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THE ROLE OF FAMILY FUNCTIONING AND PARENTAL ATTITUDES IN PREDICTING ADOLESCENT ADOPTION OF AI TECHNOLOGY

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ABSTRACT

As AI becomes increasingly integrated into adolescents' lives, it is essential to understand the factors that shape their engagement with AI to foster responsible and confident use. This study examines how family dynamics, based on the McMaster Model of Family Functioning (MMFF), influence adolescents' adoption of AI, focusing on family functioning, parental attitudes, and gender. Using SmartPLS 4, we assessed these relationships. Findings indicate that specific dimensions of family functioning, such as communication, affective responsiveness, and affective involvement, significantly predict adolescents' confidence and interest in AI, with parental attitude further enhancing these effects. Gender differences also emerged, suggesting that boys and girls respond differently to family interactions in their engagement with AI. The findings emphasize the importance of family in shaping responsible AI use and suggest that fostering open communication and emotional support within families can improve adolescents' digital readiness. This study contributes to the growing literature on family influences in technology adoption, recommending family-centered strategies to equip adolescents with the skills and attitudes required for an AI-driven future. Future research directions include examining cross-cultural variations and the longitudinal impacts of family dynamics on technology adoption patterns in adolescence.

Keywords: *Adolescent AI Adoption, Family Functioning, McMaster FAD, Parental Attitudes, Gender Differences, Problem-solving*

1. INTRODUCTION

The rise of Artificial Intelligence (AI) is reshaping adolescents' lives, influencing their educational experiences, social interactions, and development [1]. AI has shifted from futuristic speculation to daily use, appearing in personalized educational platforms, virtual assistants, and interactive applications that facilitate learning, communication, and entertainment [2]. Engaging with AI allows adolescents to develop critical thinking and problem-solving skills, fostering self-directed learning [3]. However, the rapid integration of AI raises challenges, such as concerns about data privacy, misinformation, and algorithmic biases, underscoring the need for responsible and guided AI use [4]. Supporting adolescents in navigating these technologies is essential for building their confidence and encouraging safe, effective technology habits.

Family influences significantly shape adolescents' engagement with technology, with supportive parental involvement linked to healthier technology use and better digital preparedness [5]. In contrast, restrictive parental attitudes may limit adolescents' confidence and skills, potentially hindering their academic and social development [4]. The McMaster Family Assessment Device (FAD) provides a robust framework for examining family dynamics [6]. Research indicates that families with open communication and emotional support encourage healthy digital engagement, while families lacking adaptability and cohesion may see higher instances of problematic technology use, such as internet addiction [7]. Given that AI requires both cognitive and emotional engagement, it is essential to understand how family dynamics facilitate or inhibit adolescents' willingness to adopt AI tools.

Parental attitudes toward technology further shape adolescents' perspectives and engagement with AI [8]. Supportive and encouraging parental attitudes foster healthier and more confident technology use, as adolescents receiving positive reinforcement from parents tend to approach AI with curiosity and openness [9]. Conversely, parental skepticism about AI may foster hesitation or resistance in adolescents, potentially limiting developmental benefits such as improved problem-solving and critical-thinking skills [10]. Research also shows that adolescents mirror parental attitudes in their engagement with technology, underscoring the importance of parental influence in establishing a positive technology experience [11]. Understanding how parental support impacts adolescents' AI engagement is critical for guiding families to foster responsible AI use.

Gender differences are also significant in technology adoption, with research indicating that boys and girls often approach technology differently. For instance, girls may view technology as a tool for communication, while boys may see it as a means of developing technical skills [12], impacting self-confidence and engagement with AI [13]. Yet, few studies have examined whether gender moderates the effects of family dynamics and parental attitudes on AI engagement, a potentially crucial factor in promoting equitable engagement with these tools [14]. Thus, exploring the intersection of gender with family and parental influences is essential to promoting inclusive and supportive AI engagement among adolescents.

While significant research has explored family dynamics and parental attitudes on adolescents' general technology use [15,16], studies specifically focusing on AI adoption are scarce. Moreover, while gender differences in technology engagement are well documented, limited research addresses how gender may moderate the impact of family functioning and parental attitudes on adolescents' AI engagement. This study seeks to address these gaps by examining how family dynamics, parental attitudes, and gender jointly shape adolescents' adoption of AI. Utilizing the McMaster Family Assessment Device [6], we investigate how key aspects of family functioning influence adolescents' confidence and interest in AI, assess parental attitudes as a mediating factor, and explore gender as a moderator. This research provides a comprehensive view of the familial and individual factors driving adolescents' AI adoption, offering insights to support responsible AI engagement.

2. LITERATURE REVIEW

The McMaster Family Assessment Device (FAD), rooted in the McMaster Model of Family Functioning (MMFF), offers a comprehensive framework developed by Epstein et al. (1983) that examines the complex interplay of family dynamics through six fundamental dimensions: problem-solving, communication, roles, affective responsiveness, affective involvement, and behavior control. Each dimension captures a unique aspect of family interactions that collectively shape behavioral patterns and emotional resilience, particularly in adolescents. By providing insights into how family systems operate and influence individual behaviors, the FAD has become an invaluable tool in both clinical and non-clinical research [17]. In this study, the FAD serves as a structured lens to investigate how family dynamics affect adolescents' adaptation to AI. By focusing on how each family dimension influences adolescent behavior, this model allows us to explore the adaptability of adolescents to rapidly evolving technological landscapes, offering a grounded perspective on the potential for family-based interventions that foster constructive adaptation.

2.1 Problem-solving

Problem-solving refers to a family's collective ability to address both practical and emotional challenges collaboratively, fostering resilience, adaptability, and effective coping mechanisms [18]. In the context of adolescent engagement with AI, adaptive problem-solving within families equips young individuals with essential skills to navigate complex issues, including emerging technologies [19]. Families proficient in problem-solving contribute to adolescents' emotional well-being and openness to innovation, which can positively influence their willingness to explore and adopt AI [20]. In addition, a problem-solving-oriented family environment provides psychological safety, where adolescents feel empowered to ask questions, take risks, and learn from mistakes [21]. This safe and supportive context can help mitigate anxieties related to unfamiliar technologies, offering adolescents a stable foundation to approach AI with confidence [22]. Thus, our first hypothesis is proposed:

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H_1. Families with high problem-solving abilities positively influence adolescents' AI use.

2.2 Communication

Communication in a family context refers to the exchange of information, feelings, and thoughts among family members [23]. Effective family communication allows adolescents to voice their perceptions and hesitations about AI, giving parents an opportunity to address concerns and foster an open dialogue [24]. High-quality communication helps families collaboratively explore the benefits and limitations of AI, enhancing adolescents' confidence to engage with the technology in a responsible way [25]. Research indicates that high-quality family communication is associated with increased digital literacy and more responsible use of media [26]. Transparent discussions around digital technology can equip adolescents with the knowledge and self-assurance needed to make informed choices regarding AI [27]. Based on this, we propose the following hypothesis:

H_2. Families with high-quality communication positively influence adolescents' AI use.

2.3 Roles

Defined family roles clarify individual responsibilities within the household, establishing expectations for task completion and participation in shared family goals [28]. This structured approach helps adolescents develop organization, time management, and accountability, which are essential life skills [29]. When families maintain clear and structured roles, adolescents may come to view AI not merely as entertainment but as a productive tool that can assist in personal organization and task management. For example, AI technologies for scheduling, reminders, and planning can reinforce adolescents' organizational skills, supporting a more disciplined lifestyle [30]. Supportive role patterns—where family members contribute equitably and take on roles aligned with their strengths—foster adaptability and resourcefulness in adolescents. These qualities can transfer to how they engage with AI, enabling them to use it effectively to streamline tasks and improve daily functioning [31]. Research suggests that adolescents raised in households with well-defined and shared roles exhibit higher adaptability and a stronger sense of self-efficacy [32]. Using AI tools for task management can further reinforce these skills, enabling adolescents to handle responsibilities both within the family and in broader contexts, such as school or work [33]. Based on this, we propose:

H_3. Family role organization positively influence adolescents' AI use.

2.4 Affective Responsiveness

Affective responsiveness within families refers to the ability to express, validate, and support a wide range of emotions in a constructive manner [34]. This dimension creates an environment where adolescents feel safe, understood, and emotionally supported, fostering engagement with new experiences, including interactions with AI [35]. High affective responsiveness promotes empathetic communication, which is particularly valuable when adolescents encounter challenges related to AI, such as understanding algorithms, navigating privacy issues, or handling ethical concerns [24]. Research suggests that adolescents in emotionally supportive families tend to develop higher self-esteem and confidence, equipping them to explore complex technologies independently and persistently [36]. Such an environment also fosters emotional resilience, helping adolescents manage potential frustrations from AI-related learning difficulties or technical setbacks that might otherwise discourage continued engagement [37]. Based on this, we propose the following hypothesis:

H_4. Families with high affective responsiveness positively influence adolescents' AI use.

2.5 Affective Involvement

Affective involvement in families refers to the level of interest and emotional investment that family members show in one another's activities, goals, and overall well-being [38]. High affective involvement fosters an environment in which adolescents feel valued, supported, and understood, which can influence their openness and confidence in exploring new technologies such as AI [39]. Adolescents who experience genuine emotional investment from their families are more inclined to approach challenges, including the complexities of AI, with curiosity and resilience rather than fear of failure. When families actively engage in adolescents' interests and support their exploration of technology, they provide a foundation that encourages independent learning and self-expression [40]. This emotional support helps adolescents navigate uncertainties around AI, such as learning new tools, understanding AI's potential impacts, and addressing concerns about privacy and ethics. Research shows that adolescents who feel emotionally supported by their families are more likely to develop positive attitudes toward adopting new technologies [41], viewing AI not as intimidating but as a tool that can foster personal growth and help achieve their goals [42]. Based on this, we propose the following hypothesis:

H$_5$. Families with high affective involvement positively influence adolescents' AI use.

2.6 Behavior Control

Behavior control within the family context involves setting clear standards and expectations to help adolescents use technology responsibly [43]. When parents establish guidelines and monitor technology interactions, they can reduce risks associated with excessive or inappropriate use, such as over-reliance on AI for unproductive purposes [44]. Adolescents raised with structured expectations are more likely to develop self-regulation skills, which are essential for maintaining a balanced approach to technology [24]. Parental behavior control creates an environment that fosters responsible technology habits, helping adolescents avoid risky behaviors like over-dependence on AI or exposure to harmful online content [45]. This balanced approach promotes healthier engagement with AI, allowing adolescents to use technology to support learning and productivity while balancing it with other activities, such as social interactions and physical exercise [46]. Based on this, we propose the following hypothesis:

H$_6$. Families with appropriate behavior control practices positively influence positively influence adolescents' AI use.

2.7 Parental Attitudes

Parental attitudes refer to parents' perceptions and beliefs about digital technology, including AI, and how these influence their approach to managing their children's technology use [47]. Studies show that parents' perceptions of AI, such as viewing it as a valuable educational tool, significantly shape how children engage with these technologies. Positive parental attitudes promote greater exposure to AI, fostering cognitive development and digital literacy [48]. In contrast, negative attitudes, driven by concerns about AI's impact on social skills, may restrict adolescents' engagement with AI, limiting their proficiency [49]. Additionally, parents who actively use digital tools themselves model behaviors that enhance their children's comfort with AI [47]. Previous studies highlighted the mediating role of parental attitude between family functioning and adolescents' quality of life, suggesting that parental attitudes similarly mediate the relationship between family dynamics and AI adoption. Thus, this leads to the following hypothesis:

H$_7$. Parental attitudes mediate the relationship between family functioning dimensions and adolescents' AI use.

2.8 Gender Differences

Gender differences play a significant role in moderating the relationship between family functioning and AI adoption among adolescents (Wang et al., 2022). Research indicates that boys and girls are often socialized differently in their approach to technology, with boys typically encouraged to engage with technical tools and problem-solving activities, while girls may encounter more restrictive attitudes and cultural expectations that discourage such engagement [51]. This differential socialization can lead to disparities in AI use, where female adolescents often exhibit higher levels of computer anxiety, lower confidence in their computer abilities, and more stereotypical views about technology [52]. Social role theory [53] posits that societal expectations position women as caregivers, promoting qualities such as nurturance and relationship orientation, while men are expected to exhibit assertiveness and competence. This leads to perceptions where men are rated as more competent and women as warmer [54,55]. Notably, younger generations may experience weaker gender effects due to evolving views on gender roles [56]. Moreover, technology adoption appears to vary by gender, with performance expectancy as a key factor for males and ease of use for females, which aligns with the accessible nature of tools like ChatGPT [57]. Studies show that female students, especially those in humanities or medicine, tend to hold more cautious attitudes toward AI's role in education, while males and students in technology fields exhibit higher usage and optimism[58]. Based on these findings, we propose the following hypothesis:

H$_8$. Gender differences moderate the relationship between family functioning and adolescents' AI use.

3. METHODOLOGY

3.1 Participants and Procedure

This cross-sectional, correlational study aimed to investigate the relationship between family functioning and AI adoption among adolescents. The sample consisted of 350

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adolescents, aged 10 to 17 years, recruited from six schools in diverse socioeconomic areas. A stratified random sampling approach was employed to ensure the inclusion of participants from different socioeconomic backgrounds. The schools were selected to represent a broad range of family environments, facilitating a comprehensive examination of adolescents' technology use across various contexts. Specifically, the strata included socioeconomic status (SES) and urban versus rural settings to capture diversity in family structures and technology access. Prior to data collection, detailed information about the study's purpose, procedures, and ethical considerations was provided to both adolescents and their parents. Informed consent was obtained from both parents and adolescents, ensuring that participation was voluntary and that participants could withdraw at any time without penalty. This process also included assurances of anonymity and confidentiality for all participants, with personal information being de-identified to protect privacy. All data collection procedures adhered to ethical standards approved by the university's ethics committee, and confidentiality of participant information was strictly maintained.

Data collection took place in 2024, with questionnaires administered to the adolescents to gather information on family functioning, attitudes toward AI, and technology adoption. These questionnaires were designed to capture a range of factors, including adolescents' perceptions of their family dynamics and their interactions with AI technologies. In addition to the quantitative data from the surveys, individual interviews were conducted with both adolescents and their parents to provide deeper insights into family behaviors and AI adoption, ensuring a more holistic understanding of the variables under study. The demographic characteristics of the sample were as follows: The mean age of adolescents was 14.3 years, with 55% female and 45% male. The average family size was 4.2 members (*SD* = 1.0), with approximately 2.1 children per household (*SD* = 1.0). The mean age of mothers was 38.6 years (*SD* = 6.7), while the mean age of fathers was 46.1 years (*SD* = 7.4). The educational background of household heads varied, with 6% having completed elementary education, 40.3% holding secondary education, 45.7% having a university degree, and 14% possessing postgraduate qualifications. Socioeconomic status (SES) was diverse, with 34% of families classified as low-income based on income and occupation.

3.2 Measures

3.2.1 McMaster Family Assessment Device (FAD)

The McMaster Family Assessment Device (FAD; Epstein et al., 1983; Mansfield et al., 2015) was used to assess family functioning. The 60-item self-report measure includes six subscales related to the McMaster Model of Family Functioning (MMFF): Problem-Solving (6 items; $\alpha = 0.65$), Communication (9 items; $\alpha = 0.78$), Roles (11 items; $\alpha = 0.73$), Affective Responsiveness (6 items; $\alpha = 0.79$), Affective Involvement (7 items; $\alpha = 0.77$), and Behavior Control (9 items; $\alpha = 0.74$). The FAD has demonstrated good psychometric properties in both adolescent and adult samples [17]. In this study, the overall internal consistency was $\alpha = 0.86$, with the General Functioning subscale showing $\alpha = 0.91$ [60].

3.2.2 General Attitudes toward Artificial Intelligence Scale (GAAIS)

The General Attitudes toward Artificial Intelligence Scale [GAAIS; 61] measures individuals' attitudes toward AI. This 20-item scale includes two subscales: Positive GAAIS (12 items, $\alpha = 0.88$) and Negative GAAIS (8 items, $\alpha = 0.83$). For this study, items were adapted to reflect parental attitudes toward AI, with all negative items rephrased positively. Example items include "*My parents believe AI makes daily tasks easier*" (Positive) and "*May parents think AI could pose risks*" (reversed, Negative).

3.2.3 AI Use scale

AI use was assessed using three items adapted from Davis [62]: "*I will use AI in the next days*," "*I expect my use of AI to continue in the future*," and "*I plan to use AI y in the future*." The scale demonstrated high internal consistency ($\alpha = 0.89$). All items were rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The questionnaire was back-translated into Persian following Sinaiko and Brislin et al.'s [63] procedure to ensure cultural and linguistic appropriateness, and a pre-test with 15 participants confirmed its validity and reliability.

3.3 Analytical Strategy

The research model was assessed through partial least squares structural equation modeling (PLS-SEM) using SmartPLS 4 software. A bootstrapping technique with 5,000 subsamples was applied to examine data robustness. The analysis investigated the moderating role of gender and the mediating role of parental attitude. Significance was determined at a 0.05 level, with confidence

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intervals that excluded zero indicating significant mean effects.

The research model was tested using PLS-SEM with SmartPLS 4 software, chosen for its ability to handle complex models and small-to-medium sample sizes effectively. A bootstrapping technique with 5,000 subsamples was applied to ensure the robustness of the findings, providing confidence intervals for path estimates. The analysis examined the moderating role of gender and the mediating role of parental attitude within the model. Statistical significance was set at $p < 0.05$, with confidence intervals that excluded zero considered as indicating significant effects.

Model fit was assessed using the standardized root mean square residual (SRMR), which measures the difference between observed and predicted correlations, and the normed fit index (NFI) to evaluate incremental fit improvement over a null model. These metrics, commonly applied in PLS-SEM, provided insights into the adequacy of the model fit. Additionally, reliability and validity of the constructs were verified through Cronbach's alpha and composite reliability values, ensuring that each construct was measured consistently and accurately.

4. RESULTS

4.1 Preliminary Analysis

To evaluate the measurement model, reliability, convergent validity, and discriminant validity of the scales were assessed. All factor loadings exceeded 0.70, confirming adequate convergent validity for each construct. Additionally, composite reliability (CR), Cronbach's alpha (α), and average variance extracted (AVE) values met the recommended thresholds of 0.70 and 0.50, respectively, as suggested by Hair et al. [64], indicating strong internal consistency and convergent validity (Table 1).

Discriminant validity was examined using the Fornell–Larcker criterion and the heterotrait-monotrait (HTMT) ratio. Based on the Fornell–Larcker criterion, each construct's square root of AVE was greater than its correlations with other constructs, which supports discriminant validity. HTMT values ranged from 0.359 to 0.846, remaining within acceptable limits and providing additional support for discriminant validity. The structural model's fit indices also demonstrated an adequate model fit. The SRMR was 0.061 for both the saturated and estimated models, indicating good model fit. Additional fit indices, including the chi-square ($\chi^2 = 1736$) and normed fit index (NFI = 0.962), confirmed the adequacy of the model. The model's R^2 value for AI use was 0.468, suggesting that 46.8% of the variance in AI use was explained by the model.

Table 1: Latent and Observed Variables, Reliability, and Validity.

No.	Construct	Fronell-Larcker Criterion								HTMT							α	rho_A	CR	AVE
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7				
1	AIU	0.862															0.827	0.828	0.897	0.743
2	AFR	0.591	0.86							0.685							0.883	0.887	0.919	0.74
3	AFI	0.636	0.705	0.86						0.742	0.797						0.882	0.885	0.919	0.74

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4	BC	0.574	0.73	0.83	0.807					0.678	0.836	0.952					0.865	0.866	0.903	0.651
5	CM	0.564	0.723	0.689	0.698	0.808				0.682	0.845	0.813	0.83				0.822	0.823	0.882	0.652
6	PA	0.806	0.576	0.601	0.573	0.592	0.802			0.91	0.62	0.652	0.626	0.666			0.938	0.941	0.947	0.643
7	RL	0.51	0.772	0.73	0.761	0.821	0.525	0.801		0.584	0.857	0.808	0.852	0.946	0.556		0.919	0.923	0.934	0.641
8	PS	0.4	0.595	0.547	0.584	0.62	0.421	0.589	0.871	0.533	0.771	0.708	0.762	0.823	0.518	0.745	0.681	0.686	0.862	0.758

Notes: AI use = AIU, Affective Responsiveness = AFR, Affective Involvement = AFI, Behavior Control = BC, Communication = CM, Parental attitude = PA, Role = RL, Problem solving = PS, Heterotrait–monotrait ratio = HTMT.

4.2 Structural Model

The PLS-SEM analysis results showed that five of the seven hypotheses were supported with significant associations at a 0.01 significance level (Table 2). Specifically, communication demonstrated a significant positive association with AI use ($\beta = 0.26$, $t = 2.587$, $p = 0.01$), supporting H_2. Additionally, affective responsiveness ($\beta = 0.284$, $t = 3.452$, $p = 0.001$) and affective involvement ($\beta = 0.412$, $t = 4.748$, $p < 0.001$) were also significantly related to AI use, confirming H_4 and H_5. However, the associations between problem-solving ($\beta = -0.048$, $t = 0.769$, $p = 0.442$), role ($\beta = -0.232$, $t = 2.329$, $p = 0.02$), and behavior control ($\beta = 0.051$, $t = 0.564$, $p = 0.573$) with AI use were not significant, leading to the rejection of H_1, H_3, and H_6.

The effect size (f^2) for 3each predictor was also examined to assess its contribution to explaining AI use. Based on Cohen's [65] guidelines, affective responsiveness ($f^2 = 0.05$) and affective involvement ($f^2 = 0.088$) had small but meaningful effects on AI use, indicating their modest influence on the model's explanatory power. Communication ($f^2 = 0.036$) and role ($f^2 = 0.024$) also demonstrated small effect sizes, while behavior control ($f^2 = 0.001$) and problem-solving ($f^2 = 0.002$) contributed minimally. The overall model fit was moderately high, with $R^2 = 0.468$, indicating that 46.8% of the variance in AI use was explained by the included predictors.

Table 2: Results of the Path analysis: Direct Effect.

Hypothesis	IV	DV	Path coefficient	T statistics (|O/STDEV|)	Sig	Conclusion
1	PS	AIU	0.048-	0.769	0.442	NS
2	CM	AIU	0.26	2.587	0.01	SN
3	RL	AIU	0.232 -	2.329	0.02	NS
4	AFR	AIU	0.284	3.452	0.001	SN
5	AFI	AIU	0.412	4.748	0.000	SN
6	BC	AIU	0.051	0.564	0.573	NS

4.3 Mediation Test of Parental Attitude

The mediation analysis underscores the role of parental attitude in the relationship between several predictors and AI use. Results revealed that the direct effects of problem-solving on AI use were not statistically significant, $\beta = -0.041$, $t = 0.843$, $p = 0.399$, suggesting that problem-solving alone does not substantially influence AI use. In contrast, communication showed a significant direct effect on AI use, *β* = 0.261, *t* = 2.592, *p* = 0.010, indicating that communication independently impacts AI use. Similarly, role (β = 0.234, *t* = 2.350, *p* = 0.019), affective responsiveness (*β* = 0.180, *t* = 2.712, *p* = 0.041), and affective involvement (*β* = 0.285, *t* = 2.832, *p* = 0.005) also demonstrated significant direct effects, emphasizing the influence of these dimensions on AI use. In contrast, behavioral control showed neither a significant direct (*β* = -0.100, *t* = 0.134, *p* = 0.894) nor indirect effect via parental attitude (*β* = 0.060, *t* = 1.082, *p* = 0.279) (Table 3).

Indirect effects showed that parental attitude significantly mediated the relationship between communication, affective responsiveness, affective involvement, and role with AI use. For instance, the indirect effect of communication through parental attitude was significant, β = 0.216, *t* = 3.369, *p* = 0.001, indicating that parental attitude enhances communication's impact on AI use. Similarly, affective responsiveness (*β* = 0.134, *t* = 2.143, *p* = 0.032) and affective involvement (*β* = 0.180, *t* = 2.712, *p* = 0.007) were positively mediated by parental attitude, suggesting that these dimensions significantly contribute to AI use when parental attitude serves as a mediator. The model demonstrated strong explanatory power, with R^2 values of 0.693 for AI use and 0.436 for parental attitude. Furthermore, the Q^2 values indicate robust predictive relevance, particularly for parental attitude (Q^2 = 0.563), affective responsiveness (Q^2 = 0.554), and affective involvement (Q^2 = 0.553), reinforcing the importance of these affective dimensions in explaining AI use.

Table 3: The Mediating Effect of Parental Attitude.

Path direction	Total effect			Direct effect			Indirect effect		
	β	*t*	*P*	*β*	*t*	*P*	*β*	*t*	*p*
PS→AIUSE	-0.047	0.759	0.448	-0.041	.843	0.399			
COM→AIU	0.261	2.592	0.010	.0450	.628	0.530			
RL→AIU	0.234	2.350	0.019	0.107	1.376	0.169			
AFR→AIU	0.211	2.244	0.028	0.18	2.712	0.041			
AFI→AIU	0.285	2.832	0.005	0.229	3.154	0.005			
BC I→AIU	0.096	1.082	0.894	-0.10	0.134	0.894			
PS→PATT→ AIU							0.007-	0.16	0.873
CM→PATT→ AIU							0.216	3.369	0.001
RL→PA→ AIU							0.127	1.999	0.046
AFR→PA→ AIU							0.134	2.143	0.032
AFI→ PAT→ AIU							0.18	2.712	0.007
BC→ PAT→ AIU							0.06	1.082	0.279

Note. AI use = AIU, Affective Responsiveness = AFR, Affective Involvement = AFI, Behavior Control = BC, Communication = CM, Parental attitude = PA, Role = RL, Problem solving = PS.

4.4 Moderating Test of Gender

To investigate the moderating role of gender, a multiple-group analysis (MGA) was conducted, as shown in Table 4. Prior to the MGA, measurement invariance was assessed using the Measurement Invariance of Composite Models (MICOM) procedure. The permutation test yielded *p*-values greater than 0.05 for most variables, indicating that compositional invariance was achieved across gender groups. The sample was then divided into male and female groups to proceed with the analysis. The Henseler-MGA nonparametric technique was used to evaluate the differences in path coefficients between these groups, allowing for estimation of group differences within the PLS-SEM framework [66].

The results in Table 4 indicate varying relationships across gender. For the path between problem-solving and AI use, no significant gender difference was found (*p* = 0.061), though a slight variance in magnitude was noted. However, for the path between communication and AI use, a significant difference emerged between males and females (*p* = 0.026), with males showing a stronger path coefficient (*β* = 0.426) compared to females (*β* = 0.248). The path from role to AI use did not significantly differ by gender (*p* = 0.261), while affective responsiveness and affective involvement showed some gender-based differences, though these were not consistently significant across all comparisons. Behavioral control also showed slight variance across gender, though this difference was not significant (p = 0.246). These findings suggest nuanced gender-based differences in the influence of certain parental factors on AI use, underscoring the importance of considering gender when examining these dynamics.

Table 4: PLS-MGA results.

Path	Female			Male			Δ (female – male)	Δ t (female vs male)	p (female vs male)
	Original	t	p	Original	t	p			
PS→AIUSE	0.123	2.41	0.045	0.284	6.092	0.000	-0.152	1.884	0.061
COM→AIUSE	0.248	3.213	0.000	0.426	9.536	0.000	-0.168	2.245	0.026
ROLE→AIUSE	0.361	5.221	0.000	0.316	8.091	0.000	0.075	1.126	0.261
FFR→AIUSE	0.178	1.753	0.080	0.235	5.708	0.000	-0.046	0.398	0.692
AFFI→AIUSE	0.211	2.420	0.016	0.379	8.848	0.000	-0.159	1.592	0.115
BCI→AIUSE	0.231	4.476	0.000	0.329	9.442	0.000	0.125	1.169	0.246

Note. AI use = AIU, Affective Responsiveness = AFR, Affective Involvement = AFI, Behavior Control = BC, Communication = CM, Parental attitude = PA, Role = RL, Problem solving = PS.

5. DISCUSSION

This study provides novel insights into the interplay between family functioning, parental attitudes, and gender in shaping adolescents' engagement with AI, addressing a critical gap in the literature on technology adoption during adolescence. Unlike prior research that predominantly emphasizes individual or institutional factors, this study highlights the pivotal role of family dynamics, grounded in the McMaster Model of Family Functioning (MMFF), in predicting adolescents' confidence and interest in AI. By integrating dimensions of family functioning—such as communication, affective responsiveness, and involvement—with parental attitudes as a mediating factor, this research offers a theoretical contribution by elucidating the mechanisms through which familial interactions influence adolescents' digital behaviors.

Practically, the findings underscore the importance of fostering open communication and emotional support within families to prepare adolescents for an AI-driven future. The identification of gender-specific responses to family dynamics further enriches this understanding, offering actionable insights for designing targeted, family-centered strategies to promote balanced and responsible AI use. These strategies can help equip adolescents with the confidence and digital literacy necessary to thrive in an increasingly technological world.

The findings indicate that not all dimensions of family functioning equally influence adolescents' AI engagement. Communication, affective responsiveness, and involvement emerged as significant predictors. Open communication exhibited a moderate positive effect, indicating that transparent family exchanges foster environments conducive to AI adoption. This aligns with prior research emphasizing the role of parent-child communication in enhancing digital literacy and creating supportive contexts for technology use [67]. Similarly, affective responsiveness and involvement had strong positive effects, underscoring the importance of emotional support and shared family activities in fostering adolescents' confidence and interest in AI. These findings are consistent with research linking emotional bonds to positive attitudes toward technology [68,69].

Conversely, problem-solving, roles, and behavior control did not significantly influence AI engagement. The lack of a significant effect for problem-solving suggests that while it is essential for general family functioning, it may not directly impact AI-related behaviors. Additionally, the negative relationship observed for roles implies that rigid family structures may hinder adolescents' exploration of new technologies, potentially due to restricted flexibility or autonomy. The non-significant effect of behavior control aligns with literature suggesting that excessive or insufficient parental monitoring can diminish adolescents' intrinsic motivation to engage with technology [70]. These results collectively highlight that fostering emotional engagement and effective communication within families is more impactful for encouraging AI adoption than relying on structured problem-solving or rigid role allocation.

6. IMPLICATIONS

The implications of these findings are significant for both families and policymakers. Affective responsiveness and involvement contribute to psychologically safe environments that encourage exploration and reduce fear of failure, while open communication demystifies technology and offers adolescents role models for responsible AI use [71]. Interventions aimed at fostering AI adoption among adolescents should prioritize cultivating emotional support and open communication within families. For example, parent workshops could focus on nurturing emotionally supportive environments and improving digital communication skills to bridge generational gaps in technology use.

Parental attitudes also play a crucial role in shaping family dynamics and technology adoption. Positive parental perceptions of AI can amplify the impact of communication and emotional engagement, creating a synergistic effect that benefits the entire family [72–74]. Targeted programs to improve parental attitudes, such as awareness campaigns, workshops, and hands-on training sessions, could enhance the likelihood of family-wide AI adoption. These interventions should emphasize the interplay between relational and individual predictors to maximize their impact.

This study also underscores the importance of examining gender as a moderating factor in the relationships between parental factors and AI use. For example, the stronger influence of communication on AI use among males suggests that fostering open, structured communication may be particularly effective for this group [75,76]. Conversely, the nuanced effects of affective responsiveness and involvement indicate that emotional engagement may resonate differently with males and females, reflecting gendered variations in emotional processing and family dynamics [77]. From an application perspective, gender-sensitive interventions could enhance the effectiveness of family-centered strategies. For instance, programs designed to improve communication and emotional involvement might adopt direct, goal-oriented approaches for males, while emphasizing emotional connections and responsiveness for females. Policymakers and educators should integrate these insights into technology adoption campaigns to ensure inclusivity and efficacy.

7. LIMITATION AND FUTURE STUDIES

This study's cross-sectional design limits causal conclusions, suggesting that future research use longitudinal approaches to capture changes over time. The reliance on self-reports may introduce bias; observational methods could help validate these findings. Additionally, our single-country sample calls for cross-cultural studies to better understand how family functioning and parental attitudes toward AI may vary globally. Expanding beyond parental attitudes, future research could examine influences such as peer attitudes, school environment, and personal traits. Gender differences in AI engagement also warrant further exploration to develop gender-specific educational interventions. Lastly, studying the long-term impact of family dynamics on adolescents' technological readiness could reveal sustained effects into adulthood.

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