Optimising Multimedia Learning Materials Based on Cognitive Load and Collaborative CAD

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Abstract. The existing cognitive load measurement methods are roughly divided into three categories, namely, subjective measurement, task performance measurement, and physiological measurement. In practical research, subjective measurement plays a vital role in three kinds of methods because of its unique advantages, making subjective measurement tools' sensitivity and validity particularly important. During this period, the development of multimedia and network technology promoted a change in learning style and gradually formed a brand-new research field in multimedia learning. There are differences and close links between browsing, searching, and reading behavior in multimedia learning. Under the guidance of these two theories, some studies have discussed how to control cognitive load through instructional design in multimedia learning to obtain the best learning results. Therefore, this paper studies and analyses multimedia learning based on cognitive load. In this paper, cognitive load is combined to study and analyze it. This study lays a foundation for future research on multimedia learning.

Keywords: Cognitive load; Multimedia learning materials; Optimising multimedia learning materials by load; Collaborative CAD
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1 INTRODUCTION

As a brand-new and important learning method, multimedia learning has become the mainstream and future development direction of learning methods in today's society. From the cognitive psychology perspective, cognition is information processing through selective attention, coding, storage, and extraction. The typical view is that the human information processing system includes sensory memory (SR), short-term memory (STM, also called working memory), and long-term memory (LTM), and their functions in the process of information processing are different. Cognitive load theory has been studied by researchers worldwide since it was put forward. The theoretical research of cognitive load originally comes from many research results on mental or psychological load. The load was originally a physical concept; its original meaning is the workload of power equipment, mechanical equipment, and physiological tissues in a unit of time, and it also refers to the weight borne by building components, also known as load or load. Mental workload was initially used as a term corresponding to physical workload, but academic circles have not defined it consistently for a long time [13]. Up to now, researchers have not formed a unified understanding of the definition of cognitive load, and different researchers have put forward their understanding of cognitive load and expressed different views, especially since the operational definition is quite different. The introduction of cognitive load theory strengthens teachers' concern for students' cognitive capacity and cognitive quality in senior high school mathematics teaching. With the rapid development of information communication technology and the arrival of a knowledge economy society, people are stepping into a culture of knowledge, information, and learning. This situation has brought infinite opportunities to the development of modern distance education. Lifelong learning has accelerated the development of distance education, and the ever-changing communication technology has improved the openness, flexibility, and selectivity of distance education. With the wide application of network and portable device clients in teaching, multimedia learning using words and pictures to represent materials is becoming increasingly popular. However, compared with traditional teaching materials, multimedia learning materials have the characteristics of large amounts of information, complicated temporal and spatial changes of elements, etc., which may bring a more significant cognitive burden to learners, which is not conducive to achieving efficient learning [11]. With the development of the times and the progress of science and technology, many new technologies are applied to education and life. Along with these new technologies, some problems still need to be solved by psychological research, and the application of computers and the Internet in education is one of them. With the rapid popularisation of computers, more and more teachers are required to use multimedia for teaching, and the development of multimedia learning software in the market has gradually become a booming industry [16].

Multimedia learning is a process of screening, verifying, processing, and combining multimedia information according to existing knowledge and experience. Eye movement technology can provide many details for multimedia learning, a complex and active thinking process. Through eye movement recording technology, learners' eye movement data in multimedia information processing can be obtained under natural conditions. Multimedia is an interactive presentation method based on a computer, including text, sound, static images, dynamic images, animation, and other elements. When the materials presented by computer contain more than two of the above aspects, we can consider it a multimedia presentation. Compared with traditional paper materials with only words and a few static images, multimedia presentation is vivid and rich. It can attract learners' attention and stimulate their learning motivation and interest, so it is more and more widely used in daily teaching and distance education. The multimedia learning process includes three basic behaviors: browsing, searching, and reading. A systematic discussion of the three learning behaviors in multimedia learning can expand and deepen the multimedia learning theory and provide a reference for improving multimedia learning methods and multimedia teaching effects. As the amount of information to be processed increases, so does cognitive load. Cognitive load refers to the total amount of intellectual activities imposed on working memory in a case. Cognitive load has two levels: the theoretical level mainly focuses on laboratory research, which refers to the number of psychological resources students need to complete the given cognitive tasks in the learning process; The practical level mainly focuses on practical application research, which is closely combined with educational practice. It refers to the number of cognitive processing tasks students perceive in a unit of time. Cognitive load and mental load are not much different. They are all about the relationship between the brain's information-processing ability and the psychological resources consumed by people in other jobs and tasks. However, the research on mental load has a long history and wide application fields.

This paper uses several research methods to study and analyze it. The corresponding model diagram and algorithm formula are established for study and analysis in cognitive load research. The corresponding data graph is established for further analysis and research in multimedia learning research.

Theblazenewtrailsofthissheet:

1. This paper combines the cognitive load to study further and analyze multimedia learning.

2. Based on cognitive load, this paper studies and analyses it.

2 RELATED WORK

Another theoretical basis of cognitive load is schema theory. Information science and computer science have gone deep into psychology, which has brought profound changes to the mental research of human beings in psychology, and the modern schema theory has gradually developed. Schema refers to the representation and storage of knowledge organized around a topic. Individuals have to learn and master a lot of knowledge all their lives. This knowledge is not stored in the brain in disorder but is interrelated around a specific topic and forms a particular knowledge unit, the schema. In recent years, with the rapid development of online learning and teaching practice, the emergence of online higher education has further accelerated the popularisation and internationalization of educational resources in higher education and made educational resources play an increasingly important role in developing the online economy and culture. Therefore, it is necessary to set up a particular sub-research group in the research group "Talent Training Mode Reform and Distance Open Education Pilot Project" to follow up and investigate the dynamics of multimedia educational resources in modern distance education and analyze the effects of the construction and use of multimedia educational resources in modern distance education. Learning by multimedia presentation is multimedia learning. Multimedia learning can be used as an auxiliary part of teachers' teaching in the classroom, and it can also be used as an independent teaching means to transmit teaching information completely. Because of the advantages of multimedia itself, multimedia learning has more benefits than traditional learning methods.

In the research, Ta Sir Z and Pin O C think that individuals spend cognitive resources provided by working memory capacity in task completion, which leads to external, internal, and related cognitive loads, thus affecting learning and task completion results [15]. According to the cognitive theory of multimedia learning, individuals use visual and auditory channels to process information selectively and actively simultaneously. The two channels have different information representations and independent cognitive resources. Rational use of the two channels can help learners get the best learning results. Young, John Q and Merrienboer V think that in multimedia learning, multimedia presentation, learning materials, and learners and their interaction are essential factors that affect cognitive load, while the cognitive load is mainly reflected in learners' physiology, subjective evaluation, learning behavior, and learning results [19]. Sweller J believes that the processing capacity of visual and verbal working memory or information processing channels is very limited. Suppose too many elements to be processed are presented in visual and verbal channels, such as too many words or complicated pictures. In that case, the processing information will be overloaded, thus making some elements unable to be processed [14]. According to constructivist learning theory, meaningful learning occurs when learners actively choose relevant information, organize it into corresponding representations, and integrate it with other knowledge. At the same time, cognitive construction depends on learners' cognitive processing in the learning process. Gott V, Kester L, and Nievelstein F think that it is better to present explanatory information by words and pictures than by words alone. The principle of proximity is that words and corresponding pictures should be presented simultaneously when multimedia explanatory information is presented. The related principle is that there should be fewer irrelevant words and sounds when the multimedia explanation is presented, which is more conducive to understanding. The channel principle is that presenting auditory narration is better than visual text. The redundancy principle is that illustrated text is better than displaying text by animation, narration, or screen alone [6]. AmadieuF, Gog T V, and Paas F F believe that different brain regions may produce various blood reactions, requiring more complex analysis techniques instead of the general linear model commonly used in data [1]. Ship data is usually interpreted according to brain function positioning, but it may not quickly reflect the dynamic distribution characteristics of brain activity. In addition, there is the time accuracy of data. The small sample size, indirect characteristics of signals, and limited statistical techniques limit the application of this technology. Wong A., LeahyW, and Marcus N put forward the mental load multi-resource model, which holds that several independent resource areas, rather than a single resource area, correspond to different channels, coding, and information processing stages [18]. Because many factors influence the appearance of the P300 wave, there are still some limitations in the commonly used superposition evaluation calculation method for detecting the P300 wave and the complexity and multi-dimension of the cognitive load itself.

3 COGNITIVE LOAD RESEARCH AND ANALYSIS

3.1 Research and Analysis of Cognitive Load Theory

Cognitive load theory assumes that human cognitive structure consists of working and long-term memory. Working or sensory memory is limited and can only store 5-9 pieces of basic information or information blocks simultaneously. From the cognitive psychology perspective, cognition is information processing through selective attention, coding, storage, and extraction. The typical view is that the human information processing system includes sensory memory (SR), short-term memory (STM, also called working memory), and long-term memory (LTM), and their functions in the process of information processing are different. Cognitive psychology also believes that skilled cognitive skills are characterized by schema acquisition and rule automation, and information is stored in long-term memory as schema. Schema is a cognitive structure that allows problem solvers to classify problems according to the methods and steps of problem-solving. In the view of cognitive psychologists, people understand language and solve problems according to the meaning given to events by this schema. Traditional issues are presented to students with specific materials (known information) and a well-defined goal (pointing out what needs to be solved). In addition, by using rules (such as formulas) to operate, the answer can be objectively judged to be correct or wrong [9],[8]. Therefore, a corresponding model diagram is established to study and analyze cognitive load, as shown in Figures 1 and 2.

The research shows that intrinsic cognitive load is mainly influenced by the complexity of learning materials and learners' prior knowledge. The complexity of learning materials is the interaction between learning materials, which is related to the number and schema of elements involved in the materials. Schemas are generally stored in long-term memory. To construct them, information must be processed in working memory. The intrinsic cognitive load exists due to the type of materials being processed and comes from the intrinsic characteristics (such as difficulty) of the content to be learned alone. Because of their different intellectual complexity, the cognitive load of the materials is different, which cannot be changed by instructional design.

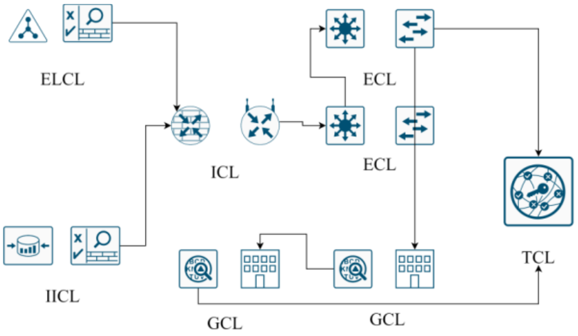

Figure 1: Classification diagram of cognitive load.

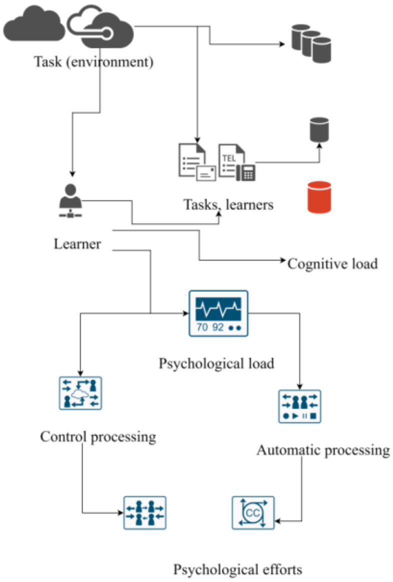

Figure 2: Cognitive load structure model diagram.

For example, content with high interaction, its internal cognitive load is still very high, no matter how it is presented. Operations involving processing a large amount of information simultaneously have higher intellectual complexity than those that can process one information component at a time. The external cognitive load originates from the teaching materials used to present information to students. It exists as instructional design results, which can be changed by reorganizing the information. For example, if properly used, the teaching materials about continental drift will be more effective than just presenting words. Therefore, the external cognitive load can be changed by changing the teaching materials given to students, thus promoting learning [17],[7].

3.2 Research and Analysis of Cognitive Load Algorithm

As the distinction between three cognitive loads (intrinsic cognitive load, external cognitive load, and related cognitive load) becomes clearer and more precise, the research on instructional design for various cognitive loads becomes richer and richer, and it is more and more critical to define the scientific measurement method for each cognitive load. The limitation of the two-task measurement method is that although it is more direct in measuring cognitive load, it is highly correlated with the nature of tasks and is inconvenient for horizontal comparison. Besides, learning results are easily influenced by many other factors, such as test methods, test types, individual differences, etc. At the same time, there may be an interaction between the two tasks, which will impact the measurement results. If the psychological effort increases, the main task may be insensitive to the change in psychological load. One of the most essential algorithms is physiological measurement, and the limitations of physiological measurement are obvious. The premise of physiological measurement is that it is assumed that changes in cognitive load will cause changes in some physiological indexes, but other factors unrelated to cognitive load may also cause these changes. For example, the generation and changes of cognitive load may also be affected by factors such as environment, attention, emotion, or psychological pressure, and the relationship between physiological indexes and cognitive load is at most indirect [10],[3]. The research establishes a corresponding formula for studying and analyzing it, as shown in formula (1).

$$F_W = \sum A_m \Delta H_m / Q \tag{1}$$

Because of the strength of the guiding load, the corresponding formula is established, as shown in formula (2).

$$G_h = \tau_h N_h N / P \tag{2}$$

Because of the influence of its guiding load intensity, the formulas are established as shown in formulas (3) and (4).

$$G = G_b + G_e + G_I + G_r + G_h \tag{3}$$

$$G = G_h + \tau_1 \frac{N}{T - \Delta T} + \tau_r \frac{N}{P} \tag{4}$$

As the load level determines its related capacity, the peak load formulas are shown in (5), (6), (7), (8) and (9).

$$\left(\frac{\tau_{WR}}{P} + \frac{\tau_h N_h}{P}\right) N + (G_h - G) = 0 \tag{5}$$

$$D = \frac{2 M_h M_v V \tau_e}{Q(1 - F_W)} \tag{6}$$

$$E = \frac{\tau_1}{T - T\Delta} + \frac{\tau_{WR}}{P} + \tau_h \frac{N_h}{P} \tag{7}$$

$$F = G_h - G \tag{8}$$

$$N_{\text{dynamic}} = (\sqrt{E^2 - 4DF} - E)/(2D) \tag{9}$$

Since the mid-1990s, some scholars have tried to measure cognitive load using a multi-index comprehensive evaluation method and conducted valuable exploratory research. In the computer simulation situation, the multivariate evaluation experiment was carried out on the psychological load of visual tracking operation. Through factor analysis, it is found that the four indicators can be attributed to the same common factor. Taking the load data of various factors (indicators) as the weighting coefficient, the "comprehensive weighted evaluation index" (GPI) of the mental load is calculated by the following formula. It is found that the "comprehensive weighted evaluation index" based on the above four indexes is effective, and its sensitivity is much higher than any single index. Through the research, we can know that learners' self-assessment of task content difficulty can be used to measure internal cognitive load, self-assessment of learning difficulty can be used to assess the external cognitive load, and self-assessment of concentration degree can be used to assess related cognitive load. However, the correlation analysis shows a significant positive correlation between these self-assessments, so they tend to think that they measure the same kind of cognitive load rather than different kinds of cognitive loads. This reason doesn't seem sufficient because of several dimensions of cognitive load: internal, external, and related cognitive load. Apart from maintaining relative independence, it is expected to have a specific positive correlation [20],[5].

4 RESEARCH AND ANALYSIS OF MULTIMEDIA LEARNING MATERIALS

4.1 Multimedia Learning Materials Combination Research and Analysis

The so-called multimedia combination refers to the selection and combination of audio-visual media with the best effect, which is complementary to the traditional media to form a multi-channel, three-dimensional teaching media. Regarding the relationship between cues and learning effects, in recent years, some researchers have tried to study and explain from the perspective of eye movement. Reasonably adding cues to multimedia learning materials can enhance the perceived prominence of key information, which helps to guide learners' attention to these cues quickly, thus improving learners' tendency to maintain attention to this information, that is, to invest more (visual) attention resources in them and promote their processing. An important possessive word in multimedia learning is optimization. The so-called optimization selects the best system scheme from various possible schemes so that the system has the best overall function. To optimize multimedia combination, the key is to break through the teaching difficulties effectively. To achieve this goal, when we choose multimedia for combination, we must put it into the overall system of the classroom teaching process to design and construct, fully consider the interrelation and interaction with other elements in the teaching process, and based on synthesizing various factors, choose the audio-visual media with the best effect to include traditional media, to realize the optimal combination of multimedia [12],[4]. Students can use various media resources for learning, so corresponding data tables are established to study them, as shown in Tables 1 and 2.

Type	*Often*	*Less*	*Nothave*	*Inall*
Characters	*66.6%*	*29.5%*	*1.3%*	*923*
Instructpersonally	*94.2%*	*4.2%*	*0.54%*	*945*
Online learning	*9.45%*	*38.2%*	*49.3%*	*834*
Watchavideo	*12.3%*	*36.5%*	*48.7%*	*823*

Table 1: Distribution table of various mediausage (1).

Type	*Often*	*Less*	*Nothave*	*Inall*
Listentothetape	*17.2%*	*29.8%*	*50.23*	*823*
CD	*6.2%*	*23.4%*	*67.3%*	*810*
Discuss	*15.3%*	*32.8%*	*50.1%*	*823*
Telephone answering	*2.3%*	*20.7%*	*74.3%*	*816*

Table 2: Distribution table of various media usage (2).

The above survey results show that the traditional and face-to-face learning method is still the first choice for students, while the proportion of using modern media for learning is very low. The type and content of multimedia should be selected according to the characteristics and educational functions of various media and the teaching content, subject characteristics, and students' characteristics to achieve good results [2]. Therefore, the corresponding data graphs are established for research and analysis, as shown in Figures 3, 4, and 5.

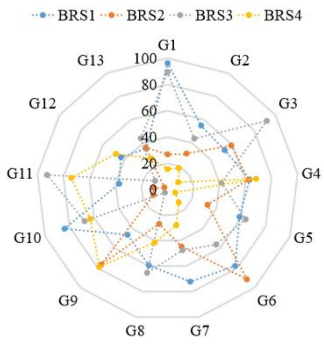

Figure 3: Research figure of multimedia learning methods.

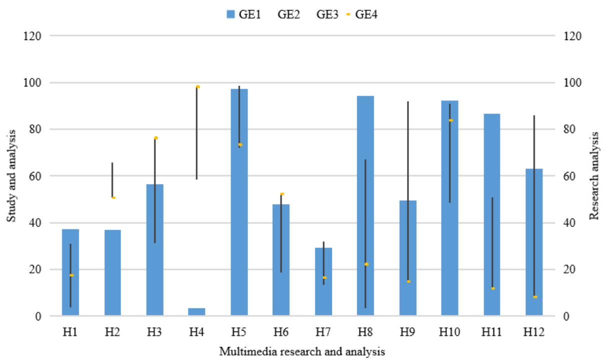

Figure 4: Multimedia research and analysis.

As can be seen from Figure 5, many factors affect multimedia learning, up to about 45.53%. There are certain boundary conditions or adjustment variables for the effective activation of the principles or instructional design techniques applied in multimedia learning; that is, only by targeting specific learners and adopting some specific design methods or learning materials can the multimedia learning principles play a more effective role.

The discussion of the potential boundary conditions of these principles is helpful not only in using these principles more reasonably but also in providing great theoretical and application value. Then, as one of the essential principles of multimedia learning, it is necessary to conduct in-depth research on whether the cue effect has specific boundary conditions. In multimedia learning, learning materials may be one of the most critical factors affecting cue effect, which includes many characteristics. The learning materials used in the cue effect study involve declarative and procedural knowledge.

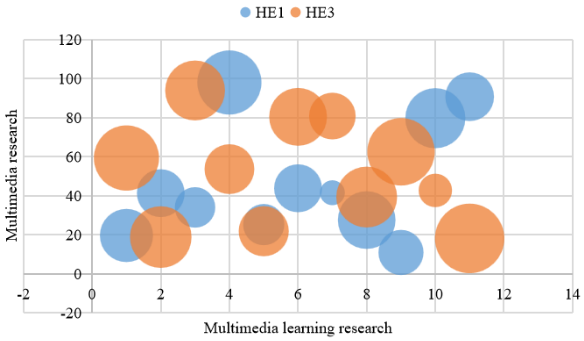

Figure 5: Research on the influence of multimedia learning factors.

According to previous research, declarative knowledge may be more abstract than procedural knowledge, and the construction of psychological representation is more complicated. Therefore, adding instructional technical clues to declarative knowledge has a relatively more significant effect on learning. In addition, according to the subject areas to which the learning materials belong, they can be divided into three categories: science, engineering, and liberal arts. Multimedia and multimedia learning materials are auxiliary materials for self-studying those who meet their learning needs. They should be able to guide individual learning of those who need learning, and the content should highlight the learning guidance of knowledge structure, disciplines, and knowledge points of curriculum units. Multimedia and multimedia learning materials should implement the principle of "fewer and newer," highlight key points, difficulties, and doubts, be convenient for self-study, and be suitable for providing references and tips for learners. The basic principle of multimedia learning materials design is optimization. The so-called optimization selects the best system scheme from various possible schemes so that the system has the best overall function. To optimize multimedia combination, the key is effectively breaking through the teaching difficulties.

4.2 Research on Multimedia Progress and Research Based on Cognitive Load

Cognitive load is mainly related to working memory capacity. The higher the proportion of resources needed for information processing to working memory capacity, the higher the cognitive load caused by it. It will hinder learning when it exceeds the total capacity of working memory. Therefore, cognitive load can be reduced in two ways: to increase the capacity of working memory and to reduce the amount of information that needs to be processed simultaneously in working memory. Reducing the external cognitive load is mainly to reduce the information that learners need to process that has nothing to do with their learning objectives, that is, to minimize redundant information and maximize the content that directly achieves their learning objectives. Although the external cognitive load comes from the organization and presentation of materials, the specific sources differ. Attention dispersion in research occurs when learners receive information from multiple resources, which must be processed simultaneously. The problem of distraction is solved by using the principle of proximity. Suppose students don't have to keep all the animations in working memory before the narration is presented, or they don't have to keep all the narratives in working memory before the animation is presented. In that case, they can learn more deeply. Research is the same as the spatial proximity effect. A variety of separate resources necessary to understand information increases the possibility that psychological resources will be spent on external activities, such as trying to recall the missing words and their relationship with the currently presented pictures or animations. Text and picture materials added to improve interest are called attractive details. Although they are related to the topic but have nothing to do with learning objectives, they can lead to higher emotional interest of learners, but they are not helpful to their cognitive interest. Music is one of the attractive details. Because the intrinsic cognitive load is caused by complex interaction between elements, the primary way to reduce the intrinsic cognitive load is to reduce such interaction among elements. Research on reducing intrinsic cognitive load is based chiefly on example learning. Therefore, based on the research, the corresponding data graphs are established to study and analyze them, as shown in Figures 6 and 7.

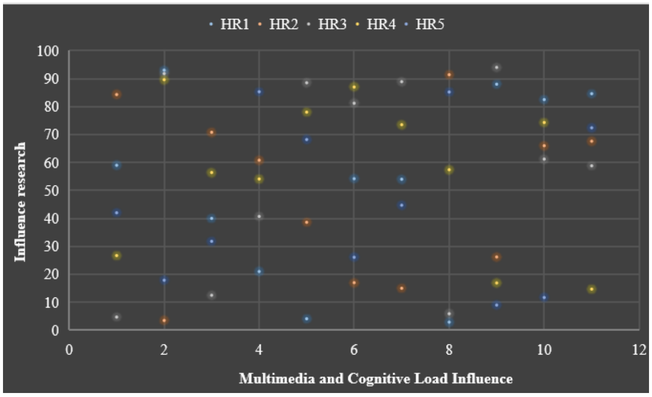

Figure 6: Data map of multimedia and cognitive load impact.

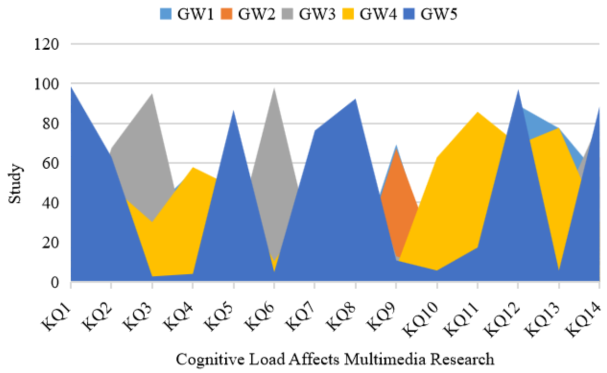

Figure 7: DataMap of cognitive load affecting multimedia research.

From Figure 7, it can be seen that multimedia research has some influences and reasons based on cognitive load, and the influence is as high as 75.43%. In the research, it is known that modular examples can avoid the problems of traditional examples by avoiding learners considering the characteristics of multiple structured tasks and solving steps simultaneously. The basic principle of this sample pattern construction is to separate the task features that can be transmitted and understood separately from the meaningful problem-solving elements, thus reducing the internal cognitive load. Besides reducing cognitive load, the second advantage of this method is that it may allow learners to understand relationships at the category level, that is, unrelated relationships below the category, such as individual structured task characteristics and individual solution steps.

However, because the intrinsic cognitive load is also closely related to learners' expertise level, it is necessary to consider learners' expertise level to reduce the intrinsic cognitive load because, by improving learners' expertise level, their intrinsic cognitive load naturally decreases. To stimulate students' motivation: increasing related cognitive load is mainly done through stimulating students' motivation or efforts to make students put more resources into schema construction or automation tasks, thus improving their learning. The research shows that controlling external and related cognitive load can improve the training effect by changing learners' attention. Their experiment followed two principles. First, the negative influence of cognitive load on cognitive schema construction was minimized. The research shows that interpretive feedback can reduce students' cognitive load in multimedia teaching, especially those with low previous knowledge, guide them to process meaning, and effectively improve transfer performance and teaching efficiency. Learners ' expertise level influences whether the information leads to related or external cognitive load. The information that makes novices generate related cognitive load may be an external cognitive load for experts. In contrast, some information related to schema construction processing for novices may hinder higher-level learners' processing. For learners with higher knowledge levels, some teaching AIDS will be too simple to help, but it will lead to an external cognitive load because it causes redundancy, which is the opposite effect of expertise.

5 CONCLUSIONS

As soon as the cognitive load theory was put forward, researchers began to seek scientific methods to measure cognitive load, but for a long time, they all used subjective evaluation methods. As the distinction between the three types of cognitive load becomes clearer and clearer, the research on instructional design for various types of cognitive load becomes richer and richer, and it is more and more critical to define the scientific measurement method for each type of cognitive load. When designing teaching, we should consider the cognitive load that learners bear in learning tasks and ensure that "the total cognitive load that learners bear does not exceed the total cognitive load that their individual can bear" is the leading idea of cognitive load theory. Applying cognitive load theory to optimize senior high school mathematics teaching is a new topic for senior high school mathematics teachers. Mathematics teachers in senior high schools should integrate modern educational concepts, take deepening curriculum reform and promoting quality education as the aim, make innovations and breakthroughs in teaching style, teaching methods, and teaching means, and promote the continuous development and excavation of students' cognitive positive load. The research shows that multimedia learning materials' application and practice are indispensable in distance open education. The research on the combination and application of multimedia learning materials in distance open education is to research training, practice, explore, and constantly summarise what kind of multimedia learning materials should be provided at different levels, learning needs, grades, and ages through teaching application practice. Cognitive load theory is consistent with the knowledge of modern cognitive psychology about memory, thinking, learning, and problem-solving. This theory regards the limitation of working memory as the main obstacle to learning. It holds that reducing the level of external cognitive load through instructional design can make the working memory capacity concentrate more on the materials to be learned, thus promoting learning. The design should smoothly transition, leveraging the strengths of each format to accommodate diverse learning styles. Scaffolding, feedback mechanisms, user testing, and iteration opportunities contribute to ongoing improvement and alignment with learners' preferences. A successful multimedia learning experience with integrated 2D and 3D elements reduces cognitive load and fosters active engagement and long-term knowledge retention. Embracing these principles in the design process ensures that educational materials leverage multimedia's full potential for efficient and impactful learning.

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