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gece kitaplığı

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INTERNATIONAL RESEARCH AND EVALUATIONS IN THE FIELD OF EDUCATIONAL SCIENCES

EDITORS

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CONTENTS

Chapter 1

THE RESULTS OF 3D ANIMATION ACTIVITIES ON VALUES DEVELOPED BY GIFTED STUDENTS: WHAT DO STUDENTS AND TEACHER SAY?

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Introduction

The concept of value is studied across various social sciences, each defining it based on their perspective, leading to multiple interpretations without a clear consensus (Çam et al., 2020; Peterson, 2020). Generally, value refers to the importance or worth of something, serving as socially accepted principles guiding behavior toward what is considered good and beautiful (Turkish Language Association, 2019; Tural, 1992). Values education involves transmitting these socially approved values to future generations, primarily through family, but also schools and the environment play crucial roles (Bosch, 2020; Ulusoy, 2019). Families shape initial value judgments and character, which are further developed through schooling and social interactions, all essential for a healthy social structure. Values guide individuals in distinguishing right from wrong and shaping behavior, with shared values being vital for social cohesion and collective progress (Halstead & Taylor, 2000; Suradi & Mawadi, 2020). However, modern challenges like cultural decay, individualism, technological advances, and globalization have caused detachment from values and cultural erosion (Demirkaya & Çal, 2018). In response, values education has gained importance, evolving through approaches such as value transmission, value development, and holistic education (Kaymakcan & Meydan, 2020). Among educational tools, animations are effective for values education as they engage multiple senses, support lasting learning, and present concrete, relatable content in a realistic way (Akıncı Yüksel, 2015; Pratiwi, 2017; Rusmini & Samsu, 2023; Birkök, 2008).Cinema and television reach a large audience in Turkey. Value is a fundamental principle accepted by society that guides individual behavior and is studied across various social sciences (Çam et al., 2020; Turkish Language Association, 2019). Values education involves transmitting these principles to individuals through family, school, and social environments, playing a crucial role in both personal and social development (Bosch, 2020). Shared values form the foundation of a healthy social structure, but factors like globalization, technology, and media contribute to the erosion of values (Demirkaya & Çal, 2018). Therefore, values education continues through approaches such as transmission, development, and holistic methods (Kaymakcan & Meydan, 2020). Additionally, animations serve as effective tools in values education by appealing to multiple senses and presenting concrete, relatable content (Akıncı Yüksel, 2015; Rusmini & Samsu, 2023).

Values are fundamental principles that guide individual behavior and are primarily shaped within the family, then reinforced by schools and the surrounding social environment (Çam et al., 2020; Bosch, 2020). These shared values are crucial for maintaining social cohesion and enabling people to work together peacefully and productively. However, contempo-

rary challenges such as globalization, rapid technological advancements, widespread use of media, and increasing individualism have contributed to the weakening and erosion of these core values (Demirkaya & Çal, 2018). To counteract these negative effects, values education has evolved through different approaches—value transmission, value development, and holistic values education—that aim to effectively instill positive principles in individuals (Kaymakcan & Meydan, 2020). In this context, educational tools like animations have proven particularly useful. Animations engage multiple senses simultaneously and present information in a concrete, realistic, and relatable manner, which helps learners better understand and internalize social values (Akıncı Yüksel, 2015; Rusmini & Samsu, 2023). Therefore, the integration of such multimedia tools can significantly enhance the effectiveness of values education in today's complex social environment.

Traditional teacher-centered education focuses on delivering knowledge objectively, with students as passive recipients. However, advances in educational technology have shifted the teacher's role toward guiding students to actively engage with and process information (Jonassen, 1991). Today, learning materials are created by graphic designers and content developers working under educators' supervision, considering multimedia elements, communication, design, and user interface principles to meet students' needs. Effective material development requires technical skills, software knowledge, and subject expertise, making tools like 3D animation valuable in education (Kumar et al., 2019).

Animations serve multiple roles beyond art, facilitating communication, creativity, group cohesion, and social participation (Moldovan, 2021). Unlike static images, animations clearly present dynamic processes, reducing cognitive load by allowing students to focus on understanding rather than mentally constructing motion, benefiting learners with varied cognitive abilities (Lowe, 2004). Studies show animation improves memory and comprehension but remains underused in Turkish education, with greater effectiveness in natural science topics (Küçük & Yıldırım, 2020; Höffler & Leutner, 2007).

Giftedness definitions vary, often highlighting different factors. Renzulli (1986) defines it as a combination of above-average ability, creativity, and motivation, while Tannenbaum (1986) identifies five components: high general ability, special talent, non-cognitive traits, environment, and chance. The Turkish Ministry of Education defines gifted individuals as those exhibiting high performance in general or special abilities compared to peers (Şahin, 2015). Gifted individuals differ cognitively, socially, and affectively from their peers (Silverman, 2013; Clark, 2002; Renzulli et

al., 2002; Bildiren, 2013).

According to Bates and Munday (2005), gifted children typically exhibit early sentence formation, a broad vocabulary, fast reading, strong concentration, abstract thinking, effective adult communication, strong memory, high imagination, and leadership skills. These distinct traits require differentiated education; however, gifted individuals are often the most neglected group in special education (Ataman, 2004). Taşçılar (2014) and the Commission on Gifted Children report (Şahin, 2015) stress that gifted students need tailored programs aligned with their abilities, as regular curricula are insufficient. Silverman (2013) adds that gifted potential must be identified and supported through expert guidance and appropriate educational practices.

Educational services for gifted students generally include acceleration, grouping, and enrichment, with choosing the best fit for each student being essential (Ersoy & Avcı, 2004). In Turkey, Science and Art Centers provide enrichment programs outside school hours to help gifted students develop their talents (Science and Art Centers Directive, 2007).

With growing technology use in special education, animations have gained attention as effective tools, especially for students with dyslexia, autism, and intellectual disabilities. Most animation studies focus on language and social skills, while research on academic skills like reading, writing, and math remains limited (Bağlama et al., 2018).

Bağlama et al. (2018) reviewed the effectiveness of animation in educating individuals with disabilities, highlighting its potential benefits. For animations to be effective, their design must support easy perception visually and textually. Text font and size should match the student's age, images must be clear, and eye-straining colors avoided. Overuse of graphics, text, or images should be minimized to prevent complexity. Educational animations should be tailored to the target audience and adapted according to the platform or product where they are used (Küçük et al., 2022).

Literature Review

Studies show that animation is effective in enhancing students' skills, motivation, and collaboration in education (Cook & Gladhard, 2002; Love, 2004). It has been demonstrated that 3D animation and computer-aided design improve the understanding of concepts in technical education (Toroğlu & İçingür, 2007). Animation benefits both students with special learning needs such as dyslexia and typical students, addressing diverse learning requirements (Taylor et al., 2007). Moreover, animation supports creativity, critical thinking, and group work, encouraging deep-

er student engagement (Fisk, 2008; Genç, 2013). Compared to traditional methods, animation-supported education increases academic achievement and knowledge retention (Karaşahinoğlu, 2013; Aslan Efe, 2015). Teachers hold positive views regarding animation's ability to simplify the understanding of complex subjects, although some practical challenges in implementation remain (Chan, 2013). It has been emphasized that strict adherence to cultural traditions limits creativity, while openness to innovation enhances it (Kaçar, 2017). The appropriate use of animation in language learning also yields effective results (Mansor, 2020). The growing role of animation in education supports student motivation and skill development and is applicable across a wide range of fields, from the arts to social participation (Mara & Thomson, 2021). In recent years, the creative and interactive use of animation in values education has enabled students to engage in meaningful discussions on moral values and contributed to their holistic development (Sy et al., 2024). Teachers' creativity and communication skills improve through animation production (Kleftodimos, 2024). The supportive impact of animation in special education is also increasing (Bağlama et al., 2018). For gifted students, animation-supported values education has positively influenced academic achievement and attitudes toward lessons (Çelik, 2019). These students acquired fundamental animation skills, yet the need for individualized study time and grouping based on needs has emerged (Berigel et al., 2017). Various programs in values education have supported awareness and behavioral development in gifted students (Dilmaç et al., 2007; Çetinkaya & Kıncal, 2014; Ateş, 2014; Tortop, 2018). It has been highlighted that resource rooms in Science and Art Centers in Turkey mainly focus on science, mathematics, and arts, while computer science education remains insufficient (Keskin, 2006; Geçkil, 2012; Sezginsoy, 2007). It is necessary to create enriched learning environments that meet the interests and needs of gifted students in computer science; otherwise, their true educational needs will remain unmet (Öngöz & Aksoy, 2015; Levent, 2011; Özbay, 2013).

This research aims to develop, implement, and evaluate 3D animation educational activities on values for gifted children. In this regard, the study seeks answers to the following questions:

1. What are the opinions of gifted students regarding 3D animation activities related to values education?

2. How should values education be presented to gifted students with the support of 3D animation?

Methods

A qualitative approach was adopted in the study. This research approach focuses on process, meaning, and understanding (Merriam & Grenier, 2019). Qualitative research aims to provide an in-depth explanation of individuals' experiences through methods such as interviews, observations, and content analysis (Yıldırım & Şimşek, 2011). Since the study aims to explore participants' opinions on animation-themed support education activities, a qualitative approach was preferred. To obtain in-depth data, the case study method was utilized. Case studies, which seek to answer "how" and "why" questions, examine real-life situations such as individual experiences, implementation processes, small group behaviors, interpersonal relationships, and school performance from a holistic perspective (Yin, 2013).

Participants

According to the Ministry of National Education's Science and Art Center Directive (2024), the number of students participating in support education programs should be between 3 and 7. Therefore, this study was conducted with five students. The participants, selected using a purposive sampling method, continue their education at a Science and Art Center in Erzurum, Turkey. Information about the students is presented in Table 1.

Table 1. *Student Information*

	Gender	Grade	Personal Computer	Daily Computer Usage Time
S1	Girl	8	Yes	Less than 1 hour
S2	Boy	8	Yes	1–2 hours
S3	Boy	8	Yes	Less than 1 hour
S4	Girl	8	Yes	1–2 hours
S5	Boy	8	Yes	Less than 1 hour

As shown in Table 1, three of the students are boys, and two are girls. The students are in the eighth grade at the middle school level. All students have personal computers. When examining their daily computer usage time, it is observed that three students use a computer for less than one hour, while two students use it for 1–2 hours. The teacher responsible for implementing the study is a social studies teacher working at the center where the application will take place. The teacher has 14 years of professional experience and holds a master's degree. To better understand the students in the learner analysis, semi-structured interviews were con-

ducted with four teachers (all male) working in the Science and Art Center in the fields of information technologies, science, Turkish, and foreign languages.

Table 2. *Information About Data Collection Tools*

Data Collection Tool		**Applied Person/ Environment**	**Time**
Interview Science and Art Center Teachers		Course Teacher	Design phase
		Implementation phase	
		Evaluation phase	
		Learner analysis	
Observation		Environment	During the Process
Student Status Evaluation Notes		Students	Middle Implementation
Forms	Student Identification and Expectations Form		Before Implementation
	Animation Education Evaluation Form		After Implementation

In this study, semi-structured interviews were conducted with course teachers and Science and Art Center teachers. The interviews were carried out to collect data from relevant individuals in line with the research questions (Büyüköztürk et al., 2008). The open-ended questions used in the interviews provided in-depth data on participants' experiences, opinions, perspectives, feelings, and knowledge (Patton, 2014). During the implementation process of the research, a participant role was adopted, and unstructured observations were conducted. Observation notes were taken in the natural setting, and audio recordings were made. The recorded audio files were transcribed into text using a word processor. Observations were used to record individuals' behaviors, interpersonal interactions, processes, dialogues, and other observable situations (Patton, 2014). In the fifth and sixth weeks of the implementation process, evaluation notes were collected to assess the ongoing training and gather student suggestions. As part of the research, the "Student Identification and Expectation Form" was used before the implementation to determine students' expec-

tations from the animation course. At the end of the implementation, data were collected through the "Animation Education Evaluation Form" to assess the process.

Research Process

The ADDIE instructional design model was used as the foundation for developing 3D animation activities on values created by gifted students. The research process is presented in Figure 1.

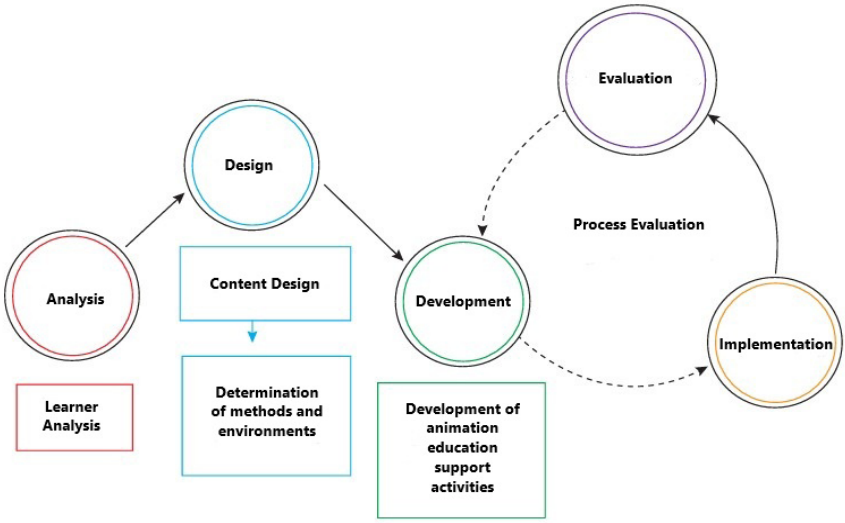

Figure 1. *Research Process*

During the analysis phase, semi-structured interviews were conducted with four subject teachers working at the Science and Art Center to gather information about gifted students and their behaviors during the lesson process. The data obtained from these interviews were analyzed and structured to inform the subject teacher, who would deliver the training during the implementation process. The design phase of the research involved determining the topics and preparing the environment and communication platforms. At this stage, the Plotagon Studio-1-11-0 software was installed on the computers before the implementation. In the development phase, a literature review was conducted as a priority during the preparation of topic headings, and existing applications were examined. The review revealed that there was no significant concentration in the literature on values education through animation. A meeting was held with the expert subject teacher to determine the content and activities. The teacher stated that the content should be simplified to suit

the student level and presented according to student needs. Accordingly, the topic headings in Table 3 were structured for a ten-week period in collaboration with the researcher and the teacher. The expert teacher had received in-service training seminars on animation education and had applied it multiple times in social studies lessons and different workshops. Additionally, the teacher had completed a postgraduate thesis on values education. The Plotagon Studio-1-11-0 software was chosen because both the teacher and students had prior experience using it at different times. Moreover, students having a subscription to the program allowed them access to a wide range of activities.

Tablo 3. *3D Animation Activities Lesson Plan on Values Education*

Week	Date	Time	Topic	Activity	Targeted Value
1	02.10.2024	16:00 - 19:00	Introduction	Introduction to Plotagon Studio, basic usage training	Technological literacy, digital productivity
2	09.10.2024	16:00 - 19:00	Compassion and Justice	Create scenarios involving justice and compassion	Justice, fairness, conscience
3	16.10.2024	16:00 - 19:00	Patriotism and Responsibility	Create animations that address patriotism and social responsibility	Patriotism, belonging, responsibility
4	23.10.2024	16:00 - 19:00	Patience and Determination	Create animations based on success stories and writing scenarios	Patience, determination, fighting spirit
5	30.10.2024	16:00 - 19:00	Collaboration and Solidarity	Animation project focusing on community help and collaboration	Collaboration, unity and togetherness
6	06.11.2024	16:00 - 19:00	Respect and Empathy	Create animations reflecting respect and empathy in daily life	Respect, tolerance, empathy
7	20.11.2024	16:00 - 19:00	Originality and Productivity	Encourage creative animation work based on original ideas	Innovation, productivity, critical thinking

8	27.11.2024	16:00 - 19:00	Love for Nature and Environmental Awareness	Create animation content to raise environmental awareness	Environmental awareness, sustainability, love for nature
9	04.12.2024	16:00 - 19:00	Family and Social Responsibility	Create scenarios about family communication and social solidarity	Family ties, social responsibility
10	11.12.2024	16:00 - 19:00	Final Project	Create and present an independent animation project based on a selected value	Integrated values education, self-confidence

The implementation process spans a period of ten weeks, with three hours per week. In Figure 2, images related to the implementation process are presented. For the evaluation of the implementation process, data obtained from a semi-structured interview with the course teacher and the "Animation Training Evaluation Form" completed by the students were used.

Figure 2. *Student Activity Works*

Data Analysis

Descriptive analysis has been used in the analysis of research data. The aim of descriptive analysis is to present the data obtained from the relevant form in an organized and interpreted manner to the reader. The obtained data is classified according to the identified themes, summarized, and interpreted. Cause-and-effect relationships are established between the findings, and when necessary, the phenomena are compared with each other (Yıldırım and Şimşek, 2011). To ensure validity, the research process and method have been expressed in detail. Additionally, direct quotations from relevant interviews have frequently been made to support the data. In the analysis of the research data, the views of two expert researchers have been consulted, and changes have been made to the text based on the suggestions from the researchers. Furthermore, in order to ensure validity, efforts have been made to ensure that the research purpose and results are consistent. To ensure reliability, direct quotations related to the identified themes have been presented in a way that indicates which quotation belongs to which theme. Additionally, a scientific expert has been consulted for a mutual evaluation regarding which statement should be matched with which theme. As a result of the evaluation, a high level of agreement ($p>0.8$) between the two researchers emerged, demonstrating the reliability of the matches. The final version of the study was presented to two scientific experts, and validity and reliability were sought by asking for feedback from other researchers.

Findings

In this section, the research findings are presented within the framework of the research questions. The findings obtained from the data collection tools are provided in tables, corresponding to the research questions. In the analysis process of the study titled "3D Animation Activities on Values Education for Gifted Students," the findings are presented in Table 4.

Table 4. Values Developed by Gifted Students Through 3D Animation Activities – Student Opinions

Category	Student Quotes	Experience	Developed Core Values
Creativity	*S2: "Through this activity, I was able to use my creativity to create my own story and turn it into an animation."*	Story creation and character design process	Creativity, Originality
Creativity	*S5: "Designing unique scenes and characters helped me develop my imagination."*	Visualizing and staging ideas	Imagination, Aesthetic Sensitivity
Responsibility	*S3: "I tried my best to fulfill my assigned role in the team because responsibility is very important to me."*	Completing individual tasks on time	Responsibility, Reliability
Responsibility	*S1:"We had to manage our time well to complete the animation, which helped me gain self-discipline."*	Meeting project deadlines	Self-Discipline, Determination
Teamwork	*S3: "We created something great together because I believe in the value of collaboration."*	Sharing tasks within the group	Collaboration, Solidarity
Teamwork	*S4: "Combining different ideas led to better results; I truly felt the value of team spirit."*	Making collective decisions	Empathy, Tolerance
Self-Confidence	*S1: "When I completed and watched my animation, I realized I could achieve things on my own, which boosted my self-confidence."*	Bringing a personal design to life	Self-Confidence, Self-Expression
Self-Confidence	*S2: "Seeing my own character come to life strengthened my belief in myself."*	Character and scene design process	Self-Respect, Self-Belief
Problem-Solving	*S4: "I faced some coding issues, but I didn't give up because I know how important perseverance is."*	Overcoming technical difficulties	Perseverance, Patience
Problem-Solving	*S5:"We tried different ways to solve problems, which helped me develop critical thinking skills."*	Finding alternative solutions	Critical Thinking, Flexibility
Leadership	*S2: "I had to coordinate tasks within my team, which helped me develop my leadership skills."*	Team management and organization	Leadership, Responsibility

Leadership	*S4: "I learned that I had to listen to everyone's opinions when making decisions. I understood the importance of being fair."*	Taking a guiding role within the team	Justice, Communication
Aesthetic Sensitivity	*S3: "I paid attention to visual harmony when choosing colors and effects in the animation."*	Using colors, shapes, and effects consciously	Artistic Sensitivity, Attention to Detail
Aesthetic Sensitivity	*S2: "To evoke emotions in the audience, I focused on scene design and discovered the power of visual arts."*	Creating emotionally impactful scenes	Emotional Intelligence, Artistic Understanding
Digital Literacy	*S5: "Using different software for animation increased my interest in technology."*	Working with animation software	Technology Literacy, Digital Skills
Digital Literacy	*S4: "I learned to use digital tools effectively, which makes me believe I can create even better projects in the future."*	Solving problems using digital tools	Openness to Learning, Innovation
Ethical Awareness	*S1: "I didn't use others' ideas in my animation because honesty is important to me."*	Adhering to copyright and ethical rules	Honesty, Fairness
Ethical Awareness	*S3: "I realized that everyone should have an equal say in the team, which helped me develop democratic values."*	Making fair decisions within the group	Democracy, Participation

Creativity and aesthetic sensitivity student opinions: Students state that they have developed their imagination and artistic sensitivity by designing unique characters and scenes. Values highlighted in the table: Creativity, originality, imagination, aesthetic sensitivity. Teacher observations: The teacher observed students' participation in creative processes, the originality of their ideas, and how consciously they used artistic elements. It was noted that a learning environment supporting students' creative aspects was provided. Responsibility and self-discipline student opinions: Students state that they took responsibility in teamwork by fulfilling their tasks and completing the project on time. Values highlighted in the table: Responsibility, reliability, determination. Teacher observations: The teacher observed students' ability to divide tasks, take responsibility, and manage their time. It was noted that students demonstrated independence in working and fulfilled their responsibilities within the group. Teamwork and empathy student opinions: Students express that sharing ideas within the team led to better results and helped them realize the importance of collaboration. Values highlighted in the table: Cooperation, solidarity, tolerance, empathy. Teacher observations: The teacher observed a high level of interaction, cooperation, and tolerance among students in teamwork. The communication and role distribution

within the group were found to be consistent with students' experiences and perceptions. Self-confidence and self-expression student opinions: Students state that completing their projects and bringing their designs to life helped them gain self-confidence. Values highlighted in the table: Self-confidence, self-respect, self-belief. Teacher observations: The teacher observed that students demonstrated a high level of independence in their work, defended their ideas, and had confidence in their designs. This alignment between students' opinions and teacher observations indicates consistency. Problem-solving and critical thinking student opinions: Students state that they learned to develop different solutions when facing technical problems and gained patience through this process. Values highlighted in the table: Perseverance, patience, flexibility, critical thinking. Teacher observations: The teacher observed students' approaches to problem-solving and their ability to develop alternative solutions. It was noted that students did not give up when facing technical issues, sought help when necessary, and attempted to find their own solutions. Leadership and justice student opinions: Students state that they developed their leadership skills while organizing tasks within their team and understood the importance of fairness in decision-making. Values highlighted in the table: Leadership, responsibility, justice, communication. Teacher observations: The teacher observed that students took on leadership roles and guided their teams effectively. This observation aligns with students' perceptions of their leadership development. Digital literacy and ınnovation student opinions: Students state that using various digital tools helped them improve their technological skills and believe they can create even better projects in the future. Values highlighted in the table: Technology literacy, digital skills, innovation. Teacher observations: The teacher observed that students had strong technological competencies and effectively used digital tools. These observations align with students' self-perceptions. Ethical awareness and honesty student opinions: Students express that they were careful not to copy others' ideas and made an effort to make fair decisions within the team. Values highlighted in the table: Honesty, justice, democracy, participation. Teacher observations: The teacher observed that students adhered to ethical rules and respected others' ideas. This indicates that students' ethical awareness aligns with the teacher's observations.

Table 5. *Teacher Opinions on Gifted Students in Science and Art Centers*

Category	**Teacher Opinions**
General Characteristics of Students	*T2: Gifted students learn faster than typically developing students. However, they may sometimes struggle to fit in with other students in the class. T1: These students have strong critical thinking and creative problem-solving abilities. However, they may require more support in terms of emotional and social development. T3: Some gifted students may have low motivation, which can hinder the teaching process and prevent them from fully reaching their potential.*
Teaching Methods and Approaches	*T4: We should adopt a more in-depth and exploratory approach for gifted students. These students can generally work more independently than traditional teaching methods allow. T3: Differentiated teaching is one of the most effective methods for these students. Creating personal projects based on each student's interests can increase their motivation. T2: Encouraging them to work with challenging and abstract materials will push their intellectual boundaries.*
Challenges and Solutions	*T3: In class, gifted students often become bored. It is important to avoid rushing through lessons and instead provide opportunities for in-depth analysis. T1: Some students, despite academic success, may experience deficiencies in social skills. Therefore, programs aimed at developing social skills should be added. T4: For students who learn quickly, the teaching process should be accelerated. Advanced-level materials suited to their level should be used.*
Learning Environment and Materials	*T2: The classroom environment should be suitable for individual work for gifted students. Providing quiet and comfortable spaces can improve their productivity. T1: Technological materials and online resources can be very beneficial in supporting the learning processes of gifted students. T4: Educational materials supported by art and scientific experiments can help develop students' creativity and intellectual abilities.*

Student Achievements and Development Processes	*T3: Gifted students can consolidate their academic success by working on original projects and research. Focusing on such projects can accelerate their development. T2: Allowing these students to learn at their own pace will make their success more visible. A roadmap tailored to each student's pace should be created. T1: Assigning mentors based on students' personal interests can help them develop their talents at a professional level.*

General characteristics of students: Gifted students are recognized for their ability to learn faster than their peers. However, despite their academic abilities, they may face difficulties in fitting in with other students in the classroom, as their cognitive pace may not align with that of their classmates. Additionally, while these students excel in critical thinking and creative problem-solving, they often require additional support in emotional and social development. Some gifted students may struggle with low motivation, which can hinder their overall potential and make teaching these students more challenging. Teaching methods and approaches: Gifted students require a teaching approach that goes beyond traditional methods, emphasizing in-depth exploration and independent learning. These students are more likely to thrive in environments that allow them to work autonomously. Differentiated instruction is highly recommended, as it allows teachers to tailor lessons to individual interests and needs, fostering greater motivation. Furthermore, providing more abstract and challenging materials can push their intellectual boundaries, encouraging deeper understanding and more advanced learning outcomes. Challenges and solutions: A significant challenge with gifted students is their tendency to become bored in class due to their quick learning pace. To address this, teachers should avoid rushing through lessons and instead create opportunities for deeper exploration of topics. In some cases, despite their academic success, gifted students may experience difficulties in social interactions, requiring special attention to social skill development through targeted programs. Lastly, to support students who learn rapidly, an accelerated teaching approach may be necessary, incorporating advanced materials that align with their intellectual capacity. Learning environment and materials: The learning environment for gifted students should support independent work. Quiet, distraction-free spaces are beneficial for enhancing their concentration and productivity. Technological tools and online resources can significantly aid in their learning process by offering more interactive and individualized experiences. Additionally, educational materials that integrate art and scientific experimentation can further stimulate students' creativity and foster in-

tellectual growth, helping to enhance their overall learning experience. Student achievements and development processes: Gifted students often achieve success through original projects and research, which solidify their academic achievements and accelerate their intellectual development. Allowing them to progress at their own pace helps them realize their full potential. Providing personalized learning roadmaps ensures that each student's development is supported in alignment with their individual needs. Moreover, mentoring based on students' personal interests can assist them in refining their talents and developing their skills at a professional level, ensuring that they reach their maximum potential.

Discussion and Conclusion

The findings of this study indicate that 3D animation activities play a significant role in the development of values among gifted students. The results demonstrate that students not only engaged in creative processes but also developed key values such as responsibility, teamwork, self-confidence, problem-solving, leadership, and ethical awareness. These findings are consistent with prior research highlighting the effectiveness of animation in educational settings (Bağlama et al., 2018; Çelik, 2019; Berigel et al., 2017). One of the key observations in this study was that students demonstrated an increased level of creativity and artistic sensitivity. The ability to create unique characters, design animations, and develop storylines enabled students to explore their imagination and aesthetic sensibilities. These findings align with research indicating that animations enhance students' engagement, motivation, and artistic development (Karaşahinoğlu, 2013; Love, 2004). Furthermore, students developed a strong sense of responsibility and self-discipline during the animation process. The need to meet deadlines and complete assigned tasks contributed to their ability to manage time effectively. Teacher observations corroborated students' perceptions of increased responsibility, which is in line with previous studies emphasizing the role of animation-based education in fostering self-discipline (Fisk, 2008; Mansor, 2020). The study also highlighted the impact of 3D animation on teamwork and empathy. Students worked collaboratively, shared ideas, and contributed to group projects, reinforcing values of cooperation, solidarity, and tolerance. These results support prior findings that suggest animation-based activities encourage social interactions and group cohesion (Chan, 2013; Aslan, 2020). Additionally, the study found that students enhanced their problem-solving and critical thinking skills. Technical challenges encountered during animation creation required students to develop perseverance and alternative solutions. These findings align with the research of Küçük and Yıldırım (2020) and Höffler and Leutner (2007), who emphasized the role of animation in fostering problem-solving abilities. Another significant outcome was the

development of leadership and decision-making skills among students. Those who took on leadership roles within their groups exhibited responsibility and fairness, confirming previous studies on the impact of animation in leadership skill development (Sy et al., 2024; Kleftodimos, 2024). Moreover, students improved their digital literacy and technological skills by using animation software, which increased their confidence in working with digital tools. This finding supports research indicating that animation enhances technological competence and innovation (Cook & Gladhard, 2002; Taylor et al., 2007). Finally, the study emphasized the role of 3D animation in ethical awareness. Students demonstrated integrity by adhering to copyright rules and making fair decisions in their teams. This finding aligns with research that suggests animation can be an effective tool for instilling ethical values (Çelik, 2019; Berigel et al., 2017).

Conclusion

In conclusion, this study provides compelling evidence that 3D animation activities contribute positively to values education for gifted students. By integrating animation into the educational process, students not only develop technical skills but also strengthen their moral and social values. The findings suggest that educators should consider incorporating animation into their teaching strategies to enhance student engagement and value development. Future research should explore the long-term impact of animation-based values education and examine its effectiveness across different age groups and educational settings. Additionally, studies should investigate how various types of animation software influence students' learning outcomes. Expanding the scope of research in this area could further enhance the integration of animation into education, providing more inclusive and effective learning experiences for students.

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Biographical

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Chapter 2

THE IMPACT OF PARENTS' SOCIOECONOMIC STATUS ON STUDENTS' COGNITION AND SCHOOL PERFORMANCE

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Introduction

It has been asserted that coming from a family of a lower social class or socioeconomic status may negatively affect an individual's educational pathway. Yet still, some individuals appear unaffected and deal effectively with the demands, challenges and hardships caused by schooling, despite living, growing up and being raised in poor conditions. This phenomenon has been termed "academic resilience". It has been highlighted that the underlying factors that make some individuals more likely to overcome adverse circumstances, unfortunate odds and unfavorable inequality compared to others remain unclear and open to debate. Research has indicated that both socioeconomic status and cognitive abilities are significantly and strongly associated with students' academic performance. The objective of the current study is to investigate how and to what extent parents' socioeconomic status and children's cognitive abilities are connected and interact in their impact on children's school grades. The study analyzed this connection and interaction between socioeconomic status, cognition and academic performance utılizing data from a study on brain and cognitive development in adolescents with a sample of 5,001 students. Ordinal regression models displayed similar patterns of connections among three measures of socioeconomic status, namely parental education, family income and neighborhood deprivation, as well as children's grades at both time points. The study found that parental education and family income were related to children's grades at both time points, without regard to whether students' cognitive abilities were modeled or not. In contrast, when children's cognitive ability was not an inner factor or variable, neighborhood deprivation only predicted students' reported grades in a statistically significant manner. Children's cognitive ability was related to and interacted with parents' level of education, acting as a potential shield against the impacts of parents' socioeconomic status on children's school performance.

Research has argued that individuals may be blank slates at birth, but this does not mean they are born, live, and grow up in the same social class or socioeconomic status backgrounds and circumstances. Numerous studies have discovered connections between students' socioeconomic origin and how well they perform in school across different age categories and diverse culture groups. It has been indicated that children's educational success is shaped, at least to some extent, by their social class or socioeconomic status (Li and Qiu, 2018; Brown and Putwain, 2022; Şirin, 2005). It has also been noted that the influence of parents' social class or socioeconomic status on children exists not only when they just start attending school but also in the very early years of the preschool period (Janus and Duku, 2007). Yet still, evidence suggests that this pattern does

not exist in developing countries (Kim, Cho, and Kim, 2019). It has been stated that school performance is not merely an aspect of cognitive, intellectual, educational and academic development that is related to socioeconomic variables, social class or socioeconomic status of parents. Research has determined that higher socioeconomic status is related to a higher quality of life and a healthier lifestyle (Poulain, Vogel, Sobek, Hilbert, Körner and Kies, 2019; Kim, Wallander, Depaoli, Elliott, and Schuster, 2021), while lower socioeconomic status in childhood and adolescence is associated with an enhanced risk for a range of mental health and behavioral problems (Reiss, Meyrose, Otto, Lampert, Klasen and Sieberer, 2019; Reiss, 2013; Singh and Ghandour, 2012; Boe, Overland, Lundervold, and Hysing, 2012; Peverill, Dirks, Narvaja, Herts, Comer and McLaughlin, 2021). An extensive population-based study concluded that relationships between parents' social class and children's performance in elementary school have existed for nearly a century, and that the power of these associations has remained consistent, constant, stable and permanent during this time (von Stumm, Cave, and Wakeling, 2022). A recent meta-analysis reviewed 300 empirical studies from over 100 countries and obtained findings supporting the same trend (Liu, Peng, Zhao, and Luo, 2022). Conversely, another study found that the strength of the relationship between parents' social class or socioeconomic status and children's academic success has gradually diminished over at least two decades (Liu, Peng, and Luo, 2020). A previous meta-analysis reviewed data obtained from more than 100,000 students and discovered moderate to strong correlations between different indicators of parents' socioeconomic status and academic success of students (Şirin, 2005).

In order to better comprehend and explain the relationship between socioeconomic status of parents and educational attainment of children, the impact of additional relevant variables was examined. It has been suggested that cognitive abilities are a primary factor influencing academic achievement and that cognitive abilities are connected to both parents' socioeconomic status and children's academic achievement. It has been indicated that cognitive abilities during childhood are a major landmark for educational, cognitive, intellectual and academic development and regulation. Cognitive function has been described as the mental ability to store, retain, retrieve, acquire and process information and involves an array of skills, including abstract reasoning, memory, executive function, attention, language, speech and processing speed (Peng and Kievit, 2020; Shi and Qu, 2021; Luciana, 2018). These cognitive skills and abilities have been examined with regard to their probable and potential influence on the relationship between socioeconomic status of parents and educational attainment of children in school. A recent study has revealed that verbal

and non-verbal abilities of children before starting school have a mediating influence on the association between parents' socioeconomic status and school performance of children (von Stumm, Rimfeld, Dale, and Plomin, 2020). Executive functions in children and their association with both parents' socioeconomic status and children's academic achievement have been examined at various ages, most often in terms of children's mathematical skills (Waters, Ahmed, Tang, Morrison and Davis-Kean, 2021; Nesbitt, Baker-Ward, and Willoughby, 2013; Dilworth-Bart, 2012; Finders et al., 2021; Fitzpatrick et al., 2014; Lawson and Farah, 2017). It has been demonstrated that activities in the home environment aimed at stimulating, nurturing and enhancing children's cognitive development, such as parental or caregiver attention, improve children's speaking skills, language abilities and academic achievement, respectively. It has been asserted that children's speaking skills and language abilities predict their future academic achievement (Lurie, Hagen, McLaughlin, Sheridan, Meltzoff and Rosen, 2021). On the other hand, several other studies do not validate substantial impacts of parents' socioeconomic status on individual differences in children's academic achievement. Children's intelligence has been highlighted as a factor influencing their academic achievement (Colom and Flores-Mendoza, 2007; Flores-Mendoza, Ardila, Gallegos, and Reategui-Colareta, 2021; Marks, 2017). It has been noted that the association between parents' socioeconomic status and children's academic achievement is complicated. Research has revealed that not only certain influences, such as subject fields and school types, but also other non-cognitive variables, such as ethnicity, gender, personality, or motivational factors, mediate the association between parents' socioeconomic status and academic achievement of children (Brown and Putwain, 2022; Brandt, Lechner, Tetzner, and Rammstedt, 2020; Vazsonyi, Javakhishvili, and Blatny, 2022; Strand, 2014; King and Trinidad, 2021; Thorsen, Yang Hansen, and Johansson, 2021). In general, intelligence has appeared to be the strongest and most reliable predictor of students' educational performance, despite involvement of additional factors both within and beyond individuals, such as parents' social class or socioeconomic status (Laidra, Pullmann, and Allik, 2007).

It is emphasized here that there is convincing evidence showing that low parental socioeconomic status can put children's educational success at risk. All the same, despite encountering and experiencing a varied and accumulated set of inequalities of opportunity that may be disadvantageous and detrimental to them, children from disadvantaged or low socioeconomic status families do well and succeed in school, meaning they are not influenced by these potentially harmful dynamics. This phenomenon is dubbed "academic resilience" in the literature (Thorsen, Yang

Hansen, and Johansson, 2021; Martin, 2002). It has been underlined that some individuals succeed in their educational lives, school and academic careers, although they come from low socioeconomic status families with adverse, disadvantaged or unfavorable circumstances. The concept related to this phenomenon has been described as academic buoyancy, which is more commonly associated with academic resilience in a more everyday sense (Martin and Marsh, 2008). The concept of academic resilience or academic vitality has been defined as the capacity of children who are born, living and growing up in socio-economic deprivation, impoverisment or other types of disadvantaged living conditions to handle, cope with and overcome the challenges and difficulties of everyday life at school. It has been pointed out that it remains unclear precisely what factors make some individuals less inclined than others to experience and suffer from the negative impacts of the adverse circumstances into which they are born. However, it has been discussed what should be done to protect children from the adverse impacts of disadvantaged, negative and poor conditions on cognitive development and school success and what some potentially protective factors are (Thorsen, Yang Hansen, and Johansson, 2021). It has been determined that psychological characteristics such as self-efficacy, control, planning, low anxiety and low concern, as well as determination, perseverance and persistence, predict students' academic resilience (Martin & Marsh, 2006). Research has underlined other psychological characteristics and attitudes related to academic resilience, and also stated that both students' confidence and belief in reading and math and their sense of belonging to their school are linked to academic resilience (García-Crespo, Fernández-Alonso, and Muñiz, 2021; Sandoval-Hernández and Białowolski, 2016). Besides, it has been asserted that factors related to children's home, classroom and school environments may have an impact on students' academic resilience. For example, it has been established that factors such as early supportive literacy activities before starting elementary school, positive teacher attitudes toward performance of students, low levels of bullying, safe, secure and orderly environments and teaching styles that concentrates on understanding, perception and deep thinking affect students' academic resilience (García-Crespo, Fernández-Alonso, and Muñiz, 2021; Sandoval-Hernández and Białowolski, 2016). It is stated that students' academic resilience is associated with school enjoyment, satisfaction, class participation, self-worth and self-respect, respectively (Martin and Marsh, 2006). Cross-national research has discovered differences in the mechanisms underlying academic resilience between students from native-born families and immigrant students from foreign-born families, indicating that students from foreign-born families generally have lower academic resilience (Gabrielli, Longobardi, and Strozza, 2022; Martin, Burns, Collie, Cutmore, MacLeod and Donlevy, 2022). It

has been asserted that unfavorable life events are typically related to students' academic resilience at the individual level. Furthermore, research has pointed to the COVID-19 pandemic as a recent global life stressor and examined the different risk and resilience factors that influence students' performance in overcoming the challenges of isolation during confinement (Verger, Urbanowicz, Shankland, and McAloney-Kocaman, 2021; Cobb, Xie, Gallo, Boyd, Wilkins and Wadsworth, 2024).

Methods

Data were collected from students taking part in a study on brain-cognitive development of adolescents. The study primarily complements the data for neurocognitive assessments and supplies information to predict students' overall performance in the final year, both for the second-year and the third-year follow-up assessments. The study also provides baseline data on parents' educational attainment, household size and family income over the past year, as well as data on the socioeconomic status of the neighborhood. A total of 5001 students took part in the study: 2656 male (53%) and 2345 female (47%), to be exact. The mean age of the students was 9.98 years, and the standard deviation was 0.6.

Students' Cognitive Performance

In order to evaluate various elements of students' cognitive performance, the Adolescent Brain and Cognitive Development study utilized seven measures of a cognitive battery. These tests were administered to students to measure and evaluate their attention, executive function, episodic memory, working memory, language and speech skills and processing speed. The present study utilized all cognitive data from the baseline assessment of the brain and cognitive development study of the adolescents. The study used a standardized composite cognition point that described and summarized students' performance along all seven cognitive tasks as an indicator of general cognitive ability.

Socioeconomis Status

It has been asserted that socioeconomic status, a broad and multifaceted concept, may be operationalized in various ways through the use of individual or composite measures derived from it. When defining individuals' socioeconomic status, variables such as educational acquisition, occupation, and income are typically taken into account. Measures of socioeconomic status can be divided into domains and provide indicators of not only individuals' direct home environments but also the conditions of homes within neighborhoods defined and positioned by factors such as public finance, security, employment or housing. The social class or

socioeconomic status of students participating in the brain and cognitive development study of adolescents was defined by means of variables such as parental educational attainment, occupation, income and neighborhood characteristics. Home-based measures included parental education, employment and occupational status and family income. The Neighborhood Deprivation Index indicated the level of socioeconomic disadvantage in the students' community and neighborhood. The analysis in the current study relied on three indicators of socioeconomic status: parental education, family income and the level of neighborhood disadvantages. Parental education indicated the highest level of school completed or the highest degree earned by the parent. Students stated their parents' level of education using numerical values that approximately indicated the number of years individuals had received formal and informal education, and on a scale ranging from 0 to 21 (0 = "I have never had any particular form of formal education" to 21 = "I have earned a doctoral degree"). Parental education was handled as a continuous variable in this analysis. Information on overall socioeconomic status for students included in the current study was gathered as part of the baseline evaluation conducted by the Study on Adolescent Brain and Cognitive Development.

School Grades

Research on adolescents' brain and cognitive development did not directly provide information from schools about students' grades or other performance indicators. Instead, both students and parents were asked to provide a general assessment of how well they did in school over the past year. When the distributions of students' and parents' self-reported grades were compared visually, a high degree of overlap between the two assessments and predictions was observed.

Procedure

In order to assess the intensity of the association between socioeconomic status variables of parents and students' grades, the study first employed a separate sequential regression model for each of the two time points. In investigating the association between socioeconomic status of parents and students' grades, school grades at each time point were defined as the dependent variable, while parental education, family income and level of neighborhood disadvantage were defined as the independent variables or predictors. The initial models were then expanded by including three interaction terms, namely children's composite cognition scores, parental education, family income and the deprivation level of the home neighborhood, respectively**.** Finally, a post hoc regression was utilized to test the effects of three indicators of parental socioeconomic

status on students' grades over time, including interaction terms among education of parants, family income, neighborhood deprivation and time point. Here, the term post hoc is used to indicate sequential events and cause-and-effect relationships, where one event is accepted as the cause of the subsequent event when it occurs before another.

The main objective of the current research is to test whether the relationship and interaction between socioeconomic status of parents and children's academic performance demonstrate that these relationships and interactions influence children's academic performance in different ways and forms, thus contributing to this emerging field of research. Interindividual differences in students' cognitive performance and socioeconomic variables are evaluated in terms of their relationship and interaction with each other in their impact on school grades. Moreover, it provides evidence about the conditions and factors that foster, nurture and develop students' academic resilience beyond the personality, behavior, and environment factors addressed above. Research has revealed that intelligence and cognitive abilities are closely related to students' academic achievement not only across a variety of subjects (Deary, Strand, Smith, and Fernandes, 2007; Roth, Becker, Romeyke, Schafer, Domnick and Spinath, 2015; Rohde and Thompson, 2007; Leeson, Ciarrochi, and Heaven, 2008) but also across a wide array of other performance indicators in educational and professional settings (Kuncel, Hezlett, and Ones, 2004; Hunter, 1986). It has also been established that parental socioeconomic status is associated with several cognitive abilities, most evidently and notably children's executive function and speech and language skills (Hackman, Gallop, Evans, and Farah, 2015; Norbom et al., 2022; Romeo, Flournoy, McLaughlin, and Lengua, 2022; Lawson, Hook, and Farah, 2018; Pace, Luo, Hirsh-Pasek, and Golinkoff, 2017; Calvo and Bialystok, 2014; Noble, Norman, and Farah, 2005; Burneo-Garcés, Quintana, Garcia, Fernandez-Alcantara, Fasfous and Perez-Marfil, 2019). It has been asserted that the socioeconomic status of parents is also related to educational and academic performance of children (Li and Qiu, 2018; Brown and Putwain, 2022; Şirin, 2005; Janus and Duku, 2007). Research has well documented and proven the impacts of cognitive abilities on academic success and the impacts of parents' socioeconomic status on both cognitive abilities and academic achievement, respectively. However, it has been argued that the relationships and interactions between parents' socioeconomic status, children's cognitive abilities and children's academic success have been less investigated. Previous studies have examined whether cognitive abilities influence the relationship between socioeconomic status and school performance at the country level. It has also been asserted that cognitive abilities do not influence the relationship between socioeconomic status

and school performance, and that such effects have not been confirmed by these studies (Boman, 2023). In contrast, the current research endeavors to specify whether the association between socioeconomic status of parents and children's academic achievement varies as a function of children's cognitive abilities at the individual level. The current analysis provides an additional assessment of the association and interaction between parents' socioeconomic status and academic achievement, utilizing data on students' academic achievement from two time points. First, the study utılizes data from Research on Adolescent Brain and Cognitive Development to evaluate correlations between parental socioeconomic status and self-reported school grades in a subsample of children aged 9 to 11. Second, the research concentrates on the relationships between socioeconomic status variables of parents and children's academic performance. This time, the time factor in field-general cognitive performance is explored to determine how and to what extent children's cognitive abilities affect the association between parental socioeconomic status and academic achievement of children. The model includes data on children's academic performance from two time points and is utilized to understand and account for the relationship between parental socioeconomic status and students' academic grades over time.

Results

Relationships between Socioeconomic Status and Students' School Grades at the 2nd and 3rd Year Follow-ups

The study examined the relationships between parents' socioeconomic status and children's academic performance, utilizing separate sequential regression models for each of the two time points. Students' school grades were integrated as the dependent variable, and education of parents, family income and neighborhood deprivation were included as independent variables or predictors. The patterns between the diverse socioeconomic variables and students' academic grades were found to be very similar at both the 2nd year and the 3rd year follow-ups. In both models, the odds ratio for achieving a higher grade in school enhanced with enhancing levels of each indicator of socioeconomic status, namely parental education and family income. Wealthier neighborhoods had lower scores on the deprivation indicator, so an odds ratio of less than 1 for the deprivation indicator showed a positive association between children living in a wealthier neighborhood and achieving higher grades in school. Tables 1 and 2 present the regression results for all predictors in addition to the odds ratios (95% confidence intervals) at the 2nd year follow-up and the 3rd year follow-up.

Table 1 Odds ratios for students reporting higher grades based on socioeconomic status at the 2nd year follow-up (N = 5001)

Predictors	β	SE	z	p
Parental Education	0.26	0.03	7.48	000 ***
Family income	0.31	0.04	7.58	000 ***
Neighborhood deprivation index (percentiles)	-0.10	0.03	-2.94	0.00 **

**P < 0.01, ***P < 0.001 (Langensee, Rumetshofer and Martensson, 2024, p. 2)

Table 2 Odds ratios for students reporting higher grades based on socioeconomic status at the 3rd year follow-up (N = 5001)

Predictors	β	SE	z	p
Parental Education	0.30	0.03	8.91	000 ***
Family income	0.31	0.04	7.66	000 ***
Neighborhood deprivation index (percentiles)	-0.11	0.03	-3.45	0.00 ***

****P* < 0.001 (Langensee, Rumetshofer and Martensson, 2024, p. 2)

The Impact of Socioeconomic Status on Students' Grades Over Time

After individual models were examined for each time point, significant major impacts of parental education, family income and neighborhood deprivation indicator scores on predicted grades were validated. A post hoc analysis was carried out, modeling the interactions between the three indicators of socioeconomic status and time point. Moreover, a substantial impact of time point emerged, indicating a higher probability of good grades at the 2nd year follow-up compared to the 3rd year follow-up. However, the interactions between the three indicators of socioeconomic status and time did not produce statistically significant impacts. Table 3 provides details on the regression estimates**.**

Table 3. Odds ratios for reporting higher grades as a function of socioeconomic status and time (N = 5001)

Predictors	β	SE	z	p
Parental education	0.26	0.03	7.50	000 ***
Family income	0.32	0.04	7.60	000 ***
Neighborhood DeprivationIndex(-Percentiles)	-0.10	0.03	-2.95	0.00 **
Timepoint	-0.20	0.04	-4.55	0.00 ***
Timepoint X education	0.04	0.05	0.81	0.42
Timepoint X family incomje	-0.01	0.06	-0.17	0.86

Timepoint X area deprivation	-0.01	0.05	-0.31	0.76

**$P < 0.01$, ***$P < 0.001$ (Langensee, Rumetshofer and Martensson, 2024, p. 3)

Relationships between Parents' Socioeconomic Status and Students' School Grades as a Function of Children's Cognitive Abilities at the 2nd and 3rd Year Follow-ups

The study utilized an ordinal regression model to examine whether the overall impact of parents' socioeconomic status on students' grades varied as a function of cognitive abilities of children. The results are illustrated in Tables 4 and 5.

Table 4. Odds ratios for reporting higher grades in school based on interactions between socioeconomic status and students' cognitive performance at the 2nd year follow-up (N = 5001)

Predictors	β	SE	z	p
Parental education	0.20	0.04	5.22	0 0 0 ***
Family income	0.24	0.04	5.65	0 0 0 ***
Area Deprivation Index (Percentiles)	-0.06	0.04	-1.55	0.12
Composite cognition scores	0.54	0.04	15.08	0 . 0 0 ***
Composite cognition scores X education	0.08	0.04	2.10	0.04 *
Composite cognition scores X family income	0.03	0.04	0.65	0.52
Composite cognition scores X neighborhood deprivation	-0.01	0.05	-0.31	0.76

*$P < 0.1$, *$P < 0.05$, ***$P < 0.001$ (Langensee, Rumetshofer and Martensson, 2024, p. 3)*

Table 5. Odds ratios for reporting higher grades in school based on interactions between socioeconomic status and students' cognitive performance at the 3rd year follow-up (N = 5001)

Predictors	β	SE	z	p
Parental education	0.25	0.04	6.79	0 0 0 ***
Family incom	0.24	0.04	5.93	0 0 0 ***
Area Deprivation Index (Percentiles)	-0.07	0.04	-1.94	0.05

Composite cognition scores	0.46	0.03	13.39	0.000 ***
Composite cognition scores X education	0.08	0.03	2.31	0.02 *
Composite cognition scores X family income	0.03	0.04	0.66	0.51
Composite cognition scores X neighborhood deprivation	-0.03	0.03	-0.90	0.37

*P < 0.1, *P < 0.05, ***P < 0.001 (Langensee, Rumetshofer and Martensson, 2024, p. 3)*

Results reveal that children's cognitive ability and parents' educational attainment interacted at both time points in their impact on the probability of reporting higher grades in school. Neighborhood deprivation, however, did not significantly predict students' grades any longer when cognitive ability was a factor in the models. Family income, on the other hand, significantly predicted students' grades at both the 2nd year and the 3rd year follow-ups. This indicated that these income increases were related to a higher probability of reporting higher grades at both time points.

Discussion

The current research investigated whether children's cognitive abilities might contribute to fostering children's academic resilience through the combined influence of both parents' socioeconomic status and children's cognitive abilities on children's school performance. More specifically, the research sought to test whether higher cognitive abilities in children could potentially buffer children from the known negative impacts of parents' low socioeconomic status on educational attainment. In other words, the researchers investigated whether children's cognitive skills reduced or eliminated the differences, inequalities and gaps in students' school performance caused by the association between higher socioeconomic status and higher academic success and the association between lower socioeconomic status and lower academic success. The significance of a better understanding and comprehension of whether children's cognitive skills contribute to moderating the association between socioeconomic status of parents and children's school performance was emphasized. It was also stated that this could be a valuable beginning point for targeted interventions designed to minimize long-term risks for children born, raised and reared under socioeconomically disadvantaged circumstances.

First, the analysis found that parental education, family income and neighborhood disadvantage significantly predicted students' grades at two time points before children's cognitive ability became a factor, that

is, before children's cognitive ability was included in the model, which is in agreement and compatible with existing literature. The odds of reporting higher grades at both the 2nd year and 3rd year follow-ups increased with higher parental education, income and lower levels of neighborhood deprivation. Compared to neighborhood deprivation, parents' education and income have larger effect sizes on children's probability of reporting higher grades. A previous study on adolescent brain and cognitive development discovered that the impacts of parental education and income on children's intelligence were twice as large as the impacts of neighborhood quality (Judd, Sauce, and Klingberg, 2022). Findings from the current study appeared consistent with those obtained in the previous study. Similarly, previous findings from the same cohort participating in a study on adolescent brain and cognitive development indicated that, among different indicators of parental socioeconomic status, family income was most closely linked to children's composite cognition scores (Tomasi and Volkow, 2021). Parental education and neighborhood deprivation were correlated with children's cognition scores, although the impacts were insignificant when family income was controlled for. The study emphasized that the connection between family income and children's cognition scores was particularly strong for the emergent element of children's cognition, and it has been pointed out that low family income may be particularly harmful to the development of language and speech-related abilities (Tomasi and Volkow, 2021), as shown earlier, even a long time before starting school (Fernald, Marchman, and Weisleder, 2013).

Second, the analysis revealed an interaction between parents' education and children's cognitive scores at both time points. Children with higher cognitive abilities appeared to benefit more from having well-educated parents compared to children with lower cognitive performance. It was asserted that the interaction between parents' education and children's cognitive scores at both time points was statistically significant, whereas the magnitude of the impact was marginal. The researchers pointed out that it was more probable that both children's cognitive abilities and parental education had individual impacts on children's school grades. They hypothesized and predicted that the potential interaction between children's cognitive abilities and parental education was more complex than what could be obtained from a simple regression model. This finding reflected the findings of a previous country-level study, which discovered that children's cognitive abilities did not impact the relationship between children's school performance and parents' socioeconomic status (Boman, 2023). The current study established that the observed effect sizes were modest and did not vary significantly between the 2nd and 3rd year follow-up assessments.

Third, the analysis indicated that when the effect of parents' socioeconomic status on students' school grades over time was examined directly, the interaction influences between time and each of the three indicators of socioeconomic status, namely parental education, family income and neighborhood characteristics, failed to reach statistical significance. Bearing in mind and taking into account the fact that the demands faced by students in school are progressively increasing, it has been asserted that coming from a privileged social class or socioeconomic status background, where there are richer and more plentiful resources available for intellectual stimulation, nurturing, development, guidance and support, is advantageous to students and is, or becomes, more useful for the more difficult and challenging demands of school, It has been pointed out that socioeconomic disadvantages are not automatically linked to the lack and absence of cognitive stimulation, nurturing and development of children in the home and family environment at the individual level, in other words, socioeconomic disadvantages do not automatically go hand in hand and side by side with the lack and absence of cognitive stimulation, nurturing and development of children in the home and family environment at the individual level. Previous research has displayed only a weak association between socioeconomic status of parents and students' academic achievement in a higher education institution (Rodríguez-Hernández, Cascallar, and Kyndt, 2020; Westrick, Le, Robbins, Radunzel, and Schmidt, 2015), and such a finding is in conflict with the assumption that the effect of parents' socioeconomic status on students' academic performance enhances over time. Reasonable explanations have been made for the assumption that the influence of parental socioeconomic status on students' academic performance decreases with time in higher education environments as students proceed through educational pathways and stages. It has been suggested that as children grow older, they gradually acquire metacognitive strategies that make it possible for them to stay on track and proceed along educational pathways and stages. It has been indicated that students exert efforts to follow, pursue, keep up and reach academic goals beyond what their social class or socioeconomic status backgrounds have prepared for them. A meta-analytic review addressed and evaluated the long-term impacts of educational interventions to teach students learning strategies and supported this notion by pointing to greater long-term benefits of strategy instruction for students from low socioeconomic status families (de Boer et al, 2018).

The analysis compared the socioeconomic status of parents between children who reported high or higher grades and those who did not, and discovered that general patterns were similar in the two groups. On the other hand, compared with children who reported lower grades, the high-

er-performing group was more likely to come from higher-income families with highly educated parents, and to a greater extent, to come from socioeconomically wealthier families. It has been asserted that children in this group are most likely to live in neighborhoods that offer convenient, positive, advantageous and favorable conditions for factors such as housing, employment and education. While the design of the current study prevents a distinction of cause and effect, the findings, along with their common trend indicators, explicitly and distinctly underline systematic differences among children. In this case, this meant that children who reported better grades in school performed better on average on a neurocognitive test battery were more likely to come from socioeconomically wealthier families. This finding indicated the existence of the "Matthew Effect" expressed in an educational context (Merton, 1968). The concept was originally invented as a term in the 1960s to define the phenomenon where famous scientists are more likely to be given additional recognition and acknowledgement for their work than an unknown scientist, despite comparable or similar achievements in their fields. Since then, the concept has been implemented to a variety of contexts, and it has been suggested that initial resources predict and determine future earnings, often making the rich richer and the poor poorer. While observational research does not allow or enable causal statements and judgments, the current study explicitly and distinctly confirmed and supported the notion that being born, living, growing up and being raised in favorable socioeconomic situations is likely to be associated with additional positive outcomes.

The current research has stressed the importance of addressing long-existing relationships between parents' socioeconomic status and grades in a large, longitudinal sample of children. It should be underlined that this is explicitly and distinctly full of problems, given that standardized tests and grading are utilized to objectively and impartially measure and evaluate the true level of children's cognitive abilities in educational settings, and not factors out of their control, such as their social structure or financial status It has been indicated that standardized tests and grading are not adequate enough to account for variations in students' cognitive capacities in educational settings and the association between socioeconomic status of parents and academic performance of students. It has been asserted that additional variables should be taken into account to explain variations in the association between parents' socioeconomic status and students' academic performance. For instance, it has been stated that personality and attitudinal factors are also likely to exert influence over academic performance in ways that differ both within and between individuals. It has been emphasized that the already complex situation becomes even more complicated owing to the fact that variables of social

class or socioeconomic status are typically highly correlated with one another. It has been alleged that, compared with individuals with fewer years of formal education, well-educated individuals are more likely to earn more money and live in wealthier neighborhoods. It has been noted that it is hard to disentangle and distinguish the unique contributions of each of the variables, namely being well-educated, earning more money and living in wealthy neighborhoods, to children's educational performance. Yet still, despite multicollinearity among variables that may predict children's educational performance, the current research nevertheless demonstrated individual, unique and strong contributions of parental education, family income and neighborhood advantage or disadvantage as three different indicators of socioeconomic status that were examined.

Students participating in study on the brain and cognitive development of adolescents reflected a data structure collected through their schools and nested with many other children attending the same school. This suggests that there are likely systematic differences in the grades reported by students attending different schools. It is indicated here that there are probably systematic differences between the grades reported by students attending different schools. For instance, children attending schools that have more resources, more highly qualified teachers or smaller class sizes can have better chances of attaining good grades compared to students from schools that are relatively less fortunate. It was stated that the difficulty and complexity of the tests and grading practices varied across schools. Unfortunately, information about the school that students attend was not available for a substantial part of the data. Therefore, the internal structure of the data could not be statistically explained in the analysis. Looking to the future, a valuable contribution of the current research is stressed as a study that assesses the strength and robustness of the results when school-specific variations are considered. It is emphasized here that there is some ambiguity concerning how and how well students' self-reported school performance determines the true level of their academic success, and that a certain degree of variation or inconsistency should not be ignored. The analysis relied on students' self-reported grades rather than being optimal as evidence pertaining to the reliability of self-reported grades is miscellaneous (Kuncel, Credé, and Thomas, 2005; Sticca, Goetz, Bieg, Hall, Eberle and Haag, 2017). However, parents' predictions about their own children have likewise been discussed, and it has been alleged that parental predictions are biased in different settings (Seifer, Sameroff, Dickstein, Schiller, and Hayden, 2004; Weden et al., 2013). It has been pointed out that self-reported findings, without regard to whether from the students themselves or from their parents, may never be interpreted with the same confidence in the absence of school transcripts.

In keeping with previous work, the current study demonstrated significant impacts of parental education, family income and neighborhood deprivation, as three different indicators of socioeconomic status, on students' self-reported school grades in a large sample across two time points. Besides, the results indicated that parental education and students' cognitive performance interacted in their influence on students' self-reported school performance. It has been alleged that students with better cognitive performance are more likely to do exceptionally well academically on steeper uphill slopes, as their parents are more educated and financially wealthier. Owing to the insignificance of the magnitude of this impact, it is stated that the current research does not as a whole ensure strong evidence for relationships between parents' socioeconomic status and students' grades as a function of children's cognitive abilities. The magnitude of the impact was found to be modest in general. This research suggests that the combined influence of various internal and external factors determines children's school achievement. Among the various factors located both within and outside the individual, only the social class or socioeconomic status of parents and the cognitive abilities of children could account for the variance in students' grades as far as a particular point in time.

Yet still, the current study has demonstrated that parents' social class, or socioeconomic status, affects children's cognitive capacity and school grades to some extent over time. This is compatible with previous literature. Teachers, policymakers and educational researchers are urged to continue their endeavors to create school environments where children's opportunities to understand, recognize and distinguish themselves academically are controlled by them, rather than by their parents' wealth and high level of education. Individuals involved in the education of children in one way or another are expected and urged to be alert to the probability of systemic socioeconomic disadvantage and to ensure that the best and most suitable learning conditions are properly created for each child's individual situation. It has been asserted that the home environment may be particularly limited when intellectual stimulation, nurturing and development exist. It has also been underlined that resources should be readily available to children outside the home and that they should be actively encouraged to make the best of these resources.

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Chapter 3

CAN PARENTS WITH HIGHER SOCIOECONOMIC STATUS COMPENSATE FOR THEIR CHILDREN'S LOWER COGNITIVE ABILITIES? AN ANALYSIS OF SOCIAL INEQUALITY IN PRIMARY EDUCATION

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Introduction

The objective of the current research is to bridge the literature on intra-family and inter-family educational inequality in order to check whether families from higher socioeconomic status (SES) compensate for lower cognitive abilities of their children during the passing to secondary school. It was indicated that the system of monitoring and selecting children's early cognitive abilities at age 10 provided a strict and rigorous atmosphere for compensative assumptions about lower abilities. The present research presented two key findings. Firstly, the study discovered that well-educated families were unable to compensate for and eliminate diversities in cognitive ability across the lower levels of the cognitive ability distributing of twins. Secondly, when addressing or controlling for the persistent and enduring cognitive abilities of parents and children, students from well-educated families were 27% more likely to be selected for, participate in and attend educational and academic pathways demanding higher cognitive scores. This result indicated that academic potential was damaged and wasted for families in lower socioeconomic status or disadvantaged families and defied the role of cognitive abilities as the primary measure of merit and value emphasized by liberal theories of equal opportunity in society, particularly those about competence and talent. These findings demonstrated the significance of other factors in explaining educational achievements, such as noncognitive abilities, the risk of avoiding downward mobility and teacher bias, which change across families depending on various resources.

Cognitive abilities are regarded as the most powerful indicators of children's learning and educational consequences (Deary et al., 2007; Deary and Johnson, 2010). Nevertheless, it has been highlighted that cognitive abilities do not necessarily bring about future educational success. In relative terms, in spite of their similar initial academic potentials, strengths and abilities, children from disadvantaged families have systematically fewer chances and opportunities for educational achievement compared to their peers from advantaged families (Bukodi et al.,2014; Papageorge and Thom, 2020). Study on intra-family disparity has revealed that these differences, inequalities and gaps are especially great among children with low educational abilities due to the tendency of higher-SES parents to use compensation and elimination strategies to repulse and counterbalance the impacts of low abilities in their children (Bernardi, 2014; Esping-Andersen and Cimentada, 2018).

Do actions for compensating for and eliminating children's lower cognitive abilities operate similarly within families? Classical microeconomic literature is based on the allocation and distribution of a family's

available resources within the household (Behrman, Pollak, and Taubman, 1982). It has been theorized that parents with higher socioeconomic status are more likely to compensate for and eliminate diversities in siblings' endowments and characteristics within the family environment (Conley, 2008). It has been asserted that, owing to greater cultural and economic resources, lower-ability siblings from families in higher socioeconomic status may achieve the same educational consequences as their more gifted siblings.

The research utilized twin fixed influences to check whether parents from higher socioeconomic status compensated for lower cognitive abilities of their children during the passing to secondary school. The fact that twins are born into the same parental conditions and share at least 50% of their genetic structure and traits eventually eliminates and disregards most confounding sources in inter-family and sibling models. The research also examined the heterogeneity and variation in the influence of parental socioeconomic status and cognitive ability on educational pathway selection across the cognitive ability distribution. It also emphasized that the compensation or elimination hypothesis should be tested with individuals at the lower levels of the cognitive ability distributing.

The present research seeks to bridge the literature on inter-family and intra-family disparity and tries to answer two new research questions: (1) How and to what extent did parents' socioeconomic status mitigate the impact of intra-family diversities in cognitive abilities on educational and academic pathway choice? (2) How and to what extent were higher-SES families able to compensate for or eliminate intra-family diversities in cognitive ability across the entire cognitive ability distributing?

In order to address these questions, the present research utılized data from the first wave of the TwinLife study (Hahn et al., 2016), performed on a representative sample of 11-year-old same-sex twins in grades 5 and 6. It has been indicated that the system of initial, early-ability monitoring and selection in education provides an curious scenario for testing the compensation or elimination hypothesis of low ability. Considering the fact that teachers provide guidance for children on educational and academic pathways based on their observed performance, parents can have less consideration or appraisement to impact educational-academic pathway decisions for children with low abilities. For instance, it has been asserted that the educational system in Germany provides a tight and rigorous test of the compensation or elimination hypothesis of low ability as opposed to educational systems without early-ability monitoring and selection (Conley and Glauber, 2008).

The results revealed that highly educated parents were unable to compensate for and eliminate the lower abilities of children at the base of the cognitive ability distributing. It was asserted that this could be stemming from the fact that the educational system predominantly relied on initial, early cognitive abilities in directing and selecting children for secondary school. Nonetheless, even when the cognitive abilities of highly educated parents and children were controlled for, children from highly educated families were reported to be selected, placed in and attended educational and academic pathways requiring higher cognitive scores with greater transition rates. These findings highlight the significance of other unobserved variables that reveal differences across families and may account for educational achievement, such as non-cognitive skills, tendency to avoid risk and teacher bias.

THEORETICAL BACKGROUND AND FRAMEWORK

Cognitive Abilities and Educational Consequences

Intelligence, or general cognitive ability, has been described as a theoretical structure and significantly valid and reliable measure (Nisbett et al.,2012), and it has been reported that it is among the most consistent, steady, invariable, stable and persistent behavioral characteristics of children after adolescence. Intelligence, or general cognitive ability, has been defined by analytical abilities such as verbal, spatial, dimensional reasoning, perception, apprehension, comprehension velocity and working memory. It has also been asserted that these abilities are highly and positively mutually associated with one another and less genetically affected compared to general structure or thought (Knopik, Neiderhiser, DeFries and Plomin, 2017). It has also been noted that cognitive abilities in children are not fixed, inflexible, unvarying, or genetically determined at birth or in the beginning, but are soft, flexible and malleable and contingent on environmental feature (Farah, Betancourt, Shera, Savage et al., 2008; Gottschling, Hahn, Beam, Spinath, Carroll and Turkheimer, 2019; Kendler, Turkheimer, Ohlsson, Sundquist and Sundquist, 2015; Ritchie and Tucker-Drob, 2018).

Intelligence has been defined and distinguished as two specific components: (1) analytical ability, that is, fluid or nonverbal, and (2) the ability to store and retain knowledge, vocabulary, as well as arithmetic and counting operations. The objective of nonverbal or fluid intelligence tests, such as the Raven Test, is to assess individuals' capability to reason and solve new problems without relying on prior knowledge. It has been emphasized that fluid intelligence tests are less affected by sociocultural determinants; however, they do not fully consider and take into account

the contextually free and open environment. It has also been noted that fluid intelligence tests do not directly assess children's creativeness, social emotionality, or field-proper cognitive skills such as reading skills, mathematics skills or scientific literacy skills (Weinert et al., 2011). Large-scale international assessment studies such as PISA, TIMMS, PIRLS focused on reading, mathematics or scientific literacy.

It has been asserted that intelligence tests, including standardized tests such as the American SAT, the British General Certificate of Secondary Education, or PISA, are good predictors of children's educational performance, competence and capacity, with correlations varying from 0.4 to 0.7 (Deary, Strand, Smith and Fernandes, 2007; Erikson and Rudolphi, 2010; Neisser et al.,1996; Rindermann, 2007). Otherwise stated, as much as 50% of the variance is explained by intelligence, which leaves a wide space for other psychological or non-cognitive traits to perform a role, such as motivation, patience and endurance (Almlund, Duckworth, Heckman & Kautz, 2011; Poropat, 2009).

It has been asserted that cognitive abilities are less closely associated with grades allocated by school or teacher compared to educational competencies, because children's grades are more affected by noncognitive or behavioral factors such as motivation and tenacity (Duckworth et al.,2012). This review has concentrated on fluid intelligence as an indicator of educational and academic competence or potential, and stated that fluid intelligence is less dependent on a sociocultural framework and individual efforts compared to measures of educational and academic performance (Bailey, Duncan, Odgers and Yu, 2017; Erikson and Rudolphi, 2010).

Inter-Family Inequality

Inter-family models typically assess educational disparities by randomly selecting one individual from each family, utilizing stylized rational action theories (Breen and Goldthorpe, 1997). These theories are constructed on primary and secondary effects, and analyze the association between parents' social class or socioeconomic status and children's educational attainment (Boudon, 1974). Primary effects formed by genetic, psychological, and cultural factors demonstrate a systematic relationship between socioeconomic status of parents and academic performance of children (Jackson, 2013). Secondary effects explain the advantage enjoyed by children from higher-class families while transitioning to higher educational stages as opposed to their laboring-class peers, when performance is controlled for Goldthorpe (2007) attributes why laboring-class children, whose academic performance is similar to that of children in

more advantaged socioeconomic status, systematically pursue fewer ambitious educational routes or are more likely to drop out of school to three possible reasons: (1) they are unwilling to take risks; in namely, they believe lower educational consequences is sufficient to avoid downward social mobility or a social class downgrading; (2) economic resources to cover direct costs such as tuition fees, indirect costs such as living expenses and opportunity costs such as lost revenues and incomes to continue studying are fewer accesible and fewer persistent; and (3) their actual and perceived chances are lower owing to poorer mean performance coupled with perceived gains of education being underestimated or conservative.

The Advantage Mechanism to Compensate for and Eliminate Low Abilities

Researchers have argued that social disparity observed in passing rates has a tendency to be concentrated among underperforming children in advantaged families (Bernardi and Triventi, 2018). In other terms, it has been discussed that families of higher social class or socioeconomic status actively compensate for their children's poor or moderate educational performance to avoid downward intergenerational mobility via tutoring, parental interest in homework and parents' educational expectations from their children. Thus, the central point of the action of compensating and eliminating advantage for low abilities in families has been underlined. It has been asserted that the life-course paths of students from privileged origins or from families of higher social class or socioeconomic status are less reliant on previous negative consequences or disadvantaged characteristics (Bernardi, 2014; Erola and Kilpi-Jakonen, 2017).

Previous Findings

A study carried out half a century ago revealed that only 9.3% of children with low intelligence scores and low-educated families enrolled and studied in college, while this rate was 58% for children with low intelligence points and highly educated parents. The distribution of IQ scores, divided into three groups as high, middle and low, displayed differences, inequalities and gaps in the college attendance rates between students from high and low-educated families. It was asserted that these differences, inequalities and gaps were relatively stable, constant and persistent. Students with moderate IQ scores from highly educated families enrolled and studied in college at a rate of 78.9%, while this rate declined to 22.9% for students with moderate IQ scores from low-educated families. College attendance rate for students with high IQ scores from highly educated families was found to be 91.1%, while it was 40.1% for students with high IQ scores from low-educated families (Sewell and Shah, 1968) Other re-

search has provided the only recent evidence on the interplay between cognitive ability and parents' social class or socioeconomic status during the passing to upper-secondary education, which demands higher cognitive scores (Bukodi, Erikson and Goldhorpe, 2014; Bukodi et al.,2017). Researchers discovered no clear and distinct moderating influence of parental origin in Sweden, for example. They also reported that disparities in England were more condensed among students in the top 20 percent of the cognitive ability distribution

Intra-Family Inequality

Compared to inter-family models, research examining the dynamics of intra-family inequality can explain a large number of traits shared by siblings, such as district, school, genes and parents' environment (Conley et al.,2015; McGue et al., 2010). By randomly selecting individuals from diverse families, the present research could not control for factors that may or may not be shared by siblings (Turkheimer and Harden, 2014). It has been indicated that siblings share environmental factors within families and that these mutual environmental factors contribute to their overall social origin (Sieben and de Graaf, 2003). However, several factors may display differences among siblings within the same family: (1) Circumstances of parent including the age of mother, birth interval and order, as well as shocks such as divorcement or job loss, may have an impact on siblings in various ways (Gratz, 2018; Harkönen, 2014). (2) It is noted here that there may be both external elements, such as chance and random events and internal elements, such as distinctive characteristics of personality for each sibling or particular to each sibling.

It has been argued that siblings, as a whole, share only approximately 50% of their genetic characteristics and have unique environmental experiences, such as teachers and peers, that are closely related to the characteristics of their personality, such as their own active choices and preferences. This being the case, researchers have claimed that approximately 65% of the variation in early educational performance of siblings, including reading and math, and approximately half of the variation in their educational acquisition occurs within the family (Conley et al., 2007; Gratz, 2018). It has also been asserted that these unique endowments and characteristics of personality within the family can result in different behaviors or responses as far as parents are concerned (Tucker-Drob, Briley and Harden, 2013). Parents' conscious or unconscious neutrality may have compensated for and eliminate, or reinforced, enhanced and strengthened the siblings' initial differences in characteristics that are linked to early educational consequences.

Parents' Response to Their Children's Education and Endowments

Most theoretical contributions and findings regarding investment in children's education have come from research on intra-family inequality. It has been asserted that families allot and spend their available resources to develop and enhance their children's endowments and to enable them to attain knowledge and skills as human capital. Parents allot, spend, and invest both money and time to strengthen, nurture, and enhance their children's education and cognitive abilities (Becker and Tomes, 1976).

The family investment model postulates that parents endeavour to realize their gains through the knowledge, skills, or human capital acquired through education, by investing equally in both children in a neutral, objective and impartial manner. The model suggests that, assuming no capital restrictions or challenges, parents either refine initial differences in ability, creating patterns of reinforcement or support over time, or invest more in children with the higher-ability, thus reinforcing and strengthening sibling diversities in endowments. On the other hand, the resolvable acquisition- passing model built on preferences of parents and intra-family disparity aversion, theorized that parents are inclined to compensate for and eliminate sibling diversities in endowments by investing more in children with the lower-ability in an effort to enhance human capital and gains of their children. As a whole, patterns of reinforcement and strengthening for initial, early endowments are mostly found for educational investments compared to health investments (Almond and Mazumder, 2013; Yi, Heckman, Zhang and Conti, 2015).

Intra-Family Equality or Inequality Based on Parents' Socioeconomic Status: Compensation and Elimination or Reinforcement and Strengthening?

Conley (2008) benefited from the microeconomic literature to theorize about the diverse patterns of intra-family disparity based on parents' socioeconomic status. He claimed that wealthy families, on account of their greater cultural and economic resources, are inclined to compensate for and eliminate intra-family diversities in endowments. In such instances, parents believed that less academically gifted children would obtain the same outcomes as their more endowed siblings. This has been described as the creation of intra-family equality. Inversely, it has been argued that, owing to a lack of resources, disadvantaged families have a tendency to act more effectively by punting on the sibling with greater educational potential, thus reinforcing and strengthening intra-family disparity.

An alternative assumption postulates that, in the case of capital restrictions and challenges, disadvantaged families cannot allot, spend and

invest time and money in the most satisfying, appropriate and time-efficient ways to develop and enhance their children's education, abilities, as well as their knowledge and skills as human capital (Becker and Tomes, 1986).

When parents with lower education and income allot, spend and invest less time and money in their children's education, this may result in higher degrees of sibling similarity. It has also been asserted that children from poorer families with higher academic ability can take the same lower level of education like a sibling with lower academic ability (Conley and Glauber, 2008).

Previous Findings

Children's initial, early talent monitoring and selection typically began at age 10, in Grade 4, or at age 12, in the final year of joint compulsory education. At this point, teachers recommended to parents a choice of educational pathways for their children. The present research has shown that the impacts of parents' social class or socioeconomic status on children's chances of entering the educational pathway remain relatively stable across diverse levels of binding suggestions (Roth and Siegert, 2016).

After Grade 4 of primary school, students are faced with entry to three educational types of secondary schools: (1) lower secondary school (*hauptschule*), (2) middle secondary school (*realschule*), or (3) upper secondary school (*gymnasium*). Lower secondary school and middle secondary school provide vocational training, while upper secondary school offers, for the most part, academically oriented and focused instruction. The great majority of upper secondary school students start university after passing the high school exit exam (Schneider, 2008).

It has been highlighted that children's academic ability differences exist as per parents' social class or socioeconomic status, a primary influence that precedes the selection of educational pathways (Blossfeld et al., 2017), and therefore, monitoring and selecting children's early talents has been reported as procedures fostering, nurturing and enhancing "talent or meritocratic selection" (Esser, 2016). As teachers often recommend educational pathway allocation or assignment according to observed educational performance, such as math, deutsche and behavior in classroom, parents of children with lower educational performance or talent can have fewer opportunities to impact decisions regarding educational pathways.

Considering that the passing to secondary school is often categorized by observed academic performance, ıt has been asserted that, in the case of underperforming children from high-socioeconomic status families,

compensation and elimination patterns may actually operate through parental pressure for positive recommendations, directly disregarding grades or positive bias of teachers (Schneider, 2008). Suggestions of teachers may be open to biases, such as misinterpreting, misperceiving and misunderstanding cultural capital as educational shine (Jæger and Møllegaard, 2017) or judging children with less behavioral problems as more suitable (Møllegaard, 2016).

Moreover, researchers alleged that parents in low socioeconomic status are more inclined to send their children to vocational training pathways even when they have a suggestion for an educational pathway, whereas the opposite is true for families in high- socioeconomic status. They also stated that higher levels of educational aspirations of parents in high-socioeconomic status could account for these differences (Jürges and Schneider, 2007)

Utilized as a measure of academic potential, cognitive abilities have been proposed to be less closely related to recommendations or educational and academic pathway selection compared to grades allocated by teachers. It has been emphasized that compensation and elimination patterns for low ability operate through parents' active involvement with the lower-ability twin, including motivation and assistance with homework and school schedules, in order to enhance and improve academic performance, The present research has attempted to isolate and distinguish these mechanisms by testing the hypothesis of the compensation or elimination advantages for children at the lower levels of the educational-ability distributing

Data

To address the abovementioned research questions, the present study utılized data from the first wave of study on the duallife - genetic and social causes of life chances (Diewald et al., 2018). The study involved 2,012 subjects born in 2003 and 2004, and included either sibling dyads or twins in 1,006 families. The study included a sample of 11-year-old, same-sex, monozygotic and dizygotic dyads and twins in grades 5 and 6. The study designated the twins at local registry offices in large cities and rural fields. Technique notices obtained from the study on DualLife correlated the distributions of key sociodemographic variables with the deutsche microcensus study. It was deduced that the twin-sample was a representative model, encompassing the full distributions for the parents' socioeconomic status variables (Lang and Kottwitz, 2017).

Variables

Selecting and Continuing an Educational Pathway

The dependent variable on selecting and studying in an educational pathway was measured with a dummy variable on the type of secondary school currently enrolled: 0 = *hauptschule* and *realschule* as vocational training pathways, lower- and intermediate-secondary schools, and 1 = *gymnasium* as educational pathway: upper-secondary schools.

Cognitive Ability

The present study applied the Culture Fair Test to children in order to measure and assess their cognitive abilities. This test has been extensively utilized in research and is regarded as a well-validated cognitive test battery. The Culture Fair Test was planned and prepared as a cognitive test battery to assess both non-verbal, or fluid, intelligence as an indicator of general cognitive ability and verbal ability as a general factor of intelligence (Schulz et al.,2017). While this test was intended to mitigate the effects of sociocultural and environmental conditions or variables, it was underlined that it nevertheless reflected these effects. The researchers applied the test as a set of four subtests and determined the total number of correct items provided by the students. They measured the students' formal (figural) reasoning skills using 15 items, their classification skills using 15 items and their matrix skills using 15 items, whereas they measured and assessed their reasoning skills "topology", the branch of mathematics that examines the properties of geometric shapes or three-dimensional objects that remain unchanged in some cases, using 11 items.

Parentas' Background

Parents' background was measured by means of a dummy model for the highest level of education attained by either the father or the mother.

DESCRIPTIVE ANALYSIS

Table 3 illustrates descriptive statistics for all variables in the analysis, stratified by parental education. On the average, 54% of students were selected, enrolled and attended the educational and academic pathways. There were significant variances according to parental education. Compared to 73% of students from families with higher education, only 36% of students from families with low or medium education were placed and studied in the educational and academic pathway, which demanded higher cognitive scores. Prior study on full siblings revealed that intra-family variance explained 50% of the total variance in students' selection and location into the educational pathway (Gratz, 2018). The present study

reached an estimate of 12.3%. As opposed to some prior findings asserting that siblings from higher-socioeconomic status families demonstrate stronger similarity in educational acquisition (Conley, 2008), the share of total educational acquisition variance elucidated within families does not differ substantially according to parental background.

RESULTS

Current study offered a brief account of the main findings. Model 1 explained and enlightened intra-family and inter-family dynamics. Net of child and parent diversities in cognitive ability, twins with highly educated parents were more than 27% more likely to select, enroll in, attend and continue in the educational and academic pathways demanding higher academic achievement scores when compared to their least advantaged peers. In other words, the number of twins with highly educated parents who selected, enrolled in, attended and continued in the educational and academic pathways demanding higher academic achievement scores was 27% more than that of their least advantaged peers. The impact of parents' education on determining their children's educational and academic pathway (regression "coefficient" at the 0.36 level before controlling for cognitive ability) was mostly demonstrated by the net of parents' and children's cognitive abilities, at 74.2%. This implied that net of varying cognitive abilities across families who have diverse socioeconomic resources, as well as other unobserved factors, such as downward mobility risk aversion and noncognitive abilities, could explain these unobserved disparities. It mediated the relationship between parental education and educational pathway selection, enrollment, attendance and continuation through grades and teacher bias. Cognitive abilities explained only about 14% of the variance in determining children's educational and academic pathways, which suggests that there is considerable margin or cause for other factors accounting for children's initial, early educational achievement.

Theories and findings on which previous studies are built have suggested that relationships within the family based on parents' socioeconomic status can be dependent on total endowments of children. This has been regarded as a major shortcoming or challenge of these theories and findings. Therefore, the compensation or elimination advantage hypothesis for low ability ought to be tested at the bottom of the academic ability distributing.

These intra-family patterns across the entire cognitive-ability distributing indicate that the compensation and elimination advantage mechanisms operated in opposite directions in the deutsche educational sys-

tem. In other words, families with higher education appeared unable to compensate for and eliminate lower academic ability of children, as lower-ability twins further down the cognitive-ability distributing displayed the largest variances in passing rates compared to their comparatively more gifted co-twins. It might be assumed that the lack of compensation patterns in advantaged families would be beneficial for equality of opportunity; however, children from highly educated families actually had greater transition rates toward academic pathways demanding significantly higher academic achievement scores.

Rational action theories have often been constructed and implemented to the study of inter-family inequalities in education. However, the present research has argued that theorized mechanisms, such as resources and risk aversion to downward mobility, that display variances among low-, middle-, and high-educated families assist us in comprehending and interpreting these contrasting patterns of equality or inequality within families. In the German education system, as well as others like it, recommendation or transition to secondary education is largely determined by children's initial academic abilities, and highly educated parents may encounter problems in compensating for and eliminating the ability differences of twins further down the cognitive-ability distribution.

CONCLUSION

The main objective of the current study was to check whether families with higher socioeconomic status compensate for their children's lower abilities during the transition to middle school within the strict and rigorous atmosphere of early talent determination and selection. Results revealed that twins with higher cognitive abilities had greater transition rates toward educational and academic pathways demanding higher academic achievement scores compared to co-twins. This finding was in conformity with previous research finding patterns of reinforcement, encouragement and support for this relationship. Research Question 1: Does parental social class or socioeconomic status moderate the impact of dyad and twin diverisites in cognitive ability on educational and academic pathway selection? The positive relationship between cognitive ability and passing toward educational and academic pathways persisted similarly for advantaged and disadvantaged families, whether creating intra-family inequality in cognitive abilities or reinforcing, encouraging or strengthening cognitive abilities. That is to say, contrary to some prior assumptions and findings (Conley and Glauber 2008), intra-family disparity in educational consequences is not heterogeneous or different across parents' social class or socioeconomic status. This result is consistent with research conducted by Gratz (2018) in Germany, which discovered no so-

cioeconomic status heterogeneity in the level of sibling similarity while accessing the educational pathway.

The major contribution of the present research was to check the assumption of compensation and elimination advantage within families at the base of the cognitive ability distributing. The results revealed that families with higher education were not capable of compensating for and eliminating lower academic abilities of children: Twins with lower-ability at the base of the cognitive ability distributing displayed the largest variances in passing rates compared to their comparatively more able twin. Rational action theories, such as reversing or avoiding the risk of downward mobility, often referred to as intra-family inequalities, can also assist us in comprehending these intra-family patterns.

It has been suggested that in a system of educational and academic pathway selection and placement, where suggestion or passing to secondary school is often a function of children's initial, early academic abilities, parents with higher education can have significant difficulty in mobilizing and implementing compensation and elimination strategies at the base of the academic-ability distributing. A continuing question is whether patterns of compensating for and eliminating low cognitive abilities arise within the educational system without initial, early academic ability selection in passings to upper secondary education, which are less closely associated with observed performance.

The absence of compensation and elimination patterns concerning children with low academic ability could be commented as positive evidence for equality of opportunity. However, it has been alleged that children from families with higher education with the same levels of cognitive ability like children from families with less education actually had greater transition rates into the academic pathway, 27 percentage points to be exact. When viewed from a normative perspective, these disparities in cognitive ability illustrated a nonusage, wastage, squandering and misspending of academic potential for disadvantaged students, endangering their upward social mobility. Besides, this scenario is in conflict with the role of cognitive ability as a primary measure of merit and ability within liberal theories of equal opportunity (Bowles and Gintis, 2002; Fishkin, 2014).

As a whole, the results highlighted the importance of unobserved factors, rather than cognitive abilities, in impacting learning, academic performance of children and passing rates in educational and academic pathway selection that may exhibit variances across families with different socioeconomic resources. Factors such as risk aversion to downward

mobility, noncognitive skills and teacher bias have been put forward as potential candidates for accounting for this lasting relationship between parents' social class or socioeconomic status and children's educational outcomes. Future research should examine these mechanisms. The absence of direct indicators of parental investment or responses to endowments of children was considered a significant limitation of this study. Future research should distinguish and analyze the specific actions that can explain the association between endowments of children, responses of parents, and educational consequences across families who have diverse socioeconomic resources.

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