

Extracurricular Time Use and Adolescent Creativity: Differential Mechanisms Across Gender and Cohort Groups



Yawen Cheng^{1,2} & Xiaoting Huang^{*, 1,2}

¹*Institution of Economics of Education, Peking University, China*

²*Graduate School of Education, Peking University, China*

Abstract: Creativity has drawn increased attention from educators in recent years, yet the impact of diverse uses of extracurricular time on adolescent creativity, along with the heterogeneity of such influence, has not been thoroughly explored. This study examines the impact of extracurricular time use on adolescent creativity, using data from the OECD 2019 Survey on Social and Emotional Skills (SSES). Results reveal that spending time on homework, online games, online chatting, and entertainment negatively impact creativity, while time spent on exercise, meeting friends, and social activities positively correlate with it. Furthermore, there are significant differences across gender groups and cohort groups. For example, a negative correlation is found between the time girls spent on homework and their creativity levels, while boys exhibit a positive correlation between their creativity and time spent socializing. In terms of mechanisms, academic anxiety mediates the relationship between extracurricular time use and adolescent creativity. Academic anxiety has a more pronounced negative effect on girls' creativity, while interactions with friends could significantly mitigate this effect. Moreover, the mediating effect of academic anxiety exhibit significant path differences among different cohorts. These findings provide insights for how to use extracurricular activities to improve creativity among different groups of adolescents.

Keywords: creativity, time use, academic anxiety, gender difference, Survey on Social and Emotional Skills (SSES)

1. Introduction

Creativity serves as a fundamental driving force of innovation, providing a solid foundation for technological and industrial progress (Adams & Owens, 2015). In the labor market, creativity is the most demanded “soft skill” by companies (Petronc, 2019; Pate, 2020). And when it comes to education, creativity has also been identified as one of the strongest predictors of academic achievement and is closely linked to well-being and lifelong success as well (OECD, 2021).

Adolescence is a critical period for nurturing creativity. Consequently, many scholars and institutions have investigated methods to enhance creativity in adolescents. Most studies focus on the impact of project interventions or experimental settings on adolescent creativity. For example, Sintra (Portugal) has organized regular learning programs to promote the development of social and emotional skills (including creativity), while the Irish government has launched the Creative Youth Plan (CYP) and placed culture and creativity at the core of its learning process. In general, a flexible, diverse, inclusive, and supportive school environment can

Corresponding Author: Xiaoting Huang
Peking University, China
Email: xthuang@pku.edu.cn

©The Author(s) 2025. Published by BONI FUTURE DIGITAL PUBLISHING CO.,LIMITED. This is an open access article under the CC BY License(<https://creativecommons.org/licenses/by/4.0/>).

promote the development of students' creativity (Davies et al., 2013).

A major challenge to these existing studies, however, is that today's adolescents navigate a more dynamic environment in which numerous factors beyond school activities influence their development (Tülübaşı et al., 2022). First of all, extracurricular learning activities may contribute to the development of creativity. Scholars have shown that appropriate homework is essential for cultivating creativity (Fan et al., 2022). However, excessive homework may precipitate test anxiety, which is detrimental to the growth of creativity (Bereczki & Kárpáti, 2018). In addition, after-school sports and social activities can impact creativity significantly. For example, previous research has emphasized the positive effects of exercise on creativity (Bollimbala et al., 2019). Also, peer interactions and social networks play a crucial role in fostering students' creativity (Leary & Baumeister, 2000). Last but not least, the impact of Internet use on students' creativity has not yet reached a consensus (Chang, 2013). And the issue of smartphone use and social media addiction has received increasing scholarly attention in recent years (Tülübaşı et al., 2023).

Existing studies have primarily focused on the effects of project interventions or experimental settings, with limited attention to the real-world learning contexts and group differences. Moreover, the role of academic anxiety as a mediating factor in this relationship remain relatively unexplored. Therefore, based on creativity investment theory, 4c model and ecological systems theory, the current study aims to explore the impact of various extracurricular activities on adolescent creativity and investigate whether these effects differ by gender and cohort.

2. Literature Review

2.1 Extracurricular time use and adolescent creativity

The critical role of extracurricular time use in fostering adolescent creativity can be effectively understood through the combined perspectives of the

investment theory and the 4C model. According to the investment theory of creativity, individuals are more likely to generate creative ideas and outcomes when immersed in an environment conducive to creativity (Sternberg & Lubart, 1991, 1995). In addition, the 4C model provides a more nuanced understanding of the optimal educational environment for nurturing creativity. It emphasizes that adolescent creativity evolves through a progression: from passive reception to active exploration, from unstructured play to the development of personal interests, and from external pressures to self-directed learning (Kaufman & Beghetto, 2009; Dai, 2021).

Specifically, with regard to the role of extracurricular learning activities in creativity, there is as yet no consensus among scholars. Appropriate homework not only consolidates what has been learned in class but also provides students with extra opportunities for practice, which are crucial for fostering creativity (Fan et al., 2022). However, an excessive amount of homework can lead to academic burden and anxiety (Cooper et al., 2012), impeding academic achievement, negatively impacting physical and mental health (Jiang & Saito, 2022), and undermining essential elements of creativity, such as curiosity and the ability to challenge norms (Zheng, 2013).

In addition, extracurricular leisure activities have been shown to exert divergent effects on creativity. First, neuroscience research suggests that physical activities promote the generation of positive emotions (Steinberg, 1997), increase flexibility and fluency in thinking (Aga et al., 2021; Yuan et al., 2022). Second, high-quality peer interaction not only contributes to increased happiness and self-esteem but also helps to reduce anxiety (Leary & Baumeister, 2000), which are beneficial for enhancing creativity. Third, the dual impact of internet usage warrants consideration, as it can simultaneously facilitate creativity and anxiety. For example, while creative online games can enhance students' creativity (Blanco Herrera et al., 2019), online game addiction negatively correlates with students' creativity

(Calvert & Valkenburg, 2013). And the problem of social media addiction has gradually attracted attention nowadays (Tülübaşı et al., 2022; Tülübaşı et al., 2023).

Numerous studies have discussed the impact of project-based interventions and experimental settings on adolescent creativity (Chen et al., 2021), but no research has examined how adolescents' time use affects their creativity in real-world learning contexts and whether there is group heterogeneity in the effects and mechanisms. Specifically, it is crucial to examine heterogeneity in these effects, as the impact of time use on creativity may vary across groups. In particular, girls and boys differ in initial levels of creative flexibility and originality, influenced by social expectations and educational environment. For example, teacher support positively predicts boys' creative flexibility, but has no significant effect on girls (Zhang et al., 2020). In addition, while upper elementary students show linear growth in creative fluency, their flexibility and originality show nonlinear growth patterns (Zhang et al., 2020). These differences suggest that extracurricular time use may influence adolescent creativity in different ways.

Furthermore, the time adolescents spend on various extracurricular activities, ranging from academic tasks to leisure activities, may shape their creative potential in both direct and indirect ways. To understand how extracurricular time use influences creativity, we need a comprehensive approach that considers both extracurricular learning and leisure activities. And exploring the heterogeneity and its potential mechanisms not only adds specificity to our understanding but also informs the design of personalized interventions.

2.2 Mediating role of academic anxiety

Anxiety has been found to have a complex impact on creativity. Theories such as the Cognitive Interference Model (Tobias, 1985), the Dual Processing Model (Kinsbourne & Hicks, 1978), and the Behavioral Inhibition Model (Flaherty, 2005) all suggest that anxiety has a significant negative impact on individual creativity. In general, anxiety affects creative performance by disrupting cognitive

processes. Specifically, anxiety has been demonstrated to lead to cognitive rigidity, where individuals find it challenging to think outside the box or explore novel ideas as their focus narrows to immediate concerns and stressors (Mikulincer et al., 1990; Fales et al., 2008).

Prior research has established a significant link between academic burden and psychological anxiety in students (Loton et al., 2016). In the context of exam-oriented education system, academic anxiety is particularly prevalent among students, both academic performance and skill development (Von der Embse et al., 2018).

Therefore, it is noteworthy that the time spent on extracurricular activities may influence adolescent creativity through the mediating factor of academic anxiety. Ecological systems theory (Bronfenbrenner & Morris, 2007) offers an essential perspective for examining how extracurricular activities influence student creativity through academic anxiety. It highlights the dynamic interaction between individuals and their environments. As a key element of the microsystem, extracurricular activities not only provide opportunities for skill development but may also indirectly enhance creativity by reducing anxiety levels. For instance, Oberle et al. (2020) found that adolescents engaged in extracurricular activities experienced a notable reduction in anxiety. Furthermore, according to this theory, the interaction of individual characteristics with micro-systems may moderate the relationship between anxiety and creativity. For example, girls who participate in team sports may relieve anxiety through social support, thus freer to explore creative expression (Rauscher & Cooky, 2016).

In particular, an increase in extracurricular learning time could exacerbate academic anxiety (Yang et al., 2023), which may impede the development of adolescent creativity. Conversely, engaging in low-intensity exercise has been found to alleviate psychological stress (Olefir et al., 2019). An experimental study of 50 Chinese students demonstrated that aerobic exercise immediately improved divergent and convergent thinking (Zhao et

al., 2022). And last but not least, cultivating positive friendships has been shown to help reduce academic anxiety (Hoferichter & Raufelder, 2015), suggesting that peer interaction may also play an important role in creativity development (Han et al., 2013).

Drawing on a comprehensive review of existing literature and empirical evidence, we propose a theoretical framework suggesting that different types of extracurricular time use have differential impacts on adolescent creativity, and that these impacts may vary across demographic groups. Furthermore, we hypothesize that academic anxiety mediates this relationship.

To test these hypotheses, we adopt a multi-step analytical approach. First, we construct a basic structural equation model to assess the direct relationship between extracurricular time use and adolescent creativity. This baseline model provides a foundation for understanding the basic associations between these variables. Second, we conduct a heterogeneity analysis to explore whether the effects of extracurricular time use on creativity differ by gender and cohort. This step helps determine whether the relationship varies significantly across specific subgroups of adolescents. Finally, we develop a multi-group structural equation model (MSEM) to examine the mediating role of academic anxiety in the link between extracurricular activities and creativity. This model allows us to analyze how academic anxiety may shape this relationship differently across gender and cohort groups.

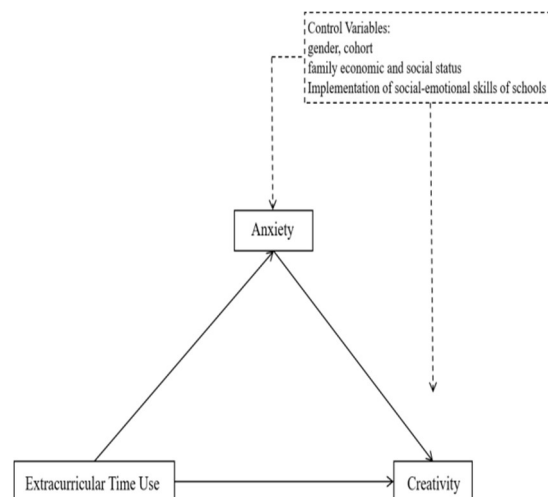


Figure 1 Proposed mediation model of extracurricular time use on adolescent creativity

Note: Extracurricular time use includes time spent on homework, online games, online chatting, online entertainment, online information, exercise, friends meeting and social networks.

3. Method

3.1 Participants

Data used in the present study were derived from the Chinese dataset of the OECD 2019 Survey on Social and Emotional Skills (SSES). In May 2023, the OECD initiated the second round of its Survey on Social and Emotional Skills (SSES) among adolescents, targeting 10 - and 15 - year - olds. The survey of 10-year-olds aims to assess their social and emotional development and future educational needs, while the survey of 15-year-olds, who are at the end of compulsory education, evaluates schooling achievements in these areas. Development for the first round began in 2016 with extensive literature reviews. And researchers conducted cognitive interviews with 10 - to 11 - year - olds in the US and an online survey in late 2017 to early 2018. An item trial followed in April - May 2018 across six cities with adolescents of both ages. Then, each city did a field test, leading to the formal survey at the end of 2019.

Conducted across a total of 10 cities in 9 countries, the 2019 SSES represents a pioneering international endeavor to compile rich information on

students' social and emotional skills and thus provide clear implications for how to enhance student competencies. And in addition to the assessment of social and emotional competencies, the SSES includes a wide range of questionnaires targeting students, families, teachers, and principals. This extensive collection of background information further provides a robust foundation that is closely aligned with our research objective.

In particular, the survey engaged 7,268 students from 151 primary and secondary schools in Suzhou, a coastal city in eastern China. Due to a significant number of incomplete responses to the parent questionnaire, the analysis focused on the student questionnaire, which was then integrated with the corresponding principal questionnaire. This approach resulted in a final sample comprising 6,903 observations, with all essential variables devoid of missing values.

3.2 Measures

3.2.1 Creativity

The SSES uses six items to assess students' creativity (Table 1). Students respond to these items using a Likert scale, selecting from "strongly disagree," "disagree," "generally agree," "agree," to "strongly agree." Initially, the SSES assigns scores ranging from 0 to 4 points based on these responses. Subsequently, the Generalized Partial Credit Model (GPCM) is applied to compute the preliminary creativity score. And adjustments are also made to address potential estimation biases associated with default response styles. Finally, the score undergoes a linear transformation, resulting in a final value with a mean of 500 points and a standard deviation of 100 points. Our research was based on the final score provided by the SSES. This scale showed good internal consistency ($\alpha = 0.86$).

Table 1 Student Self-Rated Creativity Scale

Items	Degree of agreement
find new ways to do things	0=strongly
original, come up with new ideas	disagree,
sometimes find a solution other	1=disagree,
people don't see	2=generally
like to create things	agree,
have a good imagination	3=agree,
find it difficult to create new	4=strongly
things	agree

Time on various extracurricular activities

3.2.2 Extracurricular time use

The SSES uses various items to capture the time students allocate to different extracurricular activities, such as homework, exercise, social interactions, and online activities. Specifically, the survey prompts students with the question: "During a typical weekday after school, how much time do you spend on the following activities?" Students respond by selecting from the options: "1 = no time," "2 = 1-60 minutes per day," "3 = between 1 and 4 hours per day," and "4 = more than 4 hours per day." A higher score indicates a greater amount of time dedicated to the activity. It is important to note, however, that the survey's limited four-response format may not fully capture the time students devote to these activities.

4. Data Analysis

All data analyses were conducted using Stata software (Stata version 16.0). Descriptive statistics were performed first to summarize the sample characteristics and distributions of variables. Then, baseline structural equation models were constructed to examine the relationships between extracurricular time use and adolescent creativity. And heterogeneity analyses were also conducted to explore potential differences in these relationships across different subgroups. Finally, a mediation model was constructed to evaluate the mediating role of academic anxiety in the relationship between extracurricular time use and adolescent creativity.

The structural equation modeling (SEM) approach was employed to allow for the simultaneous examination of multiple relationships and the testing of direct and indirect effects. Model fit was evaluated using a variety of indices in Stata, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and their respective 90% confidence intervals. A model fit was considered acceptable. An acceptable model fit was determined by CFI and TLI values ≥ 0.90 , and RMSEA and SRMR values ≤ 0.08 .

The baseline model of this study was as follows:

$$creativity_{ij} = \beta_1 T1_{ij} + \beta_2 T2_{ij} \dots + \beta_8 T8_{ij} + \gamma X + e_{ij} \quad (1)$$

$creativity_{ij}$ was the final creativity score of the student i in school j . $T1_{ij}$ - $T8_{ij}$ represented the time spent on homework, online games, online chatting, online entertainment, online information, exercise, friends meeting and social networks, respectively. β_1 - β_8 was the marginal effect of time spent on different extracurricular activities on adolescent creativity. X represented a series of control variables. Referring to Hora et al. (2021), we included a number of control variables that may influence adolescent creativity, such as gender (boy = 1, girl = 0), cohort (10 years old = 1, 15 years old = 0) and family social and economic status. In addition, OECD (2021) has pointed out that the implementation of social-emotional skills in schools was also related to the development of students' social and emotional skills. To this end, we further included school-level variables, such as whether the student's school provided or sponsored formal training on social and emotional skill development for teachers inside the school, whether the student's school provided or sponsored formal training on social and emotional skill development for teachers outside of the school, and whether the student's school evaluated students' achievement in social and emotional skills. e_{ij} was the error term.

In addition, there is a considerable discrepancy in the creativity exhibited by students of varying genders and age groups (OECD, 2024). Thus, the present study aimed to delve deeper into the relationship between extracurricular time use and adolescent creativity, with a particular focus on the potential differences in this relationship across diverse student demographics using Multi-group Structural Equation Modeling (MSEM). Specifically, boys and girls differ in psychological characteristics, behavioral patterns, and social expectations, and these differences may affect the development of creativity (Cheung & Ping, 2010). In addition, different cohorts differ in their cognitive development and external environment, and the development trajectory of creativity may also vary depending on the age (Shah & Gustafsson, 2021). The models for heterogeneity analysis were as follows:

For different genders:

$$creativity1_{ij} = \beta_{1,1} T1_{ij} + \beta_{2,1} T2_{ij} \dots + \beta_{8,1} T8_{ij} + \gamma_1 X + e1_{ij} \text{ for male} \quad (2)$$

$$creativity2_{ij} = \beta_{1,2} T1_{ij} + \beta_{2,2} T2_{ij} \dots + \beta_{8,2} T8_{ij} + \gamma_2 X + e2_{ij} \text{ for female} \quad (3)$$

For different cohorts:

$$creativity3_{ij} = \beta_{1,3} T1_{ij} + \beta_{2,3} T2_{ij} \dots + \beta_{8,3} T8_{ij} + \gamma_3 X + e3_{ij} \text{ for younger cohorts} \quad (4)$$

$$creativity4_{ij} = \beta_{1,4} T1_{ij} + \beta_{2,4} T2_{ij} \dots + \beta_{8,4} T8_{ij} + \gamma_4 X + e4_{ij} \text{ for older cohorts} \quad (5)$$

Finally, we constructed the following structural mediation model to examine the role of academic anxiety in the relationship between extracurricular time use and adolescent creativity. Structural equation modelling enabled the simultaneous examination of the relationships between multiple variables and the testing of direct and indirect relationships in subsequent analysis.

$$anxiety_{ij} = \alpha_1 T1_{ij} + \alpha_2 T2_{ij} \dots + \alpha_8 T8_{ij} + \delta X + \varepsilon_{ij} \quad (6)$$

$$creativity_{ij} = \theta anxiety_{ij} + \beta_1 T1_{ij} + \beta_2 T2_{ij} \dots + \beta_8 T8_{ij} + \gamma X + e_{ij} \quad (7)$$

The only difference from the baseline model and the present model was the incorporation of academic anxiety as a mediating variable. By considering Eq.(6) and Eq.(7) simultaneously, we were able to not only examine the potential effect of extracurricular time use on academic anxiety but also derive the direct effect of extracurricular time use and the indirect effect through academic anxiety. Furthermore, to better understand the relationship between extracurricular time use and adolescent creativity, we used the MSEM model to examine potential differences in the mechanisms across different genders and cohorts.

5. Results

5.1 Descriptive statistics

Table 2 presents descriptive statistics and the results of the t-tests comparing gender and cohort differences. Panel A of Table 2 shows that girls scored significantly lower on creativity than boys ($t = -6.294$, $p < 0.001$). Consistent with previous studies, female students are generally found to be less creative than male students in eastern cultures (Hu &

Yu, 2002). In addition, there were significant differences in time use between girls and boys. Girls spent more time on homework ($t = 3.455$, $p < 0.001$), while boys spent more time on leisure activities, including online games ($t = -21.395$, $p < 0.001$), online entertainment ($t = -5.825$, $p < 0.001$), exercise ($t = -11.131$, $p < 0.001$) and social networks ($t = -6.040$, $p < 0.001$).

Panel B of Table 2 shows that the younger cohort scored significantly higher on creativity than their older counterparts ($t = 28.808$, $p < 0.001$). This finding is consistent with results observed in prior research based on PISA data (OECD, 2024). Moreover, there were significant differences in extracurricular time use between the two cohorts. Specifically, the younger ones spent more time exercising ($t = 22.443$, $p < 0.001$) and meeting friends ($t = 13.404$, $p < 0.001$), whereas the older ones spent more time on homework ($t = -26.666$, $p < 0.001$), online chatting ($t = -33.411$, $p < 0.001$), and online entertainment ($t = -22.120$, $p < 0.001$).

Given these disparities, it is important to further examine creativity differences among subgroups and explore their potential underlying causes.

Table 2 Descriptive and difference statistics across subgroups

Panel A. Descriptive and difference statistics across gender

Variable	Girls (N=3267)		Boys (N=3636)		t
	Mean	SD	Mean	SD	
Creativity	593.929	104.319	609.972	106.994	-6.294***
Time spent on homework	2.768	0.703	2.708	0.730	3.455***
Time spent on online games	1.408	0.674	1.819	0.892	-21.395***
Time spent on online chatting	1.611	0.761	1.655	0.805	-2.318**
Time spent on online entertainment	1.669	0.758	1.782	0.842	-5.825***
Time spent on online information	1.706	0.612	1.751	0.684	-2.922***
Time spent on exercise	1.955	0.733	2.163	0.813	-11.131***
Time spent on friends meeting	1.788	0.746	1.858	0.791	-3.752***
Time spent on social networks	1.438	0.666	1.543	0.765	-6.040***

Panel B. Descriptive and difference statistics across cohort

Variable	Younger (N=3504)		Older (N=3399)		t
	Mean	SD	Mean	SD	
Creativity	636.593	111.191	567.109	87.402	28.808***
Time spent on homework	2.520	0.647	2.959	0.721	-26.666***
Time spent on online games	1.546	0.771	1.706	0.865	-8.113***
Time spent on online chatting	1.346	0.637	1.932	0.812	-33.411***
Time spent on online entertainment	1.525	0.730	1.939	0.825	-22.120***
Time spent on online information	1.644	0.683	1.818	0.604	-11.224***
Time spent on exercise	2.266	0.789	1.857	0.722	22.443***
Time spent on friends meeting	1.945	0.761	1.700	0.761	13.404***
Time spent on social networks	1.353	0.655	1.639	0.758	-16.785***

Notes: This table shows the descriptive and difference statistics across subgroups. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.2 Baseline results

Table 3 presents the regression results of Eq.(1). The findings indicate that the time students spent on homework, online games, online chatting, and online entertainment significant negative correlation with creativity. In contrast, time spent on online information seeking, exercise, meeting friends, and social networks showed a significant positive association with creativity. It is important to note that the use of a 4-point Likert scale for measuring time allocation may potentially introduce two biases. First, grouping meaningfully distinct time-use behaviors into adjacent categories may reduce measurement sensitivity. Second, the relatively coarse nature of the scale may fail to capture dose-response relationships. This limitation was also mentioned in PISA reports, acknowledging that categorical measurement scales hinder precise calculation of average time expenditure and limit the ability to conduct more nuanced investigations into temporal effects (OECD, 2021). Due to data limitations, we will leave in-depth

analysis for future research.

Regarding the control variables, the results consistent with previous research (OECD, 2021), indicating that boys, younger students, and those from socio-economically advantaged backgrounds tend to score higher in creativity. In addition, no significant correlation found between school activities on promoting student social and emotional skills (including setting objectives, training, and assessment) and adolescent creativity. Two possible explanations may account for this finding: (1) students' socio-economic background may largely determine the type of school they attend, which in turn contributes significantly to variations in creativity across schools; (2) according to OECD (2021), schools in Suzhou have already made substantial progress in fostering social and emotional skills, which may reduce the marginal effect of further implementation efforts.

Table 3 Time use on various extracurricular activities and adolescent creativity

Dependent variables	β	Baseline model	
		SE	t
Time spent on homework	-0.048	0.011	-4.263***
Time spent on online games	-0.063	0.015	-4.335***
Time spent on online chatting	-0.052	0.017	-3.040***
Time spent on online entertainment	-0.114	0.016	-7.203***
Time spent on online information	0.095	0.013	7.461***
Time spent on exercise	0.170	0.012	13.640***
Time spent on friends meeting	0.029	0.013	2.232**
Time spent on social networks	0.034	0.015	2.232**
R ²	0.219		

Notes: This table shows the result of the baseline model. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.3 Heterogeneity effect

Table 4 shows the differential effects of extracurricular time use on adolescent creativity across gender groups. For girls, spending more time on homework was associated with lower levels of creativity, while greater use of the internet for information seeking was linked to higher creativity. In contrast, for boys, time spent socializing (such as meeting friends and using social networks) was more positively associated with creativity compared to

girls.

The findings suggest gender difference may stem from socially constructed learning tendencies: girls are more likely to adhere strictly to academic norms, which may lead to more convergent thinking patterns, while boys tend to have stronger social advantages, gaining cognitive stimulation through peer interactions.

Table 4 Different effects of extracurricular time use and adolescent creativity across gender

Dependent variables	Girl			Boy		
	β	SE	t	β	SE	t
Time spent on homework	-0.072	0.017	-4.354***	-0.027	0.015	-1.723*
Time spent on online games	-0.054	0.023	-2.352**	-0.076	0.019	-3.909***
Time spent on online chatting	-0.051	0.024	-2.130**	-0.046	0.024	-1.909*
Time spent on online entertainment	-0.127	0.023	-5.581***	-0.101	0.022	-4.558***
Time spent on online information	0.131	0.019	7.038***	0.068	0.018	3.851***
Time spent on exercise	0.178	0.019	9.607***	0.161	0.017	9.472***
Time spent on friends meeting	0.012	0.018	0.676	0.041	0.018	2.235**
Time spent on social networks	0.024	0.022	1.103	0.045	0.021	2.128**
R ²	0.253			0.188		

Notes: This table shows the differential effects of extracurricular time use and adolescent creativity across gender. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5 presents the differential effects of extracurricular time use on adolescent creativity across cohorts. Specifically, among younger students, increased time spent on homework was associated

with lower levels of creativity. For older students, time spent playing online games had a more pronounced negative effect. The more time older students devoted to online gaming, the lower their

creativity levels were, particularly in comparison to their younger peers.

This pattern reflects the asynchronous development of cognitive control during adolescence: younger adolescents have more limited

self-regulatory resources, making them more susceptible to depletion by structured tasks, whereas older adolescents with greater autonomy are more vulnerable to distractions from digital media.

Table 5 Different effects of extracurricular time use and adolescent creativity across cohort

Dependent variables	Younger			Older		
	β	SE	t	β	SE	t
Time spent on homework	-0.065	0.018	-3.549***	-0.024	0.014	-1.753*
Time spent on online games	-0.091	0.025	-3.699	-0.045	0.017	-2.638***
Time spent on online chatting	-0.059	0.029	-2.067**	-0.049	0.020	-2.394**
Time spent on online entertainment	-0.095	0.026	-3.643***	-0.121	0.019	-6.430***
Time spent on online information	0.084	0.019	4.458***	0.112	0.017	6.515***
Time spent on exercise	0.177	0.018	9.638***	0.157	0.017	9.377***
Time spent on friends meeting	0.033	0.019	1.699*	0.022	0.017	1.297
Time spent on social networks	0.042	0.024	1.747	0.030	0.018	1.631
R ²	0.133			0.126		

Notes: This table shows the different effects of extracurricular time use and adolescent creativity across cohort.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.4 Mediation effect

Figure 3 presents the direct and indirect effects of extracurricular time use on adolescent creativity. Specifically, time spent on homework had a significant negative effect on creativity, and this effect was fully mediated by academic anxiety. In addition, time spent on exercise had a significant positive effect on creativity, which was partially mediated by academic anxiety. Last, time spent on online chatting and entertainment had a significant negative effect on creativity, and this effect was also partially mediated by academic anxiety.

These findings suggest that educational institutions should consider the potential negative effects of academic burden on adolescents' mental health when assigning students' academic tasks. Furthermore, schools and parents can support adolescents in developing effective time management skills, promoting a healthier balance between online entertainment and physical activity. In doing so, they can help reduce academic anxiety while simultaneously fostering greater creativity.

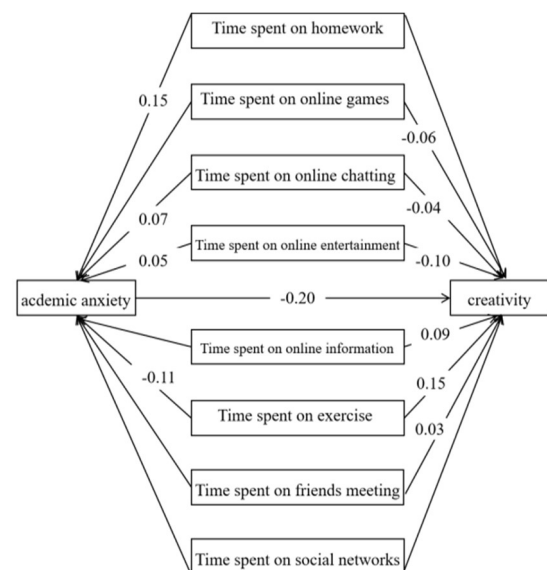


Figure 2 Time on various extracurricular activities and adolescent creativity - the mediation effect of academic anxiety

Notes: This figure shows the result of mediation effect. Only statistically significant paths at $p < 0.05$ are presented.

Creativity levels differ significantly across gender and cohorts (OECD, 2021). The above

findings confirm that distinct patterns of extracurricular time use serve varying roles for each subgroup. To this end, we further examine how the impact of extracurricular time use on adolescent creativity manifests differently across these groups.

Figure 3 shows the results of the gender heterogeneity analysis. First, girls exhibited greater vulnerability to psychological anxiety. Adolescent females are known to experience heightened hormone sensitivity and social role conflict during this developmental stage (Rose & Rudolph, 2006). Second, online information search had a significantly stronger positive association with creativity among girls. Research has shown that females tend to adopt more proactive task-completion approaches (Deravipor et al., 2022), a tendency that may facilitate systematic integration and learning from online resources, thereby enhancing creative capabilities more effectively. Third, academic anxiety mediated the relationship between friend interactions and creativity for girls but not for boys. This divergence may stem from distinct patterns of peer engagement: male peer dynamics are often characterized by instrumental rationality, whereas female peer relationships are more oriented toward emotional reasoning (Gorrese & Ruggieri, 2012). Research has consistently shown that females tend to form stronger emotional bonds with friends and provide more reciprocal emotional support than males (Gorrese & Ruggieri, 2012). Female friendships typically revolve around conversational and emotional exchanges, fostering deeper emotional closeness (Verkuyten, 1996), whereas male friendships often center on instrumental support and lack the same level of emotional intimacy (Smith, 1997). Our findings support these previous observations, demonstrating that girls are more likely to derive emotional benefits from peer interactions, while boys typically gain practical support from such engagements.

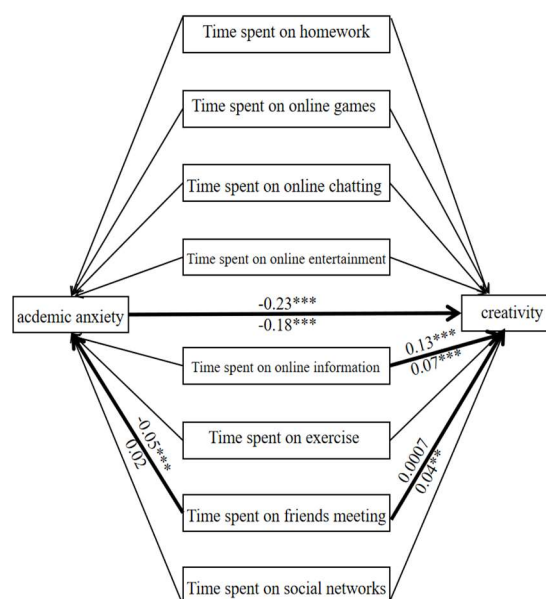


Figure 3 Time on various extracurricular activities and adolescent creativity - gender heterogeneity

*Notes: This figure shows the values of coefficients with significant differences between girls and boys. Only coefficients with significant differences at $p < 0.05$ are presented. Coefficients among girls are presented above the path line and coefficients among boys below the path line. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

Figure 4 shows the results of the cohort heterogeneity analysis. First, homework had a significantly stronger positive association with academic anxiety among younger students, possibly due to their earlier developmental stage and the foundational role of homework in shaping their academic identities. Second, the impact of time spent on online games was significantly different between cohorts: for younger students, increased gaming time was more strongly linked to heightened academic anxiety, possibly reflecting their weaker self-regulation and greater susceptibility to gaming's distracting allure. In contrast, the older students experienced a mild positive effect from the same activity, a pattern that may stem from their more advanced time-management skills, enabling a better balance between gaming and academic responsibilities. Third, exercise had a more pronounced effect on reducing academic anxiety

among younger adolescents. This may be attributed to the fact that younger adolescents are in a critical phase of physical development, where physical activity acts as an effective stress reliever. In contrast, for older adolescents, who face increasing pressure from high-stakes exams, the anxiety-reducing benefits of exercise are relatively limited.

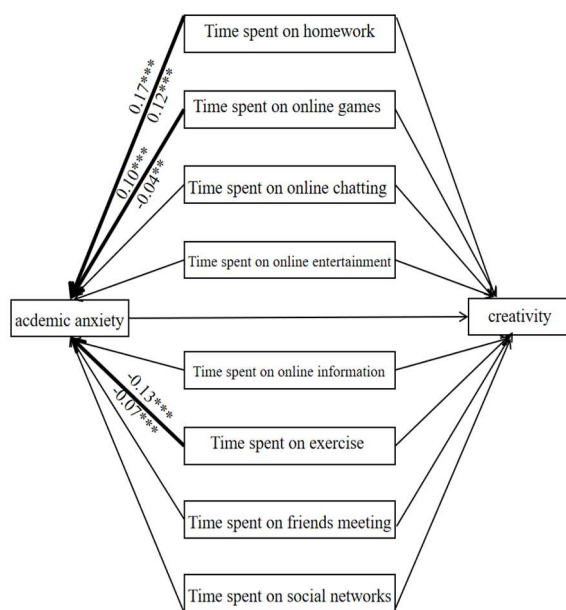


Figure 4 Time on various extracurricular activities and adolescent creativity - cohort heterogeneity

*Notes: This figure shows the values of coefficients with significant differences between younger and older cohorts. Only coefficients with significant differences at $p < 0.05$ are presented. Coefficients among younger cohorts are presented above the path line and coefficients among older cohorts below the path line. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.*

6. Discussion

Innovative talent is a critical driver of scientific advancement and national development, thus effectively fostering creativity during adolescence has long been a central concern in the field of education. Despite the large body of research on creativity, empirical research has often overlooked the differentiated impact of various types of extracurricular activities on adolescent creativity. Drawing on data from the OECD's 2019 Survey on Social and Emotional Skills (SSES), this study systematically examined the mechanisms through

which adolescents' extracurricular time use influences their creativity.

The results revealed that extracurricular time use significantly affects adolescents' creativity. On one hand, our findings suggest that academic anxiety diminishes adolescents' creative potential, suggesting that schools should evaluate the impact of academic stress and implement concrete measures to mitigate it, such as assigning homework in a more balanced and manageable manner. On the other hand, this study highlights the positive contribution of sports. Schools are therefore encouraged to promote and broaden access to physical exercise opportunities, as they foster intrinsic motivation and personal initiative, thereby creating an environment more conducive to creative development.

More importantly, this study employed a structural mediation model to examine the mechanisms through which extracurricular time use influences adolescent creativity. Results revealed a significant negative association between creativity and heightened academic anxiety. A multi-group analysis between girls and boys further revealed that girls are more vulnerable to academic anxiety, whereas boys may benefit more from social interaction with peers.

These finds provide important implications for educational practice. For female students, optimizing homework design by reducing rote memorization and incorporating open-ended inquiry tasks can help cultivate divergent thinking. When combined with digital literacy training to improve skills in information curation and synthesis, this approach can also transform internet use into a powerful catalyst for innovation. For male students, the introduction of systematically designed collaborative learning projects that blend social interaction with problem-solving—such as interdisciplinary team challenges—can enhance the creative benefits of peer engagement. This dual-track intervention model addresses structural barriers to female creativity while leveraging the positive spillover effects of male social networks, ultimately promoting more equitable ecosystems for creative development.

Our study also offers valuable insights into educational strategies that utilize cohort-specific mechanisms of extracurricular time use to enhance adolescent creativity. Drawing on the characteristics of neural development during prefrontal cortex maturation, we propose a hierarchical intervention framework. This framework targets adolescents by implementing an intelligent homework system, dynamically adjusting homework time, reducing rote learning tasks for younger students, and increasing physical activities to reduce stress for older students. In addition, schools can introduce digital literacy curricula that incorporate school-based, gamified learning modules, systematically integrating weekly playtime and learning time.

Most research on adolescent creativity has focused on developed countries. However, notable differences exist between students in developed and developing countries. For example, Chinese students are frequently perceived as less creative (Wu & Albanese, 2013), and the 2022 PISA results similarly show that students from developing countries tend to score lower in measures of imagination and creativity (OECD, 2024). To this end, the present study also offers valuable insights for fostering adolescent creativity and cultivating innovative talent in developing countries.

Conclusion

Using data from the 2019 Survey on Social and Emotional Skills (SSES), this study is the first to systematically examine the impact of extracurricular time use on adolescent creativity. The findings revealed three key insights. First, extracurricular time use significantly influenced creativity: time spent on homework, online gaming, online chatting, and online entertainment was negatively associated with creativity, whereas time spent on physical exercise, socializing, and engaging in social activities was positively associated. Second, the heterogeneity analysis identified significant variations in both the effects and mechanisms of extracurricular time use on creativity across different genders and age cohorts. Third, academic anxiety was found to mediate the

relationship between extracurricular time use and creativity, helping to explain these subgroup differences. Specifically, the negative effect of homework time on creativity was fully mediated by academic anxiety, while the effects of exercise, online chatting, and online entertainment were partially mediated.

This study has several limitations. First, the analysis focused exclusively on Chinese students, which may limit the generalizability of the findings to other cultural contexts. In cultures that place a strong emphasis on academic achievement (such as many East Asian societies), academic pressure can exacerbate anxiety, potentially influencing creativity differently than in other contexts. Cultural norms also shape how students cope with academic stress. Some cultures promote open emotional expression and help-seeking behaviors, while others emphasize self-reliance and emotional restraint, which may affect how anxiety impacts creativity. Second, the measurement of extracurricular time use was relatively coarse. More precise and repeated assessments would provide a better understanding of how adolescents allocate their time. Future research should aim to address this limitation by employing more detailed tracking methods.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

Informed consent

Informed consent for all individual participants in the study has been officially completed by the international organization OECD.

Ethical statement

The international organization OECD has completed the ethical norm for all participating countries/economies in the 2019 Survey on Social and Emotional Skills (SSES).

References

- Adams, J., & Owens, A. (2015). *Creativity and democracy in education: Practices and politics of learning through the arts*. Routledge.
- Aga, K., Inamura, M., Chen, C., Hagiwara, K., Yamashita, R., Hirotsu, M., & Nakagawa, S. (2021). The effect of acute aerobic exercise on divergent and convergent thinking and its influence by mood. *Brain Sciences*, 11(5), 546.
- Bereczki, E. O., & Karpati, A. (2018). Teachers' beliefs about creativity and its nurture: A systematic review of the recent research literature. *Educational Research Review*, 23, 25-56.
- Blanco-Herrera, J. A., Gentile, D. A., & Rokkum, J. N. (2019). Video games can increase creativity, but with caveats. *Creativity Research Journal*, 31(2), 119-131.
- Bollimbala, A., James, P. S., & Ganguli, S. (2019). Impact of acute physical activity on children's divergent and convergent thinking: the mediating role of a low body mass index. *Perceptual and Motor Skills*, 126(4), 603-622.
- Bronfenbrenner, U., & Morris, P. A. (2007). The bioecological model of human development. *Handbook of Child Psychology*, 1.
- Calvert, S. L., & Valkenburg, P. M. (2013). 28 The Influence of Television, Video Games, and the Internet on Children's Creativity. The Oxford handbook of the development of imagination, 438.
- Chang, Y. S. (2013). Student technological creativity using online problem-solving activities. *International Journal of Technology and Design Education*, 23, 803-816.
- Chen, S. Y., Tsai, J. C., Liu, S. Y., & Chang, C. Y. (2021). The effect of a scientific board game on improving creative problem solving skills. *Thinking Skills and Creativity*, 41, 100921.
- Cheungb, S. L. & P. C. . (2010). Developmental trends of creativity: what twists of turn do boys and girls take at different grades?. *Creativity Research Journal*, 22(3), 329-336.
- Cooper, H., Steenbergen-Hu, S., and Dent, A. L. (2012). "Homework," in APA educational psychology handbook, Vol.3. Application to learning and teaching, eds K. R. Harris, S. Graham, and T. Urdan (Washington DC: American Psychological Association), 475-495.
- Dai, D. Y. (2021). Evolving complexity theory (ECT) of talent development: A new vision for gifted and talented education. *Conceptions of Giftedness and Talent*, 99-122.
- Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education—A systematic literature review. *Thinking Skills and Creativity*, 8, 80-91.
- Deravipor, R., Assareh, A., Nasri, S., & Armand, M. (2022). Relationships between Computer Literacy and Analytical Literacy with Creativity in Students: The Role of Gender Moderator. *Iranian Journal of Educational Sociology*, 5(3), 41-53.
- Fales, C. L., Barch, D. M., Burgess, G. C., Schaefer, A., Mennin, D. S., Gray, J. R., & Braver, T. S. (2008). Anxiety and cognitive efficiency: differential modulation of transient and sustained neural activity during a working memory task. *Cognitive, Affective, & Behavioral Neuroscience*, 8(3), 239-253.
- Fan, H., Ma, Y., Xu, J., Chang, Y., & Guo, S. (2022). Effects of homework creativity on academic achievement and creativity disposition: Evidence from comparisons with homework time and completion based on two independent Chinese samples. *Frontiers in Psychology*, 13, 923882.
- Flaherty, A. W. (2005). Frontotemporal and dopaminergic control of idea generation and creative drive. *Journal of Comparative Neurology*, 493(1), 147-153.
- Gorrese, A., & Ruggieri, R. (2012). Peer attachment: A meta-analytic review of gender and age differences and associations with parent attachment. *Journal of Youth and Adolescence*, 41, 650-672.
- Han, Q., Hu, W., Liu, J., Jia, X., & Adey, P. (2013). The influence of peer interaction on students' creative problem-finding ability. *Creativity Research Journal*, 25(3), 248-258.

- Hoferichter, F., & Raufelder, D. (2015). Examining the role of social relationships in the association between neuroticism and academic anxiety—results from a study with German secondary school students. *Educational Psychology*, 35(7), 851-868.
- Hu, W. P., & Yu, G. L. (2002). A study on the scientific creativity of adolescents. *Educational Research*, 23(1), 44-48.
- Hora, S., Badura, K. L., Lemoine, G. J., & Grijalva, E. (2022). A meta-analytic examination of the gender difference in creative performance. *Journal of Applied Psychology*, 107(11), 1926.
- Jiang, W., & Saito, E. (2022). Lightening the academic burden on Chinese children: A discourse analysis of recent education policies. *Journal of Educational Change*, 1-17.
- Kaufman, J. C., & Beghetto, R. A. (2009). Beyond big and little: The four c model of creativity. *Review of General Psychology*, 13(1), 1-12.
- Kinsbourne M, Hicks RE (1978) Functional Cerebral Space: a model for overflow, transfer, and interference effects in human performance: a tutorial review. In: Requin J (ed) Attention and performance, VII. Lawrence Erlbaum Associates, Hissdale.
- Leary, M. R., & Baumeister, R. F. (2000). The nature and function of self-esteem: Sociometer theory. In *Advances in experimental social psychology* (Vol. 32, pp. 1-62). Academic Press.
- Loton, D., Borkoles, E., Lubman, D., & Polman, R. (2016). Video game addiction, engagement and symptoms of stress, depression and anxiety: The mediating role of coping. *International Journal of Mental Health and Addiction*, 14, 565-578.
- Mikulincer, M., Florian, V., & Tolmacz, R. (1990). Attachment styles and fear of personal death: A case study of affect regulation. *Journal of Personality and Social Psychology*, 58(2), 273.
- Oberle, E., Ji, X. R., Kerai, S., Guhn, M., Schonert-Reichl, K. A., & Gadermann, A. M. (2020). Screen time and extracurricular activities as risk and protective factors for mental health in adolescence: A population-level study. *Preventive Medicine*, 141, 106291.
- OECD (2021), Beyond Academic Learning: First Results from the Survey of Social and Emotional Skills, OECD Publishing, Paris.
- OECD (2024), PISA 2022 Results (Volume III): Creative Minds, Creative Schools, PISA, OECD Publishing, Paris.
- Olefir, V. O., Kuznetsov, M. A., & Plokhikh, V. V. (2019). Effect of physical exercises and perceived stress interaction on students' satisfaction with life. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*, (1), 30-35.
- Pate, D. (2020), The Top Skills Companies Need Most in 2020 — And How to Learn Them, <https://www.linkedin.com/business/learning/blog/top-skills-and-courses/the-skills-companies-needed-most-in-2020-and-how-to-learn-them>
- Petrone, P. (2019), The Skills Companies Need Most in 2019 – And How to Learn Them, <https://www.linkedin.com/business/learning/blog/top-skills-and-courses/the-skills-companies-needed-most-in-2019-and-how-to-learn-them>
- Rauscher, L., & Cooky, C. (2016). Ready for anything the world gives her?: A critical look at sports-based positive youth development for girls. *Sex Roles*, 74, 288-298.
- Rose, A. J., & Rudolph, K. D. (2006). A review of sex differences in peer relationship processes: potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin*, 132(1), 98.
- Shah, B., & Gustafsson, E. (2021). Exploring the effects of age, gender, and school setting on children's creative thinking skills. *The Journal of Creative Behavior*, 55(2), 546-553.
- Smith, T. E. (1997). Adolescent gender differences in time alone and time devoted to conversation. *Adolescence*, 32(126), 483.
- Sternberg, R. J., & Lubart, T. I. (1991). An investment theory of creativity and its development. *Human Development*, 34(1), 1-31.
- Sternberg, R. J., & Lubart, T. I. (1995). Defying the crowd: Cultivating creativity in a culture of conformity. Free press.
- Steinberg, L. (1997). Beyond the classroom. Simon and Schuster.
- Tobias, S. (1985). Test anxiety: Interference,

- defective skills, and cognitive capacity. *Educational Psychologist*, 20(3), 135-142.
- Tülübaşı, T., Karaköse, T., & Papadakis, S. (2022). Revealing the intellectual structure and evolution of digital addiction research: An integrated bibliometric and science mapping approach. *International Journal of Environmental Research and Public Health*, 19(22), 14883.
- Tülübaşı, T., Karaköse, T., & Papadakis, S. (2023). A holistic investigation of the relationship between digital addiction and academic achievement among students. *European Journal of Investigation in Health, Psychology and Education*, 13(10), 2006-2034.
- Verkuyten, M. (1996). Culture and gender differences in the perception of friendship by adolescents. *International Journal of Psychology*, 31(5), 207-217.
- Von der Embse, N., Jester, D., Roy, D., & Post, J. (2018). Academic anxiety effects, predictors, and correlates: A 30-year meta-analytic review. *Journal of Affective Disorders*, 227, 483-493.
- Wu, J. J., & Albanese, D. L. (2013). Imagination and creativity: Wellsprings and streams of education—the Taiwan experience. *Educational Psychology*, 33(5), 561-581.
- Yang, J., Shen, Y., & Quan, X. (2023). Physical activity, screen time, and academic burden: a cross-sectional analysis of health among Chinese adolescents. *International Journal of Environmental Research and Public Health*, 20(6), 4917.
- Yuan, S., Gu, Q., Lei, Y., Shen, J., & Niu, Q. (2022). Can Physical Exercise Promote the Development of Teenagers' Non-Cognitive Ability?—Evidence from China Education Panel Survey (2014–2015). *Children*, 9(9), 1283.
- Zhao, Y., Qin, C., Shu, D., & Liu, D. (2022). Effects of short-term aerobic exercise on creativity. *Thinking Skills and Creativity*, 44, 101033.
- Zhang, J. H., Fu, M. M., Xin, Y. W., Chen, P. P., & Sha, S. (2020). The development of creativity in upper elementary students: gender differences and the role of school support. *Acta Psychologica Sinica*, 52(9), 1057-1070.
- Zheng, Y. (2013). Problems and causes of China's education. Beijing: China CITIC Press, 125.

How to Cite: Cheng, Y. & Huang, X. (2025). Extracurricular Time Use and Adolescent Creativity: Differential Mechanisms Across Gender and Cohort Groups. *Contemporary Education and Teaching Research*, 06(5), 155-170. <https://doi.org/10.61360/BoniCETR252018200503>