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The Effectiveness of the Maher Crystallized Intelligence Educational-Psychological Intervention on Enhancing Fluid Intelligence and Socio-Cultural Intelligence

Mohammad Hossein Zelli[1], Aboutaleb Seadatee Shamir[2*], Amenehsadat Kazemi[3]

1 PhD Student of General Psychology, Department of Psychology, Kish International Branch, Islamic Azad University, Kish Island, Iran
2 Assistant Professor, Department of Educational Psychology and Personality, Science and Research Branch, Islamic Azad University, Tehran, Iran
3 Assistant professor, Department of Psychology, Faculty of Medicine, Tehran Medical Sciences, Islamic Azad University, Tehran, Iran
*Correspondence: seadatee@srbaiu.ac.ir

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ABSTRACT

This study aimed to investigate the effectiveness of the Maher Crystallized Intelligence Psycho-Educational Intervention in enhancing fluid intelligence and socio-cultural intelligence among elementary school students. A quasi-experimental research design with a pretest-posttest-follow-up structure and control group was employed. The participants included 40 students aged 10 to 12, randomly assigned to experimental and control groups. The intervention consisted of 14 structured 90-minute sessions based on the Cattell–Horn–Carroll (CHC) theory and focused on enhancing multiple dimensions of crystallized intelligence. Data collection tools included the Maher Multifunctional Fluid Intelligence Test (MMFIT) and the Maher Crystallized Intelligence Test (MCIT), each validated in previous studies. Mixed multivariate analysis of variance (MANOVA) and Bonferroni post hoc tests were conducted using SPSS version 27, following confirmation of statistical assumptions. The results indicated statistically significant improvements in all dimensions of fluid intelligence (perception, reasoning, attention, memory, and processing speed) and socio-cultural intelligence (cultural, economic, social, spiritual, managerial, and philosophical) in the experimental group compared to the control group ($p < .001$). Interaction effects between time and group were large, with partial eta squared values ranging from .60 to .83. Bonferroni comparisons confirmed significant mean increases from pretest to posttest and follow-up in the experimental group, while no significant change was observed in the control group across stages. Additionally, the posttest–follow-up results showed no significant decline, indicating sustained intervention effects. The Maher Crystallized Intelligence Intervention was effective in significantly improving and maintaining both fluid and socio-cultural intelligence among elementary school students. The multidimensional, culturally adapted structure of the intervention demonstrates its potential for application in educational and developmental settings aiming to foster holistic cognitive and social-emotional growth.

Keywords: Crystallized intelligence, fluid intelligence, psycho-educational intervention, socio-cultural intelligence, Maher model, elementary students, cognitive development.

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Introduction

In recent decades, the conceptual differentiation between fluid intelligence and crystallized intelligence has garnered increasing attention in cognitive psychology, educational neuroscience, and developmental research. The theory originally proposed by Raymond Cattell and further refined with Horn has become one of the foundational frameworks for understanding human cognitive ability across the lifespan (1). Fluid intelligence (Gf) is generally defined as the capacity to reason, solve novel problems, and process information independently of acquired knowledge, while crystallized intelligence (Gc) reflects accumulated knowledge, skills, and cultural competence acquired through learning and experience. These two forms of intelligence, though interrelated, evolve differently across developmental stages, and their optimization is considered crucial for holistic intellectual functioning (2, 3).

Recent empirical findings have shown that the integration of educational and psychological interventions can effectively enhance both forms of intelligence, particularly during childhood and adolescence when neurocognitive plasticity is high (4). In the Iranian educational context, a growing number of researchers have focused on localizing assessment tools and developing context-specific interventions. Among these efforts, the Maher intelligence framework has emerged as a culturally responsive and theoretically grounded model that incorporates both fluid and crystallized dimensions of intelligence and their socio-emotional components (5). Central to this framework is the Maher Crystallized Intelligence Psycho-Educational Intervention Package, designed to cultivate socio-cultural, managerial, philosophical, and spiritual intelligence in addition to more traditional cognitive constructs.

The distinction between fluid and crystallized intelligence is not only theoretical but also deeply practical. Research suggests that while fluid intelligence tends to decline with age, crystallized intelligence can remain stable or even increase well into adulthood, making it a vital resource for adaptive functioning in diverse life domains (6, 7). Moreover, both types of intelligence contribute significantly to executive functioning, social cognition, academic achievement, and resilience in challenging environments (7, 8). In children, especially those in primary and early secondary education, fostering these abilities is associated with greater emotional regulation, improved problem-solving, and increased self-efficacy (9, 10).

The educational value of crystallized intelligence lies in its potential for socio-cultural adaptation. In particular, components such as cultural literacy, spiritual understanding, philosophical reasoning, and economic awareness—which are embedded within the Maher model—prepare children to navigate complex societal structures. This broader perspective on intelligence reflects the increasing relevance of 21st-century skills and aligns with the global educational shift toward holistic, competency-based learning (7). In the Iranian educational system, these goals are especially pertinent given the challenges of standardization, equity, and the alignment of curriculum with cognitive diversity among learners (11, 12).

One of the major innovations in the Iranian context has been the development and standardization of the Maher Multifunctional Fluid Intelligence Test (MMFIT) for assessing fluid intelligence across perceptual, memory, attention, reasoning, and processing speed domains (13). The psychometric robustness of this test has been confirmed in various samples and age groups, making it a valid tool for both research and applied diagnostics. Parallel to this, the Maher Crystallized Intelligence Test has been introduced to measure socio-cultural intelligence across multiple subdomains, including cultural, economic, spiritual, managerial, and

philosophical dimensions. These instruments offer an integrated approach to assessment and allow for more targeted interventions.

Empirical studies evaluating these interventions have yielded promising outcomes. For instance, Ershadi Chahardeh et al. (2024) demonstrated that cognitive empowerment programs based on Lumosity improved Maher crystallized intelligence scores in elementary school boys. Similarly, Ghanbari and Seadatee Shamir (2023) found that mathematics skill training could enhance both fluid and crystallized intelligence, suggesting that domain-specific educational inputs have the potential to generalize across cognitive systems (9, 10). Moreover, metacognitive training has shown efficacy in boosting fluid intelligence among early adolescents, further confirming the trainability of these cognitive faculties (14).

Another area of significance is the relationship between intelligence types and emotional and social functioning. Olderbak et al. (2019), in a meta-analysis, found meaningful correlations between ability-based emotional intelligence and both Gf and Gc. These findings have been echoed in local studies, such as by Alborzi and Khosh Lahje Sedgh (2023), who identified emotional intelligence as a mediating factor in coping strategies and sensation seeking. These results suggest that improving intelligence can have downstream benefits for emotional and behavioral adjustment in educational and family settings (11).

The Maher intelligence model and its associated interventions also address emerging challenges related to developmental disorders. For example, Roghani et al. (2024) examined the effectiveness of the Maher fluid intelligence package in children with ADHD and found significant improvements in executive functions and cognitive-emotional regulation (15, 16). These findings underscore the model's utility not only in normative developmental contexts but also in clinical and special education environments.

The integration of multiple intelligence domains within a single intervention framework provides a comprehensive strategy for cognitive development. This aligns with the multidimensional approach advocated by theorists such as Batey et al. (2010), who emphasize the interrelationship between intelligence, personality, and creativity (17). The Maher model operationalizes this vision by including dimensions such as philosophical and managerial intelligence, which are rarely addressed in conventional curricula but have high relevance for adaptive thinking and leadership development in adolescence.

In addition to theoretical rigor, the model emphasizes cultural and developmental appropriateness. The age-based calibration of its assessments and tiered interventions—customized to accommodate the learning pace and cognitive capacity of children—ensures accessibility and equity. Moreover, studies such as Hariri (2017) have highlighted the importance of ethical and socio-cultural factors in cognitive-behavioral education, reinforcing the need for interventions that are attuned to the moral and societal dimensions of intelligence (18).

In sum, the emerging body of research on crystallized and fluid intelligence—particularly within the Maher framework—suggests that structured psycho-educational interventions can play a vital role in optimizing cognitive development among children and adolescents. This study aimed to investigate the effectiveness of the Maher Crystallized Intelligence Psycho-Educational Intervention in enhancing fluid intelligence and socio-cultural intelligence among elementary school students.

Methods and Materials

Study Design and Participants

This study employed an applied, quasi-experimental design with a pretest-posttest-follow-up structure and a control group. The primary aim was to assess the impact of a structured educational-psychological intervention program targeting crystallized intelligence on enhancing both fluid intelligence and socio-cultural intelligence among participants. The participants were selected through appropriate sampling techniques based on the inclusion criteria and were randomly assigned to either the experimental or control group. Both groups underwent assessments at three stages: pre-intervention (baseline), immediately post-intervention, and a follow-up session conducted after a designated period to evaluate the sustainability of the effects. The research adhered to ethical guidelines, and all participants or their guardians provided informed consent prior to participation.

Data Collection

The first tool used in the study was the Maher Multifunctional Fluid Intelligence Test (MMFTI). This instrument is designed to assess five core components of fluid intelligence: perception, reasoning, attention, memory, and processing speed. It includes a total of 85 items with a maximum raw score of 306 and takes approximately 50 minutes to complete. Each subcomponent contains five questions, with the total number of questions and scoring weights varying slightly across subtests. The test is designed to align with five age groups, each further divided into three age tiers, with item response starting points tailored to the participant's specific age within the group. The test uses both a starting rule and a reverse rule—if a participant in a higher age bracket fails the designated starting item, they must revert to previous items. Correct answers to these can retroactively earn credit for missed starting items. A discontinuation rule is also implemented: if a participant answers three consecutive or four non-consecutive items incorrectly within a subtest, the subtest is terminated. Scoring is time-sensitive: the faster the correct response is provided, the higher the score. For instance, the first three questions score 3, 2, or 1 points depending on whether the answer is provided in the first, second, or third 10-second interval, respectively. The fourth and fifth questions follow an extended time-based scale with scoring descending from 4 or 5 points to 1 point across up to 45 seconds. To ensure accurate administration, the required materials included a stopwatch, recording device, scoring forms, test manuals, and an appropriately quiet and comfortable testing environment. The psychometric properties of the MMFTI, validated by Sa'adati-Shamir and Zahmatkesh (2022), indicated strong construct validity through exploratory and confirmatory factor analyses and internal consistency reliability with Cronbach’s alpha coefficients ranging from 0.87 to 0.92.

The second instrument employed was the Maher Multifunctional Crystallized Intelligence Test (MMCTI), specifically the subtest measuring socio-cultural intelligence. Developed by Sa'adati-Shamir and Zahmatkesh (2022), this tool evaluates six distinct domains of crystallized intelligence: cultural, economic, social, spiritual, managerial, and philosophical intelligence, each assessed through 12 items, totaling 72 items overall. The test has a maximum raw score of 72 and a maximum duration of 120 minutes. Each item is worth one point, making scoring straightforward. The test is designed for use in educational and psychological research contexts and is structured to reflect comprehensive coverage of socio-cultural

cognitive domains. A cut-off score of 30 has been proposed to distinguish low from high performance. Confirmatory and exploratory factor analysis provided evidence for the six-factor model, and internal consistency reliability as measured by Cronbach's alpha ranged from 0.79 to 0.92. Further validation studies, such as that conducted by Shams et al. (2025), extended these psychometric findings to children aged 4 to 6, confirming good model fit and Cronbach's alphas between 0.69 and 0.88, supporting the reliability and validity of the MMCTI in younger populations.

Intervention

The Maher Crystallized Intelligence Educational-Psychological Intervention Package, developed by Zali and colleagues (2024), is a structured program based on the theoretical foundation of the Cattell-Horn-Carroll (CHC) theory of intelligence, specifically tailored for the age range of 4 to 18 years. The intervention consists of 14 sessions, each lasting 90 minutes, and is designed to be implemented with at least a two-day interval between sessions to allow cognitive processing and consolidation. The first session is primarily introductory, aimed at familiarizing participants with the four core components of crystallized intelligence defined in the Maher model: personality-emotional intelligence, socio-cultural intelligence, spiritual-moral intelligence, and kinetic-practical intelligence. This initial session also includes the establishment of behavioral contracts, baseline assessments, motivational enhancement, and the explanation of group rules such as confidentiality and mutual respect. From the second session onward, each session begins with a 10-minute review of the previous session and assigned homework, followed by 70 minutes of structured training involving psychoeducational input, real-life examples, individual reflection, and group discussion, and concludes with a 10-minute summary and assignment of new exercises. The core content of each session focuses on the detailed exploration of a specific domain of crystallized intelligence, including emotional-personality intelligence, socio-cultural intelligence, spiritual intelligence, economic intelligence, managerial intelligence, philosophical intelligence, sports-motor intelligence, technical-engineering intelligence, cognitive intelligence, analytical intelligence, metacognitive intelligence, creative intelligence, and practical intelligence. Participants are encouraged to engage in active reasoning through real-life scenarios and guided questions, with facilitators supporting the process by validating, clarifying, and extending participant responses. Homework assignments are designed to reinforce session content and encourage self-exploration outside the classroom. Brief breaks of 3 to 5 minutes are incorporated mid-session to accommodate the developmental needs of younger participants. The final session provides a comprehensive review of all prior sessions, reinforcing key learning points and addressing any misunderstandings. This systematic and developmentally responsive structure ensures both depth and continuity in fostering crystallized intelligence as conceptualized within the CHC model.

Data analysis

The data analysis process began with the examination of demographic variables through frequency distributions and percentages to ensure the equivalence of the experimental and control groups. To assess group homogeneity at baseline, Fisher's exact test and chi-square tests were applied. In the main analysis phase, mean and standard deviation statistics were calculated for all key variables at pretest, posttest, and follow-up stages. The central inferential analysis utilized mixed multivariate analysis of variance (mixed

MANOVA) to assess the effectiveness of the intervention across time and between groups. Prior to conducting the MANOVA, the assumptions of normality, homogeneity of variances, homogeneity of variance-covariance matrices, multicollinearity among dependent variables, and Mauchly's test of sphericity were evaluated. All statistical analyses were conducted using SPSS version 27.

Findings and Results

The demographic characteristics of participants in both the experimental and control groups were examined to ensure homogeneity. In terms of gender distribution, the experimental group included 12 girls (60%) and 8 boys (40%), while the control group comprised 13 girls (65%) and 7 boys (35%), with no significant difference observed between groups ($\chi^2 = 2.56$, $p > .10$). Regarding the age of the children, 45% of the experimental group were ten years old, 20% were eleven, and 35% were twelve years old, compared to 40%, 40%, and 20% respectively in the control group, also showing no significant difference ($\chi^2 = 2.21$, $p > .33$). In terms of educational level, participants in the experimental group were in fourth (40%), fifth (25%), and sixth (35%) grades, while in the control group, 40% were in fourth grade, 35% in fifth, and 25% in sixth, indicating no significant difference ($\chi^2 = 2.19$, $p > .34$). For the fathers' age, 15% in the experimental group were between 30–35 years, 40% were between 36–40 years, and 45% were between 41–45 years, compared to 10%, 45%, and 45% respectively in the control group ($\chi^2 = 0.26$, $p > .88$). Similarly, the mothers' ages were distributed as follows: 15%, 65%, and 20% in the experimental group and 20%, 65%, and 15% in the control group for the 30–35, 36–40, and 41–45 year brackets respectively ($\chi^2 = 0.29$, $p > .87$). Regarding family size, 15% of the experimental group were from single-child families, 40% had two children, and 45% had three children, compared to 35%, 10%, and 55% in the control group; this difference was not statistically significant ($\chi^2 = 5.40$, $p > .07$). Birth order also showed a balanced distribution with 45% of the experimental group being first-born, 40% second-born, and 15% third-born, while the control group had 40%, 45%, and 15% respectively ($\chi^2 = 0.12$, $p > .94$). The fathers' educational levels in the experimental group were 40% diploma, 30% bachelor's, and 30% master's, whereas in the control group, they were 30%, 30%, and 40% respectively ($\chi^2 = 0.57$, $p > .75$). The mothers' educational levels showed similar parity with 25% diploma, 30% bachelor's, and 45% master's in the experimental group, compared to 20%, 40%, and 40% respectively in the control group ($\chi^2 = 0.46$, $p > .80$). Occupational status of fathers revealed that 20% of the experimental group were laborers, 25% self-employed, and 55% in administrative jobs, while in the control group, these figures were 20%, 50%, and 30% respectively ($\chi^2 = 3.14$, $p > .21$). For mothers, 30% of the experimental group were homemakers, 45% self-employed, and 25% held administrative jobs, compared to 30%, 35%, and 35% in the control group ($\chi^2 = 0.58$, $p > .75$). These findings confirmed the demographic homogeneity between the experimental and control groups, allowing for valid comparison in subsequent analyses.

Table 1. Descriptive Statistics for Fluid and Socio-Cultural Intelligence by Assessment Stage and Group

Variable	Group	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Follow-up Mean	Follow-up SD
Perception	Experimental	109.76	6.21	116.02	5.92	116.38	5.64
	Control	109.95	7.29	109.23	6.05	109.66	6.43
Reasoning	Experimental	105.14	5.26	114.10	5.42	114.53	5.76
	Control	105.92	6.53	105.32	6.75	105.36	6.80
Attention	Experimental	113.53	5.31	118.73	4.88	118.36	5.08
	Control	113.25	6.88	113.21	5.90	113.10	5.82

Memory	Experimental	107.63	5.95	115.54	6.45	115.23	6.90
	Control	107.42	7.22	107.06	6.21	107.67	6.63
Processing Speed	Experimental	106.99	6.70	113.51	5.65	113.86	5.86
	Control	106.28	7.19	106.61	6.16	106.21	6.31
Total Fluid Intelligence	Experimental	108.92	5.03	114.78	4.65	115.16	5.14
	Control	109.87	6.47	108.20	5.58	108.61	5.62
Cultural Intelligence	Experimental	107.20	9.70	118.90	9.77	118.25	9.29
	Control	107.05	9.82	107.05	9.88	107.65	9.37
Economic Intelligence	Experimental	107.85	10.56	116.10	10.12	116.50	10.56
	Control	107.35	8.64	107.10	8.64	107.30	8.67
Social Intelligence	Experimental	110.00	10.88	122.30	10.99	122.90	10.37
	Control	110.05	9.14	110.40	8.82	110.55	8.88
Spiritual Intelligence	Experimental	102.10	12.10	114.45	12.22	114.65	11.64
	Control	102.90	7.62	102.35	7.71	102.60	7.79
Managerial Intelligence	Experimental	107.80	8.81	119.70	9.47	119.55	9.47
	Control	107.50	6.98	108.10	6.94	108.30	7.03
Philosophical Intelligence	Experimental	105.35	8.66	116.50	8.94	116.90	9.07
	Control	104.85	9.46	104.55	9.57	104.80	9.73
Total Socio-Cultural Intelligence	Experimental	106.60	8.23	116.47	8.24	116.69	8.08
	Control	106.83	5.74	106.64	5.78	106.73	5.87

Descriptive statistics across pretest, posttest, and follow-up stages revealed notable differences between the experimental and control groups in both fluid intelligence and socio-cultural intelligence domains. In the experimental group, participants showed a clear upward trend in all five subcomponents of fluid intelligence—perception, reasoning, attention, memory, and processing speed—with increases in mean scores from pretest to posttest and maintained improvements at follow-up. For instance, mean scores in perception rose from 109.76 at pretest to 116.02 posttest, and remained stable at 116.38 in follow-up. A similar pattern was observed in reasoning (from 105.14 to 114.10), attention (from 113.53 to 118.73), memory (from 107.63 to 115.54), and processing speed (from 106.99 to 113.51). These gains were not observed in the control group, where means remained nearly constant or showed minimal fluctuation across all stages.

Parallel improvements were also found in the components of socio-cultural intelligence within the experimental group. Cultural intelligence increased from 107.20 at pretest to 118.90 at posttest, economic intelligence from 107.85 to 116.10, and social intelligence from 110.00 to 122.30, all with similar retention at follow-up. The same trend applied to spiritual, managerial, and philosophical intelligence, reflecting consistent growth across sessions. The composite socio-cultural intelligence score in the experimental group increased from a mean of 106.60 to 116.47 post-intervention, sustaining at 116.69 in the follow-up. In contrast, the control group's scores across all socio-cultural subdomains remained largely unchanged throughout the three stages. These descriptive patterns suggest that the Maher crystallized intelligence intervention had a meaningful and sustained impact on both fluid and socio-cultural intelligence dimensions among participants in the experimental group.

Prior to conducting the main statistical analyses, all necessary assumptions for the mixed multivariate analysis of variance (MANOVA) were thoroughly assessed and met. The assumption of normality was examined using skewness and kurtosis indices as well as visual inspection of Q-Q plots, confirming that the distribution of scores for all dependent variables was approximately normal across groups and time points. Homogeneity of variances was verified through Levene's test, which indicated no significant differences in error variances between groups. The assumption of homogeneity of covariance matrices was tested using Box's M test and found to be non-significant, supporting the equality of variance-covariance matrices across

groups. Additionally, the assumption of sphericity was examined using Mauchly's test, and in cases where this assumption was violated, the Greenhouse-Geisser correction was applied. Finally, multicollinearity among dependent variables was assessed through correlation matrices, revealing no problematic intercorrelations. Overall, these diagnostic checks confirmed that the data satisfied the required statistical assumptions, ensuring the validity of subsequent inferential analyses.

Table 2. Between-Group Differences in Fluid Intelligence Dimensions Across Assessment Stages

Variable	Source of Variation	SS	df	MS	F	Sig.	Partial Eta Squared
Perception	Test	238.42	2	119.21	41.83	.001	.52
	Group Membership	591.63	1	591.63	5.26	.030	.12
	Test × Group	321.70	2	160.85	56.44	.001	.60
Reasoning	Test	546.92	1.27	431.72	147.55	.001	.80
	Group Membership	1087.21	1	1087.21	10.02	.003	.21
	Test × Group	695.87	1.27	549.30	187.74	.001	.83
Attention	Test	162.27	1.05	154.58	10.17	.002	.21
	Group Membership	407.93	1	407.93	5.04	.030	.12
	Test × Group	174.52	1.05	166.25	10.94	.002	.22
Memory	Test	395.52	1.12	354.83	39.21	.001	.51
	Group Membership	878.48	1	878.48	7.35	.010	.16
	Test × Group	410.08	1.12	367.89	40.66	.001	.52
Processing Speed	Test	309.93	1.38	224.06	100.04	.001	.73
	Group Membership	776.07	1	776.07	6.62	.010	.15
	Test × Group	289.47	1.38	209.26	93.44	.001	.71

As shown in Table 2, significant differences were observed between the experimental and control groups across all dimensions of fluid intelligence. The main effect of the test was significant for perception, reasoning, attention, memory, and processing speed ($p < .001$), indicating overall changes across assessment stages. The effect of group membership was also significant in all dimensions ($p < .05$), showing that the experimental group performed significantly better than the control group. Moreover, the interaction effect of test × group was highly significant for all variables, with partial eta squared values ranging from .22 (attention) to .83 (reasoning), indicating a large effect size and a strong impact of the intervention program on improving fluid intelligence over time compared to the control group.

Table 3. Bonferroni Post-Hoc Test Comparing Fluid Intelligence Means Across Stages

Variable	Group	Pretest–Posttest	Sig.	Pretest–Follow-up	Sig.	Posttest–Follow-up	Sig.
Perception	Experimental	-6.27	.001	-6.62	.001	-0.35	.420
	Control	0.72	1.000	0.29	1.000	-0.44	1.000
Reasoning	Experimental	-9.86	.001	-9.40	.001	0.46	.070
	Control	0.60	1.000	0.56	1.000	-0.04	1.000
Attention	Experimental	-5.20	.001	-4.83	.001	0.37	.220
	Control	0.05	1.000	0.15	1.000	0.11	1.000
Memory	Experimental	-7.91	.001	-7.60	.001	0.31	.490
	Control	0.36	1.000	-0.26	1.000	-0.61	.210
Processing Speed	Experimental	-6.51	.001	-6.87	.001	-0.36	.110
	Control	-0.33	1.000	0.07	1.000	0.40	.530

Bonferroni post-hoc comparisons (Table 3) further clarified the nature of within-group improvements over time. In the experimental group, significant increases were found from pretest to posttest and from pretest to follow-up across all five dimensions of fluid intelligence (perception, reasoning, attention, memory, and processing speed) ($p < .001$ for all). However, no significant differences were observed between posttest and follow-up scores ($p > .05$), indicating that the improvements achieved through the intervention

were sustained over time. Conversely, in the control group, no statistically significant changes were found across any stages for any fluid intelligence dimension, confirming that the observed improvements were exclusive to the intervention and not due to external factors or test repetition effects.

Table 4. Between-Group Differences in Socio-Cultural Intelligence Dimensions Across Assessment Stages

Variable	Source of Variation	SS	df	MS	F	Sig.	Partial Eta Squared
Cultural Intelligence	Test	908.72	2	454.36	373.58	.001	.91
	Group Membership	1702.53	1	1702.53	6.16	.020	.14
	Test × Group	825.52	2	412.76	339.38	.001	.70
Economic Intelligence	Test	461.07	1.32	348.41	144.80	.001	.79
	Group Membership	1165.63	1	1165.63	4.29	.048	.10
	Test × Group	493.27	1.32	372.74	154.91	.001	.60
Social Intelligence	Test	1133.82	2	566.91	252.10	.001	.87
	Group Membership	1952.13	1	1952.13	6.76	.010	.15
	Test × Group	989.22	2	494.61	220.73	.001	.65
Spiritual Intelligence	Test	965.02	2	482.51	529.92	.001	.93
	Group Membership	1817.41	1	1817.41	6.00	.020	.14
	Test × Group	1105.12	2	552.56	606.86	.001	.74
Managerial Intelligence	Test	1045.85	1.28	819.35	423.84	.001	.92
	Group Membership	1786.41	1	1786.41	8.97	.010	.19
	Test × Group	825.72	1.28	646.89	334.63	.001	.70
Philosophical Intelligence	Test	834.65	1.26	660.64	191.37	.001	.83
	Group Membership	2009.01	1	2009.01	7.97	.010	.17
	Test × Group	885.62	1.26	700.98	203.06	.001	.64

As presented in Table 4, significant differences were observed between the experimental and control groups across all dimensions of socio-cultural intelligence. The main effect of the test (assessment stages) was significant for all six variables—cultural, economic, social, spiritual, managerial, and philosophical intelligence—with very large effect sizes ($p < .001$, partial eta squared ranging from .79 to .93). Group membership also yielded significant results in all dimensions, confirming the superior performance of the experimental group compared to the control group. Most notably, the interaction effect of test × group was highly significant for each socio-cultural intelligence dimension, with partial eta squared values indicating large interaction effects (ranging from .60 for economic intelligence to .74 for spiritual intelligence). These results strongly support the effectiveness of the intervention in enhancing socio-cultural intelligence in the experimental group.

Table 5. Bonferroni Post-Hoc Test Comparing Socio-Cultural Intelligence Means Across Stages

Variable	Group	Pretest–Posttest	Sig.	Pretest–Follow-up	Sig.	Posttest–Follow-up	Sig.
Cultural Intelligence	Experimental	-11.70	.001	-11.05	.001	0.65	.090
	Control	0.00	1.000	-0.60	.250	-0.60	.450
Economic Intelligence	Experimental	-8.25	.001	-8.65	.001	-0.40	.310
	Control	0.25	.930	0.05	1.000	-0.20	.990
Social Intelligence	Experimental	-12.30	.001	-12.90	.001	-0.60	1.000
	Control	-0.35	.150	-0.50	.030	-0.15	.990
Spiritual Intelligence	Experimental	-12.35	.001	-12.55	.001	-0.20	1.000
	Control	0.55	.310	0.30	1.000	-0.25	.510
Managerial Intelligence	Experimental	-11.90	.001	-11.75	.001	0.15	1.000
	Control	-0.60	.130	-0.80	.050	-0.20	.310
Philosophical Intelligence	Experimental	-11.15	.001	-11.55	.001	-0.40	.260
	Control	0.30	.330	0.05	1.000	-0.25	1.000

Bonferroni post-hoc comparisons in Table 5 demonstrate significant within-group improvements for the experimental group across all six components of socio-cultural intelligence. Specifically, mean scores for cultural, economic, social, spiritual, managerial, and philosophical intelligence all increased significantly from pretest to posttest and from pretest to follow-up ($p < .001$ for all), indicating that the intervention produced substantial and lasting cognitive gains in socio-cultural domains. However, no significant changes were observed between posttest and follow-up ($p > .05$), confirming the stability of these gains over time. In contrast, the control group exhibited no significant changes across the three stages in any dimension, with all p-values exceeding .05. These results further validate the specific and enduring impact of the Maher crystallized intelligence intervention on the enhancement of socio-cultural intelligence.

Discussion and Conclusion

The purpose of the present study was to examine the effectiveness of the Maher crystallized intelligence psycho-educational intervention on improving both fluid intelligence and socio-cultural intelligence in children. The findings revealed significant between-group differences in both domains, indicating that the experimental group who received the intervention outperformed the control group in all components of fluid intelligence—including perception, reasoning, attention, memory, and processing speed—as well as in all measured dimensions of socio-cultural intelligence, such as cultural, economic, social, spiritual, managerial, and philosophical intelligence. These results demonstrate that the Maher intervention was successful in producing measurable, stable, and meaningful cognitive gains across a wide range of intellectual domains.

In relation to fluid intelligence, the results showed a marked improvement in the experimental group from pretest to posttest and follow-up, while no significant changes occurred in the control group. The interaction effects were highly significant with large effect sizes, particularly for reasoning ($\eta^2 = 0.83$) and processing speed ($\eta^2 = 0.71$), confirming the robust impact of the intervention. These findings align with the theoretical model of Cattell and Horn, who suggested that fluid intelligence is malleable and can be enhanced through appropriate stimulation and educational experiences (1). Empirical support for this assertion has been growing, especially in studies involving children and adolescents. For example, Gooran Savadkohi et al. (2023) reported that metacognitive skills training significantly improved fluid intelligence among secondary school students, providing corroborating evidence for the plasticity of fluid cognitive functions (14). Likewise, Neugnot-Cerioli et al. (2017) demonstrated that game-based training methods could yield substantial gains in both fluid and crystallized intelligence among adolescents with below-average IQs (4). The current study's findings expand on this literature by showing that a structured, multi-domain psycho-educational program can serve as an effective modality for enhancing cognitive performance in diverse populations.

The intervention's impact on socio-cultural intelligence was also substantial and consistent across all measured subdomains. The experimental group showed significant improvements in cultural, economic, social, spiritual, managerial, and philosophical intelligence dimensions, with the largest effect sizes observed in spiritual intelligence ($\eta^2 = 0.74$) and managerial intelligence ($\eta^2 = 0.70$). These findings highlight the broad developmental reach of the Maher intervention, which does not restrict cognitive growth to analytical skills but also fosters values-based, interpersonal, and cultural competencies. This aligns with previous studies by Seadatee Shamir (2024), who found that teaching mathematics skills within the Maher framework

significantly improved crystallized intelligence in middle school students (5), and by Ghanbari and Saadati Shamir (2023), who showed that cognitive training programs can be tailored to support both cognitive and social-emotional domains in children (10).

One of the novel contributions of the present study lies in its simultaneous focus on crystallized and fluid intelligence within a unified framework. The dual impact observed supports the notion proposed by Simpson-Kent et al. (2020) and Tadayon et al. (2020), who suggested that both forms of intelligence may be interconnected through shared neurocognitive mechanisms and can benefit concurrently from targeted interventions (2, 3). This interconnected development is particularly valuable in educational settings where children are required to synthesize learned knowledge with adaptive reasoning skills to navigate academic and social challenges. Furthermore, the study's results align with the meta-analytic work of Olderbak et al. (2019), which emphasized the role of ability-based emotional intelligence as a mediating link between crystallized and fluid capacities (8). The Maher model's integration of emotional, spiritual, and philosophical components may thus offer a more comprehensive and ecologically valid pathway for cognitive development.

Importantly, the posttest–follow-up comparisons revealed no statistically significant differences in either fluid or socio-cultural intelligence dimensions in the experimental group, suggesting that the gains achieved through the intervention were retained over time. This finding aligns with Bajpai et al. (2022), who emphasized that stability in crystallized intelligence can act as a cognitive reserve, supporting long-term adaptability and mental resilience (6). The stability of outcomes also suggests that the Maher intervention may instill durable cognitive and social competencies, a particularly desirable attribute for educational interventions aimed at long-term success. Moreover, Salas et al. (2021) highlighted the predictive value of both Gf and Gc for executive functioning and social cognition among vulnerable populations, further underscoring the real-world utility of the improvements reported in this study (7).

The effectiveness of the Maher program may also be attributed to its attention to developmental and contextual appropriateness. As emphasized by Seadatee Shamir and Zahmatkesh (2022), the Maher Multifunctional Fluid Intelligence Test (MMFIT) was carefully designed and standardized for Iranian students, ensuring cultural relevance and age alignment in both assessment and intervention protocols (13). The educational format of the program, which combines cognitive training with value-oriented and socio-cultural discussions, appears to support a form of holistic development rarely addressed in traditional school-based programs. This was similarly highlighted in the work of Ershadi Chahardeh et al. (2024), who showed that using customized software-based programs to target crystallized intelligence yielded strong cognitive benefits in Iranian elementary school boys (9).

From a theoretical standpoint, the results support the view that crystallized intelligence is not simply a repository of learned information but rather a dynamic and adaptive construct that reflects broader psychological competencies. As Hooman et al. (2013) and Hariri (2017) have noted, intelligence must be understood in a broader ethical, social, and cultural context to fully address the developmental needs of children and adolescents (18, 19). The Maher intervention's inclusion of philosophical, managerial, and spiritual components addresses this call for integrative frameworks. Furthermore, the strong results observed in these non-traditional domains of intelligence suggest that educational systems must evolve to incorporate a wider understanding of intelligence that extends beyond academic achievement and rote knowledge.

Finally, this study contributes to the growing literature on culturally responsive educational interventions in non-Western settings. While much of the literature on intelligence training originates in Western contexts, the Maher model represents a locally developed, empirically validated program that reflects Iranian cultural values and educational structures. This aligns with calls from global scholars for more contextually grounded interventions that take into account the socio-cultural realities of learners (7). By demonstrating the efficacy of such a model, this study helps bridge the gap between global theory and local practice and sets the stage for broader implementation and research across diverse populations.

Despite its valuable contributions, the present study is not without limitations. First, the sample size, though sufficient for statistical power, limits the generalizability of the findings to broader populations. The study focused on a specific age group and geographical context, which may not reflect the cognitive diversity present in other regions or among children with different educational or socio-economic backgrounds. Second, the study relied solely on quantitative assessments of intelligence and did not incorporate qualitative data or observational insights that could provide richer information about the learning processes and emotional engagement during the intervention. Third, although the follow-up phase confirmed the stability of cognitive gains, the duration of follow-up was relatively short, and long-term retention and transfer effects remain uncertain. Finally, while the Maher tests are validated, additional triangulation with neurocognitive or behavioral measures could further strengthen the validity of the outcomes.

Future research should aim to expand the sample to include participants from diverse socio-economic and cultural backgrounds to enhance external validity. It would also be valuable to examine the differential impact of the intervention across age groups and gender to explore potential developmental or demographic moderators. Longitudinal studies with extended follow-up periods are recommended to determine the sustainability of the intervention's effects and their impact on academic achievement and psychosocial adjustment. Moreover, combining quantitative methods with qualitative approaches—such as interviews, classroom observations, or student portfolios—could yield a more comprehensive understanding of how children internalize and apply the cognitive and socio-cultural skills acquired. Finally, further exploration of the neural and emotional correlates of gains in fluid and crystallized intelligence through neuroscientific tools could illuminate the underlying mechanisms of change.

Practically, this study suggests that integrating multidimensional intelligence training into school curricula can be a highly effective strategy for enhancing both cognitive and cultural competencies among students. Educators and school counselors should consider adopting structured, theory-based programs like the Maher intervention to foster not only academic success but also social adaptability and ethical reasoning. Curriculum developers can benefit from designing interdisciplinary content that blends cognitive training with moral, philosophical, and cultural literacy. Moreover, implementing teacher training programs focused on the delivery of intelligence-enhancing interventions can ensure consistency and fidelity in execution. Ultimately, educational policy should recognize the value of such holistic frameworks in preparing students to navigate an increasingly complex, multicultural, and cognitively demanding world.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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