary admission centres across Australia. Principally, the problem concerns mapping values on a coarse-grained scale (IB scores) to values on a fine-grained one (admission ranks). The difference in granularity between the two scales means that it is inevitable that some students will be advantaged, and others disadvantaged by the conversion.

Recently, the International Baccalaureate Organisation (IBO) has provided UAC fine-grained data, in the form of percentage marks and grades achieved by Australian IB students in each of their individual IB subjects, and Extended Essay (EE) and Theory of Knowledge (TOK) components. This paper explores the nature of this additional data and proposes ways in which this data could be used to further differentiate IB students with the same overall diploma score.

On the basis of our analyses of the fine-grained data, a fine-grained IB schedule is proposed, with these following characteristics:

- The basis of the schedule is a fine-grained IB score, which is calculated for each student using their percentage marks on IB subjects.
- At the top range of the schedule, ranks are available for fine-grained IB scores: 45.50, 45.00, 44.50, 44.00, 43.50 and 43.00.
- Below 43.00, ranks are created for each fine-grained IB score at 0.25 intervals.
- The current IB schedule is retained with its ranks (anchors) placed at the midpoint of each score (42.50, 41.50, 40.50, …, 23.50, 24.50).
- The new ranks are determined by linear interpolation between the anchors.

Greater differentiation between IB students means that the admission ranks and outcomes would become more equitable. This paper also proposes the assessment procedure for using this fine-grained schedule, and provides some comparative data on how this new schedule affects IB students' admission ranks.

1. Background

1.1 The IB schedule

In 2017, just over 2,000 students around Australia (and over 500 in New South Wales) received the IB qualification. This IB cohort has been steadily growing for some years, with the IB students graduating from high school alongside their counterparts who receive an ATAR based on their results in an Australian Year 12 qualification (eg, Higher School Certificate (HSC) in NSW).

For university admission purposes, an IB student's achievement on the IB diploma, given as a score out of 45 with 24 being the passing score, is assessed and given an admission rank which is deemed

to be ATAR-equivalent. The correspondence between each IB score and the admission rank is given by the combined IB schedule, which is created by combining the individual conversion tables calculated by four tertiary admission centres (VTAC, SATAC, UAC, QTAC)[1]. The IB schedule is revised annually and the 2018 schedule is shown in Table 1.

Table 1. The 2018 IB schedule

IB score	Rank
45	99.95
44	99.85
43	99.70
42	99.40
41	98.80
40	98.25
39	97.50
38	96.70
37	95.75
36	94.50
35	93.30
34	92.10
33	90.65
32	88.95
31	87.10
30	84.40
29	81.90
28	79.90
27	77.65
26	75.15
25	72.10
24	68.70

1.2 The problem with the IB schedule

The IB schedule is notable for its coarseness. While there are 2,000 different ATARs ranging from 0.00 to 99.95 (at 0.05 intervals), there are only 22 IB scores, and therefore 22 corresponding ranks. Thus, all IB students with a score of 45 are given the same admission rank of 99.95. In 2017, 13 IB students achieved 45 in NSW, equivalent to 2.40% of the NSW IB cohort. In comparison, only 46 HSC students received an ATAR of 99.95, equivalent to approximately 0.08% of the NSW HSC cohort. In other words, controlling for cohort size, roughly *30 times* more IB students received the top rank than did HSC students.

The chief reason cited for this disparity between the IB and HSC cohorts is that the IB cohort is a highly selective group, and hence the disproportionate number of their students achieving the top score. That is, the IB programme is offered by a handful of independent schools in NSW and around Australia where students are typically from higher socio-economic backgrounds, and that the schools are well-funded and resourced. Anecdotally, it has also been suggested that the more academically-

[1] A summary of the methodology used in creating each schedule contribution from Victoria, South Australia, New South Wales and Queensland is available here: https://www.uac.edu.au/assets/documents/international-baccalaureate/determining-atar-ib-equivalents.pdf

able students at these schools are encouraged to choose the IB programme over their home state's Year 12 qualification.

While it is indisputable that the IB cohort in NSW and Australia is on average, a highly academic one, what could be disputed is that not all students scoring 45 are equal in their ability and achievements, and therefore it may be possible to further differentiate between these top students. The same argument applies for students on other IB scores. That is, any particular IB score will cover a group of students with a wide range of scholastic achievement.

The aim of this paper is to outline evidence for the above claim. Further, if students on the same IB score could be differentiated from each other, then it may be possible to assign different ranks for these students to reflect these differences. That is, the IB schedule could become more fine-grained, and therefore more equitable for IB students.

1.3 Requirements of the IB diploma

In July 2018, the IBO provided the Universities Admissions Centre with data pertaining to Australian students who have studied for the IB diploma in 2016 and 2017. The dataset contains the marks and grades each IB student has achieved in all their subjects, plus two other compulsory areas of the IB diploma – the Extended Essay (EE) and Theory of Knowledge (TOK).

An example of the data for one student is shown in Table 2. The IB curriculum stipulates that a student must take six subjects, one each from Groups 1 to 5, and either one from Group 6 or substitute another from one of the other groups. At least three subjects must be studied as a "Higher Level" (HL), with the rest studied as "Standard Level" (SL). The subject groups are as follows:

- Group 1: Studies in language and literature
- Group 2: Language acquisition
- Group 3: Individuals and societies
- Group 4: Experimental sciences
- Group 5: Mathematics
- Group 6: The arts

Further, to qualify for the IB diploma, the student must meet three requirements: EE, TOK and CAS (creativity, activity, service), which consists of participation in community work, sport and creative activities.

Table 2. An example of a student's IB results, as part of the data provided by the IBO

Subject	Level	Grade	Percentage	Lower boundary	Upper boundary
HISTORY	EE	C	20	16	22
ENGLISH A LIT	HL	6	78	70	80
HISTORY	HL	5	53	49	61
PSYCHOLOGY	HL	5	55	44	55
BIOLOGY	SL	6	67	65	75
CHINESE B	SL	5	68	57	69
MATHEMATICS	SL	5	59	58	71
THEORY KNOWL.	TOK	C	15	11	16

1.4 Assessment and report of IB results

Students' performance on each HL and SL subject is marked out of 100. The mark is then translated into a grading scale from 1 to 7. The lower and upper boundaries for the 7 grades are different across different subjects studied at different levels and examined at different time points (e.g., May versus November exams). Table 3 shows an example for the 2017 November grade boundaries for biology studied at the standard level.

Table 3. Lower and upper boundary for grades in biology, 2017 November

Grade	Lower boundary	Upper boundary
1	0	14
2	15	26
3	27	39
4	40	51
5	52	64
6	65	75
7	76	100

In Table 2, the student who has studied Biology SL had a mark of 67, which is within the boundaries for grade 6. In this manner, marks are converted into grades for all HL and SL subjects. A similar process is carried out to derive a grade from A to E for EE and TOK. These grades are converted into a score out of 3 by using the diploma points matrix, as shown in Table 4.

Table 4. The diploma points matrix for deriving a score for EE and TOK

EE/TOK	A	B	C	D	E /no grade
A	3	3	2	2	Fail
B	3	2	2	1	Fail
C	2	2	1	0	Fail
D	2	1	0	0	Fail
E / no grade	Fail	Fail	Fail	Fail	Fail

In our example from Table 2, the student had a C grade for both EE and TOK. Two C grades correspond to 1 point. To calculate the overall diploma score for this student, the grades for the 6 subjects, and the points from EE/TOK are summed. In this case then, the student's diploma score is 6 + 5 + 5 + 6 + 5 + 5 + 1 = 33.

To achieve the maximum diploma score of 45, a student therefore must get a grade of 7 for each of the six subjects, and 3 points from TOK and EE (either a combination of two As, or one A and one B).

The grade for each subject, EE and TOK, as well as the overall IB diploma score, are reported to the IB candidates. The underlying marks (out of 100) are not reported, but the school can help the student access these marks.

The IB diploma is awarded if the student satisfies all of the following conditions:

- the overall IB score is at least 24,
- a minimum of 12 points from their HL subjects and a minimum of 9 points from their SL subjects,
- completion of EE, TOK and CAS, with no fails.

2. Analysis of the fine-grained IB data

2.1 Data cleaning

The data provided by IBO contains 33,148 results from 4,451 unique candidates, over the years 2016 and 2017. Most of the results were from the November rather than the May exam sitting. There were duplicate candidates who have attempted the diploma in both years, and candidates who did not complete the required number of HL and SL subjects. Further, the data contains candidates who did not qualify for the IB diploma for failing to meet the conditions listed above. Because the schedule is based on students who have successfully qualified for the diploma, these conditions were applied to determine those candidates whose results would be retained for this analysis. In the end, results from 3,793 candidate attempts were included in the analysis. This includes 6 candidates who qualified for the diploma in both 2016 and 2017.

Based on the IB curriculum, it was expected that for each candidate, there would be 8 results – an EE grade, a TOK grade, and 3 results each for HL and SL subjects. For some candidates, there were duplicate results for a single subject (e.g., two different scores for HL Mathematics). In these cases, the lower result was removed from the analysis.

A check was carried out to verify that the overall diploma score (out of 45) provided by the IBO is correct as according to the summation of the grades and the matrix points for EE and TOK (Table 4). All students' data passed this check.

2.2 Percentage-decimal measure

As seen in section 1.4, a particular grade for an IB subject (HL or SL) covers a range of marks, with the range for each grade being different for each subject. In our example, the student with a mark of 67 in Biology received a grade 6, as 67 within the grade 6 boundaries of 65 to 75. It could be argued that the student is at the lower rather upper end of grade 6.

The "percentage-decimal" was devised by David Hallam (SATAC) as a standardised measure to reflect the underlying performance in each IB grade. In the percentage-decimal, the extent by which a student's percentage mark exceeds the lower boundary of the grade is taken into the account, and is given by the formula:

Percentage-decimal = (Percentage mark – lower boundary_1) / (lower boundary_2 – lower boundary_1)

where lower boundary_1 is the lower boundary for the result's grade and lower boundary_2 is the lower boundary for the grade immediately above. If the result's grade is 7, lower boundary_2 takes on a value of 101.

For the student in our example, the percentage-decimal for Biology is therefore (67 – 65) / (75 – 65 + 1) = 0.182. The idea is that for each student, the percentage-decimal for the six subjects could be averaged, giving an indication of how, on average, the student lies within the grade. It was envisaged that the overall IB score out of 45 will continue to be reported to students, with the average percentage-decimal reported as a supplement to give further gradation to the score.

2.3 Percentage-decimal measure – statistics

In total, there were 11,402 HL and 11,356 SL results in the analysis data. HL results slightly outnumbered SL results because a handful of students elected to do four HL and two SL subjects, rather than three each. The percentage-decimal was calculated for each mark in the dataset, and the

summary statistics of this measure for HL and SL subjects are shown in Table 5 and 6 respectively. Each table also displays the statistics for subjects with more than 200 results.

Table 5. Summary statistics for HL subjects

HL subjects	Average of percentage-decimal	Number of results	Standard deviation of percentage-decimal
Total	*0.409*	*11,402*	*0.286*
HL subjects with > 200 results			
ENGLISH A LIT	0.419	1,907	0.289
BIOLOGY	0.413	1,161	0.282
PSYCHOLOGY	0.420	1,070	0.290
CHEMISTRY	0.404	1,059	0.283
ECONOMICS	0.386	998	0.284
HISTORY	0.421	677	0.288
BUS MAN	0.387	592	0.285
VISUAL ARTS	0.426	562	0.291
ENGLISH A LAL	0.392	515	0.294
PHYSICS	0.411	511	0.278
MATHEMATICS	0.409	439	0.282
GEOGRAPHY	0.368	411	0.290
THEATRE	0.408	210	0.276

Table 6. Summary statistics for SL subjects

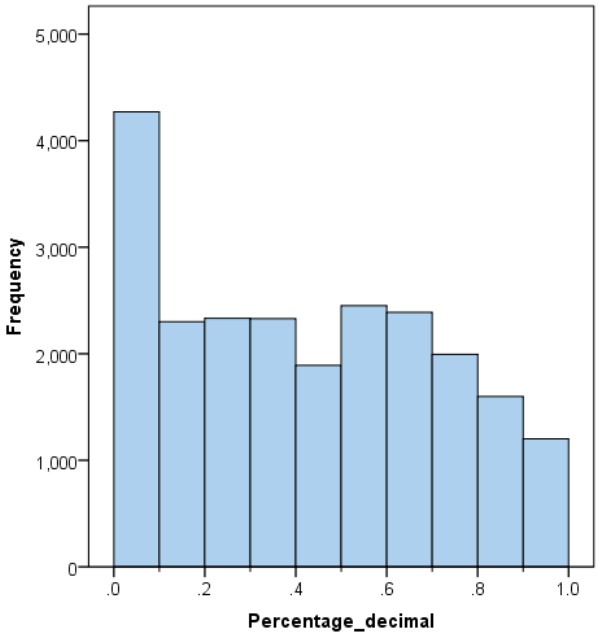
SL subjects	Average of percentage-decimal	Number of results	Standard deviation of percentage-decimal
Total	*0.427*	*11,356*	*0.284*
SL subjects with > 200 results			
MATHEMATICS	0.441	2,125	0.285
MATH.STUDIES	0.431	1,229	0.287
CHEMISTRY	0.413	1,060	0.284
SPANISH AB.	0.453	955	0.285
ENGLISH A LIT	0.416	767	0.282
FRENCH B	0.428	661	0.278
BIOLOGY	0.405	618	0.286
PHYSICS	0.393	477	0.273
ENGLISH A LAL	0.430	380	0.284
FRENCH AB.	0.423	364	0.288
ENV. AND SOC.	0.415	330	0.280
CHINESE B	0.459	253	0.275

Overall, the average percentage-decimal is 0.409 HL and 0.427 for SL subjects. The average varies little across subjects with more than 200 results. The standard deviation is just under 0.300 for both HL (0.286) and SL (0.284) subjects.

Statistically, if all marks within a grade were equally likely, then the average percentage-decimal would be around 0.500. This is not the case as the distribution of marks on each grade appears to be positively-skewed. That is, more marks are on or just above the lower boundary than on or just below the upper boundary of a grade. Of the total 22,758 HL and SL percentage marks, 2,239 (9.8%) are on

the lower boundary of a grade, compared with just 1,269 (5.6%) marks on the upper boundary. Similarly, more marks are just one above the lower boundary (1,912 or 8.4%) than just one below the upper boundary (1,453 or 6.4%). This positive skew is reflected in the histogram of percentage-decimals of all marks, as shown in Figure 1. Overall, the average percentage-decimal for all HL and SL marks (N = 22,758) is 0.418, with a standard deviation of 0.285.

Figure 1. Histogram of percentage-decimals, all HL and SL marks (N = 22,758)

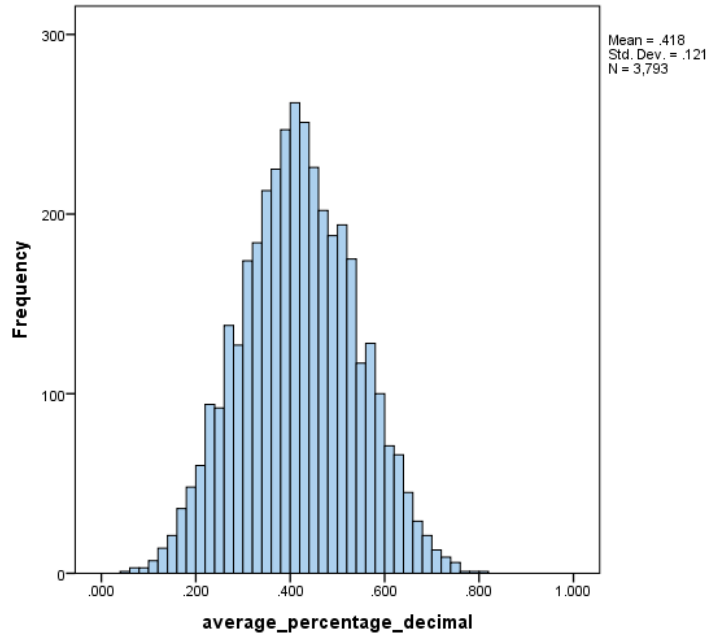


It is unclear why the distribution should be positively skewed. The pattern may be an artefact of the way by which IB subjects are assessed, that assessors may be considering whether the student has met the threshold for a particular grade. Potentially, students on learning their results may be more likely to ask for a re-mark if their percentage falls just below the threshold for the next grade. In such cases, an improvement of one percent on a subject would mean an increase of one integer point in their overall IB diploma score – a substantial gain from a minor change for the student.

2.4 Average percentage-decimal by student (APD)

by student, which we will refer to as APD for short. For each student, the APD is calculated by taking an average of the percentage-decimal of his/her six HL and SL subjects. The distribution of students' APDs (N = 3,793) is shown in Figure 2. The central tendency of this distribution, the mean, is 0.418, with a standard deviation of 0.121. Notably, the distribution ranges from 0.044 to 0.810. In fact, only one student has an APD above 0.800. That is, virtually all students' APDs fall within the range of 0.000 to 0.800.

Figure 2. Histogram of average percentage-decimals (APDs) of students (N = 3,793)



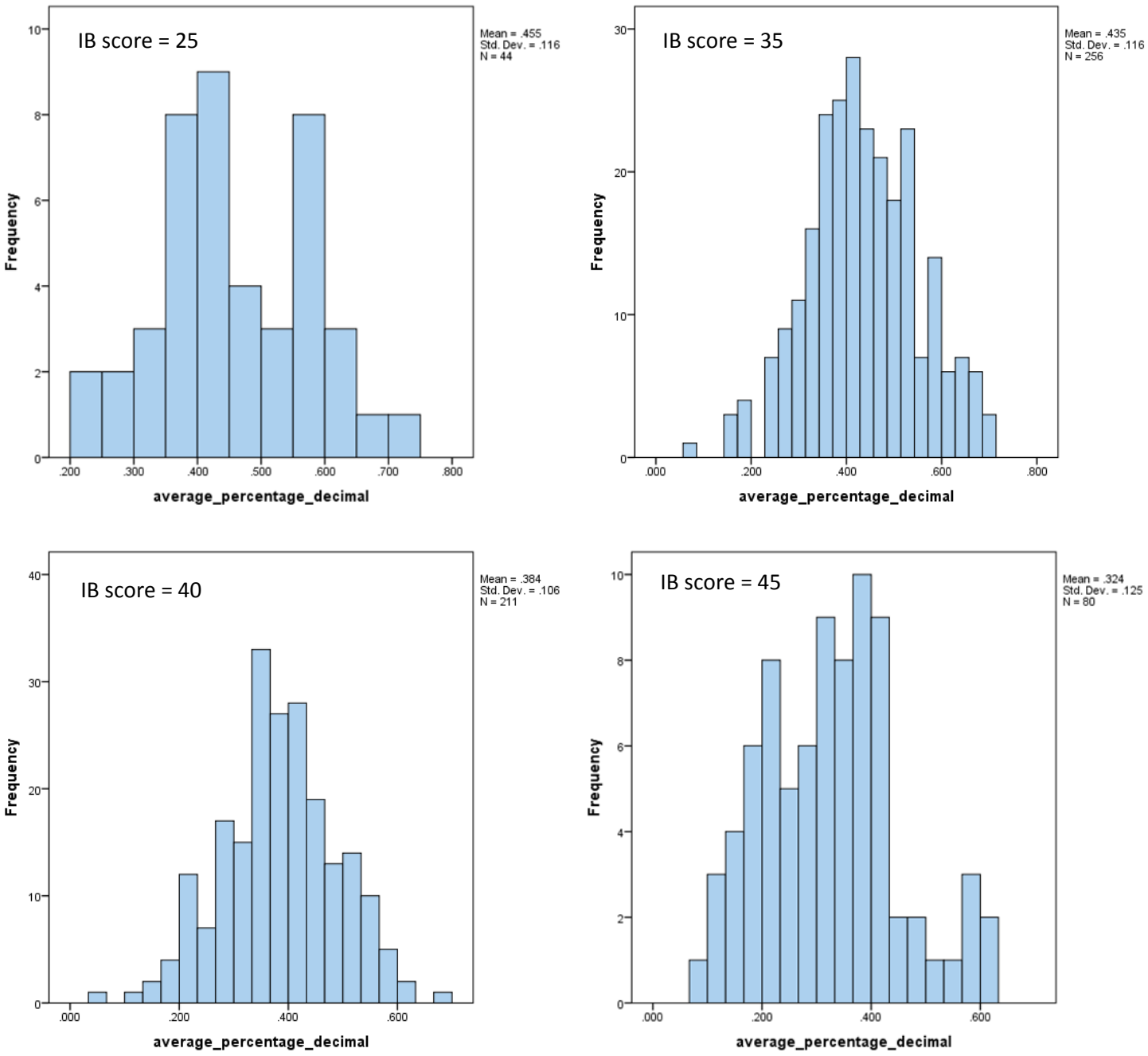
The distribution of the APD is also examined individually at each overall IB diploma score. At lower scores, the central tendency of the APD is higher than 0.400. As IB scores increases, the central tendency drops below 0.400. Table 7 gives the mean, SD, and range of the APD at each IB score. Figure 3 shows the histograms of the APD for students on IB score of 25, 35, 40, and 45. Roughly speaking, for students achieving high grades (those with IB scores over 40), their percentage mark is on average closer to the lower boundary than the upper boundary of the grade.

Table 7. The mean, standard deviation, range (maximum, minimum) and number of students (N) of average percentage-decimal (APD) by IB diploma score

Diploma score	Mean	Standard deviation	Minimum	Maximum	N
45	0.324	0.125	0.075	0.619	80
44	0.339	0.117	0.074	0.607	109
43	0.331	0.102	0.117	0.584	138
42	0.337	0.095	0.153	0.638	165
41	0.365	0.092	0.142	0.568	166
40	0.384	0.106	0.044	0.685	211
39	0.400	0.116	0.095	0.690	238
38	0.424	0.119	0.158	0.692	253
37	0.412	0.116	0.125	0.744	234
36	0.421	0.114	0.12	0.729	258
35	0.435	0.116	0.082	0.709	256
34	0.448	0.118	0.101	0.782	255
33	0.440	0.116	0.169	0.713	240
32	0.450	0.116	0.187	0.810	242
31	0.455	0.117	0.207	0.735	202
30	0.452	0.116	0.183	0.731	182
29	0.446	0.120	0.097	0.723	175

28	0.452	0.115	0.196	0.678	121
27	0.467	0.115	0.172	0.734	100
26	0.472	0.118	0.233	0.746	81
25	0.455	0.116	0.218	0.701	44
24	0.443	0.145	0.072	0.672	43
Total	*0.418*	*0.121*	*0.044*	*0.810*	*3,793*

Figure 3. Distributions of the average percentage-decimal (APD) at IB score = 25, 35, 40 and 45



3. Creating finer-ranks in the IB schedule

3.1 How fine?

The number of additional ranks that could potentially be added between IB scores is constrained by the gap between existing ranks on the current schedule (Table 1). We will refer to these existing ranks on the current schedule, each corresponding to an integer IB score, as "anchors".

At the very top, only one other rank (99.90) separates IB score of 45 and 44. There is a gap of two ranks between 44 and 43 (99.80, 99.75). Moving down the schedule, the gaps between anchors become wider. Between 40 and 39, there is a gap of 14 ranks; between 35 and 34, a gap of 23 ranks; between 30 and 29, a gap of 49 ranks and so on. Thus, for IB scores of say between 24 and 42, it is possible to use the APD to determine additional ranks between scores.

3.2 Additional ranks between IB scores of 43 to 45

At the top end of IB scores between 43 and 45, the anchors are too close for several ranks to be added in between. Moreover, for students on 45, the only possible way for further differentiation is that some of these students would receive a rank of 99.90, which is one rung lower than the top anchor of 99.95. This means that continuing downwards, students on 44 must also be differentiated by having some of these students receiving a rank lower than the current anchor of 99.85. At some point, there needs to be a switch so that students on the same IB score are differentiated "upwards" – ie, those on a lower APD getting the rank at the anchor, and those on a higher APD getting a rank above the anchor. We propose that this switch happens at IB score of 43.

Table 8 illustrates the assignment of additional ranks between 42 and 45. The current anchors for IB scores between 42 to 45, as per the IB schedule are in bold and all other ranks between anchors are also shown. Thus, those students who achieved more highly on 45 (eg, have higher average percentage-decimal) is in the "high-45" group, compared with those with lower achievements on 45, the "low-45" group. High-45 is mapped to 99.95, meaning low-45 is mapped to 99.90.

Because there are two available ranks between 43 and 44, it is possible to accommodate four groups of students – high-44, low-44, high-43 and low-43. The assignments of ranks are shown in the table.

Table 8. Proposed schedule with additional ranks between 43 and 45

IB score	Rank	Number of students (2016–17)
high-45	**99.95**	**20**
low-45	99.90	60
high-44	**99.85**	**33**
low-44	99.80	76
high-43	99.75	32
low-43	**99.70**	**106**

3.3 Splitting students into high and low groups – IB score = 43 to 45

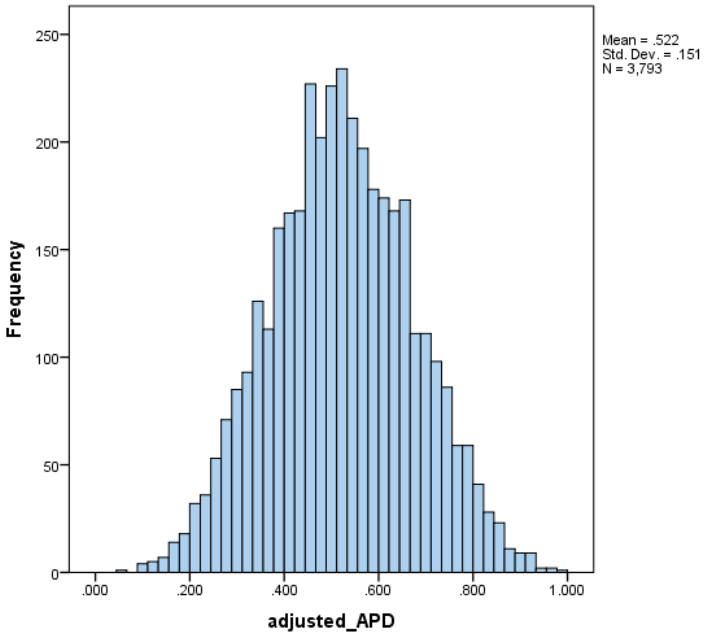
A simple way to divide students into high and low groups is to set an arbitrary threshold on the APD, say 0.500. Those with APD of 0.500 or above are in the "high" group and those below are in the "low" group. However, setting the threshold at 0.500 may be problematic because as seen in Figures 2 and 3, the central tendency of the APD is around 0.400, and it is lower than 0.400 for students with high IB scores. To compensate for the skewness in the distribution, an adjustment to the APD is proposed.

Since almost all students' APDs are in the range of 0.000 to 0.800 (see Figure 2), the APD could be adjusted by scaling the measure to a 0.000 to 0.999 range.

$$\text{Adjusted-APD} = \text{APD} / 0.800$$

If adjusted-APD is equal or above 1.000, round down value to 0.999. The result of this adjustment is that the mean of this adjusted-APD distribution is now 0.522, compared with mean = 0.418 (see Figure 2). Figure 4 shows the distribution of the adjusted-APD.

Figure 4. Histogram of adjusted APDs of students (N = 3,793)



Given this adjustment, a threshold of 0.500 can be applied to split students on each IB score 43, 44 and 45 into two groups. The last column in Table 8 shows the number of students in the high and low groups after the split. Under this proposed schedule, 20 of the 80 students on 45 would receive the top rank, with the remaining 60 assigned 99.90. On all three IB scores – 43, 44 and 45, roughly a quarter of the students are in the "high" group. This outcome entirely reflects that on these high IB scores, most students achieved marks closer to the lower than upper boundary of the grades (see Table 7), and the adjustment to the APD retains this positive skew of the distribution, ie, the central tendency would not be shifted to 0.500 here.

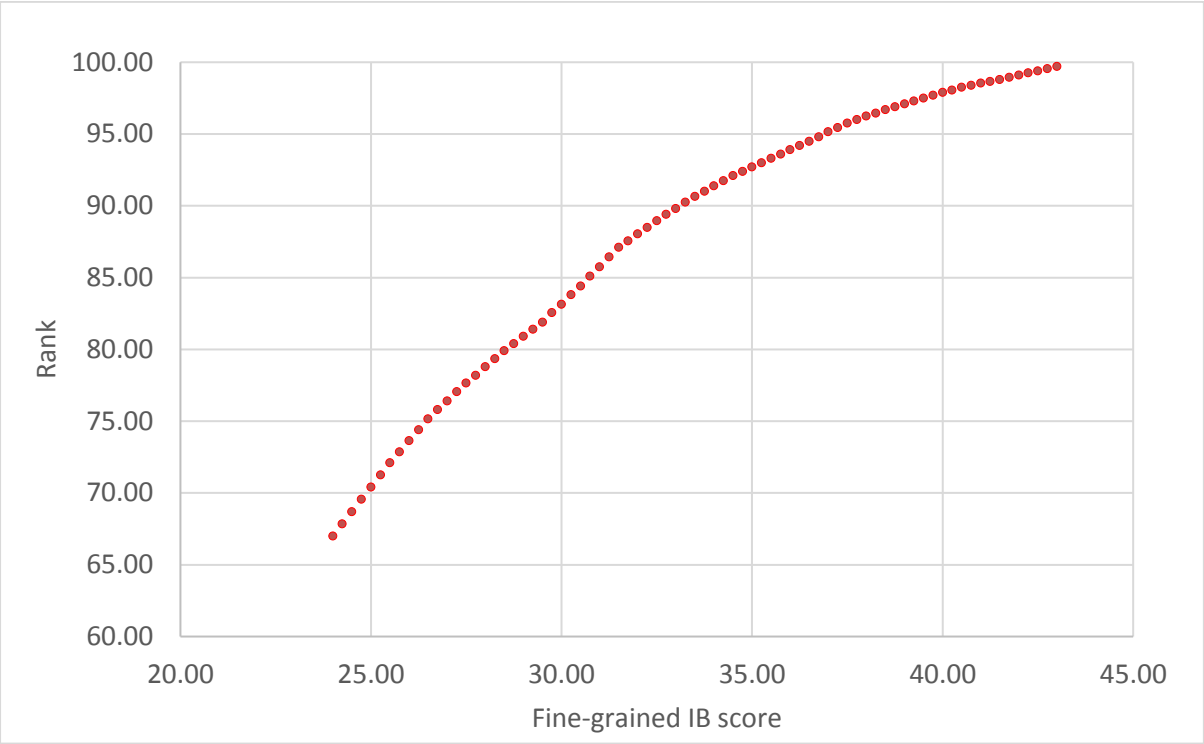
3.4 Additional ranks for IB scores from 24 to 42

For IB scores 24 to 42, there are enough ranks between anchors to make partitioning students into several groups possible. There is no correct number of partitions to be made. As a starting point, it is proposed here that *three additional ranks* are to be established between anchors.

A rethinking of the current schedule is required before partitioning is carried out. The IB schedule has been conceived to map to each IB score to the closest ATAR-equivalent rank. Given the coarseness of the IB scale, it should be more appropriate to think of the equivalent rank as representing the *middle student* on that IB score. Thus, if the schedule is to be modified to map the (IB score + adjusted-APD) to ranks, then the left column in Table 1 should have values of 42.5, 41.5, 40.5, …., 23.5, 24.5, with the anchors remaining unchanged.

In between two fine-grained IB scores (eg, 42.5 and 41.5), three further ranks could be added at 42.25, 42.00, 41.75. These ranks are determined by linear interpolation between two existing anchors.

Figure 5. Plot of the proposed fine-grained IB schedule



4. The fine-grained IB schedule

4.1 Summary of the proposed fine-grained IB schedule

The proposed fine-grained IB schedule has these characteristics:

- The basis of the schedule is a fine-grained IB score, which is calculated for each student using their percentage marks on IB subjects.
- At the top range of the schedule, ranks are available for fine-grained IB scores: 45.50, 45.00, 44.50, 44.00, 43.50 and 43.00.
- Below 43.00, ranks are created for each fine-grained IB score at 0.25 intervals.
- The current IB schedule is retained with its ranks (anchors) placed at the midpoint of each score (42.50, 41.50, 40.50, …, 23.50, 24.50).
- The new ranks are determined by linear interpolation between the anchors.

The proposed schedule in its entirety is in Table 9. The trend in ranks between 24.50 and 25.50 has been extrapolated downwards to create ranks for fine-grained IB score = 24.25 and 24.00.

Table 9. The proposed fine-grained IB schedule

Fine-grained IB score	Proposed fine-grained schedule	Current IB schedule (anchors)	Fine-grained IB score	Proposed fine-grained schedule	Current IB schedule (anchors)
45.50	99.95	99.95	34.00	91.40	
45.00	99.90		33.75	91.00	
44.50	99.85	99.85	33.50	90.65	90.65
44.00	99.80		33.25	90.25	

43.50	99.75		33.00	89.80	
43.00	99.70	99.70	32.75	89.40	
42.75	99.55		32.50	88.95	88.95
42.50	99.40	99.40	32.25	88.50	
42.25	99.25		32.00	88.05	
42.00	99.10		31.75	87.55	
41.75	98.95		31.50	87.10	87.10
41.50	98.80	98.80	31.25	86.45	
41.25	98.65		31.00	85.75	
41.00	98.55		30.75	85.10	
40.75	98.40		30.50	84.40	84.40
40.50	98.25	98.25	30.25	83.80	
40.25	98.05		30.00	83.15	
40.00	97.90		29.75	82.55	
39.75	97.70		29.50	81.90	81.90
39.50	97.50	97.50	29.25	81.40	
39.25	97.30		29.00	80.90	
39.00	97.10		28.75	80.40	
38.75	96.90		28.50	79.90	79.90
38.50	96.70	96.70	28.25	79.35	
38.25	96.45		28.00	78.80	
38.00	96.25		27.75	78.20	
37.75	96.00		27.50	77.65	77.65
37.50	95.75	95.75	27.25	77.05	
37.25	95.45		27.00	76.40	
37.00	95.15		26.75	75.80	
36.75	94.80		26.50	75.15	75.15
36.50	94.50	94.50	26.25	74.40	
36.25	94.20		26.00	73.65	
36.00	93.90		25.75	72.85	
35.75	93.60		25.50	72.10	72.10
35.50	93.30	93.30	25.25	71.25	
35.25	93.00		25.00	70.40	
35.00	92.70		24.75	69.55	
34.75	92.40		24.50	68.70	68.70
34.50	92.10	92.10	24.25	67.85	
34.25	91.75		24.00	67.00	

4.2 Procedure for assessment

The procedure for assessment is as follows:

1. For each student who has qualified for an IB diploma, calculate the percentage-decimal for each HL and SL subject using the formula given in section 2.1.
2. For each student, take the unweighted average of the percentage-decimals from the six subjects that are counted towards their IB diploma score. HL and SL subjects are treated equally. This gives the average-percentage-decimal (APD) measure for each student.

3. Calculate the adjusted-APD by dividing the APD by 0.800. Round adjusted-APD down to 0.999 if it greater or equal to 1.000.
4. Add the adjusted-APD to the student's IB diploma score to derive the fine-grained IB score.
5. Apply rounding rules to the fine-grained IB score:
    a. If the fine-grained IB score is greater than 43, *round down* to the nearest 0.50 interval. For example, if the fine-grained IB score = 43.8, round to 43.5; if it is 44.3, round to 44.0.
    b. If the fine-grained IB score is below 43 and the adjusted-APD >= 0.75, *round down* the adjusted-APD component to 0.75. For example, if the score = 40.85, round down to 40.75. This is to prevent the adjusted-APD from being rounded up to the IB integer score above (eg, normal rounding would render 40.85 to 41.00).
    c. If the fine-grained IB score is below 43 and the adjusted-APD < 0.75, do conventional rounding to the adjusted-APD component to nearest 0.25 interval. For example, if the score = 40.15, round to 40.25; if the score = 40.10, round to 40.00.
6. Look up the equivalent rank on the proposed fine-grained IB schedule for the fine-grained IB score calculated. Take the rank below if the fine-grain IB score falls in between two values on the schedule.

Table 10. An example of the assessment procedure

Subject	Level	Grade	Percentage	Lower boundary	Upper boundary	Percentage-decimal
HISTORY	EE	C	20	16	22	
ENGLISH A LIT	HL	6	78	70	80	0.727
HISTORY	HL	5	53	49	61	0.308
PSYCHOLOGY	HL	5	55	44	55	0.917
BIOLOGY	SL	6	67	65	75	0.182
CHINESE B	SL	5	68	57	69	0.846
MATHEMATICS	SL	5	59	58	71	0.071
THEORY KNOWL.	TOK	C	15	11	16	
Average (APD)						*0.509*
Adjusted-APD						*0.636*

Table 10 shows the example from Table 2, with the percentage-decimal for each subject calculated. The APD for this student is 0.509, and the adjusted-APD is therefore 0.509 / 0.800 = 0.636. Adding this to the diploma score gives a fine-grained IB score of 33.636. Since this is below 43, round the score to the nearest 0.25 interval (33.75). According to the proposed schedule, the student would receive a rank of 91.00.

4.3 Comparison between original and new rank

Using the proposed schedule (Table 9) and assessment procedure, new ranks could be determined for our 2016-17 IB student sample. These new ranks are compared to what the original ranks would be, if the current IB combined schedule was used (Table 1).

Overall, more than half of the sample would not see a change in their rank if the proposed schedule was adopted, 17% of the students would see a drop of the rank, and 26% would see a rise. Table 11 shows at each diploma score level, the percentage of students whose rank would decrease, stay the same, or increase with the proposed fine-grained schedule, and the average amount of these decreases and increases.

Table 11. Percentage of students with a decrease, the same, or an increase in rank on the proposed schedule, compared with existing IB schedule

	Percentage			Average		
Diploma score	**Decrease**	**Same**	**Increase**	**Decrease**	**Increase**	**N**
45	75%	25%	0%	-.05	-	80
44	70%	30%	0%	-.05	-	109
43	0%	77%	23%	-	.05	138
42	37%	58%	5%	-.15	.15	165
41	22%	71%	7%	-.15	.15	166
40	21%	64%	15%	-.20	.15	211
39	19%	58%	23%	-.20	.20	238
38	16%	54%	30%	-.25	.20	253
37	20%	60%	20%	-.30	.25	234
36	15%	60%	25%	-.30	.30	258
35	12%	59%	29%	-.31	.30	256
34	10%	59%	31%	-.35	.30	255
33	12%	58%	30%	-.40	.35	240
32	10%	57%	33%	-.45	.45	242
31	10%	54%	36%	-.65	.45	202
30	11%	52%	37%	-.60	.70	182
29	13%	53%	34%	-.52	.65	175
28	9%	55%	36%	-.55	.50	121
27	6%	52%	42%	-.60	.55	100
26	10%	48%	42%	-.75	.65	81
25	9%	55%	36%	-.85	.75	44
24	16%	40%	44%	-.97	.85	43
Total	***17%***	***57%***	***26%***	***-.27***	***.39***	***3,793***

The larger decreases and increases are observed at lower IB scores, because the gaps between anchors are larger here and the added gradations would remain larger at this end of the schedule than at the top.

At diploma score 43, 44, and 45, there is only one possible change (increase for 43, decrease for 44 and 45) due to the small gaps between anchors. This agrees with the proposed ranks outlined in Table 8.

As diploma score decreases down the schedule, students are more likely to see an increase than a decrease in rank. This is due to the way percentage marks are distributed according to the diploma score. As seen in Table 7 and Figure 3, the APDs of students tend to shift closer to 0.500 and become more centrally distributed for lower than higher diploma scores.

For over half of the students, they would not see a change in their rank under the new schedule.

5. Concluding remarks

The fine-grained IB schedule proposed here has retained elements of the current ACTAC-approved IB schedule, but allows for further discrimination between students at each diploma score.

The basis for differentiation is the APD, which is calculated using the percentage marks attained by students on each of their HL and SL subjects. Thus, if the fine-grained schedule is to be adopted, percentage marks data, as well as grade boundary information must be supplied by the IBO for each year's IB cohort.

Currently, the proposed schedule differentiates students into two ranks if they scored 43, 44 or 45. There are four possible ranks for students at each diploma score 42 to 24. If finer discrimination is required, it may be possible to add further gradations in this part of the schedule.

In developing the fine-grained schedule, linear interpolation was used to identify what the additional ranks should be. In developing the NSW contribution to the combined schedule, a cohort study with equipercentile mapping was used. It was not possible to use equipercentile mapping in creating the fine-grained schedule since the underlying percentile distribution of the combined schedule is unknown. For those jurisdictions who contribute to the combined schedule (NSW, South Australia, Victoria, Queensland), it may be worthwhile for each jurisdiction to incorporate the fine-grained IB data in the development of their contribution. This may be the preferred method of creating a fine-grained combined IB schedule.

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