

The Role of Virtual Social Interaction in Driving Adolescent Cognitive Development Based on Piaget's Theory

Rahmad Mahadi¹, Latifatuz Zahra², M. Albab Mananna³, Indah Wigati⁴, Fitri Ovi Yanti⁵

Universitas Islam Negeri Raden Fatah Palembang, Indonesia

¹rahmadmahadi2205@gmail.com, ²latifatuz2003@gmail.com, ³albabmananna14@gmail.com,
⁴indahwigati_uin@radenfatah.ac.id, ⁵fitrioviyanti_uin@radenfatah.ac.id

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ABSTRACT

The purpose of the current research is to examine the extent to which social media and online games support Piaget's notion of adolescents' ability to think abstractly, reason in a structured way, and develop metacognition. The study relies on a qualitative descriptive method based on the most recent literature from the last five years. The study concluded that social interaction in virtual environments is a space where higher-order thinking, self-reflective thinking, and the ability to think hypothetically and deductively are developed. The ability to think formally and to reason is enhanced through social media and online games, where players must collaborate and engage in discussions. Consequently, what Piaget viewed as the symbiotic relationships between social interaction and knowledge construction should now include the emergence of new digital socialization technologies. Educational practitioners and parents are encouraged to guide the purposeful use of virtual socializations to foster adolescents' cognitive development.

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Keywords:

Virtual Interaction;
Adolescent;
Cognitive Development;
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INTRODUCTION

In these years, the individual acquires abstract, logical, and hypothetico-deductive thought capabilities for the first time, engaging in complex problem solving and scientific reasoning alongside the formation of their own identity. In particular, the years from 12 and older signify Piaget's final Operational Stage, the Formal Operational Stage of development. During these years, the development of individual identity and social relations progresses into deeper and more complex layers. Changes in abstract and logical thought, alongside self-identity and the ability for complex social interaction during adolescence, have been reported in various studies, including Indonesia (Hakim et al., 2024).

The very landscape and social activities during these years, however, are more profoundly influenced by technology. Most social and societal activities during this operational stage are conducted through virtual social platforms. Most of their social activities occur through social media such as Instagram, TikTok, and social gaming platforms, in what has become, for many, an inseparable social structure. While these platforms create new opportunities for social interaction that did not previously exist, they also present new challenges for the developing adolescent. Aged from 12-17 years, adolescents are also impacted by the rapid expansion and development of social media, where the major socialization activities take place on social media and through gaming, which also exposes individuals to issues of social isolation, social media addiction, cyberbullying, and miscommunication (Ramadhani & Jatnika, 2025).

The relationship between technology and cognitive development has been discussed at length by previous researchers, who have different focuses and theoretical frameworks. In the collaborative research of Loso Judijanto et al., the positive impact of educational technology on cognitive development and creativity is highlighted (Judijanto et al., 2024). There are also studies, such as one conducted by Mesayu which illustrate that the learning activities at SMA Negeri 3 Medan demonstrate the application of Piaget's theory, as students at that age can think abstractly, logically, and can solve real problems (Ardiningtyas, Harahap, & Panggabean 2023). However, social virtual interaction also raises concerns, some of

which are identified by research conducted by Frenndly. Social media's lack of empathy towards others, internet addiction, and the ease of communication can lead to social lethargy and reluctance to engage in face-to-face communication and convey verbal messages (Albertus et al., 2025). This necessitates a more in-depth examination of Piaget's theory of cognitive development (formal operational stage) in the context of social virtual interactions.

This research is focused on assessing the role of social media and multiplayer online games (online games) in the development of Formal Operational skills (hypothetical-deductive reasoning, abstract thinking, and metacognition). More specifically, the analysis is geo-focused and only considers the positive impacts and possible development and stimulation of norms, excluding the negative impacts, challenges, and psychological risks of virtual interactions. Such understanding and knowledge should serve educators, parents, and policymakers to assist adolescents in the constructive and healthy use of digital technologies.

METHOD

This study used a descriptive qualitative approach with the library *research method*. This approach was chosen because the research focuses on the analysis of theories and the results of previous research relevant to the topic of virtual social interaction and adolescent cognitive development based on Jean Piaget's theory. The goal of this approach is to deeply understand the relationship between virtual social phenomena and adolescent cognitive development processes without conducting direct field data collection. The research design used is descriptive analytical, namely describing and systematically analyzing the relationship between virtual social interaction (through social media and online games) and adolescent cognitive development at the formal operational stage as described by Piaget. Through literature analysis, this study seeks to find the relevance of the concept and its implications for adolescent education and development in the digital era.

The data sources in this study consist of two types, namely primary data and secondary data. Primary data were obtained from the main literature on Jean Piaget's theory of cognitive development, while secondary data came from scientific articles, Mahadi et.al (*The Role of Virtual...*)

books, national and international journals, as well as the results of recent research in the last five years that discuss virtual social interactions, social media, online games, and adolescent cognitive development. The data collection technique is carried out through the documentation method, namely by searching, reading, and studying various sources of scientific literature that are relevant to the focus of the research. This process includes determining search keywords such as virtual social interaction, cognitive development, Jean Piaget, teenagers, social media, and online games, then selecting literature that is in accordance with the focus of the research, as well as analyzing and grouping information based on the theme of the theory and variables studied.

The data that has been collected is analyzed using descriptive qualitative analysis techniques. The analysis stages include data reduction by selecting relevant information, classification of data based on the research theme, content analysis to interpret the meaning of each literature finding, and concluding to show the relationship between virtual social interaction and adolescent cognitive development. To ensure the validity of the data, this study uses the source triangulation technique, which involves comparing and confirming the results of studies from various different literatures, such as books, journals, and research reports, in order to obtain valid, objective, and comprehensive conclusions.

RESULTS

According to Jean Piaget, cognitive development happens sequentially, progressing through four stages of development, where each is defined by the unique way of thinking in that stage. The following are some of the development stages (Nadlifah, Zahriani, & Latif, 2022).

Sensorimotor stage (0 - 2 years)

At this early stage, babies understand the logic of the world through their senses and motor skills (e.g., sucking, grasping, and seeing). They start to understand the relations of their actions and the results in the environment. One of the most essential cognitive achievements in this stage is the realization of the object permanence. They

begin to become aware that an object continues to exist even when they cannot see, hear, and touch it. In the early part of this stage, the baby will act as though the object is completely absent, however, in the last part of the stage, she will search for it actively. At this point in time, infants are beginning to show signs of understanding that entities exist even when they are out of sight. One study explains that infants begin to understand that objects continue to exist even when they are not visible (Hikmawati, 2023). This suggests that this ability in infants is the first sign of conceptual thinking. Therefore, this period is critical for developing the ability to think symbolically.

Pre-Operational Stage (2 - 7 Years)

At this period, the child is able to understand that words and images can be used to symbolize and represent real-life objects. This new gained ability of symbolic thinking then further allows the child to participate in imaginary play and acquisition of new vocabulary. Being egocentric, their thinking is still narrow as this refers to the inability to understand and appreciate situations with regard to the other person's point of view. In addition, they show a tendency to concentrate, which is focusing on one dimension of an object or situation while neglecting other features, which makes them not understand the concept of conservation.

Symbolic representation presents itself in children in the age range of two to seven years, but they remain egocentric in their thinking and focus on one single aspect and as such do not grasp the meaning of conservation (Novitasari and Prastyo 2020). Although the ability to use symbolism has developed to some extent, the facts of egocentrism and centration indicate the child in the pre-operational stage is not yet capable of fully logical thinking and not understanding that an object's quantity remains the same even if its form changes (air). From the above, one can conclude the pre-operational stage is incredibly formative in the symbolic and linguistic functions of a child, and yet they do not possess the ability for logical thought and the understanding of conservation until the subsequent stage.

Concrete Operational Stage (7 – 11 Years)

In this concrete operational stage, one of the significant cognitive developments in children is the ability to think systematically in a logical manner about concrete or real events or objects present around them. In this stage, children are able to get past egocentrism and centrism as well as understand the concept of conservation (that is the same as volume remains the same even if the shape of what is in the container is changed). Children are also able to master the skills of sequencing and classifying. However, this logical thinking is restricted to the real and tangible and not to the abstract. Children between the ages of 7-12 can understand how volume works and think logically about real-world issues and objects in the primary operational stage (Rizqiyati et al, 2023). It can be seen from the child's growing ability to logically think at the operational stage that they can sort, categorize, and understand the concept of conservation. However, the ability to think at this stage is limited to the tangible. Thus, it can be seen that this operational stage is certainly an essential point in the child's logical development, but it is still rather insufficient for the child to move to the stage of abstract and deductive thinking.

Operational Stage (12 years and above)

The last stage of cognitive development is when the individual is able to think abstractly and hypothetically. At this point, the adolescent can use deductive reasoning. This is the ability to think generically and arrive at specific conclusions. It also involves the ability to visually manipulate ideas, even in the absence of physical objects. At this stage, the adolescent is also able to systematically consider possible solutions for a given problem, and delves into philosophical, theoretical and even social issues. This stage is the peak of cognitive development in the perspective of Piaget's theory.

DISCUSSION

Forms of Virtual Social Interaction for Teens

Iswaratama (2024) claims virtual social interaction as social interaction via the internet and social media, creating an ability to bypass any need for in-person

communication. This interaction encourages social relationships and creates the ability for users to communicate and establish social networks without the barriers of distance and time. This form of social networking creates an opportunity for users to enhance their social identities digitally and access niches within the different realms of the internet. Select virtual social interaction dwellings for teenagers include:

Social networking sites constitute the most frequent form of online social interaction among teenagers.

Social networks serve multifaceted purposes such as social networking, communication, and social site content sharing (Ramadhani, 2024). Social networking sites for teenagers include Instagram, TikTok, Facebook, and X for self-expression and self-image construction. Social media also acts as a primary communication and chatting platform, which allows friends, family, and other strangers in the user's social sphere to communicate freely and instantly in person and in groups using Directs and Group messaging available on social networking sites. A different important aspect is that social media can form online communities where teens can join various groups or forums that relate to their different interests and hobbies or where they can connect and unite toward common goals within groups such as hobby discussion groups or fanbases of particular artists. These communities can even have structured debates.

Besides being communities for social media users and a form of self-expression, social media are also communities for informal learning for teens (Kumar and Nanda 2024). Based on the content and tutorials on social media, they can have academic discussions and go beyond the walls of the classroom. Frequently, social media users go to sites such as YouTube or TikTok Edu or use discussion forums that are less formal than traditional education to acquire new knowledge.

Online games have evolved from merely being a source of entertainment to being a source of development for teenagers. Multiplayer online games have social features such as voice and text chat and Discord where players interact and collaborate. They use these features to indirectly develop their strategic thinking, problem-solving, and decision-making skills (Suprpto and Avida Rizka Amalia 2023). During gameplay, teenagers often try to achieve their objectives quickly. This

is especially true for games that employ strategic and role-playing game (RPG) elements. Players are required to utilize effective resource management, advanced goal planning, and teamwork to achieve objectives. These skills increase critical thinking and logical thinking, as well as the use of hypothetical scenarios. These are all aligned with the cognitive developmental stages of Jean Piaget and are deemed necessary for all teenagers. Gaming forums, social media, and Discord communities create global channels for communicating and exchanging perspectives and experiences. This activity enhances global understanding, improves participants' intercultural communication abilities, and develops a sense of social connectedness.

Piaget on Virtual Social Interaction and Its Impact on the Cognitive Development of Adolescents

Social media and online game platforms provide a unique, highly symbolic, and interactive digital space through which a cognitive 'laboratory' can be created. This space nurtures the development of skills relating to Piaget's Formal Operational Stage theory – skills such as abstract, hypothetical, and systematic reasoning. Below are some of his roles.

a. Reasoning and Critical Thinking

The digital virtual space creates an environment for advanced hypothetical reasoning and systematic deduction. For example, in multiplayer online games, players are often required to create strategic hypotheses, predict an opponent's movements (a deduction), and implement a coordinated, systematic plan with their team in real-time voice communications or text chats. Additionally, virtual forums and social media platforms encourage participants to defend their positions and respond to criticisms, which in turn compels adolescents to reason through the structure of their arguments logically and to revisit their proposed solutions in a systematic way.

b. Enhancement of Abstract and Symbolic Thinking

The adolescents' world of communication that is simultaneously abstract, virtual, and super characterised is specialised in the development of abstract thinking.

The adolescents have to decode memes and use digital shorthand and emojis, which serve as intensive language abstraction training. Moreover, participation in online debates and discussions on social philosophy and ethics (including social justice) stimulates the ability to handle and appreciate abstract and complex constructs that exceed the boundaries of the tangible and the physical.

c. Augmentation of Metacognition and Self-Reflection

The “social mirror” that virtual interactions provide enhances metacognition (thinking about one’s own thought processes), which is one of the hallmarks of the Formal Operational Stage. Adolescents use social media as a stage for themselves (an identity hypothesis) and receive peer feedback instantaneously. This compels the adolescents to think about the effectiveness and authenticity of their self-representation. The vast, unrestricted communication environment, coupled with peer feedback, aids in self-representation. The virtual world’s endless possibilities also promote a refined, critical outlook and enhance self-regulation of social media behaviours, e.g., constructive use of social media versus idle browsing.

To consider the role of social interaction online, the digital phenomenon of the present age, including social media and online gaming, emulating what Jean Piaget referred to as the Formal Operational Stage of his Theory of Cognitive Development, would, therefore, not represent a contradiction to Piaget's theory, rather a corroboration. Piaget posited that the development of the Cognitive domain would be a result of the interaction of the individual with their environment. (Sutarto 2017). While social media and online gaming platforms may not be perceived as educational tools, Piaget's theory would credit them as 'digital cognitive laboratories' where adolescents can build and refine cognitive faculties, even during free time. Hypothetical gaming strategy development, or even self-reflective metacognition, represent the 'active interaction' with the environment, of which the modern computer environment comprises complex symbols and abstractions. In the light of Piaget's theory, the adolescents' virtual world proficiency is simply a manifestation of the Formal Operational Stage. Piaget's principle that cognitive development would be

gradual, constructive must therefore be confirmed; however, stimulation would be from the virtual as opposed to the purely physical.

CONCLUSION

From the literature review, we can conclude that Jean Piaget's theories, which posit that social interactions can stimulate an adolescent's cognitive development, can also be applied to social interactions occurring through social media and online video games. The internet has created a digital space where social interaction can occur and where adolescents can engage in hypothetical-deductive reasoning and other higher-level cognitive functioning. Self-expression and social interaction through social media are also complemented by informal learning, as adolescents can gain knowledge on a variety of topics. In addition, problem-solving, strategic thinking, and collaboration fostered by many online games also enhance cognitive development. Thus, the theory of social interaction in a virtual context does not contradict Piaget's theory. The theory of cognitive development in an adolescent is therefore true, as active participation in the environment has changed from a physical environment to a virtual environment. The productive use of social interaction for cognitive development is where support from educators, parents, and society as a whole is needed.

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