

Semiotic Multimodality Communication in The Age of New Media

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Abstract

The age of new media is changing the social order of communication. The availability of the widest access for internet users to communicate without time and region limitations is a feature of this digital media era. The second distinctive feature is the communication of digital media by using semiotic multimodality (a combination of verbal and nonverbal signs, for example, emojis, images, videos, sounds, and music). The purpose of this paper is to identify how cultures communicate with the New Media Age's semiotic multimodality. The approach used is semiotics, that is, an approach that views the media as a medium of exchange for signs of multimodality (complex verbal and nonverbal signs used in real-time). This paper concludes that the new media produce three models of communication between social media users, namely verbal and verbal language (sign) communication, verbal and nonverbal communicating by utilizing the three models to remain critical in responding to various information received and disseminated. Because the use of semiotic multimodality that is compatible with communication models can cause problems in the meaning of the message conveyed.

Keywords: multimodality semiotics, new media, communication

1. Introduction

One of the interesting topics for discussion is still concerned with communication. The problems involve understanding and interpreting messages in texts from digital media concerning social media conversations. Social semiotic multimodality is a popular strategy for user-to-user communication on social media, including the simultaneous use of verbal and nonverbal indicators (emojis, movies, music, audio, etc.). Language, both spoken and unspoken, has changed the way people use digital media to talk to each other.

We now live in a digital age. People from all around the world can connect through digital media. Digital media also makes it simpler for people to interact with one another, offers instant access to information, and allows for endless communication. People are now able to produce, send, and share information with anyone, anywhere, thanks to interactive media. In real-time, a lot of global problems can be immediately and simply identified. Digital media is becoming a source of information (science, technology, and art). The internet and other new technologies are changing how people interact with one another, how stories are shared and disseminated, and how reality is portrayed and understood in cyberculture (Vulchanova et al. 2017). The distinctions between the functions of those who create, publish, and consume texts for digital media are becoming blurry.

Long ago, McLuhan (1911–1980) claimed that during the 1960–1970 period, the availability and accessibility of information in many regions of the world fostered the development of the global community (Danesi 2002). People can readily and rapidly learn about events happening in a nation.

Smartphones, tablets, and laptop computers are examples of digital gadgets that have evolved into information access points. With just one finger, we can search the entire world for knowledge. Previously watched television shows on LED TVs are now accessible through apps on cellphones and social media. News and information have been published online and in print by the regional, national, and international press. Additionally, they have employed digital media to supplement their learning activities from elementary school through university. Learners now require technological tools like online dictionaries, verb conjugations, and other educational resources. Covid-19 is a specific illustration. At all educational levels, the pandemic created a global learning crisis that necessitated the utilization of online learning resources. Everybody also buys their daily requirements online.

The internet and the digital era have altered how people think and act globally. According to a survey by Vulchanova (2017), many moms in the UK use tablets to read a narrative or a fairy tale to their children before bed. To encourage their kids to eat healthfully, many mothers use YouTube to share animated video stories for youngsters (Geddes 2019). According to a poll of parents with infants between the ages of 2 and 4 months conducted in the United States, by the age of three months, roughly 40% of kids frequently watch TV, DVDs, or videos, and at the age of 24 months, that percentage rises to 90%. (Zimmerman 2005). According to other studies, babies who are not exposed to media have slower language development than those who are (Ferguson & Donellan, 2014). According to American research (Westlund et al. 2016), "social" robots have a favorable impact on children's language development. Sheridan (2016) asserts in his research that digital technologies are changing how people write and conduct research, as well as how they learn and teach. He claims that it occurs in all academic domains, including the humanities. The digital humanities are a result of the digital age. Different countries, like the United States, have different ways of defining and describing DH projects for all kinds of activities.

It is obvious that, according to data from wearesocial.com (2020), there were 4.5 billion internet users worldwide in 2020, or more than 60% of the world's population. It indicates that social media is now used by more than 50% of the world's population. 3.8 billion out of 4.5 billion individuals use social media.

Users of social media are constantly growing in number. This could lead to the creation of a brand-new, time- and space-independent society (a cyber society). Internet users can communicate in real time with one another indefinitely. In the interim, over 50% of Indonesia's population will have an internet connection by 2020. This assertion is supported by data from Wearesocial (2020), which reveals that there were 175.4 million internet users in Indonesia in that year. The application that is utilized most frequently is social media.

According to a study by We Are Social (2020) and Hootsuite, the majority of Indonesians spend 3 hours and 26 minutes every day on social media. 59% of Indonesians utilize social media, which has 160 million active users, and 99% of them use smartphones to do it. Moreover, the top 10 social media sites in Indonesia The most popular app is YouTube, which has 88% of users between the ages of 16 and 64. Between now and then, the most popular social media sites are Facebook (82%), Instagram (79%), and WhatsApp (84%).

Due to various breakthroughs, the information age has had an impact on the growth of many different disciplines (Schwab, 2016). Language use in computer-mediated communication (CMC) is impacted by the digital age many different disciplines (Schwab, 2016). Language use in computer-mediated communication (CMC) is impacted by the digital age. According to McQuail (1997), computer-mediated communication (CMC) is when text-based communication and digital media (such as chatting, email, messaging, forums, and social networking) are used to facilitate human conversation (social media messages). CMC is a method that links the sender and recipient using an internet middleman so they can communicate with one another. Linguistic study now focuses on the language of computer communication through media (CMC). To understand language use in computer-mediated communication, a linguistic approach is employed, for example, to evaluate the use of features like emojis, loanwords, sentence structure in chat rooms, and pragmatic principles in communication, such as conversations, registers, styles, and dialects. Language studies are a sort of text-based computer-mediated communication employed by CMC (computer-mediated discourse analysis).

Gee and Hayes (2016) assert that language variants are impacted by the quick development of digital technology. As the language used in digital communication, particularly on social media, the use of verbal and visual language (emoji) is being addressed. Nowadays, internet users communicate their views and feelings through both verbal and non-verbal language (emojis). Emojis have taken over most social media conversations (chats). Social semiotic multimodality—the use of both verbal and nonverbal language simultaneously in communication (conversation) on social media—is a communication phenomenon that may be seen on social media. It's interesting to think about how language is used in CMC in the modern digital world. The usage of social media, which is on the rise and is changing how people (Internet users) communicate, is a hallmark of the digital era (conveying messages).

The use of social semiotic multimodality is a language phenomenon that is particularly prevalent in social media. When communicating on social media, both individually and in a group, thoughts and emotions are expressed using both verbal and non-verbal language, one of which is emoji. Semiotics is a method that can be used to discuss social semiotic multimodality in verbal and non-verbal (visual) communication, a topic that has recently come to light. Understanding how semiotic resources are used by internet users in digital media is the goal of media semiotics (social).

One of the methods taken into account is semiotic analysis, which examines language in digital media. Semiotics, which focuses on sign systems, and the communication of meaning through signs in digital media, are closely connected disciplines. Digital media text creation is at a denotative (informative) level in semiotics. The process of exchanging signs between the text and the reader is known as text circulation (publishing). The act of communicating meaning through

reading a text, which results in denotations, connotations, and myths, is known as text consumption (Barthes 1977). The production, dissemination, and consumption of digital media texts by people or internet users will be the focus of the semiotic analysis of these texts. Riffaterre (1978) says that the meaning of a text is carried out by readers (Internet users) and dialectics, specifically the dialectic between denotation and connotation.

2. Multimodality Semiotics: The Basic Semiotic Concept in Computer-Mediated Communication

Images, symbols, signs, and other things with comparable meanings are all studied in the scientific field of semiotics. It seeks to comprehend their purpose and significance. In a social environment, semiotics looks for the meaning of these objects (social media). Social semiotics is a branch of poststructuralist theories that uses techniques from both structuralist semiotics and social interaction. A subfield of semiotics called social media semiotics studies how people make meaning in certain social and cultural contexts and makes an effort to explain meaning-making as a social practice. To produce multiple texts and meanings in a variety of situational circumstances and contexts of culturally significant activity, social media semiotics also makes use of semiotic practices unique to cultures and communities. In social media semiotics, complex signs are used to investigate human interaction.

By defining a science that examines how signs function in social life, Saussure (1959) highlighted the idea of signs. The existence of signs is essential to civilization. A sign is a system of verbal and nonverbal language (pictures, graphics, photographs, etc.) that is made and passed on.

In 1957, Barthes expanded our understanding of signs to include any sign that is not part of a language (photography, fashion, magazines, and films). The terms "semiotic resources," which provide a perspective of signals founded on relationships between modes, are used by Halliday (1978) and Theo van Leeuwen (2005). Van Leeuwen's idea of semiotic resources includes not just overt forms of communication like language, gesture, visuals, and music but also covert ones like food, attire, and commonplace items that all have cultural worth and significance (2005). A semiotic resource can be used to create meaning. According to Van Leewen's semiotics, sign resources play a significant role in determining a sign's capacity to generate both specific and general meanings (dominant code, Hall, 1980; and referent systems, Williansom, 1978).

How professionals investigate digital media that allow users to interact with their online communities and social networks via signs is a subject that might be posed concerning semiotics. Semiotics is the study of how signs are used in society as a system of signs and how people interpret signs as part of social behavior (Poulsen & Kvle, 2018).

Multimodal texts, such as posts on social media sites like Facebook, WhatsApp, and Instagram, are thus the main focus of media semiotics, followed by social activities in online communities and social networks. Technology aspects used in the design, production, distribution, and consumption of digital media are inseparable from the usage of text in those components. For instance, generating a text post on WhatsApp requires employing other capabilities, such as emojis, movies, photographs, and so on, in addition to taking and uploading images. Users choose and negotiate with the many things digital media offers, which is an active part of the process of making meaning.

Technology is used in multimodal digital semiotics (multimodality). The use of computers to facilitate communication between users Multimodality is when people use more than one way to communicate at the same time, like when they talk and use emojis, graphics, photos, videos, audios, music, etc. (Kress and van Leeuwen, 1996).

To explain the popularity of emojis, photos, audios, and videos as modalities and how multimodal communication mixes traditional and digital media, the semiotic modes (multimodality) are increasingly broadening the scope of linguistics (social media). To improve communication in social networks, Gunther Kress and Theo van Leeuwen (1996) expanded Halliday's social semiotic and implemented a new functional "grammar." Kress and van Leeuwen (1996) see this language as a semiotic resource that is made by social networks and used to make sense of things that are made through multimodality.

3. Research Method

A conversational text using multimodality (verbal and nonverbal cues) in associated social media is the study's main focus. Direct observations of interactions on social media were also made. As a result, online social media user surveys, literature reviews, and observation were used as data collection methods. The goal of text analysis of digital media is to demonstrate how narrativity and multimodal communication use multimodal semiotics.

Making observations on the internet is how the research process' initial phase is initiated (online news media that provide commentary rubrics and social media to observe information spread and comments from internet users). Additionally, social media groups, internet media stories, and comments are observed (reading room). The process of problem identification is complete. Data are gathered through the online distribution of surveys on social media based on the identification of problems. A theoretical approach and mapping are used to examine the acquired data to provide answers to the problem's formulation (semiotics). The investigation concludes with the withdrawal stage.

4. Results and Discussion

4.1 Multimodality Semiotic (Verbal and Visual Language) in Communication

The use of social semiotics in multimodal communication is a phenomenon of language (linguistics), which combines verbal and non-verbal language. Emojis are a type of sign language that can be used as nonverbal cues. Emojis are standardized social semiotic resources that are used on social media. For example, smileys and people (facial expressions), animals and nature, food and drink, activity, travel, and locations, and objects, symbols, and flags are the three main categories of emoji used in digital media. A social semiotic multimodal emoji that connects signifiers and signified. The signified is the meaning that emojis produce, and the signifiers are emojis in various categories that social media users can choose from depending on the message to be sent. The signifiers are the numerous ways that people use emoji shapes to convey their thoughts, sentiments, and emotions in different situational circumstances. The expression is an emoji (signifier), while the meaning is an emoji (signified) (content). Emojis and verbal words are used in conjunction to create multimodal communication that has meaning. Emojis are used in multimodal communication to indicate emotions (happy, sad), thoughts, and other things.

According to this research, WhatsApp discussions can be used to express personal emotions and feelings by employing emoticons, such as smileys and people. Emoji use in nonverbal communication also suggests that people are willing to communicate their feelings and emotions in public settings.

Internet users can use the emojis that are available on WhatsApp based on the situations in which they are used. Each language type has been given the identity of an emoji. Emojis are used by 86.6% of users to express emotions and other subjective aspects of communication, according to the data in figure 2. The Parole emoji illustrates how the other participants in a social media conversation can also exercise their right to free speech, as in a WhatsApp group, in addition to the sender and the recipient.

Emojis are excretions as signifiers that inspire meaning as signifiers of ideas, sentiments, and emotions of the sender, according to semiotic theory (internet users). By observing the senders' facial expressions, the interlocutor can determine their intents (signifiers).

4.2 Models of Communication in The New Media Era

Communication on social media by using the semiotics of multimodality (a combination of verbal and nonverbal signs by the user) generates three models of communication:

- 1. Verbal-to-verbal communication: language-based communication between Internet users.
- 2. Verbal communication—nonverbal (emoji): communication between Internet users using a combination of verbal and nonverbal language (emoji, music, images, and videos).
- 3. Nonverbal communication (emoji, music, images, and videos): nonverbal communication between users (nonverbal signs).

These three communication models can be described at the syntactic, semantic, and pragmatic levels. Language is nonverbal at the syntactic level (emoji have become part of sentence structure (as subject and object) and punctuation (opening and closing sentences). At the semantic level, how does nonverbal language reinforce verbal meaning in greeting messages to the interlocutor on social media? At the pragmatic level, non-verbal language reinforces the meaning of verbal language by showing the emotional connection between users of social distancing.

Syntax Level

The wording used to convey the message implies that it includes both verbal and nonverbal communication, such as emoji (sentence structure). Consequently, writing on social media uses both verbal and non-verbal language (emojis). As evidenced by the sentence structure in some of these platforms (such as WhatsApp) (emojis), social media users appear to use social semiotic multimodality, a blend of verbal and nonverbal language. Emojis are used at the start and conclusion of the statement, which is a clear indication of this. According to the data, 76.9% of users add emojis after sentences, 14.2% in the middle, and 9% at the start. It implies that the emoji serves as a sentence's cover function. Emojis are non-verbal symbols that act as punctuation, taking the place of the period.

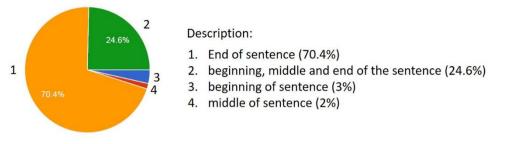
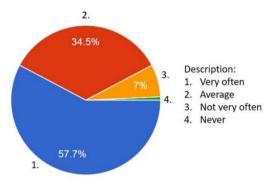
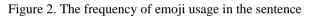


Figure 1. Figure Position of emoji in the sentence

Emojis that are sentence-level components can be shown using both spoken language (sentences) and emojis. Figure 2 shows that Internet users prefer to send messages with a mix of spoken text and emoji.





Emojis and verbal text are often used by users to create sentences to express ideas and emotions. The same holds for when they respond to a message from the interlocutor. Emoji and text are combined in the response. Emojis are used in sentence structure to emphasize and clarify the content being communicated.

Semantics level

The emojis as social semiotic multimodality in WhatsApp, consisting of smileys and people, animals and nature, food and drink, activity, travel, and places, objects, symbols, and flags, have meaning. The naming of each emoji places emphasis on the emoji's usage. For example, the person emoji of a grinning face (table 1) is an example.

Table 1. Semantics of Emoji

| Emoji | Semantic |
|-------|---|
| | Grinning Face: A yellow face with straight, open eyes and a wide, open smile that exposed some of the top teeth and tongue. Frequently communicates feelings of joy, gladness, or humor. (https://emojipedia.org/grinning-face/) |

Emojis' identities are described in their names. For instance, the "grinning face" emoji depicts the concept of joy and pleasure, allowing WhatsApp users to utilize it to convey these emotions. The collection of emoji names serves as a means of denotation and as the user's starting point for communicating connotations as a means of expression and the manifestation of feelings. Using an illustration from Figure 6, it can be mentioned in a sentence.

At the semantic level, social media users use verbal-nonverbal language (emoji) communication models to express ideas (thoughts), feelings, and emotions. The use of both words and emojis to emphasize the meaning of a message sent to another person, followed by the other person's response using a combination of words and emojis.

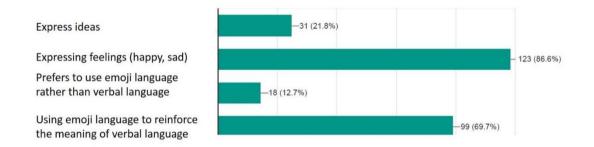


Figure 3. Reasons to use emoji language in communicating on social media

Pragmatics level

Pragmatics in multimodal communication demonstrates that the interaction of dialogues (speech acts) between the speaker and the interlocutor involves the use of social semiotic multimodality (verbal language and non-verbal emoji). Emotional relationships are known to be a part of the dialogue on social media through social semiotic multimodality. Emoji and verbal language are combined to create social semiotic multimodality, which is used in pragmatics as a means of communicating both private and public messages. In addition to communication between personas, informal or formal settings, social interactions, and hierarchical relationships between personas can all be indicated through social semiotic multimodality. This is evident in the way that students and teachers interact, as well as in peer interactions and relationships between parents and children.

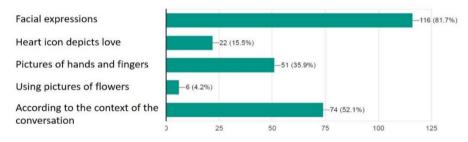


Figure 4. Use of the Emoji language to show social relationships on social media

At the pragmatic level, the reason for using Emoji in addition to verbal language is to indicate the social relationship between social media users. Social relations (familiarity in one social media group) no longer emphasize the relationships between social strata in society, for example, between leaders and employees, teachers and students, etc. What emphasizes the pragmatic level is how communication between social media users takes place effectively.

5. Conclusions

According to Leewan (2005), multimodality refers to the way that people communicate by using a variety of social semiotic multimodalities as semiotic resources at the same time in one medium. This is true of communication activities in the digital era that use technological devices, for example, social media. Social media, product design, and other fields have made extensive use of social semiotic multimodal communication. The in-issue social semiotic multimodalities is a form of communication that blends spoken and unspoken language (emoji, photographs, animation, video, music, audio, and other modes). A semiotic resource that generates (creates) meaning is referred to as a multimodality semiotic. This linguistic tendency has been observed in messaging on social media. Social media communication uses a variety of simultaneous modes (signs) to create the meaning of the message. Social semiotic multimodalities make the meaning of the message and the social connections between the people involved stronger.

Three communication models are produced by user conversation on social media when semiotic multimodality is present. There are three types of communication: verbal communication; verbal communication combined with nonverbal language (emoji, video, music, sound, etc.); and nonverbal communication using non-verbal language (emoji, photographs, videos, audio, etc.).

Multimodal communication demonstrates the real-time interactivity of communication between two or more people (in a group) that transcends geographical (national) barriers. Internet users' participation in semiotic communication also demonstrates their roles as producers of text (messages), publishers of text (shared messages), and consumers of text. They can create texts (messages, news, comments, etc.) and post them, on the one hand. On the other hand, they are text aficionados (news, information, and even hoaxes).

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References

- Ali, Tengku Intan Marlina bt. Tengku Mohd. (2008). Teori Semiotik Peirce dan Morris: Suatu Pengenalan. Jurnal Melayu, 3, 1-10.
- Ananiadou, S., John, Mc., & Paul, T. (2016). The English Language in The Digital Age. White Paper Series. Springer Nature.
- Arafah, B., & Hasyim, M. (2019). Transformasi Tata Bahasa Digital Emoji dalam Bahasa Daring: Mendefenisikan Kembali Paradigma Tata Bahasa Di Era Industri 4.0. *Laporan Penelitian Skim PDU*. Makassar: LP2M Universitas Hasanuddin
- Arafah, B., & Hasyim, M. (2020). Covid-19 Mythology And Netizens Parrhesia Ideological Effects Of Coronavirus Myths On Social Media Users. *Palarch's Journal of Archaeology of Egypt/Egyptology*, 17(4), 1398-1409.
- Asteroff, J. F. (1987). Paralanguage in electronic mail: A case study. Unpublished doctoral dissertation, Columbia University, New York. 1987.
- Barthes, R. (1957). Mythologies. Paris: Editions de Suil.
- Barthes, R. (1977). Image Music Text Essays (selected and translated by Stephen Heath). London: FontanaPress.
- Barthes, R. (2006). The Language of Fashion. New York: Bloomsbury Academic.
- Brinkman, C. S., Gabriel, S., & Elaine, P. E. (2020). Social achievement goals and social media. *Computers in Human Behavior*, 111, 106427. https://doi.org/10.1016/j.chb.2020.106427
- Danesi, M. (2002). Understanding Media Semiotics. London: Arnold. https://doi.org/10.1515/semi.2002.057
- Danesi, M. (2004). Messages, Signs, and Meanings: A Basic Textbook in Semiotics and Communication Theory. Canada: Canadian Scholars' Press Inc.
- Danesi, M. (2017). The Semiotics of Emoji: The Rise of Visual Language in the age of the Internet. London: Bloomsbury Publishing, Plc. https://doi.org/10.5040/9781474282024
- Danet, B., Ruedenberg-Wright, L., & Rosenbaum-Tamari, Y. (1997). "Hmmm... Where's That Smoke Coming From?" writing, play, and performance on internet relay chat. *Journal of Computer-Mediated Communication*, 2. https://doi.org/10.1111/j.1083-6101.1997.tb00195.x
- Fan, J. P. (2006). Charles Morris's Semiotic Model And Analytical Studies Of Visual And Verbal Representations In Technical Communication. J. Technical Writing And Communication, 36(2), 121-139. https://doi.org/10.2190/B8XB-VY4R-R792-DQJG
- Geddes, L. (2019). What's so fascinating about weird children's TV shows? Dalam https://www.bbc.com/future/article/20191206-why-children-find-weird-television-so-mesmerising
- Gee, James Paul dan Elisabeth Hayes. (2011). Language and Learning in The Digital Age. Routledge. https://doi.org/10.4324/9780203830918
- Hall, S. (1980). Encoding and Decoding in the Television Discourse. University of Birmingham.
- Halliday, M. A. K. (1978). Language as Social Semiotic. London: Arnold. https://we are social.com diakses pada tanggal02Oktober 2020
- Kress, G., & Van Leeuwen, T. (1996). Reading Images: The Grammar of Visual Design. London: Routledge.
- McLuhan, M. (1964). Understanding Media: The Extensions of Man. New York: McGraw-Hill.
- McQuail, D., & Windahl, S. (1997). Communication models for study of mass communications. London: Longman.
- Morris, C. (1964). Signification and Significance: A Study of the Relations of Signs and Values. Massachusetts: Massachusetts Institute of Technology.
- Morris, C. W. (1938). "Foundations of the theory of signs". In Otto Neurath et al. (eds.). *International encyclopedia of unified science*, *I* (2), 1-59. Chicago, Illinois: The University of Chicago Press.
- Munif, A. (2018). Potret Masyarakat Multikultural di Indonesia. Journal Multicultural of Islamic Edication, 2(1), 1-10.

- Rezabek, L., & Cochenour, J. (1998). Visual Cues in Computer-Mediated Communication: Supplementing Text with Emoticons. *Journal of Visual Literacy*, 18(2), 201-215. https://doi.org/10.1080/23796529.1998.11674539
- Riffaterre, M. (1978). Semiotics of Poetry. London: Indiana of University Press.
- Sanderson, D. (1993). Smileys. Sebastopol, CA: O'Reilly.
- Saussure, de Ferdinand. (1959). Course In General Linguistics. New York: Philosophical Library.
- Schwab, K. (2016). The Fourth Industrial Revolution. Geneva, Switzerland: World Economic Forum.
- Sheridan, M. P. (2016). "Recent Trends in Digital Humanities Scholarship". Dalam Daniel Dejica, Gyde Hansen, Peter Sandrini, Iulia Para (eds.). 2016. Language in the Digital Era. Challenges and Perspectives. Berlin: De Gryter Open.
- Van Leeuwen, Theo. (2005). *Introducing Social Semiotics*. Routledge: New York. https://doi.org/10.4324/9780203647028
- Vulchanova, M., Baggio, G., Cangelosi, A., & Smith, L. (2017). Editorial: Understanding Language Development in the Digital Age. *Frontiers in Human Neuroscience*, 11(447), 1-7. https://doi.org/10.3389/fnhum.2017.00447
- Williamson, J. (1978). Decoding Advertisements. London: Marion Boyars.
- Yu, B. (2011). Computer Mediated Communication. Beijing: Beijing Institute of Graphic Communication.
- Zimmerman, F. J., & Christakis, D. A. (2005). Children's television viewing and cognitive outcomes: a longitudinal analysis of national data. Arch. Pediatr. Adolesc. Med., 159, 619-625. https://doi.org/10.1001/archpedi.159.7.619

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