Student Profiles and Academic Achievement in Mexican Middle Schools

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Abstract

The aim of the study was to describe student profiles associated with educational achievement from four sets of personal variables: psychological, academic, health, and technology use. A representative sample of middle school students from Baja California, Mexico, was given an ad hoc questionnaire and academic results were obtained from a standardized academic achievement test. Cluster analysis k-means allowed us to define two student profiles. Equal numbers of students were found in both groups, with Cluster 1 grouping high-achieving students and Cluster 2 those with a lower level of educational achievement. All of the personal variables help to describe and differentiate between the two groups, except for the number of times they have changed schools.

Keywords: academic achievement, middle school, adolescents

1. Introduction

An interest in understanding the variables that explain students' attainment has furthered the development of various methodological proposals and analysis techniques, and in particular those that focus on obtaining and characterizing student profiles and the variables associated with their levels of achievement (Bravo, Salvo & Muñoz, 2015; Chaparro, González & Caso, 2016; Corpus & Wormington, 2014; Da Silva, Nunes, Santos, Queiroz, & Leles, 2010; De Groot, van Dijk, & Kirschner, 2015; Dull, Schleifer, & McMillan, 2015; Hayenga & Corpus, 2010; Linnakylä & Malin, 2008; Ning & Downing, 2015; Pellicer, García, Morales, Serra, Solana, González, & Toca, 2015; Rodríguez-Ayán, 2010; Sparks, Patton, & Ganschow, 2012; Valle et al., 2008; Valle et al., 2009).

Although such analytical procedures contribute to configuring various types of student profiles, entailing an understanding of the variables related to educational achievement, this type of technique has not been used frequently and the variables involved tend to be linked to, and restricted to, specific fields, which suggests the use of more comprehensive analysis schemes (De Groot et al., 2015). Existing studies that focus on student profile characterization tend to include personal variables, either of a psychological or affective-motivational nature.

1.1 Variables Analyzed in Studies on Student Profiles

Motivation. This variable has received most attention in studies on student profiles (Hayenga & Corpus, 2010). Valle et al. (2009) found that students who were motivated to learn and achieve better results than others, and who had high levels of perception of their own academic skills, displayed better academic performance. Corpus and Wormington (2014) observed that students included in the intrinsic motivation cluster displayed higher academic performance.

In another study, Dull et al. (2015) showed that students with low motivation displayed lower academic performance, whereas students with better performance came from the cluster that combined motivation toward mastery and performance. Furthermore, in that cluster, students displayed higher personal expectations of academic achievement and higher self-efficacy, but also higher anxiety.

Goal-orientedness and learning strategies. Setting goals is associated with performing academic tasks and

activities, which are in turn linked to the selection and use of learning strategies (Bipp, Kleingeld, Van Den, & Schinkel, 2015; Bjørnebekk, Diseth, & Ulriksen, 2013; Dull et al., 2015; King & Mcnerney, 2016; Rogers, 2013). In a study conducted by Gargallo and Suárez (2014) with high-performing students, it was found that these students are characterized by better learning strategies (cognitive, metacognitive and support strategies) and motivation toward mastery. In another study, Valle et al. (2008) concluded that students who self-regulate their learning had better educational results. Linnakylä and Malin (2008) showed that students with better academic performance display a higher degree of school engagement, commitment, and organization in schoolwork, and respond to various academic demands in a timelier manner. A study by Bravo et al. (2015) revealed that students' educational expectations were one factor that explained performance in mathematics.

Self-esteem and self-concept. The way in which a student perceives and describes him or herself has proven to be a variable associated with educational achievement (Hassan, Jami, & Aqeel, 2016; Moradi-Sheykhjan, Jabari, & Rajeswari, 2014). Imhof and Spaeth-Hilbert (2013) observed that students with positive academic self-concept and high levels of invested effort showed higher learning and lower dropout rates.

Physical exercise. Physical exercise is a factor associated with academic achievement that has recently been included in studies on student profiles. Pellicer et al. (2015) found that students from the cluster with the highest level of physical exercise displayed higher academic performance.

Internet Use. Torres, Duart, Gómez, Marín, and Segarra (2016) found that students who downloaded software and audio and video content, and who made use of all entertainment possibilities, were less likely to fail courses than students who only used the Internet minimally.

1.2 Other Variables in Psychological and Educational Literature

Although the findings from these studies that focus on student profile characterization have served to expand the bodies of knowledge on factors associated with educational success, the exclusion of variables explored in the most recent findings in psychological and educational literature limits the explanatory power of the models proposed and our understanding of them as an object of study in a broader context.

Academic performance variables. Various studies have produced results that point to previous academic performance as a predictor of academic success (Gómez, Oviedo, & Martínez, 2011; Ocaña, 2011; Regueiro, Suárez, Valle, Núñez, & Rosário, 2015). Another variable commonly associated with academic achievement is attendance. Ning and Downing (2015) showed that motivation to attend class was strongly linked to school achievement, while attendance and punctuality were associated with better grades in school. Study expectations are also positively associated with educational achievement (Figueroa, Padilla, & Guzmán, 2015; García-Castro & Bartolucci, 2007; Shaw, 2013).

Authors like Griffin, MacKewn, Moser, and VanVuren (2012) have discussed the importance of concentration and attention in improving learning while studying. Furthermore, authors such as Bove, Marella, and Vitale (2016) have shown that students who perceive a better school environment tend to show better academic results. Additionally, there is a relationship between preschool attendance and academic achievement. Children who attend preschool perform better in academic tasks (Aslan & Arnas, 2014).

Finally, there is some evidence that the age of entry into elementary education is a determining factor in educational achievement (Sakic, Brusic, & Barbatovic, 2013). In addition, Anderson (2017) stated that changes of schools are a variable associated with educational achievement in middle school students.

Health variables. A relationship exists between health-oriented behavior and academic achievement. Kristjánsson, Sigfúsdóttir, and Allegrante (2010) showed that personal healthcare variables such as a healthy diet and physical activity are associated with higher educational achievement in university students. Substance use is one of the factors most strongly associated with low performance and school dropout rates. Hill and Mrug (2015) found that consumption of tobacco, alcohol, and marijuana, and a combination of these, was associated with low academic performance. Sung, So, and Jeong (2016) showed that junior high school students who often consumed alcohol had, on average, lower school grades. Specialized literature has documented the repercussions of sexual activity on adolescent development. Price and Hyde (2009) demonstrated that early sexual activity in adolescents was associated with other risk behaviors such as substance use, low academic performance, and dropping out of school.

Computer skills. A study by Ziya, Dogan, and Kelecioglu (2010) showed the order of importance of predictive variables for PISA achievement scores in mathematics: (a) self-reliance in performing Internet-related operations; (b) using computers for program and software purposes; (c) self-reliance in performing operations requiring a high level of computer skills (using the word processor, using an electronic tabulating program to

draw graphs, prepare presentations, prepare multimedia presentations and design web pages); and (d) using computers for Internet and entertainment purposes. However, variables (b), (c), and (d) had a negative effect on scores in mathematics.

In sum, broader sets of variables, which provide a more detailed explanation of student profiles, have yet to be incorporated. Therefore, the aim of this study was to characterize middle school student profiles associated with educational achievement by including four sets of variables, namely psychological variables (analyzed in studies on student profiles) and three other sets of variables: academic, health-related, and those concerning technology use. All of these have been reported as explanatory variables in the literature.

2. Method

2.1 Participants

The information analyzed in this study was taken from the database of a research project (Contreras, Rodríguez, Caso, Díaz, & Urias, 2012). The sample was made up of 21,724 students (50% male and 50% female) aged between 11 and 16, from 88 schools in the state of Baja California, Mexico, and made up as follows: general (57.8%), technical (26.3%), private (9.7%), and distance-learning junior high program (6.2%).

2.2 Instruments

Student questionnaire. The questionnaire comprised 26 variables divided into four aspects: psychological, academic, health, and technology use variables (see Table 1). The levels used to measure each variable are given in the Appendix (Table A1). The instrument includes acceptable reliability and validity values [the name of the study in which the validity was analyzed was omitted to respect the double-blind review].

Table 1. Variables considered in this study

Psychological variables	Academic variables
• Cognitive strategies • Academic motivation • Goal-orientedness • Academic self-concept • Academic expectations • Causal attribution of low grades • Difficulties concentrating while studying	• Kindergarten or preschool attendance • Age of entry into elementary school • Number of times he/she has changed school • Lack of punctuality in attending class • Perception of school environment • Exam preparation activities • Enjoyment of reading • Learning strategies
Health variables	Technology use variables
• Sexual activity • Age of first use of tobacco • Age of first use of alcohol • View of the use of harmful substances • Personal healthcare • Healthy diet • Physical exercise • Attitude towards environment protection	• Perception of computer skills • Use of the Internet to read e-mails • Use of the Internet to chat • Use of the Internet to read the news • Use of the Internet to consult a dictionary or encyclopedia • Use of the Internet to look for information on a specific topic • Use of the Internet to take part in debates or forums • Use of the Internet to take part in social networks

National Assessment of Academic Achievement in Schools (ENLACE, in Spanish). ENLACE scores in Spanish and mathematics was used. ENLACE is an assessment carried out by the Secretariat of Public Education for informational purposes and taken by students from public and private schools. (http://www.enlace.sep.gob.mx/).

2.3 Data Analysis

In order to sort the high number of subjects in the sample into two groups, a k-means cluster analysis was performed based on the set of variables mentioned. Prior to that, it was necessary to recode and standardize the values that are assignable to these variables to homogenize the measurement scales so that they all had a mean of 0 and a typical deviation of 1.

3. Results

After 20 iteration steps, the final solution was reached with 12,202 students. However, the distances between the centroids were minimal from the first five iterations (see Table A2 in the Appendix). In cluster 1 there were 6,360 students, and 5,842 students were grouped in cluster 2. The final mean values for each variable in both

clusters are shown in Table 2, and reflect the characteristics of the prototypical case for each cluster.

Table 2. Central values for the final solution

Variables	Cluster	
	1	2
Sex	-.15	.06
Enjoyment of reading	.31	-.25
Use of the Internet to read e-mails	.20	-.25
Use of the Internet to chat	.26	-.27
Use of the Internet to read the news	.26	-.29
Use of the Internet to consult a dictionary or encyclopedia	.46	-.43
Use of the Internet to look for information on a specific topic	.42	-.40
Use of the Internet to take part in debates or forums	.08	-.18
Use of the Internet to take part in social networks	.31	-.30
Goal-orientedness	.49	-.42
Academic self-concept	.52	-.37
Causal attribution of low grades	-.18	.18
Academic expectations	.38	-.30
Perception of computer skills	.42	-.40
Sexual activity	-.20	.09
Age of first use of tobacco	-.21	.15
Age of first use of alcohol	-.08	.11
View of the use of harmful substances	.31	-.19
Attitude towards environment protection	.47	-.38
Personal healthcare	.24	-.27
Healthy diet	.36	-.32
Physical exercise	.15	-.15
Kindergarten or preschool attendance	.21	-.14
Age of entry into elementary school	.05	-.04
Number of times he/she has changed school	-.01	.01
Exam preparation activities	.27	-.28
Perception of school environment	.33	-.26
Academic motivation	.41	-.30
Cognitive strategies	.51	-.51
Difficulties concentrating while studying	.11	-.02
Learning strategies	.52	-.47
Lack of punctuality in attending class	-.20	.15
Performance in Spanish	.48	-.29
Performance in mathematics	.43	-.25

Table 3 shows which variables contributed to the cluster solution. Variables with high *F* values provide greater separation between clusters. The variables are arranged in descending order by their *F* value, and all are significant except for the number of times the student changed school. Thus, cognitive strategies for study were the highest contributor to the final solution, and the age of entry into elementary education had the least impact.

Table 3. ANOVA values for each variable grouped across both clusters

Variables	Root mean square of the cluster[a]	Root mean square error[b]	*F*
Cognitive strategies	3,172.28	.74	4,272.94
Learning strategies	3,020.22	.75	4,026.88
Goal-orientedness	2,534.66	.76	3,321.72
Academic self-concept	2,438.78	.77	3,171.53
Use of the Internet to consult a dictionary or encyclopedia	2,406.94	.78	3,090.57
Attitude towards environment protection	2,236.43	.77	2,906.51
Perception of computer skills	2,074.08	.80	2,565.42

Use of the Internet to look for information	2,018.99	.79	2,563.06
Performance in Spanish	1,802.42	.88	2,052.29
Academic motivation	1,543.20	.77	1,985.17
Healthy diet	1,436.45	.82	1,744.98
Academic expectations	1,428.20	.84	1,699.87
Performance in mathematics	1,423.38	.96	1,474.41
Use of the Internet to take part in social networks	1,136.99	.89	1,276.98
Perception of school environment	1,051.44	.88	1,190.53
Enjoyment of reading	953.97	.87	1,088.73
Use of the Internet to read the news	947.78	.88	1,072.14
Exam preparation activities	905.05	.89	1,013.85
View of the use of harmful substances	765.34	.79	962.51
Use of the Internet to chat	848.71	.91	924.61
Personal healthcare	804.77	.94	850.17
Use of the Internet to read e-mails	618.15	.91	672.51
Kindergarten or preschool attendance	375.13	.88	422.34
Age of first use of tobacco	381.86	.93	408.31
Causal attribution of low grades	388.03	.97	397.90
Lack of punctuality in attending class	363.41	.92	391.58
Sexual activity	259.98	.85	305.31
Physical activity	274.86	.94	290.03
Use of the Internet to take part in debates or forums	201.50	.88	228.96
Sex	138 28	.98	140.32
Age of first use of alcohol	114.47	1.00	113.40
Problems concentrating while studying	59.45	1.01	58.53
Age of entry into elementary education	20.86	.96	21.72
Number of times he/she has changed school	0.68	1.00	0.68

Note. ᵃ = 1 degree of freedom. b = 12,200 degrees of freedom. All variables had a significance level $p < .001$, with the exception of the number of times he/she has changed school.

Figure 1 shows the mean values of all personal variables considered in both clusters. It is possible to observe, on the one hand, that cluster 1 grouped together students with a higher level of educational achievement and more favorable psychological and health characteristics and academic background, whereas cluster 2 was made up of low-achieving students with less favorable personal characteristics.
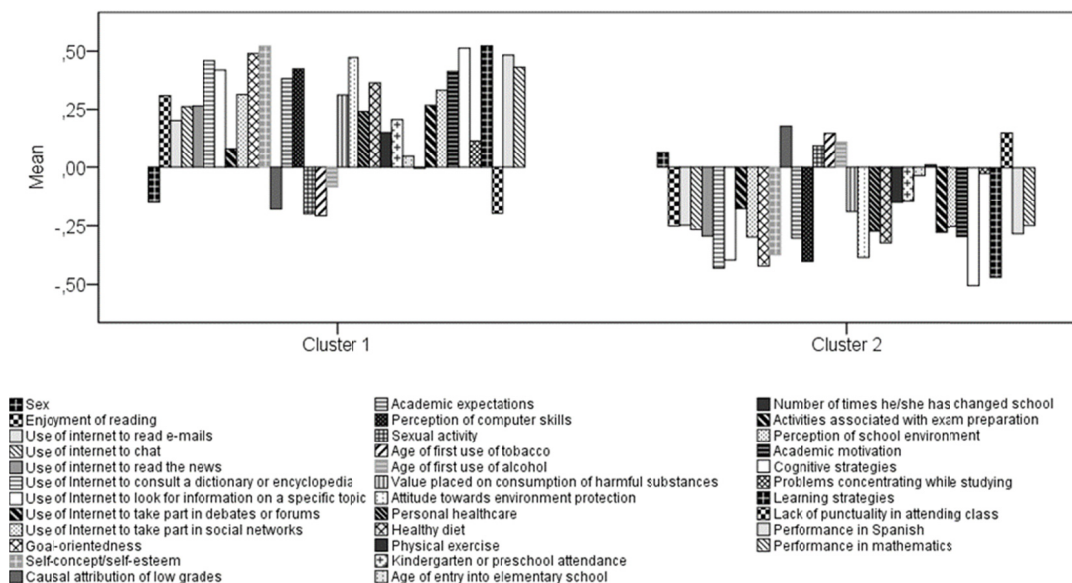

Figure 1. Mean values of the psychological variables in both clusters

To make it easier to view and describe the information shown in Figure 1, the variables were disaggregated and divided into five groups: academic performance, psychological variables, academic variables, health variables, and variables associated with technology use.

Figure 2 shows the distribution of student achievement in Spanish and mathematics, as per the categories proposed by the ENLACE. In both cases, we observe that the highest percentage of students with good and excellent performance is found in cluster 1, whereas in cluster 2, the highest percentages are found in the insufficient and basic categories.

Figure 2. Percentage of students at each level of academic achievement in Spanish and mathematics, in each cluster

As for the psychological variables shown in Figure 3, cluster 1 brings together students with better cognitive strategies, higher academic motivation, higher goal-orientedness, and a higher academic self-concept, with higher study expectations and causal attribution of their low grades to internal factors. However, this cluster also included students that reported greater problems concentrating while studying. Cluster 2, on the other hand, comprised students with a poor repertoire of cognitive strategies, low levels of academic motivation and goal-orientedness, and lower academic expectations, who attributed their low grades to external factors and experienced fewer difficulties concentrating while studying.
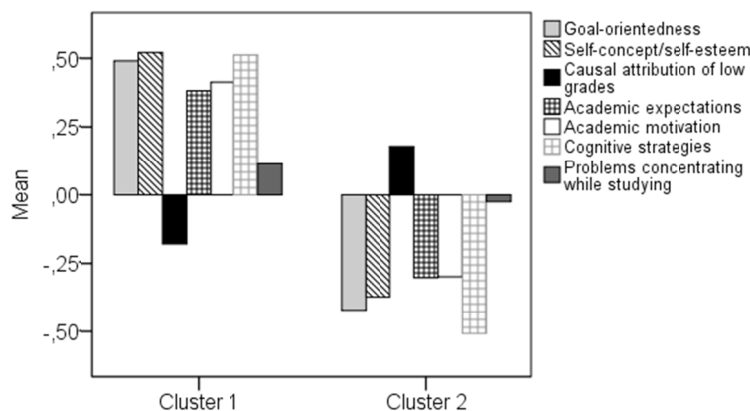

Figure 3. Mean values of the psychological variables in both clusters

Figure 4 presents the academic variables. Cluster 1 brings together students that enjoy reading more, attended kindergarten or preschool, began elementary school at the standard age, and have few records of changes of school and a broader range of exam preparation activities and learning strategies. Furthermore, this group includes students with the highest levels of punctuality and attendance, and a positive perception of the school environment.

Cluster 2, on the other hand, included students with lower enjoyment of reading, who did not attend kindergarten or preschool, began elementary school outside the normal age range, and have more records of changes of

schools, a poor set of learning strategies, low levels of attendance and punctuality, and a negative perception of the school environment.
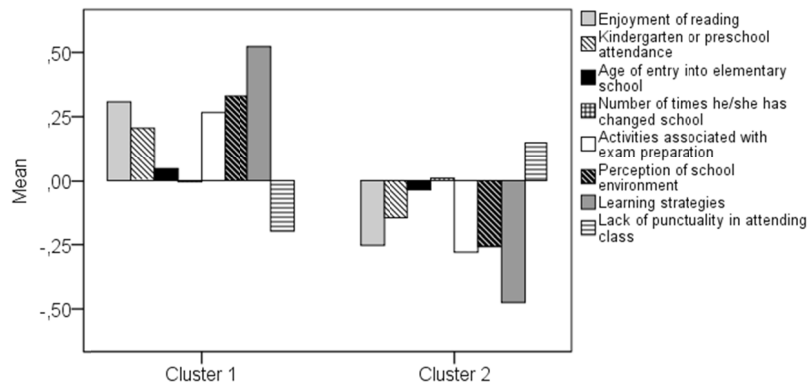

Figure 4. Mean values of the academic variables in both clusters

Health variables are presented in Figure 5. Cluster 1 brought together students who had not become sexually active or begun to consume tobacco and alcohol, and had a more negative view of the use of harmful substances, a better attitude towards environment protection, a broader range of personal healthcare activities, a healthier diet, and more physical exercise. Cluster 2, by contrast, included students who had already become sexually active and begun to consume alcohol and tobacco, and had a less negative view of the use of harmful substances, a negative attitude towards environment protection, poor personal healthcare, an unhealthy diet, and low levels of physical exercise.
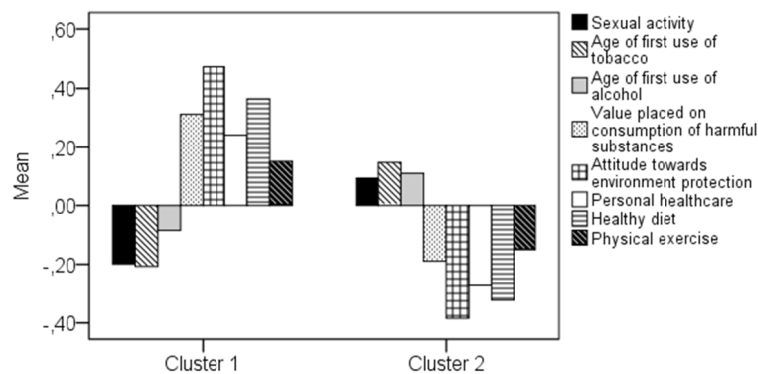

Figure 5. Mean values of the health variables in both clusters

Finally, Figure 6 shows the results of variables associated with technology use. We observe that cluster 1 included students who use the Internet more often for various academic and personal activities: reading e-mails, chatting, reading the news, consulting a dictionary or encyclopedia, looking for information on a specific topic, taking part in debates or forums, and using social networks. Similarly, students in this cluster see themselves as skilled in computer use. The reverse is true with students in cluster 2, who use the Internet much less frequently for academic and personal activities, and have a low level of perceived computer skills.
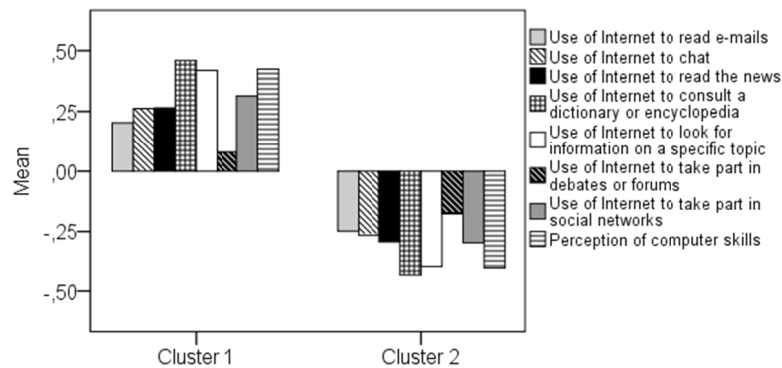
Figure 6. Mean values of the variables associated with technology in both clusters

4. Discussion

Two perfectly-defined student profiles associated with academic achievement were identified through the results obtained: Cluster 1 brought together students who exhibited higher educational achievement, and Cluster 2, students with lower educational achievement. It should be stressed that this study included a greater and more diverse set of variables than other studies (Chaparro et al., 2016; Corpus & Wormington, 2014; De Groot et al., 2015; Dull et al., 2015; Ning & Downing, 2015; Pellicer et al., 2015; Rodríguez-Ayán, 2010; Rogers, 2013; Sparks et al., 2012; Valle et al., 2008; Valle et al., 2009), and all these variables contributed to describing the different student profiles.

Based on these early findings, it is feasible to conclude that student profiles associated with educational achievement are described firstly by psychological and academic variables, and secondly by variables relating to health and technology use.

In the set of *psychological variables*, it was possible to determine that students with better levels of educational achievement are more oriented towards task fulfillment (Dull et al., 2015; Valle et al., 2009), their academic self-concept is positive, and they have an internal locus of control (Corpus & Wormington, 2014, Dull et al., 2015; Hayenga & Corpus, 2010), which is why they attribute their infrequent low grades to external causes. This means that when good students receive poor grades, they attribute this to variables not related to themselves. One important point is that they state that they wish to study past basic-level education (in Mexico, basic-level education [educación básica] includes preschool, elementary school, and middle school up to ages 14-15), meaning that their study expectations are high (Bravo et al., 2015; García-Castro & Bartolucci, 2007). Furthermore, they enjoy better cognitive and learning strategies (Gargallo & Suárez, 2014; Valle et al., 2008) and are goal-oriented, which is usually associated with high self-esteem (Imhof & Spaeth-Hilbert, 2013; Linnakylä & Malin, 2008; Valle et al., 2008) and higher academic motivation (Corpus & Woemington, 2014; Dull et al., 2015; Linnakylä & Malin, 2008; Valle et al., 2009).

However, it was remarkable that these students experienced greater difficulties concentrating while studying (Griffin et al., 2012). It is very likely that this is due to the fact that they tend to be harder on themselves and are more oriented towards task fulfillment, which makes them more aware of the importance of concentration and the problems caused by a failure to maintain it.

In the set of *academic variables*, the students with better educational achievement attended kindergarten (Aslan & Arnas, 2014) and began elementary school at the standard age (Sakic et al., 2013). However, the variable relating to the number of times the student has changed school was not significant, as shown by Anderson (2017). Additionally, students with higher levels of achievement show greater levels of behavior oriented toward exam preparation (Gargallo & Suárez, 2014; Valle et al., 2008) and have a positive perception of the school environment (Bove et al., 2016), which results in attendance and punctuality in class (Ning & Downing, 2015).

As far as variables associated with technology use are concerned, the results indicated that students with higher levels of academic achievement use the Internet for functional purposes and see themselves as skilled computer users (Ziya et al., 2010).

Lastly, by associating the *health variables* with educational achievement, it was observed that students with better academic performance have not had sexual intercourse (Price & Hyde, 2008), consumed tobacco and

alcohol at an older age (Hill & Mrug, 2015; Sung et al., 2016), and considered these substances harmful to health. In addition, their attitude toward personal healthcare and the environment is positive, which leads to a healthy diet and more regular exercise (Pellicer et al., 2015). It has been confirmed that many factors contribute to educational achievement, and there is a diverse set of characteristics that may influence students' academic results. As a result, explanatory models of achievement must acknowledge the multi-factorial nature of this construct. It follows from all the above that using k-means clusters was a useful data mining technique in describing student profiles (DeFreitas & Bernard, 2015; De Groot et al., 2015).

Finally, it is worth noting that one limitation of this study is the fact that the variables used were not planned in advance but were taken from a preexisting database. This restricted the ability to obtain a better-configured student profile.

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Appendix

Table A1. Levels of the variables included in the analysis

Psychological variables	Academic variables	Health variables	Variables associated with computer and Internet use
• Cognitive strategies for study (score based on 1-4 Likert scales) • Motivation to attend school (score based on 1-4 Likert scales) • Goal-orientedness (score based on 1-4	• Kindergarten or preschool attendance (can't remember, no, yes for a year or less, yes for a year or more) • Age of entry into elementary school	• Sexual activity (yes, no) • Age at which tobacco was first used (I have never smoked, 10 years old or younger, 11 years old, 12 years old, 13 years old, 14	• Perception of computer skills (score based on 1-4 Likert scales) • Internet use to… (never, sometimes, very often, always): o read e-mails

- Likert scales)
- Academic self-concept (score based on 1-4 Likert scales)
- Academic expectations (junior high school, high school or technical course, bachelor's degree, master's degree or doctoral degree)
- Causal attribution of low grades (I never get low grades, financial problems, family problems, problems understanding teachers, health problems, laziness)
- Problems concentrating while studying (score based on 1-4 Likert scales)

(can't remember, 5 years old or less, 6 years old, 7 years old, 8 years old or older)
- Number of times he/she has changed school (never, once, twice, 3 times or more)
- Lack of punctuality in attending class (never, once or twice, 3 or 4 times, 5 or more times)
- Perception of school environment (score based on 1-4 Likert scales)
- Exam preparation activities (score based on 1-4 Likert scales)
- Enjoyment of reading (I don't like it at all, I like it a little, I somewhat like it, I like it a lot)
- Learning strategies (score based on 1-4 Likert scales)

years old or more)
- Age at which alcohol was first consumed (I have never drunk alcohol, 10 years old or younger, 11 years old, 12 years old, 13 years old, 14 years old or more)
- View of the use of harmful substances (score based on 1-4 Likert scales)
- Personal healthcare (score based on 1-4 Likert scales)
- Healthy diet (score based on 1-4 Likert scales)
- Physical exercise (never, sometimes, very often, always)
- Attitude towards environment protection (score based on 1-4 Likert scales)

o chat
o read the news
o consult a dictionary or encyclopedia
o look for information on a specific topic
o take part in debates or forums
o use social networks

Table A2. Iteration history

Iteration	Change in cluster center	
	1	2
1	8.528	10.057
2	.348	.826
3	.259	.467
4	.186	.287
5	.132	.181
6	.096	.121
7	.072	.086
8	.049	.056
9	.031	.035
10	.021	.023
11	.011	.012
12	.007	.007
13	.004	.004

14	.004	.004
15	.002	.002
16	.002	.003
17	.001	.001
18	.003	.003
19	.003	.003
20	.002	.002
Cases in each cluster	6 360	5 842
Valid	12.202	
Lost	6.733	