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THE MENSA DENMARK IQ TEST AS A PREDICTOR OF MATHEMATICS PERFORMANCE IN CHILEAN SECONDARY STUDENTS

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Abstract

This article presents results from the process of adaption of the Mensa Denmark IQ Test in Chile. The test was adapted to discriminate between groups of Chilean students with different intellectual capacities. The instrument was applied to two samples of Chilean secondary students: 2994 (normal group) and 394 (advanced group). The instrument shows adequate levels of confidence, and the validity of the instrument was confirmed by means of factor analysis and Rasch analysis. Concurrent validity was established when comparing the performance of the Chilean school population in other types of previously standardized intelligence tests. This instrument is able to differentiate individuals in both groups (normal and advanced) and their scores correlate positively with their performance in mathematics. This article discusses the main implications of this study for the Chilean school system.

Keywords: logical intelligence; mathematics; school performance

Introduction

Generally in the educational field, intelligence tests complement the evaluation of educational programs; they also become one of the factors to be considered when explaining academic performance (Deary, Strand, Smith & Fernandes, 2007). From this, the administration of the test to the school population allows the diagnosis and prognosis of the potential or eventual difficulties of the

students in their academic performance and school learning (Watkins, Lei & Canivez, 2007).

Currently, there seems to be a broad consensus regarding the predictive nature of an individual's level of general intelligence with their professional performance, their ability to solve problems, and school success or failure (Almeida, Guisande, Primi & Lemos, 2008; Blackwell, Trzesniewski & Sorich , 2007; Deary et al, 2007; Furnham, Monsen & Ahmetoglu, 2009; Kotz, Watkins & McDermott, 2010; Steinmayr, Ziegle & Tráuble, 2010). There is also evidence of a positive association with memory and tasks of a visuospatial nature (Ferreira, Almeida, Prieto & Guisande, 2012; Johnson & Bouchard, 2005). However, factors such as self-esteem, health, morbidity, economic situation and even problems with the law, qualify this relationship, as various investigations have shown (Arden, Gottfredson & Miller , 2009 ; Deary , Taylor , Hart , Wilson , Smith & Blane , 2005 ; Gottfredson & Deary , 2004 ; Kornilova, Kornilov & Chumakova, 2009; Rindermann, 2008, to name a few).

Cognitive potential shows a consistent and stable trajectory as one goes through the school itinerary, showing significant differences between men and women (Roselli, Ardila, Matute & Inozemtseva, 2009; Ferrándiz, Bermejo, Sainz, Ferrando & Prieto, 2008; Kaufman, Kaufman, Liu & Johnson, 2009; Klein, Adi-Jaha & Hakak-Benizri, 2010). The latter is relevant, because even when differences are observed in specific areas of academic achievement such as mathematics, these seem to be due more to cultural patterns and gender equity than to differences in basic abilities (Else-Quest, Hyde & Linn, 2010). . General intelligence is an important predictor of school performance in various academic subjects and especially in mathematics (Deary *et al.*, 2007; Furnham*et*

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al. 2009; Kotz *et al.*, 2010; Lynn & Mikk, 2009; Spinath, Freudenthaler & Neubauer, 2010).

The evidence of intelligence as a general factor is accentuated for the so-called *fluid or non-verbal intelligence* , which stands as one of the best simple predictors of school performance (Almeida et al, 2008). *Fluid intelligence* refers to the ability to adapt and face new situations flexibly without prior learning constituting a determining source of help for its manifestation (Almeida, 2008; Kvist & Gustafson, 2008). *fluid* intelligenceIt allows reasoning with abstract content, establishing relationships or extracting differences and reasoning logically, which suggests its importance in the development of mathematical skills (Dodonova & Dodonov, 2012; Gullick, Sprute & Temple, 2011). This type of intelligence seems to reach its maximum development in adolescence, hence the intention to contribute with a new instrument to evaluate the secondary school population in Chile.

On the other hand, in recent years in Chile, evidence has been found of the positive relationship of logical intelligence with elaborate and deep learning strategies, confirming significant differences with respect to age, gender and social background in students of various levels. educational (Cerda, Ortega, Pérez, Flores & Melipillán, 2011), which is coincident with the differences observed in academic performance or achievement—in mathematics and various areas at a national and international level—that have been observed in applications of instruments at various levels and subjects to Chilean and international students (Crosnoe & Huston, 2007; MINEDUC, 2007a, 2007b, 2010a; 2010b).

Regarding students called 'talented' or with superior academic performance, consistent evidence has been reported regarding the existence of significant

differences in terms of the logical and mathematical skills they possess (Cerda, Pérez & Melipillán, 2010) compared to groups not selected. This may be a consequence of the fact that those students with high performance in mathematics have high-level cognitive skills, such as planning, review, control, selection and evaluation of their own intellectual activities (Onrubia, Rochera & Barberá, 2003). In fact, another study with talented students in Chile indicates that according to their teachers, these students present academic and socio-affective characteristics that are quite similar to the rest. with the exception of the specific domain of logic and mathematics (Flanagan & Arancibia, 2005). In the same sense, those educators who tend to identify IQ as the basis for determining the talent of their students generally highlight analytical skills as a fundamental part of the structure of intelligence above personal characteristics (García-Cepero & McCoach, 2009).

In Chile there has been notable progress in access and coverage in education, but with few achievements in quality and equity of learning, this being a quite critical situation in vulnerable sectors (Cox, 2007). *A diagnosis of students' fluid intelligence* abilities could allow classroom planning to be better structured or groups separated for better school achievement, especially in mathematics. In the scope of this school discipline, students need to recognize patterns or make sense of disorganized or confusing material and find or identify rules underlying a series of figurative stimuli such as those examined by the instrument examined in the present research.

The Mensa Denmark Group IQ Test, designed by Anders Ditlev Jensen, is a free access instrument available at www.iqtest.dk . It is a figurative, incomplete series and multiple choice test that considers lacunary multiple choice matrices, all of them similar aspects to those of Raven's Progressive Matrix Test (Raven,

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Raven & Court, 1993). Furthermore, no processes of comprehensive reading, information management or prior knowledge are involved in its resolution.

From the above, the potential that the IQ Test can have to evaluate the capacity for logical-mathematical reasoning in the Chilean school population is clear. However, for this instrument to serve this purpose, it must meet the attributes and psychometric characteristics required of an instrument with such a condition, which is the research objective of this work. It is for this reason that the research attempts to answer the following questions:

- Will the IQ Test have the appropriate psychometric characteristics to be considered a valid and reliable instrument in the Chilean school population?
- Will this instrument allow us to differentiate between those students with superior academic abilities?
- Will the scores on this instrument be related to general academic performance and, in particular, to performance in mathematics?

Method

According to the objectives of the study, the research focuses on a quantitative paradigm with a descriptive correlational design, since it attempts to describe the characteristics and relationships presented by the phenomenon under study.

Participants

A pilot application was carried out on a first sample of 200 students in order to see the adequate understanding of the instructions and whether the drawn objects were adequately recognized by the students, in addition to other factors that could distort the responses. Preliminary analyzes of the items and the reliability of the instrument were carried out on this same sample. The analysis of the pilot application indicated the existence of six items whose discriminative

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and loading qualities were not adjusted to the standards for this effect. Without their inclusion, the instrument in general presented very adequate reliability and validity indices.

After the pilot stage, a final sample of proportion stratified by educational level was selected. In Chile there is evidence that indicates that the social extraction group (high, medium and low) is comparable to the type of administrative dependency of the establishments in the educational system (private, subsidized and municipalized, respectively) García-Huidobro and Bellei (2003) . The final sample was defined based on criteria of educational level, gender and age of the students throughout the country, according to what Table 1 shows.. Additionally, it was decided to consider in the application of the instrument an additional (separate) group of outstanding students in mathematics, to whom the test was also applied. This group of students considered outstanding in mathematics corresponded to the group of students participating in the "Regional School Mathematics Championship, CEMAT" competition.

TABLA 1.
Distribución de la muestra final de estudiantes en función de la extracción social de los establecimientos a los cuales asisten y su edad (años) para el IQ Test

Clase social	EDAD						Total
	12	13	14	15	16	17	
Alta	15	44	29	30	17	16	151
Media	134	245	306	347	256	131	1419
Baja	89	158	305	365	304	203	1424
Total	238	447	640	742	577	350	2994

Fuente: elaboración propia

The total sample has an average age of 14.13 years and a standard deviation of 1.687. For its part, the sample of students designated as talented reached a total of 394 students distributed as follows: 142 students from high socioeconomic

level establishments, 201 students from medium socioeconomic level establishments and 51 students from low socioeconomic level establishments. low, with an average age of 14.22 years and a standard deviation of 1.641. Of the total talented students, 226 are men and 168 women.

Procedure

The research was carried out in educational establishments in the Bío Bío region, Chile. When considering the application of instruments and compilation of socio-academic background, APA regulations were followed regarding *Ethical Principles and Codes of Conduct*, which implied, among other things, contacting educational establishments and planning the actions to be carried out within the institution. the establishments. For this, the informed consent of the students, parents or guardians and the authorities of the educational establishments had to be obtained, with respect to the confidentiality of the results and their restricted use for the purposes of this investigation.

Once the instruments were applied, the responses were tabulated in recording forms, in which individual antecedents related to academic performance extracted directly from the school performance records were incorporated.

Instruments

IQ Test: It has 39 items and an administration time of 40 minutes. Each exercise presents the structure indicated in Figure 1 on the left: in the center there is a structure with 9 boxes, where the final box of the series is empty and must be completed with one of the 8 alternatives proposed in the lower part of the same. For the collective application process, a printed version was generated in which each exercise was listed and the proposed alternatives were arranged in a single row below the structure to be able to present several exercises on the

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same sheet. Both formats, virtual and printed respectively, are presented in Figure 1.

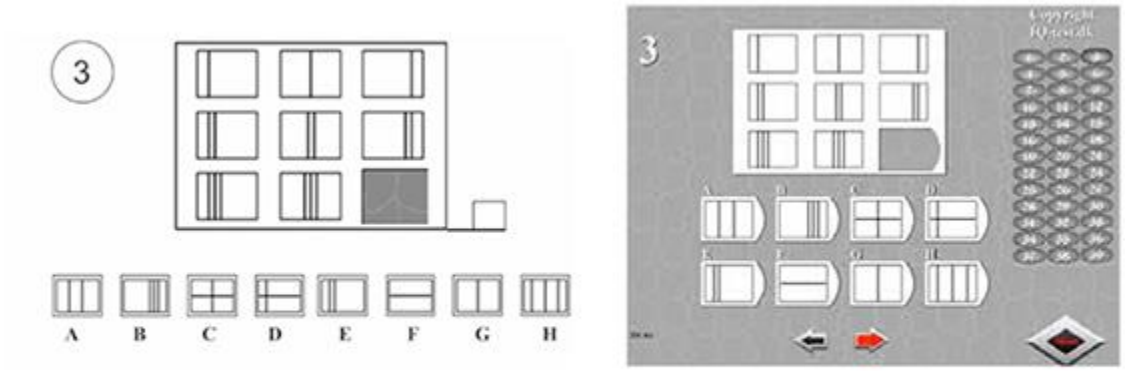

Figura 1: Versiones web (derecha) e impresa (izquierda) de uno de los ítems del IQ Test considerados para el trabajo de investigación

Fuente: elaboración propia

To facilitate the understanding of the task required by the test, three additional items were created as examples that allow us to understand the way in which it must be solved and that are not part of the final exam. This test allows us to measure aspects of *fluid intelligence*, which shows a relationship with the ability to make sense of disorganized or confusing material by recognizing patterns or rules underlying a series of figurative stimuli.

Higher Logical Intelligence Test (TILS): It consists of 50 items and an administration time of 30 minutes. In its application protocol it considers five additional examples that allow

understand how to respond. Its items are figurative, including abstract geometric shapes such as points, straight or curved lines, polygons, etc. Each item or reagent presents the same type structure, duly numbered. In the left sector of the sheet there are four figures from a series linked by some rule or pattern. To this series we must add a fifth figure that continues said sequence, for which the person must choose the correct alternative among five possibilities that are

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presented. Cronbach's alpha is 0.94. Figure 2 shows two items that are part of the induction examples of the instrument.

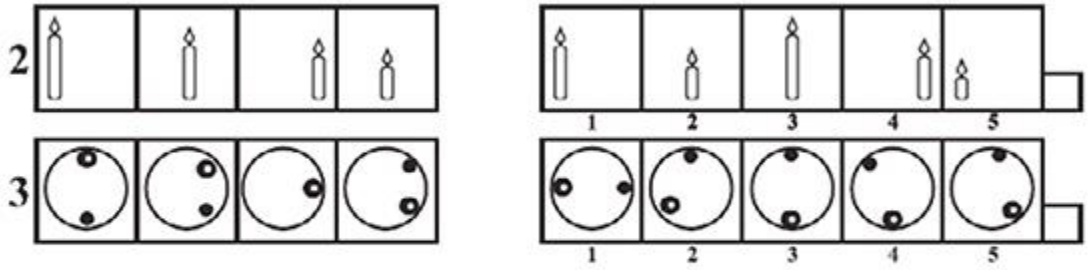

Figura 2: Ejercicios tipo del TILS

Fuente: elaboración propia

This test measures inductive *logical intelligence , understood as the ability of people to envision solutions and solve problems, structure elements to make deductions and substantiate them with solid arguments.* It involves the ability to recognize, in a series of elements, the general rule that governs or underlies them.

With respect to the variables associated with academic performance, two have been considered: general performance understood as the average grades obtained by students in the various secondary education courses in the subjects they take in a school year, and performance in mathematics. , understood as the average of the grades in the mathematics subject or course in that school discipline in the same school year.

Analysis of data

As mentioned above, the main objective of the study is to establish whether the IQ Test meets adequate levels of validity and reliability in the Chilean school population. In the case of the evaluation of construct validity, a Rasch analysis was carried out for dichotomous items (Embretson & Reise, 2000). An advantage of this type of analysis compared to those derived from classical test

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theory is that the latter treats all items as equivalent, ignoring the interaction of the levels of the latent trait involved in the items with the level of the trait in individuals, who can produce particular response patterns (Muñiz, 2010).

The Rasch model assumes that the probability of answering an item favorably is a logistic function of the difference between the level of the latent trait exhibited by an individual and the level of difficulty of the item, that is:

$$p_i(\theta) = \frac{e^{(\theta - b_i)}}{1 + e^{(\theta - b_i)}}$$

In the previous expression, p(θ) is the probability that an individual with a level θ of the latent trait responds affirmatively to item *i*, while b_i is the difficulty parameter of that item.

For an adequate interpretation of the results obtained in a Rasch model, it is required that the data satisfy the assumptions of *unidimensionality* and *local independence*. The assumption of *unidimensionality* refers to the items analyzed measuring a single latent trait. To evaluate this assumption, the scale items were subjected to an exploratory factor analysis (EFA). For its part, the assumption of *local independence* implies that when the levels of the latent trait measured are controlled, the responses to the different items are independent of each other. Thus, we are in the presence of *local dependency*if the responses to different items show a covariation that is explained by different factors (e.g. similar content or phrasing of the items) than the common relationship that said items maintain with the latent trait measured. To determine whether the scale items satisfied this assumption, a principal components analysis was conducted on the residuals of the model. As criteria to determine the existence of *local dependence* between the items, the following were considered: a) the presence of principal components that explained more than two units of variance

(Linacre, 2010) and b) that said principal components showed a sufficient number of items with loadings that exceeded the criterion |0.30|.

Finally, the fit of each of the items to the Rasch model was analyzed using the *Infit* and *Outfit statistics*. These statistics allow us to detect anomalies in the fit of the data to the characteristics of the model, such as the presence of inconsistencies in response patterns, or the presence of items with different levels of discrimination. As a criterion to interpret the existence of a good fit, it is proposed that the *Infit* and *Outfit* values of each item should be located within the interval 0.5 to 1.5 (Linacre, 2010).

Along with the above, concurrent validity was also evaluated by examining Pearson product-moment correlations between the criterion variables general academic performance, mathematics performance and logical intelligence. Regarding the reliability analyses, Cronbach's alpha coefficient was used to evaluate the internal consistency of the items.

Additionally, analysis of simple variance and difference of means were carried out to determine possible differences based on age, gender and social background group, in addition to the Levene test to determine the homogeneity of the variances and compliance with the assumption of normality. To carry out these analyzes the programs SPSS 19, MPLUS 6 and WINSTEPS 3.70.0 were used.

Results

The IQ Test presents an adequate level of reliability ($r_a = 0.81$) and the analysis of its items shows that they generally exhibit normal degrees of difficulty and adequate and moderate levels of discrimination and homogeneity.

Dimensionality evaluation

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To verify the assumption of *unidimensionality* , 33 of the IQ Test items that remained after the pilot application were subjected to an analysis.

exploratory factor analysis (EFA) to examine whether they were related to a single factor. The quality of the fit was carried out using and interpreting the CFI, TLI and RMSEA statistics (Albright & Park, 2009). The factor solutions for one and two factors are presented in Table 2 .

TABLA 2.
Calidad del ajuste a los datos obtenidos por los modelos de uno y dos factores para el IQ Test

Modelo	$\chi 2$(gl)	CFI	TLI	RMSEA	SRMR
1 Factor	2091.43*** (495)	0.94	0.94	0.03	0.06
2 Factores	1037.40*** (463)	0.98	0.98	0.02	0.04

*** $p < 0.001$

Fuente: elaboración propia

As seen in Table 2 , the two factorial models analyzed showed an adequate fit to the data, since they presented a CFI and TLI of the order of 0.95, as well as an RMSEA coefficient less than 0.05, all of them considered appropriate values for a factorial model (Albright & Park, 2009). By complementing the analysis of the previous results with the examination of the configuration matrices of the two factor solutions, it was concluded that the one-factor model turned out to be the most appropriate for interpretation purposes based on the matrix of configuration coefficients for this factor. factorial solution, as shown in Table 3 .

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TABLA 3.
Matriz de configuración para la solución de un factor del IQ Test

Ítem	Carga	Ítem	Carga	Ítem	Carga	Ítem	Carga
1	0.77	10	0.38	19	0.52	28	0.52
2	0.71	11	0.24	20	0.22	29	0.27
3	0.81	12	0.56	21	0.31	30	0.36
4	0.78	13	0.60	22	0.46	31	0.20
5	1.00	14	0.29	23	0.54	32	0.37
6	0.86	15	0.69	24	0.54	33	0.33
7	0.72	16	0.54	25	0.37		
8	0.74	17	0.63	26	0.31		
9	0.66	18	0.60	27	0.22		

Fuente: elaboración propia

Based on this result we can conclude that the IQ Test has an adequate structure to be subjected to a Rasch analysis.

Local dependency

Once the Rasch model was adjusted, we proceeded to evaluate whether the responses to the different items showed any association not explained by the model. For this, a principal component analysis of the waste was carried out. Regarding the residual variance explained by the extracted components, it was observed that the maximum variance reached a value of 1.7 units, which is lower than the criterion of 2 units indicated as an indicator of the presence of a residual component (Albright & Park, 2009).

Adjustment of the items to the Rasch model

When analyzing the values obtained by the items of the instrument in the *Outfit statistic,* it was observed that 28 of the 33 items from the pilot stage (85%) presented a value equal to or less than 1.5, which allows us to conclude that these items contribute to defining a single latent trait. The items that exhibited values higher than this value were: 20, 31, 27, 21 and 30. Given the inadequate fit evidenced by these items, they were eliminated, after which the Rasch

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analysis was repeated with the items. 28 items selected. The results of this purification were subjected to a new analysis, the results of which are presented in Table 4 .

TABLA 4
Análisis de Rasch para los ítems de la versión final del IQ Test, ordenados según su medida

Ítem	Medida	EE	Infit	Outfit	Ítem	Medida	EE	Infit	Outfit
26	2.03	0.04	1.09	1.27	23	0.55	0.04	0.96	0.99
33	2.03	0.04	1.05	1.33	16	0.05	0.04	1.00	1.07
29	1.84	0.04	1.14	1.43	15	-0.02	0.04	0.87	0.79
22	1.77	0.04	0.98	1.21	13	-0.09	0.04	0.95	0.94
14	1.75	0.04	1.12	1.41	17	-0.36	0.04	0.93	0.89
10	1.57	0.04	1.06	1.24	9	-0.94	0.05	0.94	0.98
25	1.36	0.04	1.07	1.33	7	-1.23	0.06	0.91	0.94
32	1.19	0.04	1.07	1.22	4	-1.85	0.07	0.88	0.78
19	1.10	0.04	0.96	1.09	6	-2.07	0.07	0.80	0.58
12	1.00	0.04	0.94	0.95	8	-2.10	0.07	0.88	1.11
18	0.97	0.04	0.89	1.04	2	-2.21	0.08	0.97	1.10
28	0.85	0.04	0.96	1.04	3	-2.24	0.08	0.85	0.90
11	0.81	0.04	1.22	1.35	1	-3.20	0.11	0.90	0.80
24	0.66	0.04	0.96	1.01	5	-3.22	0.11	0.71	0.25

Fuente: elaboración propia

Figure 3It allows you to graphically observe the distribution of the participants' ability measures and the difficulty of the 28 items resulting from the IQ Test in the same linear continuum generated by the Rasch model. The results of the participants are presented to the left of the vertical line. At the top are the participants with the highest skill levels. At the bottom are the participants with the lowest level of skill. The results of the items are presented to the right of the vertical line. The items with the highest level of difficulty are located at the top. Items with a lower level of difficulty are located at the bottom. When comparing the average on the logits scale of the Rasch model obtained by the sample of participants (M = 1.05, SE = 0.53) and by the test items (M = 0.00,

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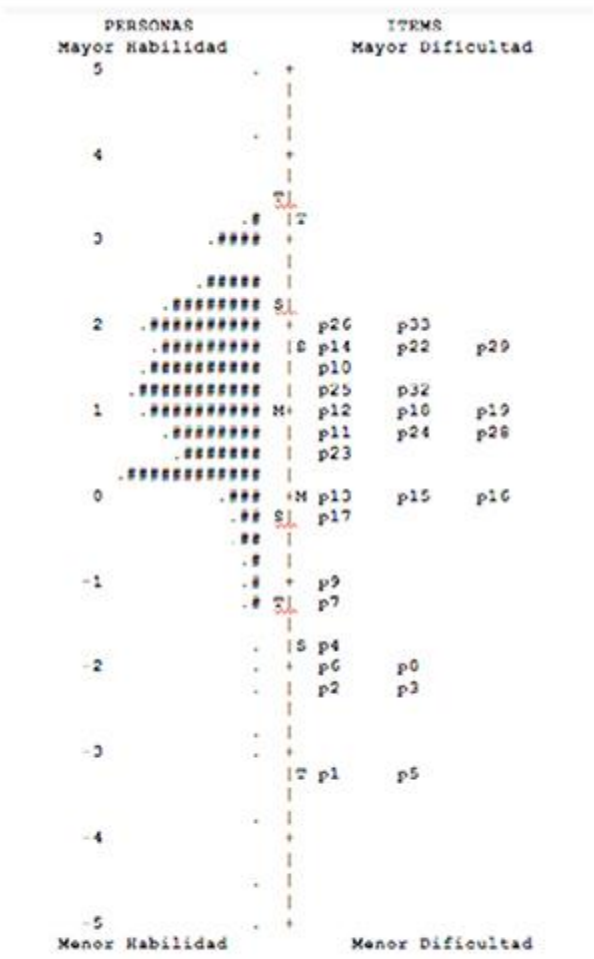

Figura 3. Distribución de las medidas de habilidad de los participantes y la dificultad de los 28 ítems del IQ Test en el mismo continuo lineal generado por el modelo de Rasch

Fuente: elaboración propia

Criterion validity

Criterion validity was analyzed by studying the Pearson product-moment correlations between the test scores and the criterion variables: general grade average and mathematics grade average, also with respect to the score achieved by the same students in the TILS that was previously applied to the same school population and that is validated and standardized in Chile (Cerda *et al.*, 2011). As seen in Table 5 , the correlations allow us to support the criterion validity (academic performance) and also the concurrent validity (logical

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intelligence) of the IQ Test. The previous analysis of the scatter graphs allowed us to verify the non-existence of non-linear relationships between the variables, as well as the absence of influential outliers.

As seen in Table 5 , the IQ Test shows significant correlations in the expected direction with each of the criterion variables. It is observed that the test exhibits direct and significant relationships with the students' general grade average r(2770) = 0.388, $p < 0.001$ and with the mathematics grade average r(2924) = 0.425, $p < 0.001$. When analyzing the correlations between the IQ Test and the TILS scale, the observed correlation corresponds to r (2934) = 0.616, $p< 0.001$, which is highly significant. Regarding the size of the effect associated with the identified relationships, it is observed that the most intense relationship occurs when correlating the IQ Test and TILS scores (r > |0.50|), while the remaining correlations analyzed exhibit relationships of moderate intensity (r ~ |0.30|).

Tabla 5.
Matriz de correlaciones producto-momento de Pearson para el IQ Test, TILS y promedios de notas

Variables	1	2	3	4
1: IQ Test	—	0.616***	0.388***	0.425***
2: TILS		—	0.379***	0.439***
3: Promedio general			—	0.728***
4: Promedio matemáticas				—

*** p < 0.001

Fuente: elaboración propia

All of the above allows us to conclude that the IQ Test has adequate criterion validity attributes to be used when analyzing the levels of inductive intelligence of students in the Chilean school population, this is presented in the following sections.

Analysis of students' inductive intelligence levels

When analyzing the scores obtained in the IQ Test according to age, the existence of significant differences in the mean scores depending on the age of

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the students who take it is confirmed F(5.2990)= 21.057, p< 0.001 . A consistent increase is observed as students mature cognitively or get older. With respect to the scores achieved by men and women, it is observed that there are no significant differences (t(3132)= -2.231, ns) even though the average score achieved by women is slightly higher (M= 19.01, SD= 5.267) and (M= 18.58, SD= 5.306) respectively.

Similarly, the results showed significant differences when comparing the scores achieved by the students depending on the social extraction group F(2.3131)= 103.784, p<.001. Students who attend schools of high social extraction (M= 22.20, SD= 4.033) show a higher performance than that obtained by students of medium social extraction (M= 19.74, SD= 5.025) and these in turn show a higher performance. higher than that of students who attend establishments of low social extraction (M= 17.55, SD= 5.337).

When comparing the level of logical intelligence of the students from the normal group of the research sample with those students belonging to the so-called group of talented students, the existence of significant differences in favor of the group of talented students is verified: (M= 22.32, SD = 4.041) and (M= 18.81, SD= 5.285), which gives t(3557)= -12.738, p< 0.001.

Unlike what happens with the total sample of students, in the group of talented students the analysis by social extraction groups shows that there are no significant differences between the average scores achieved by each of the groups in comparison F(2.391) = 3.566, ns. Students from high social groups present an average score (M= 22.85, SD= 3.764) slightly higher than that of students from the middle social extraction group (M= 22.25, SD= 4.096) and those who belong to the social class low (M= 21.12, SD= 4.357), but these differences do not turn out to be significant.

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With respect to the scores achieved by men and women, it is observed that men achieve a slightly higher average score than women (M=22.58, SD= 4.036) and (M =21.98, SD=4.034) respectively, although these differences They also do not turn out to be statistically significant (t(392)= 1.457, ns).

Discussion

The IQ Test presents a distribution that fits the normal curve with slight negative asymmetry. From a psychometric point of view, the IQTest in its adjusted version is a valid and reliable instrument. By adding this to its characteristic of free access through the Internet, it is then constituted as a valuable tool to examine the inductive logical intelligence of the population of Chilean secondary education students. Furthermore, the comparative results allow establishing categories that allow their use and capacity for diagnosis or analysis of differentiated impact, given that they allow establishing a comparison based on the social extraction group and gender, avoiding over or underestimations of said performances. The analysis of the IQ Test items using the Rasch model, explained in Figure 2, allows us to point out that the final items of the refined version are adjusted appropriately. Additionally, given that the item and person parameters are expressed on the same scale (scale*logit),* the distribution of item difficulty measures allows the test to be divided into two equivalent parts, which favors its use in before-after experimental designs.

Another notable aspect is its distribution in the difficulty of the items, since it ranges between -3 and 2 *logit* in proportions such that it can be used massively in the target population, in this case, secondary education students. By having items of below average difficulty, normal students can solve the problems without problems. On the other hand, a high concentration of items with

difficulty between 1 and 2 logit is also observed , which allows us to adequately discriminate students with outstanding inductive logical intelligence.

The existence of significant differences between the average scores achieved by the groups of students depending on their age and level of education was verified. A consistent increase is observed as students mature or move up their educational pathway. This result is consistent with other related research that proves that the older the age, the greater the logical-mathematical or mathematical intelligence, and that these present positive, statistically significant relationships of moderate magnitude with the subscales evaluated in the psychometric test referring to numerical reasoning. logical and general cognitive level (Ferrándiz *et al.*, 2008; Kaufman *et al.*, 2009; Roselli *et al.*, 2009).

On the other hand, there is a significant correlation of a directly proportional nature between the performance observed in the test and other areas of general academic performance and mathematics. That is to say, students who present good general academic performance and in mathematics tend to obtain better scores on the general intelligence and logical reasoning tests. This coincides with the prominent role that *fluid intelligence plays.*when explaining the variability of school performance, within many other variables, such as nutritional, socio-economic, family and demographic aspects in the Chilean school context (Ivanovic et al., 2004). The average logical intelligence score of men is slightly higher than that of women, however these differences are not statistically significant. These results agree with those reported by other research (Else-Quest et al., 2010; Ferrándiz et al., 2008; Kaufman et al., 2009; Klein et al, 2010).

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It was also confirmed that students called 'talented' have levels of logical intelligence that are significantly higher than those of students considered 'normal'. 'Talented students' are students who voluntarily attend mathematical enrichment courses outside their regular school day or participate in mathematical competitions, in which they solve problems of a higher level of complexity than those they normally do in their classes. The differences found support studies that maintain that these students have high-level cognitive skills, such as the ability to plan, review, control, select and evaluate their own intellectual activities, all of them of a metacognitive nature (Onrubia et al., *2003* ; Sternberg,

Furthermore, the results found in this research are congruent with another previous study related to talented students in Chile, which established that beyond the academic and socio-affective characteristics—which are quite similar to those of other students—, talented students present a better specific mastery of mathematical, abstraction and logic, and geometric skills, compared to the other group (Flanagan & Arancibia, 2005). These findings differ from those reported by a study with Colombian youth in which no significant differences were reported between the groups of talented students and those with a normal average. That is to say that according to the study, there would be no differences in the levels of organization,

The study provides background to revalue the role of the so-called higher cognitive variables with respect to content when it comes to explaining or improving performance in the area of mathematics or general academic performance. Indeed, those students who have levels of logical intelligence tend to show positive performance in this curricular area, regardless of their age, sex and social background. However, we must point out among the limitations of

this study, the lack of a more detailed analysis of the mathematical curricular contents or the different ways in which these affect the practice of teaching that is given, both to schoolchildren of ordinary academic results like those we have considered talented. This is currently being subject to further investigation.

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