Learning & Education
ISSN:2251-2802

Pisco Med Publishing

Music, Technology and Education

Jiaqi Xu

Jingning Music, Nanjing City, Jiangsu Province 210012, China

Abstract: This article explores the profound impact of technological development on music education. It points out that since the 1980s, driven by government initiatives, computer and telecommunications-based technologies have been gradually integrated into the education system. This integration has prompted a shift in teaching methodology from teacher-centred knowledge transmission to a student-led framework for exploration primarily facilitated by technological tools. This study defines "music technology" as a broad conceptual domain, whose scope is not limited to digital software (e.g., Soundplant, Audacity) but also encompasses long-standing auxiliary tools such as pitch forks and pianos. Research indicates that the application of music technology has significantly influenced music education. For instance, it makes learning more intuitive through recording and analysis technologies (from phonographs to simulation systems); it stimulates student creativity and fosters unexpected inspiration through exploratory activities; and it promotes interdisciplinary collaboration and a transformation of teacher and student roles through projects like 'live coding'. In the process of utilizing these new technologies, the role of the teacher also shifts, increasingly becoming that of a supervisor and co-learner in the learning process. Furthermore, technological advancements create pathways for more individuals to learn music more effectively, as exemplified by the "Plug IT" project, which assists individuals with disabilities in participating in music creation, thereby broadening the inclusivity of music. In summary, technology serves as an empowering tool that not only optimizes teaching effectiveness and extends the horizons of possibility and creativity within music education but also enables both educators and learners to discover their individualized insights amid exploratory pursuits.

Keywords: Music Technology; Music Education; Pedagogy; Creativity; Teacher Role Transformation; Interdisciplinary Collaboration; Integration

1 Introduction: Core Questions About Technology and Music Education

This essay focuses on the impact of technology on music education. We are in an era of rapid technological development. Internet devices are not only growing every year, but they are growing at an ever-increasing rate. New technology is being updated more and more rapidly as time goes by. We can search the internet for almost anything we need. But at the same time, as technology continues to improve, more and more simple tasks can be replaced by technology. What impact has technology had on education?' What exactly does the term 'music technology' stand for? And what aspects of music education does technology affect? These are the three main points of this piece of essay.

2 The Influence of Technological Development on Education

First of all, how does the constant development of technology affect education? Somekh (2000) points out that since 1980, the government has been committed to introducing new technologies into education. And he quotes Tony Blair's speech in 1997, arguing that technology, in addition to already changing the way we live and work, will also continue to contribute to the development and change of education. So, children and teachers alike should be constantly learning about new technology and techniques in order to work more effectively in the future (p. 20). The term 'new technology' needs to be noted here, as the author refers to all computer and telecommunications-based technologies collectively as new technology. As technology continues to develop, there is no doubt that our work and life are becoming easier and easier. With the government pushing forward, education is embracing technology step by step. New things mean change, so teachers and students must learn new technologies to adapt to different times before change comes. When learning and using new technology, we need to be clear about the status of the technology. Its use should not just be a mandatory requirement, but rather a process of continuous breakthrough. Learning technology is a process of receiving new knowledge, and selecting the right technology to use in teaching is a test of the teacher's familiarity with this knowledge. Somekh and Davies (1991) also suggest that 'the development of a pedagogy for IT' is the process of interconnecting people with computers in educational learning. These technologies do not exist only as tools, they are also guides and witnesses to

our growth (p. 154). Thus, it is important to focus not just on the technology itself, but on the ways in which we want students to learn whatever we want them to learn.(Mishra & Henriksen, 2017, p. 11). And in order to choose the most appropriate technology, to teach effectively and quickly, teachers must understand the different ways in which multiple technologies can be presented and think about their relevance to pedagogy. The variety and multi-faceted nature of technology require teachers and students to carefully select the right one for them in order to get the best results.

3 The Transformation of Teaching and Learning Roles Driven by New Technologies

Somekh and Davies (1991) state that:

The computer, by providing an additional source of knowledge and information, reduces the dependency of students upon the teacher. They can use software to control and pace their own learning, taking the active role of constructing knowledge rather than the more passive role of receiving it (pp. 159-160).

To some extent, new technologies have expanded the options available to teachers and students, allowing them to choose more and more appropriate technologies to complete their learning. Somekh (2000) has done a number of studies on the use of new technology in teaching, such as students using the alternative keyboarding device Quinkeys to write long stories, which allows four students to sit around the computer and write their parts at the same time. There is also the author's research into the Apple Classroom of Tomorrow (ACOT) programme in Scotland (P. 24). From the results of the study, it seems that new technologies can be useful for classroom education if they are used in a way that helps teachers to observe each student's learning process better and faster and to identify and discuss problems that students do not understand immediately. They also allow students to be more aware of their progress, to have a better grasp of their strengths and weaknesses, and to be the first to practice. With the use of new technology, you will find that teachers are becoming less preoccupied with lectures in the classroom and students are becoming directly involved in the learning process. It reminded me of a lesson I had where the teacher asked us to learn and use a programme called Soundplant to create. The whole lesson was a little different from the previous ones in that the teacher's explanations were inserted. After a brief introduction to the software, the students' practise began. After a period of fumbling around, which coincided with finding some problems that could not be solved, the teacher again explained in more depth how to use the software better. This instantly solved the questions in our minds and deepened our impressions of what we had learned. We then used this knowledge to create a new piece of work, and so on. And so on and so forth until the final product was created. In this lesson, I felt that my own initiative and the teacher's real-time solutions not only made me more interested in what I was learning but also helped me remember it better. The teacher, on the other hand, was more of a guide and supervisor during the course of the lesson. Somekh & Davies (1991) also argue that the use of new technologies in the classroom can reduce the teacher's over-involvement and that the teacher's role becomes more of a supervisor and coordinator. The authors emphasise that the use of these technologies also transforms the teacher into a 'co-learner' who works with students to discuss and solve problems as they arise (p. 161). In summary, the constant advancement of technology has brought to education not only the need for constant learning, but also a shift in identity, which has made teaching and learning somewhat more straightforward and clearer and has allowed both teachers and students to improve.

4 The Definition and Scope of Music Technology

So, what does music technology look like? Before we do that, we need to define music technology. The term 'music technology' is widely used nowadays - the Soundplant mentioned above, or the well-known Audacity, are all music technology. However, these computer and software technologies do not represent the whole spectrum of music technology. In other words, music technology has never been just digital technology. It is not the same concept as the 'new technology' mentioned above. Himonides (2012) also agrees and points out from a historical perspective that not only computer technology, but also music scores, pitch forks, pianos, metronomes, etc., created long ago, are all part of music technology. From a macro perspective, 'music technology' is everything that helps us learn music better. Himonrides and Purves (2010) point out that technology is already present in almost everyone's lives. However, the term 'music technology' is not well defined. So, the authors consider 'music technology' as a broad concept, while it can help us to continuously understand music and the impact it has on our lives; to continuously capture music; to create better teaching and learning experiences; to facilitate communication between

music and music; to make us better musicians; and to be able to monitor and evaluate teaching practises (P. 123-124).

5 The Multidimensional Impact of Music Technology on Music Education

With this understanding of what music technology really is, let's look at the impact of music technology on music education. Firstly, music technology is constantly evolving to include more than just expensive large-scale technology. More and more powerful and practical music technology is being released on the internet, being downloaded and used for free, and the expansion of resources is allowing teachers to use technology in the classroom more often (Savage, 2005, p. 167). The most intuitive aspect of the use of technology for me is that it makes it easier for me to capture my own voice. The recording technology that Himonides (2019) points out is one of the technologies that I use most for music, the phonograph, invented by Thomas Edison in 1877 when sound could be preserved for the first time. Then came the 'analog domain', where sound vibrations could be converted into different electrical signals and stored on tapes etc. The quality and duration of sound preservation have greatly increased. Later, different types of microphones were developed for different people, with a completely different focus (pp. 1-9). These techniques constantly facilitate a better understanding of how to use the voice. Just like I used to record every vocal lesson I had so that I could listen to it over and over again during practise for better results. It has also been shown through research data that new technologies enable students to have more direct access to sound and to analyse research based on this more closely (Savage, 2005, p. 171). As well as allowing us to record and analyse sounds in a better and more direct way, the constant use of music technology allows students to be more creative. Torrance (1972) notes that children tend to think and learn more creatively when they are engaged in manipulative or exploratory activities (p. 115). Therefore, as they continue to explore new techniques, students may inadvertently become inspired. The process of creativity is the sudden discovery of unexpected elements in the process of working and their use at the right time (Stravinsky, 1974, P. 50). Savage (2005) also points out that in exploring various musical techniques, there are always many 'surprises' that arise. And these accidents are the spark of creativity (p. 172). In other words, active and continuous exploration of music technology allows students to move away from 'standard answers' and explore and create more answers of their own. Paynter (1997) also points out that information technology is a means rather than an end, and that technology offers many opportunities for us to learn to enjoy music, 'it offers the opportunity to explore different timbres' or 'the opportunity to create a unique interpretation of music for each individual' (P. 108). Being imaginative in the use of music technology not only makes teaching easier and simpler, but also allows you to find your own unique sound in learning. While music technology can help us learn music better, it can also contribute to a certain extent to the interdisciplinary development of students and the meaningful collaboration between teachers and external teachers. For example, in Learning From Live Coding, the author combines live code and music education in an experiment using Sonic Pi as a learning object. The results of the experiment confirm that the learning and use of this software has led to an improvement in students' abilities in music, coding and live coding performances. And to a certain extent, it has allowed teachers and experts to become music artists. Computer teachers and others have established partnerships that better facilitate teaching and learning (Burnard et al., 2016, pp. 5-11). It is also worth noting that music technology has been very helpful in the education of people with disabilities. 'Plug IT', a project run by the Drake Music Project in London, aims to provide disabled people with the opportunity to create music, using music technology to break through their limitations and enjoy creating their music (Himonides, 2012, pp. 10). I think this project proves that technology is not just an aid but also has the potential to create new lives. It breaks things that would otherwise not be possible and allows people to better communicate with each other. Also, as the project ultimately required a full performance, the students themselves had to use a large number of extremely complex musical techniques, each with a different purpose, some to help the students, some to make music, etc. And learning to coordinate these musical techniques also made the students better themselves.

6 Conclusion: Technology as an Enabler in Music Education

It can be seen that music technology can push the limits of the human body, turning the uncontrollable into the controllable and making people understand the importance of music.

In an era of data explosion, we need to understand that technology is our enabler. It guides and helps teachers and students learn better. And music technology is one of these many categories of technology. It is important to understand that music technology is something that enables teachers and students to learn music better, it makes teachers more accessible, it makes students more creative, it allows both to find

their own answers in explorers, and it empowers people with disabilities to participate in music learning.

References

[1] Burnard, P., Florack, F., Blackwell, A. F., Aaron, S., & Philbin, C. A. (2016). Learning From Live Coding. Routledge Handbooks Online. https://doi.org/10.4324/9781315686431.ch4

[2] Hallam, S., McQueen, H., Creech, A., Adams, P., Conlon, J., Durrant, C., Ellison, J., Gaunt, H., Himonides, E., & Laurence, K. (2010). Music Education in the 21st Century in the United Kingdom: Achievements, Analysis and Aspirations. Institute of Education Press (IOE Press). http://ebookcentral.proquest.com/lib/ucl/detail.action?docID=1047876

[3] Himonides, E. (2012, September 6). The Misunderstanding of Music-Technology-Education: A Meta Perspective. The Oxford Handbook of Music Education, Volume 2. https://doi.org/10.1093/oxfordhb/9780199928019.013.0029_update_001

[4] Himonides, E. (2019, April 11). Ave Verum Pentium. The Oxford Handbook of Singing. https://doi.org/10.1093/oxfordhb/9780199660773.013.55

[5] Mishra, P., & Henriksen, D. (2017). Creativity, Technology and Education: Exploring Their Convergence. Springer International Publishing AG. http://ebookcentral.proquest.com/lib/ucl/detail.action?docID=5183823

[6] Paynter, J. (1997). Editorial. British Journal of Music Education, 14(2), 107–108. https://doi.org/10.1017/S0265051700003533

[7] Savage, J. (2005). Working towards a theory for music technologies in the classroom: How pupils engage with and organise sounds with new technologies. British Journal of Music Education, 22(2), 167–180.

[8] Somekh, B. (2000). New Technology and Learning: Policy and Practice in the UK, 1980–2010. Education and Information Technologies, 5(1), 19–37. https://doi.org/10.1023/A:1009636417727

[9] Somekh, B. (2007). Pedagogy and learning with ICT. London: Routledge.

[10] Somekh, B., & Davies*, R. (1991). Towards a pedagogy for information technology. The Curriculum Journal, 2(2), 153–170. https://doi.org/10.1080/0958517910020205

[11] STRAVINSKY, I. (1974) The Poetics of Music. Cambridge, MA: Harvard University Press.

[12] Torrance, E. P. (1972). Can We Teach Children To Think Creatively?*. The Journal of Creative Behavior, 6(2), 114–143. https://doi.org/10.1002/j.2162-6057.1972.tb00923.x

Learning & Education
ISSN:2251-2802

Pisco Med Publishing

The Impact of Teacher-student Relationship on Students' Academic Satisfaction in Calligraphy Aesthetic Education: With Academic Self-efficacy, Coping Styles, and Grit as Mediators

Jin, Min kou, heung*

Sehan University, Yeongam-gun, Jeollanam-do 58447, South Korea

Abstract: This study aims to explore the impact of teacher-student relationship on students' academic satisfaction level in calligraphy aesthetic education, as well as the mediating effects of coping styles and self-efficacy in this process. Taking 500 college students from 5 universities offering calligraphy aesthetic education courses as the research subjects, this study collected data through questionnaires. An empirical model was constructed with "teacher-student relationship" as the explanatory variable, self-efficacy, coping styles and grit as mediating variables, and academic satisfaction as the explained variable, and relevant hypotheses were tested. The results show that the teacher-student relationship in calligraphy aesthetic education has a positive impact on academic satisfaction, and self-efficacy, coping styles and grit also play positive mediating roles between the two. This study holds that in calligraphy aesthetic education, teachers should focus on guiding college students to improve teacher-student relationship, cultivate self-efficacy, optimize coping styles and develop grit, so as to enhance students' academic satisfaction.

Keywords: Calligraphy Aesthetic Education; College Students; Teacher-Student Relationship; Academic Satisfaction; Self-efficacy; Coping Styles; Grit

1 Introduction

Academic satisfaction of college students is a key indicator for measuring educational quality, student development, and college life experience. It is directly related to students' learning motivation, mental health, academic achievement, as well as their career development and social adaptation after graduation (Wei & Fang, 2005; Wen & Shi, 2013; Wen, 2019).

Therefore, paying attention to and improving college students'academic satisfaction is of great significance to individuals, educational institutions, and the whole society (Wu, 2011). When students can fully concentrate on learning, actively participate in class discussions, and take the initiative to explore and think about problems, they are more likely to achieve good academic performance and academic recognition, thereby improving their satisfaction with their studies (Cui, 2020). College students'self-efficacy also plays an important role in their academic satisfaction. Self-efficacy refers to an individual's confidence and belief in their ability to successfully complete a specific task (Bandura, 1986). When college students possess positive coping styles, they are more likely to invest actively in learning and make sustained efforts, thus improving their academic satisfaction (Woolfolk, 2008).

Based on the aforementioned existing studies, this research deems it necessary to explore the correlation between teacher-student relationship and factors affecting coping styles, self-efficacy, grit, and college students'academic satisfaction. Niu (2017) pointed out that the group difference trends of the two dependent variables—teacher-student relationship and academic satisfaction—are surprisingly consistent, which further confirms a strong correlation between teacher-student relationship and students'academic satisfaction. Therefore, this study takes 500 college students from 5 universities offering calligraphy aesthetic education courses as research subjects, and analyzes how teacher-student relationship, self-efficacy, coping styles, and grit—factors influencing academic satisfaction—relate to the level of academic satisfaction.

The purpose of this study is to examine the impact of teacher-student relationship on academic satisfaction in calligraphy aesthetic education, as well as the mediating roles of coping styles and self-efficacy in this process. Specifically, it first analyzes the overall characteristics of teacher-student relationship, coping styles, self-efficacy, grit and academic satisfaction of college students in calligraphy aesthetic education programs at the sample universities, and explores whether there are significant differences in terms of demographic variables. Then,

it focuses on investigating the impact of teacher-student relationship on academic satisfaction in calligraphy aesthetic education, and the mediating effects of coping styles, self-efficacy, and grit between the two. Based on the results, this study provides suggestions for enhancing college students'coping styles, self-efficacy, and grit, improving teacher-student relationship, and boosting academic satisfaction. This study draws on research methods in the field of educational psychology to investigate the impact of teacher-student relationship on college students'academic satisfaction—specifically, the state of academic satisfaction after the implementation of calligraphy courses—and the mediating roles of variables such as self-efficacy and coping styles.

The following research questions are proposed:

Q1: Under the influence of teacher-student relationship, are there differences in the level of academic satisfaction among different groups of students?

Q2: Does the quality of teacher-student relationship of college students in calligraphy aesthetic education have a direct impact on their academic satisfaction?

Q3: In calligraphy aesthetic education, do college students'self-efficacy, coping styles, and grit have a direct impact on their academic satisfaction?

Q4: In calligraphy aesthetic education, when teacher-student relationship affects college students' academic satisfaction, do self-efficacy, coping styles, and grit exert an influence on college students' academic satisfaction?

Q5: In calligraphy aesthetic education, can college students'academic satisfaction be mediated by self-efficacy, and what effect does this mediation have in the process of teacher-student relationship influencing academic satisfaction?

Q6: In calligraphy aesthetic education, can college students' academic satisfaction be mediated by coping styles, and what effect does this mediation have in the process of teacher-student relationship influencing academic satisfaction?

Q7: In calligraphy aesthetic education, can college students' academic satisfaction be mediated by grit, and what effect does this mediation have in the process of teacher-student relationship influencing academic satisfaction?

2 Theoretical Background

2.1 Teacher-Student Relationship

This study mainly refers to Walker & Baepler (2017) for its definition of teacher-student relationship, which defines it as a relationship of interaction and cooperation, in which teachers act as mentors and guides, providing support and guidance to help students achieve success in academic and personal development. The summary of the elements of teacher-student relationship also draws on Walker & Baepler (2017), who summarized the elements of this relationship in their research, including formal student-teacher relationship, informal student-teacher relationship, and the role of students as teachers.

(1)Self-efficacy

Bandura defined self-efficacy as an individual's judgment of their ability to organize and execute the courses of action required to achieve predetermined behavioral goals (Zhang, 2023). The widely used version of the GSES was developed in 1981 by Professor R. Schwarzer, a renowned clinical and health psychologist from Freie Universität Berlin, and his colleagues (Schwarzer, 2009).

(2)Coping Styles

The concept of coping is translated from the English word cope, which means to deal with or face, usually in the context of abnormal situations, anxiety, or stress. According to Webb (1999), there are four research perspectives on coping. Internationally, the most widely used scale for measuring coping styles is the Ways of Coping Questionnaire developed by Lazarus & Folkman (1984). Additionally, there is the COPE Inventory compiled by Carver et al. (1989).

(3)Grit

Duckworth et al. (2007) argued that grit, a character strength mentioned in positive psychology, refers to the perseverance and determination to accomplish grand and long-term goals, despite inevitable failures, adversities, and stagnations in the process. Regarding the connotation of grit, Duckworth (2007) was the first to discuss it and proposed the two-factor concept of grit.

(4)Academic Satisfaction

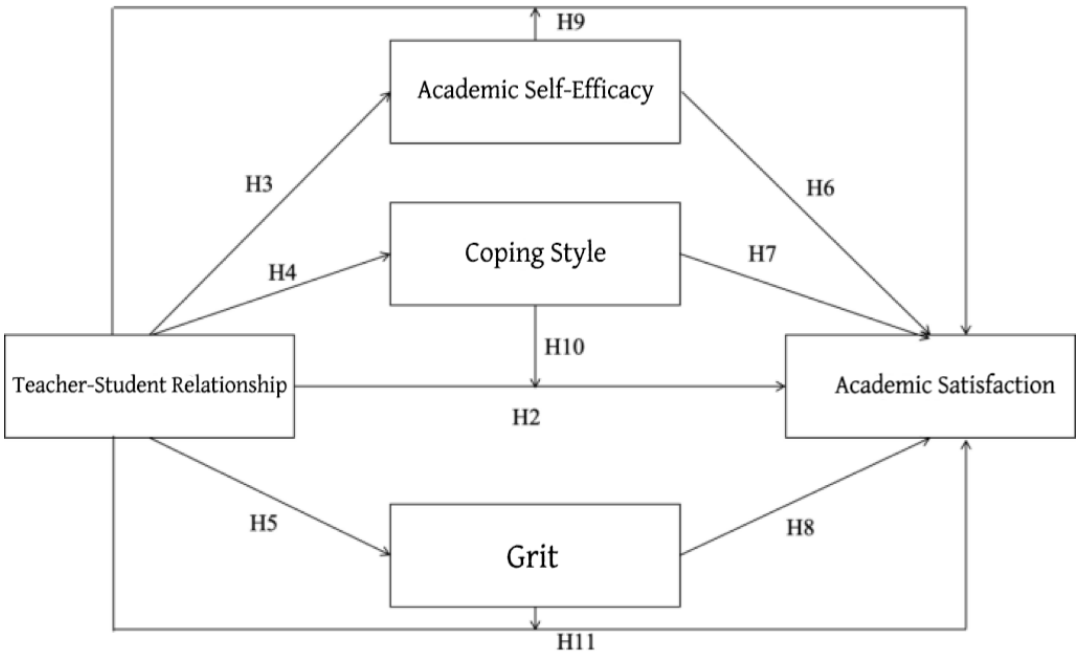
Appleton-Knapp & Krentler (2006) believed that the essence of academic satisfaction lies in college students' subjective evaluation of their university's educational quality based on their own subjective feelings, which also reflects students' attitudes and tendencies towards learning and campus life. Du et al. (2003) argued that students evaluate aspects such as teachers' teaching and campus environment according to their own evaluation criteria, and they are considered satisfied if the actual situation meets or exceeds these criteria. Jaeger (1974) divided academic satisfaction into dimensions such as satisfaction with teachers and satisfaction with courses.

3 Research Methods

3.1 Research Model and Hypotheses

3.1.1 Research Model

The purpose of this study is to examine the relationships between college students' self-efficacy, coping styles, and academic satisfaction level in calligraphy aesthetic education based on teacher-student relationship, and to verify the contribution of teacher-student relationship to college students' academic satisfaction level in calligraphy aesthetic education. On the basis of theories and previous studies on various variables, a model is constructed, with teacher-student relationship as the independent variable, self-efficacy and coping styles as mediating variables, and academic satisfaction level as the dependent variable, as shown in [Figure 1].



[Figure 1] Research Model

3.1.2 Research

Hypotheses Based on the theoretical background and previous studies, this study formulates the following research hypotheses in accordance with its research objectives:

<H1> Do demographic variables of different student groups lead to differences in the impact of teacher-student relationship on self-efficacy, coping styles, grit, and academic satisfaction level?

<H2> Does the teacher-student relationship have a direct impact on students' academic satisfaction level in calligraphy aesthetic education?

<H3> Does the teacher-student relationship have a direct impact on students' self-efficacy in calligraphy aesthetic education?

<H4> Does the teacher-student relationship have a direct impact on students' coping styles in calligraphy aesthetic education?

<H5> Does the teacher-student relationship have a direct impact on students' grit in calligraphy aesthetic education?

<H6> Does college students' self-efficacy have a direct impact on their academic satisfaction level in calligraphy aesthetic education?

<H7> Does coping style have a direct impact on academic satisfaction level in calligraphy aesthetic education?

<H8> Does grit have a direct impact on academic satisfaction level in calligraphy aesthetic education?

<H9> Does the teacher-student relationship in calligraphy aesthetic education affect academic satisfaction level through the mediating role of self-efficacy?

<H10> Does the teacher-student relationship in calligraphy aesthetic education affect academic satisfaction level through the mediating role of coping styles?

<H11> Does the teacher-student relationship in calligraphy aesthetic education affect academic satisfaction level through the mediating role of grit?

3.2 Research Subjects

The samples of this study consist of 500 college students from 5 universities offering calligraphy aesthetic education courses, including the Central Academy of Fine Arts, China Academy of Art, Luxun Academy of Fine Arts, Xi'an Academy of Fine Arts, Guangzhou Academy of Fine Arts, and Hubei Academy of Fine Arts. This survey was conducted from June 1, 2025, to September 30, 2025, spanning a total of 18 weeks. Additionally, a questionnaire survey was distributed from September 1 to September 30, 2023, with 510 questionnaires issued in total. After excluding erroneous and invalid questionnaires, the actual number of valid samples was 500, resulting in an effective questionnaire rate of 98.04%. The demographic variables included in the questionnaire cover gender, grade, and others. Statistical data on the number of participants show that among the college students surveyed, there are 325 females (65.00%) and 175 males (35.00%). In terms of grade distribution, there are 124 freshmen (24.80%), 135 sophomores (27.00%), 121 juniors (24.20%), and 120 seniors (24.00%).

3.3 Research Instruments

3.3.1 College Students' Academic Satisfaction

The main instrument used in this study to measure college students' academic satisfaction is the 12-item General Health Questionnaire (GHQ-12; Zhang et al., 2008), which has been revised according to the specific characteristics of the respondents' satisfaction. The original questionnaire has no dimensional division; in the revised version, items 1–5 are positively worded (5 items), and items 6–10 are negatively worded (5 items), totaling 10 items.

3.3.2 Teacher-Student Relationship

The measurement of teacher-student relationship in this study mainly refers to the Teacher-Student Relationship Measurement Scale developed by Walker & Baepler (2017). This scale consists of 3 dimensions, namely formal student-teacher relationship (5 items), informal student-teacher relationship (5 items), and the role of students as teachers (6 items), with a total of 16 items.

3.3.3 Coping Styles

In this study, coping styles are categorized into positive coping styles and negative coping styles. Lazarus & Folkman (1984) developed a Coping Styles Scale, which divides coping styles into two dimensions: positive coping styles and negative coping styles. Additionally, the Simplified Coping Style Scale developed by Xie (1998) also includes two aspects: positive coping styles and negative coping styles. Based on these two scholars' scales, this study adjusted the Coping Styles Scale according to the characteristics of college graduates in central China. The adjusted scale used in this study has 10 items and 2 dimensions, namely positive coping styles (5 items) and negative coping styles (5 items).

3.3.4 Self-efficacy

The measurement of self-efficacy in this study is based on the Self-efficacy Scale (SES) developed by Bandura in 1977, which has been revised according to the specific self-efficacy characteristics of the respondents. The revised scale includes 2 dimensions: Academic Ability Self-efficacy: Including 2 items on judgment of failure avoidance and 3 items on confidence in failure avoidance (5 items in total); Academic Behavior Self-efficacy: Including 3 items on learning methods and 2 items on goal-directed behavior (5 items in total). The scale has 10 items

in total. 5) Grit The measurement of grit in this study mainly adopts the Grit Questionnaire designed by Duckworth (2007). This questionnaire has a structured format and contains 12 items, covering two dimensions: consistency of interests (6 items) and perseverance of effort (6 items).

3.4 Research Procedures

This study will be conducted in the following steps:

First, a survey will be conducted to collect data on respondents' basic information, as well as college students' self-efficacy, coping styles, and academic satisfaction level in calligraphy aesthetic education. Descriptive statistics will then be performed to determine whether there are differences among different groups.

Second, a correlation analysis of the variables will be carried out to identify the correlations between them.

Third, a regression model will be constructed to test the impact of teacher-student relationship on academic satisfaction, and to verify the mediating effects of self-efficacy and coping styles.

4 Research Results

4.1 Descriptive Statistics

The results of descriptive statistics show that: the mean value of the teacher-student relationship variable is (M = 3.548); the mean value of the self-efficacy variable is (M = 4.038); the mean value of the coping styles variable is (M = 3.577); the mean value of the grit variable is (M = 2.626); and the mean value of the academic satisfaction variable is (M = 3.058).

4.2 Correlation Analysis

<Table 1> Correlations Between Teacher-Student Relationship and Scales of Self-efficacy, Coping Styles, Grit, and Academic Satisfaction

Variable	1	2	3	4	5
1.Teacher–Student Relationship	1				
2.Academic Satisfaction	.61**	1			
3.Self-efficacy	.53**	.54**	1		
4.Coping Style	.62**	.69**	.68**	1	
5.Grit	.60**	.65**	.73**	.55**	1

As shown in <Table 1>, in the multi-factor correlation analysis of teacher-student relationship with self-efficacy, coping styles, and academic satisfaction, the teacher-student relationship exhibits a significant positive correlation with self-efficacy ($r = .530$, $p < .01$), with coping styles ($r = .620$, $p < .01$), and with academic satisfaction ($r = .610$, $p < .01$).

5 Conclusions

The results of this study indicate that the teacher-student relationship in calligraphy aesthetic education exerts a positive impact on academic satisfaction, and self-efficacy, coping styles, and grit also play positive mediating roles between the two. Therefore, this study suggests that in calligraphy aesthetic education, teachers should focus on guiding college students to improve the teacher-student relationship, cultivate self-efficacy, and optimize coping styles, so as to enhance students' academic satisfaction.

References

[1]Appleton-Knapp, S. L., & Krentler, K. A. (2006). Measuring student expectations and their effects on satisfaction: The importance of managing student expectations. Journal of Marketing Education, 28(3), 254–264.

[2]Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. Journal of Personality and Social Psychology, 92(6), 1087–1101.

[3]Du, H. M., Wang, K. W., Shao, X. P., et al. (2003). A survey on graduate students' satisfaction with the present situation of graduate education in higher education. Journal of Chongqing University, (6), 161–163. (In Chinese)

[4]Jaeger, R. M. (1978). Chapter 7: About educational indicators: Statistics on the conditions and trends in education. In Review of Research in Education (Vol. 6, No. 1, pp. 276–315).

[5]Lazarus, R. S., & Folkman, S. (1984). Stress, appraisal, and coping. Springer Publishing Company.

[6]Niu, K. H. (2017). Current situation, problems and countermeasures of college students' learning process evaluation: A survey based on 16 undergraduate universities nationwide. University Education Science, (6), 42–49+121. (In Chinese)

[7]Printz, B. L., Shermis, M. D., & Webb, P. M. (1999). Stress-buffering factors related to adolescent coping: A path analysis. Adolescence, 34(136), 761–778.

[8]Schwarzer, R., & Renner, B. (2009). Health-specific self-efficacy scales (14th ed.). Freie Universität Berlin.

[9]Walker, J. D., & Baepler, P. (2017). Measuring social relations in new classroom spaces: Development and validation of the Social Context and Learning Environments (SCALE) Survey. Journal of Learning Spaces, 6(3), 34–41.

[10]Zhang, D. C. (2023). A classification analysis of "45-degree youth" and the cultivation of the spirit of striving. Journal of Yunnan University (Social Sciences Edition), (6), 94–101. (In Chinese)

Learning & Education
ISSN:2251-2802

Pisco Med Publishing

The Impact of Working Memory on Cognitive Load via Viewing Bilingual Subtitles

Jinyang Li, Chao Han*

Faculty of Foreign Languages and Cultures, Kunming University of Science and Technology, Kunming 650500, China

Abstract: This study explores the relationship between working memory and cognitive load during bilingual subtitle viewing. 42 Chinese university students completed a working memory test and watched an English documentary with bilingual subtitles. After viewing, they reported their perceived intrinsic, extraneous, and germane cognitive load using a validated questionnaire. Regression analyses showed that working memory significantly predicted germane load but not intrinsic or extraneous load. These findings suggest that learners with greater working memory are more likely to invest in meaningful learning processes. The study offers insights into the cognitive mechanisms underlying multimedia language learning and calls for more individualised approaches in instructional design.

Keywords: Working Memory; Cognitive Load; Bilingual Subtitles; Multimedia Learning

1 Introduction

In multimedia second language (L2) learning, learners often face simultaneous auditory, visual, and textual information. Bilingual subtitles display both the first language (L1) and the L2 text during audiovisual input (Wang & Pellicer-Sánchez, 2022), supporting comprehension and vocabulary development (Montero Perez et al., 2020), but increasing cognitive processing demands due to multi-modal information coordination (Gottlieb, 1998). These demands may exceed working memory capacity if instructional design fails to optimise cognitive resource allocation (Kalyuga et al., 1999).

Working memory, which is responsible for temporarily storing and processing information (Baddeley, 2000), affects performance in complex L2 tasks (Linck et al., 2014; In'nami et al., 2022). However, its link to learners' subjective cognitive effort in multimedia settings, especially with bilingual subtitles' unique demands, remains understudied. Cognitive Load Theory (Sweller et al., 2011) distinguishes intrinsic (content complexity), extraneous (instructional design), and germane (meaningful learning) load. Empirical studies on how working memory relate to each load type in bilingual subtitle are limited.

To address this gap, the present study investigates whether working memory predicts the three cognitive load types in bilingual subtitle viewing. It enhances understanding of L2 multimedia cognitive processing and highlights learner characteristics' role.

2 Literature review

2.1 Subtitles in different linguistic formats and cognitive load

Subtitle linguistic format has common types including full, keyword, glossed, and bilingual subtitles, each varying in linguistic and visual complexity. Glossed and keyword captions reduce extraneous load by offering targeted lexical support without redundant information (Teng, 2023; Montero Perez, 2012). In contrast, bilingual subtitles are more cognitively demanding, requiring simultaneous processing of two languages, images, and sounds. Though they may boost comprehension via redundancy, poor design risks overload (Winke et al., 2010). Eye-tracking studies show bilingual and full captions lead to longer fixations and stronger split-attention effects than simplified formats (Montero Perez et al., 2014; Winke, Gass, & Sydorenko, 2013), linking to higher extraneous load when coordinating visual, audio, and subtitle input.

Cognitive Load Theory (CLT) explains these effects: intrinsic load depends on audiovisual content's linguistic complexity, while extraneous load relates to subtitle presentation. Overly dense or asynchronously bilingual subtitles increase extraneous load, reducing resources for germane processing (Sweller et al., 2011; Leppink et al., 2014). Thus, instructional designers must optimise subtitle format and alignment.

2.2 Working memory and cognitive load

Working memory, a key individual difference variable, shapes cognitive load experience and regulation in multimedia learning. According to Baddeley's (2000) multicomponent model, it consists of a central executive and two storage systems: the phonological loop for verbal information and visuospatial sketchpad for visual information, which is relevant in subtitle-video tasks.

Several studies have found positive relationships between working memory and L2 listening, reading, and vocabulary performance in multimedia settings (Linck et al., 2014; In'nami et al., 2022; Miyake & Friedman, 1998). Learners with higher working memory better process concurrent audiovisual input, integrate it with prior knowledge, and experience lower extraneous load and higher germane engagement. Winke et al. (2010) noted higher working memory learners benefit more from full and bilingual captions, while lower-capacity learners face greater overload risk. Recent findings also emphasise the component-specific working memory effects. Teng (2023) found phonological working memory best predicts incidental vocabulary learning from captioned videos in younger learners, suggesting input modality and age moderate its role in load regulation.

Moreover, working memory interacts differently with each load type. It does not reduce content's intrinsic complexity but filters extraneous elements and promotes germane load. Low working memory learners struggle with subtitles, especially bilingual ones, lowering content attention and learning outcomes (Sydorenko et al., 2017).

2.3 Cognitive load theory

Developed by Sweller (1988), Cognitive Load Theory (CLT) frames learning's mental demands, emphasising working memory limits and effective cognitive resource management. CLT categorises load into intrinsic, extraneous, and germane load (Sweller, Ayres, & Kalyuga, 2011). Leppink et al. (2014) created a multidimensional questionnaire to measure perceived intrinsic, extraneous, and germane load, which is widely used in experiments and education for reliable load assessment in complex tasks. Mayer's (2001) CLT extension to multimedia learning stresses coherence, signalling, and dual-channel processing, which is critical for subtitled videos where learners process simultaneous audio and text. Studies by Montero Perez et al. (2014) and Sydorenko et al. (2017) have shown that subtitle design impacts learning by altering load distribution: poor synchronisation or excessive text increases extraneous load, while well-aligned, concise subtitles boost germane load and deeper engagement.

While subtitle format and working memory both affect cognitive load, few studies explore how working memory shapes processing during bilingual subtitle viewing. Guided by CLT, this study investigates if working memory predicts different load types in this context.

3 Methodology

3.1 Participants

42 Chinese English-major students (37 females, 5 males; Mage=20, SDage=1.47) from a university in southwest China participated in this study voluntarily. The sample size matches similar studies (Zhang & Zhang, 2022; Teng, 2024) and suffices for mixed-effects modelling. All participants completed English proficiency and working memory tests, and signed consent forms at first.

3.2 Materials

3.2.1 Measurements of participants' working memory

The Reading Span Task (RST) (Daneman and Carpenter ,1980) measured working memory. It used 70 unrelated English sentences (11-13 words each, half grammatical, half ungrammatical), with participants judging grammaticality and recalling final words to ensure active syntactic processing. Administered via E-prime 3.0, the task had a maximum total score of 140 (70 each for working memory's processing and storage). RST is reliable in L2 research (Juffs & Harrington, 2011) with Cronbach's alpha=0.83 (Teng, 2024).

3.2.2 Experiment materials

The video clip: An 856-word excerpt from the BBC documentary Animal Odd Couples (2013) was edited with Clipchamp (Microsoft Corporation, 2023). Focused on a bear-tiger-lion friendship, the clip content matched participants' vocabulary. Post-viewing interviews with

another similar 7 learners indicated that 1.0x speed was too fast. Therefore, the playback speed was adjusted to 0.8x with 6 minutes and 55 seconds totally. Python (v3.9.6) analysed the top 3,000 frequent words covered 97% of the material, with the Corpus of Contemporary of American English (COCA) (Davies, 2008) as the reference corpus.

Vocabulary test: the Vocabulary Size Test (VST) (Nation, 2007) includes 140 items (10 items per level), covering the 1,000 to 14,000 word-family levels, with a maximum score of 14,000. The Cronbach's alpha of the test was 0.80(Peters, 2019). On average, participants had a vocabulary size of approximately 4,986 words, which was sufficient to understand the English subtitles of the video.

Subtitles: The original English video script was translated into Chinese, cross-checked with an amateur translation (Bilibili, n.d.) and reviewed by 3 English-fluent native Chinese speakers. CapCut Professional software (v7.5.0) ensured L1 and L2 subtitle synchronisation with audio and images.

Comprehension test: A 5 multiple-choice questions test (2 points each, max=10) was designed to evaluate participants' understanding of the video. No target words were included, and "I don't know" was an option. All the participants had achieved a score over 8 (M=9.78, SD=0.63).

3.2.3 Measurements for participants' cognitive load

Leppink et al.'s (2014) post-task self-report cognitive load questionnaire was used to validate and distinguish load types, which adjusted the contextual information for film comprehension. It had 14 items (10-point Likert scale: 1= "not at all", 10= "completely"):

Intrinsic Cognitive Load (IL) included 4 items that evaluated the complexity of the video content itself. Participants rated the visual, auditory, subtitle-related language complexity, and the mental effort for the overall complexity of the video.

Extraneous Cognitive Load (EL) consisted of 7 items that measured the clarity and effectiveness of the information presentation, assessing the clarity of visual and auditory information, the subtitle comprehensibility, the inefficiency of English and Chinese subtitles in supporting vocabulary learning, and the mental effort for unclear presentation.

Germane Cognitive Load (GL) included 3 items that evaluated the perceived contribution of the video to knowledge construction, assessing the video's role in learner's understanding, their vocabulary knowledge, and the mental effort for knowledge enhancement.

Cronbach's alpha confirmed reliability: IL=0.927, EL=0.856, GL=0.842, supporting construct validity and contextual suitability.

3.3 Procedures

The study comprised three stages: English vocabulary size and working memory test; consent form signing and video viewing that focused on comprehension; comprehension test and a cognitive load questionnaire. The complete processes are shown in Figure 1.

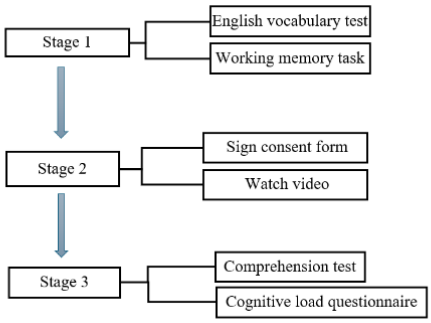


Figure 1 The experiment process

4 Results and Discussion

4.1 Working memory results and cognitive load results

Working memory scores ranged from 50 to 115 (M=90.02, SD=15.21), with slight negative skewness (Skewness=-0.69) and moderate kurtosis (Kurtosis=0.65). As shown in Table 1, IL's scores ranged from 4 to 25, the mean was 13.71 (SD = 5.07), with near-normal distribu-

tion (Skewness=-0.03, Kurtosis=-0.68), suggesting a relatively symmetrical distribution with slight platykurtic tendencies. For EL's scores ranged from 7 to 32, the mean was 18.29 (SD = 8.03). The skewness (0.17) and kurtosis (-0.89) indicated a moderately right-skewed distribution. GL's scores ranged from 12 to 30, the highest mean was 20.05 (SD=4.70) among the three dimensions, which suggested a positively skewed and near-normal distribution (Skewness=0.37, Kurtosis=0.09).

Table 1 Descriptive statistics of cognitive load

Cognitive load	Mean	SD	Max.	Min.	Skewness	Kurtosis
IL	13.71	5.07	25	4	-0.03	-0.68
EL	18.29	8.03	32	7	0.17	-0.89
GL	20.05	4.70	30	12	0.37	0.09

4.2 The Impact of Working Memory on Cognitive Load

To examine the effect of working memory capacity on cognitive load, three linear regressions (working memory as independent variable, each load type as dependent variable) were conducted.

Table 2 The impact of working memory on cognitive load

Cognitive load	F	p	R^2	Adjusted R^2
IL	0.014	0.908	0.000	-0.025
EL	2.661	0.111	0.064	0.040
GL	6.588	0.014*	0.144	0.123

The regression analysis for IL indicated that working memory was not a significant predictor, F (1, 39) = 0.014, p = .908. This result suggests that the perceived complexity of the audiovisual material remained consistent across learners. This aligns with CLT's claim that IL depends on material inherent complexity and prior knowledge (Sweller et al., 2011), and working memory does not alter perceived material complexity (Leppink et al., 2014; Montero Perez et al., 2014).

Similarly, no significant relationship was found between working memory and EL, F (1, 39) = 2.661, p = .111. This indicates that participants' evaluations of instructional clarity or the quality of subtitle presentation was largely independent of their working memory capacity. This outcome partially aligns with Winke et al. (2010), who reported that subtitle format can influence EL, and Teng (2023), who noted that well-synchronised captioning reduces EL variance across cognitive profiles.

In contrast, a significant effect was observed for GL, F (1, 39) = 6.588, p = .014. This finding suggests that higher working memory correlated with more effort for meaning construction and knowledge integration. This finding is consistent with In'nami et al. (2022) and Linck et al. (2014), who emphasised that working memory is positively associated with deeper L2 processing, and Teng (2023) who indicated that stronger phonological working memory enhances captioned input benefits. It also supports CLT's view that germane load reflects motivation and meaningful processing ability (Sweller et al., 2011). The regression results are visualised in Figures 2, 3, and 4.

Figure 2 Scatter plots with regression line showing the relationship between working memory and IL

Pisco Med Publishing

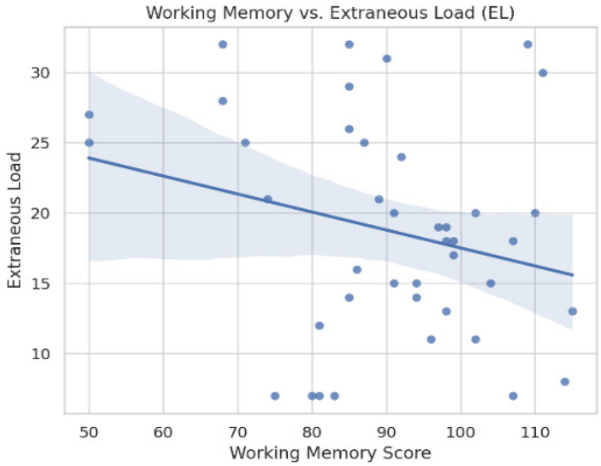


Figure 3 Scatter plots with regression line showing the relationship between working memory and EL

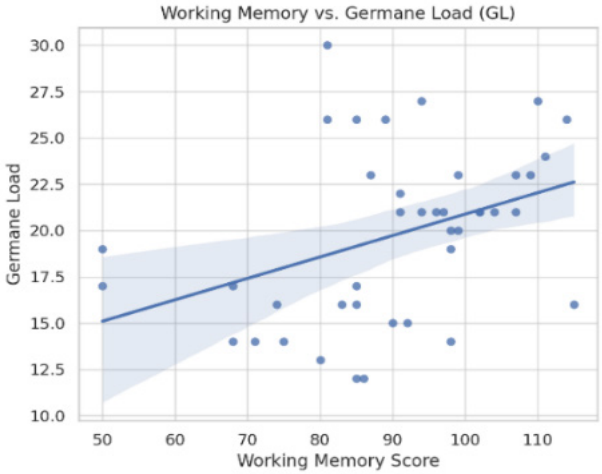


Figure 4 Scatter plots with regression line showing the relationship between working memory and GL

5 Conclusion

This study examined how working memory capacity affects cognitive load during bilingual subtitle viewing. The results showed that working memory did not significantly predict intrinsic or extraneous cognitive load. However, it did significantly predict germane cognitive load, indicating that learners with higher working memory were more likely to invest effort in meaningful learning processes. These findings support the distinction among the three types of cognitive load and highlight the role of individual cognitive capacity in multimedia learning. They suggest that while working memory may not affect how learners perceive complexity or presentation, it contributes to their ability to engage in deeper processing. This study is limited by its small sample size and single-subtitle condition. Future research should consider using more diverse participants, varying subtitle formats, and incorporating objective measures of cognitive load. Overall, the study adds to our understanding of how working memory interacts with bilingual subtitle processing and provides useful implications for the design of language learning materials.

References

[1] Baddeley, A. (2000). The episodic buffer: A new component of working memory? Trends in Cognitive Sciences, 4(11), 417–423.

[2] BBC. (2013). Animal odd couples. https://www.bbc.co.uk/programmes/b03jp46s

[3] Bilibili. (n.d.). 奇特的动物伙伴 1 [odd animal couples 1]. https://www.bilibili.com/video/av21620515/

[4] Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. Journal of Verbal Learning and Verbal Behavior, 19(4), 450–466.

[5] Davies, M. (2008). The corpus of contemporary American English (COCA): 450 million words, 1990-present.

[6] Gottlieb, H. (1998). Subtitling. In M. Baker (Ed.), Routledge Encyclopedia of Translation Studies (pp. 244–248). Routledge.

[7] In'nami, Y., Koizumi, R., & McLean, S. (2022). Working memory and L2 reading: A meta-analysis. Language Learning, 72(3), 742–785.

[8] Juffs, A., & Harrington, M. (2011). Aspects of working memory in L2 learning. Language Teaching, 44(2), 137–166.

[9] Kalyuga, S., Chandler, P., & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. Applied Cognitive Psychology, 13(4), 351–371.

[10] Leppink, J., Paas, F., Van der Vleuten, C. P. M., Van Gog, T., & Van Merriënboer, J. J. G. (2014). Development of an instrument for measuring different types of cognitive load. Behavior Research Methods, 45(4), 1058–1072.

[11] Leppink, J., Paas, F., Van Gog, T., Van Der Vleuten, C. P. M., & Van Merriënboer, J. J. G. (2014). Effects of pairs of problems and examples on task performance and different types of cognitive load. Learning and Instruction, 30, 32–42.

[12] Linck, J. A., Osthus, P., Koeth, J. T., & Bunting, M. F. (2014). Working memory and second language comprehension and production: A meta-analysis. Psychonomic Bulletin & Review, 21(4), 861–883.

[13] Mayer, R. E. (2001). Multimedia learning. Cambridge University Press.

[14] Microsoft Corporation. (2023). Clipchamp (version x.x) [software]. Microsoft Corporation. https://www.clipchamp.com

[15] Miyake, A., & Friedman, N. P. (1998). Individual differences in second language proficiency: Working memory as language aptitude. In A. F. Healy & L. E. Bourne (Eds.), Foreign language learning: Psycholinguistic studies on training and retention (pp. 339–364). Lawrence Erlbaum.

[16] Montero Perez, M. (2012). Learning L2 vocabulary through subtitled video: An eye-tracking study [Doctoral dissertation, Ghent University].

[17] Montero Perez, M. (2020). Second or foreign language learning through watching audio-visual input and the role of learner differences. Applied Linguistics Review, 11(2), 301–328.

[18] Montero Perez, M., Peters, E., Clarebout, G., & Desmet, P. (2014). Effects of captioning on video comprehension and incidental vocabulary learning. Language Learning & Technology, 18(1), 118–141.

[19] Nation, P. (2007). A vocabulary size test. The Language Teacher, 7, 9–13.

[20] Peters, E. (2019). The effect of imagery and on-screen text on foreign language vocabulary learning from audiovisual input. TESOL Quarterly, 53(4), 1008–1032.

[21] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285.

[22] Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. Springer.

[23] Sydorenko, T., Hellmich, A., Colpaert, J., & Desmet, P. (2017). Subtitles in the second language classroom: Balancing benefits and cognitive load. ReCALL, 29(2), 178–199.

[24] Teng, L. S. (2023). Understanding the effects of caption types on vocabulary learning: Working memory and cognitive load perspectives. System, 117, 102886.

[25] Teng, M. F. (2024). Working memory and prior vocabulary knowledge in incidental vocabulary learning from listening, reading, reading-while-listening, and viewing captioned videos. System, 124, 103381.

[26] Wang, A., & Pellicer-Sánchez, A. (2022). Incidental vocabulary learning from bilingual subtitled viewing: An eye-tracking study. Language Learning, 72(3), 765-805.

[27] Winke, P. M., Godfroid, A., & Gass, S. M. (2013). Introduction to the special issue: Eye-movement recordings in second language research. Studies in second language acquisition, 35(2), 205-212.

[28] Winke, P., Gass, S., & Sydorenko, T. (2010). The effects of captioning videos used for foreign language listening activities. Language Learning & Technology, 14(1), 65–86.

[29] Zhang, S., & Zhang, X. (2022). The relationship between vocabulary knowledge and L2 reading/listening comprehension: A me-

ta-analysis. Language Teaching Research, 26(4), 696-725.

About the Authors:

Jinyang Li (March, 2001), female, Bai, Baoshan City, Yuannan Province, Master's Student, research interest: Second Language Acquisition.

Corresponding author:

Chao Han* (September, 2000), female, Han, Yanji City, Jilin Province, Master's Student, research interest: Second Language Acquisition.

Funding statement:

This study is funded by graduate project supported by the Education Bureau of Yunnan Province (Grant No. 2024Y135) awarded to Jinyang Li.