



Research article

Assessment of multiple intelligences in elementary school students in Mexico: An exploratory study



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ABSTRACT

Multiple Intelligence (MI) helps to evaluate the brain processes of individuals. Identifying the types of multiple intelligence can help teachers to understand their students better. Several studies have identified MI in school children; nevertheless, in Mexico, these studies have been scarce. Therefore, the objective of this study was to analyze the differences of MI between genders and the grades-in-school of Mexican elementary schoolchildren. In an effort to investigate the differences of MI in elementary school children in Mexico, we provided a self-administered questionnaire to 161 Mexican students. Overall, our findings showed that the students' mean averages in the eight categories of MI were similar in both genders; in fact, the only significant differences in gender were found in intrapersonal intelligence (males reporting higher intrapersonal differences than females). No other significant differences in MI were found, nor were there interaction effects between gender and the grade in school. In summary, these results give us an understanding that the different types of MI may not be that well implemented in elementary school children.

1. Introduction

The Multiple Intelligence Theory (MI) is a theory that examines and assesses two types of brain processes, namely, mental capabilities and the processes of learning and knowledge acquisition (Gardner, 1983). Gardner (1983) identified several subtypes of intelligence that every normal individual should develop to some extent, although certain individuals will develop some far more than others. These are object-related intelligence, logical-mathematical, spatial, and bodily-kinesthetic intelligence. The object-free forms of intelligence are linguistic and musical. Finally, the two types of personal intelligence are interpersonal and intrapersonal. Later, Gardner (1999a, b) added additional types of possible intelligence, for example, naturalistic intelligence. Gardner (1983, 1999a, b) defines the eight classifications of intelligence as follows:

- Logical-Mathematical Intelligence: Consists of the capacity to analyze problems logically, perform mathematical operations, and investigate

issues scientifically. This intelligence is the most often associated with scientific and mathematical thinking.

- Linguistic Intelligence: This intelligence includes the ability to effectively use language to express oneself rhetorically or poetically and language as a means to remember information.
- Spatial Intelligence: It gives one the ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains.
- Musical Intelligence: Involves skill in the performance, composition, and appreciation of musical patterns. It encompasses the capacity to recognize and compose musical pitches, tones, and rhythms.
- Bodily-Kinesthetic Intelligence: Entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements.
- Interpersonal Intelligence: Is the ability to notice and make distinctions among other individuals and, in particular, their moods, temperaments, motivations, and intentions. It is also the ability to understand the intentions, motivations, and desires of other people. It allows people to work effectively with others.

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- Intrapersonal Intelligence: Is the ability to distinguish and identify various personal thoughts and feelings and to use them to understand one's own behavior.
- Naturalist Intelligence: Is the ability to identify similarities, discern differences, and make classifications of the living organisms in one's environment.

MI-based teaching recognizes that each student has all these types of intelligence but that they are not always developed well or effectively, and individuals differ in the strengths of these. Therefore, the purpose of the assessment of MI is to know the intellectual capabilities of the students in the context of practice activities in the classroom, with appealing material, without time constraints, and giving children the freedom to manipulate this material (Almeida et al., 2010). The emphasis is on learning rather than on outcomes, as the evaluation process gathers information about the individuals' capabilities to provide useful and relevant information for learning (Gardner, 1999b). Thus, Gardner considers the assessment of intelligence as a procedure which should be understood as a part of the teaching and learning process (Almeida et al., 2010). Each of the MI types can serve as gateways to personalize important cognitive and emotional processes that underlie learning such as attention, memory, motivation, creative cognition, problem-solving, and understanding (Armstrong, 2017). The benefit of embedding MI in learning is that it can easily span diverse cultures because each school represents a cultural system of educational beliefs, social ideas, and practices (Shearer, 2018).

Current theories of MI suggest that the intelligence types, to one degree or another, have to interact with one another (Moran et al., 2006) and cooperate (Torresan, 2007). In one study, Savas (2012) analyzed the relationship between intelligence, language, and learning. The results showed that each intelligence type has a role in learning a foreign language, and the extent that the role each intelligence plays varies. Some play large roles, whereas others play small ones. Another study examined whether personality correlates with incremental attitudes towards the growth of MI (Furnham, 2014). The results showed that people distinguish between the changeability of different types of intelligence. They believed that it is relatively difficult to increase musical intelligence; however, they did think that verbal, naturalistic, and intrapersonal intelligence was relatively easy to acquire. In a study by Özdilek (2010) of Turkish elementary school children, it was reported that mathematical-logical, visual-spatial, and interpersonal intelligence have a positive correlation with academic achievement. More recently, the work of Gürkan et al. (2019) found that using MI in the activities of preschool children from Tukey had a positive effect on children's interest and active participation in the daily activities because the activities used all eight intelligence types and addressed the various learning styles of the children. Also, the work of Hassan (2020) reported that using MI theory in the teaching of geometry encouraged elementary students in Egypt to practice many mental habits; they thought mutually, applied previous knowledge to current situations, and actively participated.

Generally, MI theory has been used as a way to explore and compare the different types of intelligence among students as a tool to help students with deficient school achievement and to contrast the benefits of MI theory and general intelligence (g) theory (Almeida et al., 2010; Chen et al., 2009). Nevertheless, there is robust evidence that each MI possesses neural architectural coherence that is clear, distinct, and aligned with accepted cognitive-neural correlates (Shearer, 2020). These neural patterns are consistent with Gardner's hypothesis that general intelligence is most closely associated with linguistic and logical-mathematical intelligence (Shearer and Karanian, 2017).

Few studies have studied and discussed the benefits of knowing and identifying the different types of MI in Mexico. Martínez and Lozano (2007) reported that when applying soft music in the classroom in the background, students who had more points in their musical intelligence saw a strong and positive impact on academic achievement. In another study, results reported that apart from motivation or attitude, the

different types of intelligence may determine the students' chances for successful academic achievement (Funderburk et al., 2013). Lastly, a study reported that students' highest intelligence was bodily-kinesthetic, interpersonal, intrapersonal, and musical (Tapia et al., 2013).

However, the samples in the aforementioned studies were comprised of adolescents. To our knowledge, there are no works assessing MI in elementary school children in Mexico. According to Tapia et al. (2013), it is important to assess the students first in order to provide useful information for the professor and then generate teaching strategies to address the needs of the students by applying specified treatment and then evaluating the progress of the students. Moreover, identifying the students' individual differences can help teachers to guide students and suggest strategies to succeed (Reyna and Ocampo, 2012). Therefore, our main objective was to analyze the differences of MI between gender and school grades of elementary Mexican school children. It was expected to find gender and school grade differences in students with MI.

2. Materials and methods

2.1. Sample

The sample contained a total of 161 elementary school children (grades 3, 4, 5, and 6) from 5 public schools located in Monterrey, Nuevo Leon, Mexico, of whom 71 were girls and 90 were boys. The mean age of the overall sample was 9.87 ± 1.37 years (mean $\pm$ SD), and the age range was 8–13 years old.

2.2. Measures

2.2.1. Minds scale of multiple intelligences

The scale was elaborated by Ruiz (2004) and consisted of 72 questions looking for responses on a seven-point Likert scale that ranges from totally disagree (1) to totally agree (7). It evaluated the eight multiple intelligences classified by Gardner: Logical-Mathematical Intelligence, Linguistic Intelligence, Bodily-Kinesthetic Intelligence, Musical Intelligence, Spatial Intelligence, Interpersonal Intelligence, Intrapersonal Intelligence, and Naturalistic Intelligence. The score is achieved with the sum of the items that correspond to each of the types of intelligence; higher scores mean there is a higher presence of the various types of intelligence. The scale has obtained good internal consistency with a Cronbach alpha of 0.88 compared to 0.94 in previous studies (Ruiz, 2004; Delgado, 2017; Rodríguez, 2016). In this study, Cronbach's alpha was 0.92.

2.2.2. Academic achievement

For this measure, the schools provided the students' grade point average (GPA) for the overall school year. The GPA of the schools ranges on a scale from 0 to 10. When the score is ≤ 6 , it means fail, and when it is ≥ 7 , it means a satisfactory score.

2.3. Procedure

This descriptive cross-sectional study was applied to 5 main elementary schools in Monterrey, Mexico. They were selected from those who best follow the standards promulgated by the Secretary of Public Education (SEP) in the state of Nuevo Leon. For this study, the total sample size of 250 students was selected. A total of 89 participants were excluded due to nonresponse or refusal to participate. The application had an estimated response time of 25 min; the questionnaires were applied during school classes. Data collection was voluntary, and students received no payment of any kind. Parents of each of the participants signed a letter of informed consent, and so did the school administrators. The research project was approved by the Research Ethics Committee of the School of Medicine and Health Sciences from

Table 1. Means and standard deviations (SD) of each variable from the study.

	Mean	SD
Logical-Mathematical intelligence	25.45	4.61
Linguistic intelligence	37.99	5.88
Bodily-Kinesthetic intelligence	37.99	5.88
Musical intelligence	27.30	6.38
Spatial intelligence	32.94	5.66
Interpersonal Intelligence	39.68	6.41
Intrapersonal intelligence	36.96	6.37
Naturalistic intelligence	34.42	6.63
Academic performance	8.61	.72

Tecnologico de Monterrey, and it complied with the principles of the Declaration of Helsinki regarding research on human participants.

2.4. Statistical analysis

To evaluate the differences for each dependent variable, we conducted a multiple-analysis-of-variance (MANOVA), considering gender and school grade as independent variables and the 8 types of intelligence as dependent variables. The indicators that showed significant differences in the MANOVA were subjected to a post hoc analysis using the Tukey honestly significant difference test. The partial eta-squared (η_p^2) was used as a measure of the effect size as follows: effect sizes between 0.01 and 0.05 were considered low, between 0.06 and 0.13 moderate, and above .014 high (Cohen, 1992). The Statistical Program for the Social Sciences (version 25) was used for all analyses.

3. Results

The mean average and the standard deviation of the students' MI scores and academic achievement are shown in Table 1, which reports the students' average levels of MI. Significant differences were found in gender in intrapersonal intelligence, meaning that boys reported a higher intrapersonal intelligence than girls (Males: 37.91 ± 6.42 ; Girls: 35.76 ± 6.16 , $F(1, 157) = 4.41$, $p = 0.03$; $\eta_p^2 = 0.027$). No further significant differences were found. When considering school grades, a significant difference was found with respect to academic performance. Students in the 3th and 4th grades obtained a lower GPA than students in 5th and 6th grades (Grades 3 and 4: 8.40 ± 0.89 ; Grades 5 and 6: 8.81 ± 0.61 , $F(1, 157) = 12.05$, $p = 0.001$; $\eta_p^2 = 0.71$). No additional significant differences were found; also, there was no interaction effect between gender and school grade with MI. (See Tables 2 and 3).

4. Discussion

The purpose of this study was to determine the differences in MI between gender and school year of elementary Mexican school children. Our results reported that boys presented higher levels of intrapersonal intelligence than girls, which is similar to a study by Beceren with Turkish children (2010), but contrary to what Llor et al. (2012) found, which was that Spanish boys distinguished themselves with a more logical-mathematical and interpersonal intelligence, and girls stood out in the interpersonal and intrapersonal intelligence. Moreover, Chen (2006) found that Chinese school children reported less intrapersonal intelligence than girls. Generally, intrapersonal intelligence is referred to as the capacity to understand oneself (Gardner, 1993). This result agrees with the idea that children from an early age start developing their sense

Table 2. Means, standard deviations (SD), and numbers of participants according to gender and school grades by Multiple Intelligence and academic performance.

		Gender						Total		
		Boys			Girls					
		Mean	SD	N	Mean	SD	N	Mean	SD	N
Logical-Mathematical intelligence	3th and 4th grade	25.51	4.40	45	25.36	4.99	33	25.45	4.63	78
	5th and 6th grade	25.73	4.47	45	25.16	4.84	38	25.47	4.62	83
	Total	25.62	4.41	90	25.25	4.87	71	25.46	4.61	161
Linguistic intelligence	3th and 4th grade	37.98	5.81	45	38.24	5.47	33	38.09	5.63	78
	5th and 6th grade	38.38	5.36	45	37.34	6.98	38	37.90	6.14	83
	Total	38.18	5.56	90	37.76	6.30	71	37.99	5.88	161
Bodily-Kinesthetic intelligence	3th and 4th grade	37.98	5.81	45	38.24	5.47	33	38.09	5.63	78
	5th and 6th grade	38.38	5.36	45	37.34	6.98	38	37.90	6.14	83
	Total	38.18	5.56	90	37.76	6.30	71	37.99	5.88	161
Musical intelligence	3th and 4th grade	28.24	6.34	45	27.94	6.20	33	28.12	6.24	78
	5th and 6th grade	27.47	6.74	45	25.45	6.01	38	26.54	6.46	83
	Total	27.86	6.52	90	26.61	6.18	71	27.30	6.38	161
Spatial intelligence	3th and 4th grade	32.16	5.58	45	32.76	5.20	33	32.41	5.40	78
	5th and 6th grade	34.04	6.10	45	32.74	5.64	38	33.45	5.89	83
	Total	33.10	5.89	90	32.75	5.40	71	32.94	5.66	161
Interpersonal Intelligence	3th and 4th grade	40.33	4.89	45	40.36	5.46	33	40.35	5.11	78
	5th and 6th grade	40.31	6.51	45	37.61	8.21	38	39.07	7.41	83
	Total	40.32	5.73	90	38.89	7.15	71	39.69	6.41	161
Intrapersonal intelligence	3th and 4th grade	36.80	6.58	45	36.64	5.36	33	36.73	6.06	78
	5th and 6th grade	39.02	6.12	45	35.00	6.76	38	37.18	6.69	83
	Total	37.91	6.42	90	35.76	6.16	71	36.96	6.38	161
Naturalistic intelligence	3th and 4th grade	35.73	6.27	45	34.94	5.10	33	35.40	5.78	78
	5th and 6th grade	33.71	7.09	45	33.26	7.55	38	33.51	7.26	83
	Total	34.72	6.73	90	34.04	6.54	71	34.42	6.64	161
Academic performance	3th and 4th grade	8.43	0.89	45	8.36	0.91	33	8.40	0.89	78
	5th and 6th grade	8.74	0.58	45	8.88	0.65	38	8.81	0.61	83
	Total	8.59	0.76	90	8.64	0.82	71	8.61	0.79	161

Table 3. Statistical data (F_s , signification level, and partial eta-square) on each variable according to gender and school grade.

	Gender (1, 157)			School grade (1, 157)			Gender and School grade (1, 157)		
	F	P	η_p^2	F	p	η_p^2	F	p	η_p^2
Logical-Mathematical intelligence	.239	0.62	.002	.000	0.99	.000	.084	0.77	.001
Linguistic intelligence	.168	0.68	.001	.071	0.79	.000	.447	0.49	.003
Bodily-Kinesthetic intelligence	.168	0.68	.001	.071	0.79	.000	.477	0.49	.003
Musical intelligence	1.325	0.25	.008	2.622	0.10	.016	.721	0.39	.005
Spatial intelligence	.153	0.69	.001	1.074	0.30	.016	1.122	0.29	.007
Interpersonal Intelligence	1.747	0.18	.011	1.887	0.17	.012	1.827	0.17	0.12
Intrapersonal intelligence	4.417	0.03	.027	.087	0.76	.001	3.754	0.05	.023
Naturalistic intelligence	.348	0.56	.002	3.086	0.08	.019	.027	0.87	.000
Academic performance	.080	0.77	.001	12.053	0.001	0.71	.757	0.38	.005

of self-understanding, self-regulation, and self-image (Markus and Nurius, 1984; Mendo-Lázaro et al., 2017). Contrary to past studies, gender differences were found in school children where they apply different instruments for assessing MI (Almeida et al., 2010; Berecem, 2010; Miller, 1999; Özdilek, 2010), in our results, we could not find any gender differences with the rest of the intelligence types. This may be due to the lack of implementations of socio-emotional learning in the curricula of the students in order to promote their MI. Furthermore, when considering school grades, our results did not report any differences with MI. Currently, schools are implementing socio-emotional competencies in their curricula; by implementing these competencies, students have a better psychosocial adjustment and have improved attitudes and academic and behavioral results (Weissberg et al., 2015). Socio-emotional learning (SEL) has produced significant positive effects in different aspects of adjustment and improvements in the academic performance of students (Durlak et al., 2011). However, SEL is not implemented in all the schools. In the case of Mexico, there are some mentions about the importance of socio-emotional competencies; nevertheless, real implementation of these competencies is scarce in the school system. This may explain why students in this sample reported proper differences with their MI. On the other hand, we must consider that possibly the reason why students have little difference in the classifications of MI is that the teachers do not motivate their students to exercise it. There are certain studies where it has been found that the application of MI during class by teachers helps to improve the academic development of students (Dolati and Tahriri, 2017; Ghamrawi, 2014; Yaumi et al., 2018). In further research, this could be a better way to analyze MI by considering to study both the teacher and the students, not just one or the other. Moreover, educators in Mexico can benefit from applying MI in their curricula because it can help to detect specific pedagogical, didactic, and instrumental experiences. Furthermore, the curriculum may be organized conceptually to provide an integrated education from prior knowledge of the needs and interests of the students and their strengths in MI; this could help the students develop critical thinking while stimulating discovery and creativity (Díaz-Posada et al., 2017). It is also worth mentioning that assessing MI in students may help to identify and prevent certain risk factors in schools, such as symptoms of depression (Gomez-Baya et al., 2017), body dissatisfaction and eating disorders (Cuesta-Zamora et al., 2018), and anxiety (Zysberg, 2018). In the other direction, it may help students to identify and take advantage of their aptitudes, such as resilience (Droppert et al., 2019), high self-esteem (Gardner and Lambert, 2019), optimism (Taylor et al., 2017), and creativity (Salavera et al., 2017).

It should be noted that there are some limitations to this study. First, this study took place in only one city in the state of Nuevo Leon, Mexico. In the future, it would be desirable to expand the study to several cities to have more precise and probabilistic ideas of the individual differences of students. Also, the sample was obtained only from several public schools and did not include students from private schools. Future work can be oriented toward assessing the differences between private and public

schools. Second, only one assessment tool, the questionnaire, was used to evaluate the MI of the participants, and there was a lack of positive results. For future studies, the use of several instruments to measure MI should be considered, such as in the work of Kuo et al. (2010).

5. Conclusion

The results of the current study were that male school children reported higher scores in intrapersonal intelligence, which means that they are aware of their own behavior and the consequences of their actions. Nevertheless, educators in Mexico should consider integrating the assessment of the eight types of intelligence in their curricula, especially beginning in the early education years, because the curriculum content should be selected considering the children's backgrounds and previous experiences. The absence of socio-emotional learning in schools may delay the comprehensive educational development of students. Consequently, the implementation of MI theory in Mexican schools should be adopted.

Declarations

Author contribution statement

I. R. González-Treviño: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

G. M. Núñez-Rocha: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

J. M. Valencia-Hernández: Performed the experiments; Contributed reagents, materials, analysis tools or data.

A. Arrona-Palacios: Analyzed and interpreted the data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

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