Multiple intelligences: Educational and cognitive development with a guiding focus

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Development and dissemination of innovative pedagogies continues to be one of the challenges of the 21st century. The visible deficiencies in the educational field have highlighted the need for other types of pedagogies that promote complete student development. Gardner's theory about multiple intelligences (MIs) has great potential that has not yet been realised in practice in school contexts. With this research we aimed to analyse the relationship between the intelligences that students develop in primary education and the increase in certain cognitive and academic capacities, and to demonstrate that a pedagogy based on Gardner's theory does more to promote creativity, maturation and school performance than traditional teaching-learning pedagogies. A total of 420 participants from 2 state-funded schools participated in this study (experimental group = EG; control group = CG). The EG (n = 230) was taught using Gardner's theory and the CG (n = 190) was taught according to traditional pedagogy. There was an association between the intelligences developed by the students and their academic, creative, and maturational levels. Finally, significant differences were found between the EG and CG, with the EG obtaining a higher mean in the variables analysed in favour of the EG. In conclusion, using MIs in classrooms allows for a more mature and creative development and greater academic performance.

Keywords: creative development; intellectual maturity; multiple intelligences; school performance

Introduction
The current educational system is based on the principle that school education should produce autonomous, critical, and thinking individuals. If we assume that every person is capable of his or her talents, it is important to recognise that the nature of these talents varies among individuals. A greater development of the intellectual capacity of children is a key objective for any region since it allows a possible future economic development of the country. From the point of view of emerging economies, it is essential that this is taken into account and promoted (Harber & Mncube, 2011). Gardner reflects in his work the capacity of each person to learn, know and explore new things that allows him/her to promote changes in the context that surrounds him/her (Iyitoglu & Aydin, 2015). Following this reasoning and taking into account the importance of the development of more than one intelligence, Singh, Makharia, Sharma, Agrawal, Varma and Yadav (2017) developed a method to evaluate different forms of intelligence in students and to compare these different intelligences with the intelligence quotient (IQ) scores. They found that different students had different forms of intelligences and most students had more than one form of intelligence. Therefore, taking advantage of students' intelligences can help improve their learning process. Our curriculum should have an amalgam of teaching for all kinds of intelligences for maximum productivity (Díaz-Posada, Varela-Londoño & Rodríguez-Burgos, 2017).

Many investigations that emerge as alternatives to unitary intelligence have achieved limited acceptance by psychologists and educators. Despite critique of empirical validity, Gardner's theory of MIs (Gardner, 1988) has been of great interest to educators throughout the world. Nowadays, the idea of MIs has been recognised as important because of the implications it has for students' cognitive development and broader development of abilities in any international educational context. In short, the development of this pedagogy in different educational contexts is perceived as an undoubted opportunity to promote not only an educational impact, but a social and scientific impact mainly in the most disadvantaged societies. Therefore, the development of intelligence as a single construct in schools, low academic performance, increasing intellectual maturity, and low creativity were the promoting factors for this article in which we focus on child neurodevelopment.

Theorical Framework
The theory of MIs proposes that a number of intelligences exist, where intelligences are understood as capabilities and potentials that a person can possess. Many studies promote teaching based on MIs at school due to the numerous benefits that it provides (see the systematic review Shearer, 2018). Particularly, this research demonstrates positive results in academic performance and creativity levels through teaching based on multiple intelligences aimed at the development of creative writing, discussing issues in an interdisciplinary way, using music and the body as a means of communication, developing natural thinking, simulating situational problems, visual metaphors, cooperative work, setting own goals, et cetera.

The proposal of eight areas of knowledge has provided educational professionals with a pedagogical, methodological and didactic strategy that can be used to evaluate and enhance the academic performance of students and increase their chances of achieving success in school (Batdi, 2017; Peña García, Ezquerro-Cordón & López Fernández, 2017; Pérez Molina & Sánchez Serra, 2014). Shearer and Karanian (2017) show evidence of neuroscience that supports the neuronal validity of the eight intelligences. They reviewed 318 neuroscience reports confirming the fact that neuronal regions exist for the central cognitive components of each intelligence.

These neural data were organised per intelligence into four levels: primary regions, subregions, particular structures and multi-regions. Authors showed that there is solid evidence that each intelligence has a clear neural coherence, distinct and aligned with the cognitive-neuronal correlates accepted.

Studies where pedagogies based on MIs have been implemented have been developed with the aim of improving academic performance. Akkuzu and Akçay (2011) for example, carried out an intervention study in which the EG received teaching focused on the development of MIs, using specific didactic material (concept maps, puzzles, stories, classical music playing in the background, group games and photos). The results show that the intervention had substantial academic benefits, promoting a good attitude towards school and improving intrinsic motivation, which helped to improve academic performance. In addition, Ahvan and Pour (2016) studied the relationship between MIs and academic performance of high school students revealing that there is a moderate correlation between verbal-linguistic and visual-spatial intelligences and academic performance. Multiple intelligences, such as logical-mathematical, visual-spatial, verbal-linguistic, intrapersonal, bodily-kinetic, interpersonal and naturalistic have a significant positive relationship with the academic performance of students. It became clear that multiple intelligences such as visual-spatial, verbal-linguistic and interpersonal were able to predict academic performance. Stanciu, Orban and Bocos (2011) tested an MI-based intervention for children with learning difficulties. The results show that the intervention produced improvements in academic performance and promoted a clearer and more favourable view of the school environment.

In accordance with cognitive development, previous studies have shown that evaluation models based on the theory of MIs are highly beneficial to students' cognitive capacity (Ferrándiz, Bermejo, Sainz, Ferrando & Prieto, 2008). The solid arguments and empirical testing about MIs developed by different authors in school contexts have turned it into a solid educational tool in spite of teachers' initial doubts about this theory (Shearer & Karanian, 2017). Until recently it was thought that particular functions were carried out by particular regions of the brain without the involvement of other regions, but imaging data has confirmed that the brain acts like a symphony orchestra, with several cerebral areas interacting simultaneously. Creativity is one of the capabilities that is developed simultaneously in various parts of our brain. Creativity is a neural capacity that allows the generation of new ideas in different situations facilitating the generation of new concepts and promoting cognitive development. Chávez, Graff-Guerrero, García-Reyna, Vaugier and Cruz-Fuentes (2004) observed that creativity was positively associated with cerebral blood flow in brain regions involved in complex multimodal processing, emotion management, and cognitive abilities. Creativity must also be understood from educational and neuropsychological perspectives – seen as the sum of intellectual, affective, and motor skills. In this way, one can easily understand their relationship with MIs that are stimulated through intrinsic and extrinsic motivation (Velásquez Burgos, De Cleves & Calle Márques, 2010), understanding that the practice of a specific task requires different types of intelligences. It is essential to perform a task of greater demand and thus allowing development of innovative solutions to problems raised in the classroom (Stecconi, 2015). Literature (e.g. Shearer & Karanian, 2017) has concluded that teaching methods based on MIs promote children's creativity and create a relationship between creativity and MIs. Finally, Ekinci (2014) points out that in children aged 11 to 12 years the intelligences most strongly correlated with the creative capacity were the mathematical, linguistic, and intrapersonal logic.

Application of the theory of MIs should result in an approach to teaching that satisfies the students' needs for a personalised approach to learning and a wider range of evaluation processes; it should improve the overall quality of education, so that students leave education more mature and better prepared for life outside school (Goodnough, 2001). Few studies have investigated how MI-based pedagogies affect the intellectual maturity of students, so further research is needed in this area. Confirmatory factor analysis carried out by Almeida, Prieto, Ferreira, Bermejo, Ferrando and Ferrándiz (2010) point to the absence of a general intelligence factor and provide evidence that corroborates the theory of MIs. This new model of intelligences promotes a higher maturational development in children.

Several researchers have tried to relate the main variables used in this study by following different methodologies and approaches (e.g. Audivert Valencia, 2015; Camps Ribas, 2016; Garaigordobil & Berrueco 2007). We confirm the relationship among those variables and state the benefits thereof if developed in students.

Objective of the Study

Based on the theoretical and empirical literature on the concept of MIs, in particular the studies discussed above, our study had two key objectives: (a) to analyse the relationships between the development of different intelligences and creativity, intellectual maturity, and academic performance; (b) to demonstrate that children taught using an approach informed by the theory of MIs show greater improvement in academic

performance, creativity, and intellectual maturation than those taught through traditional methods.

Method
Research Design
This was a quantitative, quasi experimental study that employed a post-test-only design (Arnal, Del Rincón & Latorre, 1992; Moazami, Bahrampour, Azar, Jahedi & Moattari, 2014; Sung, Shen, Jiang & Chen, 2017). The EG consisted of students in a school where the theory of MIs was used in the classroom, while the CG consisted of students in a school where traditional pedagogy was used. The dependent variables, creativity, academic performance, and intellectual maturity were analysed in relation to the independent variable, MIs. The two schools had similar characteristics because they were geographically close and the mean academic performance of their students was comparable.

Participants
The participants were students in the second and third stages of primary education (*M* age = 9.95 years; *SD* = 1.355) at two state-funded schools in the south of Spain (*n* = 420; CG *n* = 190; EG *n* = 230). These educational stages were selected as they are when children enter, what Piaget (1947) called the *concrete operational* stage of development, which is characterised as the stage when true cognitive development begins, as children start investigating and begin to use logic.

The sample was determined by simple random sampling, taking as reference the complete group class, which resulted in differences in the total number of subjects in each group. The research team considered that this small difference would not affect the results and that, being stable groups of students, could improve the results, as is supported by Cerezo, Fernández, Amieiro, Valle, Rosário and Núñez, (2019). The sample was composed of eight group classes in the CG and 12 in the EG.

The participating schools were separated by less than 100 meters and located in an area of average socioeconomic character. The demand for the enrolment of children in both schools was high since the schools' students have been reflecting a history of good academic results, published in SENECA (virtual portal on the academic management of schools in Andalusia, Spain).

Implementation of Treatment
The EG (*n* = 230) offered a 5-year programme of which the academic content is based on the MI model of Gardner and Hatch (1989). The programme is based on the premise that every student is different and that a personalised, flexible pedagogical approach is needed to address academic diversity and maximise students' capabilities. This involves assessing students'

progress individually, presenting a wide range of content and activities that will engage students and reflect their interests, and a pedagogical approach based on practice, experience and experimentation, that will promote cooperative and collaborative work and inter-student relationships, and stimulate students' MIs. The school tries to ensure that, in recognition of the fact that every student is unique, teaching and evaluation are personalised at all times. Every teacher is aware of the specific needs of every student and adapts to them, evaluating students individually.

The CG (*n* = 190) was drawn from a school that uses a more traditional pedagogical model; the school focuses on development of the main subjects and students are classified according to general capacity (intellectual quotient). The objectives to be reached by the learners are not individualised – the needs or capacities of individual students are not specifically addressed, but the achievement of general objectives by all students are pursued. In addition, the subject content and activities are taken from textbooks considered as the main resource. Evaluation is focused on measuring permanent improvements in students' academic performance through assessment sheets and formal examinations.

Instruments
Multiple intelligences
The MIs test is based on Gardner and various proposals made by the author himself (Gardner, 2001, 2012). It consists of a series of statements that describe the initial seven intelligences proposed by Gardner (verbal; logical-mathematical; visual-spatial; musical; kinaesthetic-corporal; interpersonal; intrapersonal). Students are required to place a X next to statements that they think apply to them. Each intelligence section is then calculated representing the level of student development on each intelligence (5 points = completely developed; 4 points = partially developed; < 4 points = not developed).

The requirements that children must have met to be considered having developed each of the intelligences, are the following:
- Verbal intelligence. Children have to show facility in reading, writing, telling stories and doing crossword puzzles.
- Logical-mathematical intelligence. Children have to be interested in measurement patterns, categories and relationships and find it easy to solve arithmetic problems, strategy games and experiments.
- Kinaesthetic-corporal intelligence. Children have to process knowledge through bodily sensations. They enjoy and do well at sports, dancing and crafts such as sewing, woodwork, et cetera.
- Visual-spatial intelligence. Children have to think in images and with the aid of drawings. They can solve puzzles, dedicate free time to drawing, show a preference for constructive games, et cetera.

- Musical intelligence. Children have to identify sounds easily. They often spontaneously produce songs and sounds.
- Intrapersonal intelligence. Children have to appear introverted and timid. They live through their own feelings and become intellectually self-motivated.
- Interpersonal intelligence. Children have to communicate well and be leaders in their groups. They show a good understanding of the feelings of others and easily develop interpersonal relationships.

Content validation was carried out by expert judges to determine the extent to which the measures represented each element of the construct. Ten judges (four men and six women) chosen at random from experts in new educational pedagogies participated in the validation exercise. They were given 15 days to assess the relevance of each item on a scale of 1 to 10 (1 = not relevant; 10 = highly relevant). Once all the judges had completed their assessment of the questionnaire, the members of the research team met to analyse the answers. Descriptive statistics (frequencies, percentages, means and standard deviations) of ratings for alignment with and relevance to the construct were calculated using the Statistical Package for Social Sciences (SPSS) v. 22. As a validation methodology, those items that did not obtain at least 75% unanimity and corresponded with, near or under 9, were eliminated. Then Kendall's *W* test was used to determine the degree of agreement between *k* sets of ranks, in this case, between the answers given by the 10 judges. Finally, the questionnaire answers were validated with the eliminated items mentioned above. Overall, the coefficient $W = 161$, and $\chi^2 (34) = 54.830$, $p = .213$, indicating adequate concordance among the judges.

Creativity

Creativity was measured with the *Prueba de imaginación creativa* (PIC-N) (Artola, Ancillo, Barraca & Mosteiro, 2010), which was inspired partly by the classic Torrance test of Guilford (1967) and Torrance (1974). The PIC-N, which has been shown to have good psychometric properties (Cronbach's alpha = .83; convergent validity with G factor, $r = .40$, $p < .01$), was designed specifically for the Spanish population (8–12 years) and is widely used for the evaluation of creativity (Ferrándiz, Ferrando, Soto, Sáinz & Prieto, 2017; González & Mairal, 2004; Soto, G, Ferrando, Sáinz, Prieto & Almeida, 2015). The test evaluates creativity by examining how subjects use their imagination in four different tasks. The first three tasks or games focus on narrative creativity and the fourth measures graphic creativity. In game one, the instructions are: "Look at the image and imagine everything that could be happening, do not tell a story, but write down all the ideas that you can think of (each one on a different line). There are no right or wrong answers, so let your imagination go and fantasise and try to write down

as many ideas as you can." In game two the child is told: "Write a list of everything you could do with a plastic tube, think of interesting and original things, however incredible. You can use as many different numbers and lengths of pipe as you want." In game three, students are told: "Imagine what would happen if every squirrel suddenly became a dinosaur, do not tell a story, but write a list of things that could happen." Finally, the instructions for game four were: "On this page you will see some incomplete drawings, try to complete them in the most original way possible. Try to draw something that no one else would draw. When you are finished, write an interesting title for each drawing." This test provides indications of fluency, flexibility, originality, elaboration, shadows and colour, title, and special details.

Intellectual maturity

Intellectual maturity was evaluated with the Goodenough-Harris drawing test (GHDT) (Goodenough, 1926; Harris, 1963). The GHDT test indicates the cognitive ability of the student that is represented in terms of intellectual maturity. In this study we used the most recent edition of the test, in which students are asked to make two full-body drawings, one of a man and the other of a woman (Soto, CM, Mendoza & Ramírez, 2009). Drawings are evaluated in terms of the level of detail and the proportions of the figure (man: 73 details; woman: 71 details). The GHDT test is designed for evaluating children and adolescents up to 15 years of age and exists in several editions, all validated. The GHDT has shown good reliability and validity compared with other intelligence tests for children aged 3 to 15 years (Abell, Horkheimer & Nguyen, 1998; Plbrukarn & Theeramanoparp, 2003). We used the average of the gross scores for the two drawings, which represent the number of details included.

Academic performance

Academic performance was evaluated as the average of a student's school grades in language, mathematics, natural sciences, social sciences, physical education, music, art and English in the last two trimesters of the 2017–2018 school year. Several authors have argued that school grades are a reliable measure of academic performance (e.g. Allen, 2005; Lambating & Allen, 2002). We determined that school grades justify the student's learning objectives.

In addition, the academic performance was assessed through the Pediatric Quality of Life Inventory (PedsQLTM) in its Spanish version (*Cuestionario de Calidad de vida Pediátrica*). This examines, in one of its dimensions, the aptitude of children towards school. It uses a Likert scale on which low scores represent better school performance. The part of the questionnaire used in

this study has been shown to have an internal consistency of α = .63 in children aged 8 to 12 years (González-Gil, Mendoza-Soto, Alonso-Llore, Castro-Murga, Pose-Becerra & Martín-Arribas, 2012).

The Experimental Research Process

We started by asking the schools for permission to carry out the study with their students. Once the schools had granted permission for the study, tutors were given information and consent forms to distribute to children and parents. We only worked with students who provided written consent for participation. The school that developed the education based on the MIs carried out this type of educational treatment for 5 years. The various questionnaires and tests were administered to students during a 1-hour session that was incorporated into regular classes. The EG carried out the post test at the end of the course of the 5th year of treatment and the CG at the same time. Trained researchers were responsible for administering the post test. A tutor from the school and a researcher were present throughout the administration of the assessments. Finally, the tutors of participating classes were asked to provide students' school grades for the past two trimesters. Once all the information had been obtained, the data were analysed.

Data Analysis

Analysis were performed with SPSS v.22. Firstly, a count was made of the multiple intelligences developed by each child. Subsequently, to determine the relationships between variables, and to avoid the multicollinearity problem, we calculated Pearson's correlations (first objective presented). Group differences in number of intelligences, creativity, intellectual maturity, and academic performance were assessed with *t*-tests (second objective presented). Effect sizes were calculated as Cohen's *d* and used to determine group differences (Cohen, 1988). Finally, a MANOVA was used to verify the covariance of several variables that had not been analysed in the reference investigations.

Results

We achieved our first objective by analysing the associations between the number of intelligences and the creativity, intellectual maturity, school grade, and aptitude for school variables. The intelligences variable was positively correlated with creativity ($r(420) = 259$, $p = .000$), intellectual maturity ($r(420) = 106$, $p = .029$), and school grades ($r(420) = .196$; $p = .000$). The intelligences variable was also negatively correlated with aptitude for school ($r(420) = -.173$; $p = .000$), reflecting the inverse scoring used on this instrument (Table 1).

Table 1 Pearson correlation between developed intelligences, creative level, intellectual development and academic performance

	DI	GC	GHDT T	ASG	SP
DI	1	**.59****	.106*	.196**	-.173**
GC		1	.460**	.396**	-.183**
GHDT T			1	.328**	-.047
ASG				1	-.227**
SP					1

Note. DI = Developed intelligences; GC = General creativity; GHDT T = Total score of the Goodenough Harris Drawing Test; ASG = Average school grades; SP = School performance; * = $p < .05$; ** = $p < .01$.

With regard to the second objective, Table 2 shows that students at the EG school had partially or completely developed an average of four intelligences whereas CG students had developed an average of two. In addition, a large effect size was shown, determining that the standard deviation of difference between the two groups was high.

Table 2 Differences of means between the EG and CG with respect to the development of MIs

	Group	N	M(SD)	t	Sig.	d
DI	EG	230	4.07(1.656)	11.440	.00	1.060
	CG	190	2.32(1.435)			

Note. Sig. = Significance.

Table 3 shows that the EG had partially or completely developed the logical-mathematical intelligence, intrapersonal and interpersonal intelligences, whereas the CG had developed the kinaesthetic and verbal intelligences.

Table 3 Student's MI profiling and type of school

Group	N	Intelligence	%
		Verbal intelligence	
EG	118		28.1%
CG	**73**		**17.4%**
		Logical-mathematical intelligence	
EG	**154**		**36.7%**
CG	60		14.3%
		Visual-spatial intelligence	
EG	128		30.5%
CG	32		7.6%
		Kinaesthetic-corporal intelligence	
EG	146		34.8%
CG	**80**		**19.0%**
		Musical intelligence	
EG	105		25%
CG	58		13.8%
		Intrapersonal intelligence	
EG	**149**		**35.5%**
CG	68		16.2%
		Interpersonal intelligence	
EG	**147**		**35%**
CG	**72**		**17.1%**

A series of *t*-tests revealed group differences in narrative, graphic and general creativity ($p < .01$), intellectual maturity ($p < .01$), school grades ($p < .01$), and aptitude for school ($p < .01$).

The effect sizes for the differences in narrative and general creativity were large ($d > .5$) and the effect sizes for the other differences were moderate ($d > .2$) (Table 4).

Table 4 Differences of means between EG and CG with respect to the creative level, intellectual maturity, and academic performance

Group	Variables	M(SD)	t	Sig	d
EG	GC	16.73(5.38)	3.137	.002	0.313
CG		15.05(5.57)			
EG	NC	29.00(10.47)	6.599	.000	0.706
CG		22.17(8.61)			
EG	TC	45.17(12.91)	6.424	.000	0.615
CG		37.25(12.12)			
EG	GHDT M	33.33(10.64)	2.875	.004	0.282
CG		30.48(9.40)			
EG	GHDT W	33.71(10.45)	3.032	.003	0.282
CG		30.77(9.12)			
EG	GHDT T	33.45(10.27)	2.972	.003	0.292
CG		30.63(8.87)			
EG	ASG	8.02(1.29)	2.545	.011	0.249
CG		7.70(1.26)			
EG	SP	4.77(2.96)	-4.004	.000	0.373
CG		5.87(2.62)			

Note. Narrative creativity (NC); Total creativity (TC); Score of Goodenough Harris Drawing Test for man details (GHDT M); Score of Goodenough Harris Drawing Test for woman details (GHDT W). Interpretation of the values of the Cohen's *d* test: trivial (< 0.2), small (0.2-0.49), medium (0.5-0.79) and large (> 0.8).

Finally, we carried out MANOVAs with general creativity and performance as dependent variables, number of intelligences developed as a fixed factor and group (pedagogical approach) as a covariate (Table 5). The EG had higher creativity ($M = 45.17$) than the CG ($M = 37.25$). The ANOVA was not significant in the CG according to Fritz, Morris and Richler (2012). The size of the partial effect η^2 also highlights a greater effect on the EG without being excessively high. Similar values are appreciated if the academic performance variable is taken into account as dependent. The EG obtained the most significant values.

Table 5 Covariance analysis between creativity, academic performance and MIs according to the type of pedagogy used

			Creativity		
Group	M	SD	F	Sig.	η^2 parcial
EG	45.7	12.91	2.383	.023	.070
CG	37.25	12.12	1.795	.090	.065
			Academic performance		
EG	3.54	.942	3.363	.002	.096
CG	3.12	.740	2.012	0.56	.072

Note: Partial effect η^2: small $= .01$-$.06$, medium $= > .06$-$.14$, large $= > .14$.

Discussion and Conclusion

In this investigation we analysed the associations between the number of intelligences developed by students and their creativity, intellectual maturity, and academic performance, as well as determining the benefits of a pedagogy based on the theory of MIs in performance. The academic performance, creativity, and intellectual maturity of children in the second and third stages of primary education at a school using MI-based pedagogy were compared with those of children taught using a traditional teaching model.

Some research provides evidence that the use of MI-based methods in the classroom produces benefits relative to traditional pedagogical methods (Hanafin, 2014; Nadal Vivas, 2015; Sánchez Povedano, 2015), but there is still a lack of objective analyses of this type of innovative pedagogy in real-world contexts. Guzmán and Castro (2005) note that teachers may have a theoretical grasp of this type of pedagogy, yet fail to translate it into teaching strategies and implement it in the classroom. Adcock (2014) conducted a survey of teachers who were doing graduate studies, about how they valued the theory of MIs and if later they would develop it in the classroom. The teachers expressed very positive opinions about this type of educational theory, saying that they considered it to be a fundamental tool that could help teachers learn about and introduce new and effective teaching methods. Similarly, in a review of literature, Díaz-Posada et al. (2017) conclude that applying the theory of MIs in schools leads to improvements in teaching models, pedagogical activities, didactic resources, evaluation strategies and instruments, and positive educational experiences.

Our results suggest that a number of intelligences is positively associated with academic performance. This finding is supported by results showing that students taught using MI-based methods had higher school grades and a greater

aptitude for school than students in a more traditional school.

An analysis of covariance corroborated the existence of a group difference in mean post-test academic performance. This finding is consistent with a study by Singh et al. (2017) that showed that even children with low IQ who were taught using MI-based methods developed more than one intelligence and performed better than those taught using other pedagogical approaches. They concluded that the school curriculum should include a mixture of pedagogical styles catering to all kinds of intelligence, in line with the theory of MIs.

Baş and Beyhan (2010) observe a significant difference between the achievement levels of students who are educated through MI-supported project-based learning methods and students who are educated through the traditional methods of teaching in languages lessons. Students who are educated through MI-supported project-based learning methods were more successful than students who were educated through traditional learning in terms of academic performance.

Ekinci (2014) investigated the relationships between academic performance and the practical, creative, and human analytical capacities as defined in Gardner's theory of MIs. This author showed a relationship among three intelligences (linguistic, logical-mathematical, and intrapersonal) and school grades in children of 11 and 12 years. In contrast, Díaz Martínez, Llamas Salguero and López-Fernández (2016) found no associations between the intelligences and either general academic performance or performance in specific subjects in students from professional teaching media of the graphic area.

We found that students being educated using MI-based methods were more creative than those taught using more traditional methods. Studies such as those of Stecconi (2015) provide a theoretical rationale, derived from classical work on MIs by proponents of the theory of MIs, such as Gardner, for an association between MIs and creative capacity. On the other hand, Mourgues, Tan, Hein, Elliott and Grigorenko (2016) used structural equation modelling to show that creativity mediates the relationship between academic performance and development of MIs in secondary school students. Díaz Martínez et al. (2016) observed positive correlations between creativity and most MIs, with the highest correlations between creativity and verbal corporal-kinaesthetic and logical-mathematical intelligences. However other studies (e.g. Jung & Chang, 2017) have shown that creativity was negatively related to the corporal-kinaesthetic and interpersonal intelligences and found no evidence of associations between these variables.

In our study, the logical-mathematical, intrapersonal and interpersonal intelligences were partially or completely developed in a higher proportion of students in the EG, which is in line with the results obtained by Ekinci (2014), who demonstrated that students aged 11 to 12 years whose education was based on Gardner's theory of MIs, develop the logical-mathematical, verbal and intrapersonal intelligences in a more solid way than peers taught using other methods. Similarly, Gutiérrez Sas, Fontenla Fariña, Cons Ferreiro, Rodríguez Fernández and Pazos Couto (2017) showed that workshops using MI-based methods led to improvements in intrapersonal and interpersonal intelligences that manifested as improvements in children's social skills, emotional intelligence, and self-esteem.

Del-Moral-Pérez, Guzmán-Duque and Fernández (2014) used playful scenarios to promote the development of a greater number of intelligences in primary school children. They highlight the impact of this educational technique on logical-mathematical intelligence and visual-spatial intelligence in girls and on verbal and interpersonal intelligence in children in general.

The main limitation of our research is the lack of a pre-test measure of the variables of interest. However, the schools started from similar educational quality reflected in the evaluation criteria of SENECA. The strengths of the study are the relevance of the subjects and the multiple uses of the working theory of MIs at school.

In conclusion it is important to emphasise that educational methods based on the theory of MIs can be very useful in primary education anywhere in the world, producing improvements in creativity, intellectual maturity, and academic performance. We have demonstrated that these outcomes are positively associated with the number of intelligences developed by the students, and that the MIs influence creativity and academic performance. Our research confirms that pedagogical approaches designed to promote the development of diverse intelligences in the school environment should be a key to contemporary education and a subsequent social impact. The main impact lies in the neuroeducational development that occurs in children if they are taught through education based on the development of MIs.

It is important to emphasise that students at schools that incorporate the notion of MIs into their pedagogy show greater creativity and intellectual maturity, and better academic performance than the peers who have been taught through traditional methods. The education systems of the world must adapt to the needs of different students, seeing the development of the students as an opportunity for the development of society – particularly of the most disadvantaged societies.

Authors' Contribution

BBA conducted the research, presented the statistics and wrote the manuscript. CAR conceptualised the manuscript. APV conducted to the statistics and revised the manuscript.

Notes

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