A NOVEL TEACHING TECHNOLOGY MODEL AND ITS APPLICATION BASED ON COGNITIVE PSYCHOLOGY

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Abstract

It is generally agreed that the teaching technology based on cognitive psychology can satisfy the needs of culture, society and science. This paper aims to improve teaching efficiency and enhance the knowledge acquisition and practical ability of students. The author first reviewed the theories related to teaching technology, including learning theory, information technology theory, and educational theory. On this basis, the incentive mechanism and learning expectancy of cognitive psychology were introduced to the teaching technology, creating a novel teaching technology model. The effectiveness of the model was compared with the traditional teaching technology through application experiment. The results show that the proposed method outperforms the traditional approach in teaching efficiency and learning effect. The research findings provide a new direction for the reform of teaching method in colleges.

Key words: Cognitive Psychology, Curriculum, Teaching Technology, Learning Expectancy.

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INTRODUCTION

Cognitive process is the information processing by individuals. Cognitive psychology regards cognitive process as a system of information processing according to a certain procedure, which consists of a series of continuous cognitive operation stages, such as acquisition, coding, storage, extraction and use of information (Verschaffel, Van Dooren, & Star, 2017). With the development of economy and society, the information age has gradually entered our life. In order to enhance students’ ability and efficiency of understanding knowledge and accepting new knowledge in the teaching process, we must study cognitive psychology, which is the study of people’s deep psychology (Johnson, 2016). In the teaching of cognitive psychology, traditional teaching methods, which requires the learning of basic theoretical knowledge first and then comes practice and application, make it difficult for students to understand many concepts in teaching. In this way it is difficult to achieve ideal teaching effect and teaching objectives and to ensure the quality of teaching (Teo & Le Fevre, 2017). Therefore, at present, colleges and universities are paying more and more attention to practice, investing a lot of manpower and material resources in laboratory construction, and even many majors have regarded laboratory construction their own professional characteristics (Wall, Higgins, Remedios et al., 2013; Kucuk & Sahin, 2013). In this kind of learning, an individual has to learn an operation or a series of operating procedures under certain conditions so as to complete the entire operation according to the program. Educational technology is the research and ethical practice that promotes learning and improves performance by creating, utilizing, and managing appropriate technical processes and resources. If the cognitive psychology theory can be effectively applied in teaching practice, it will definitely show stronger vitality (Noh & Webb,
2015).

In the field of cognitive psychology, with the help of the research method of vocal thinking, the most influential cognitive model of writing process is proposed from the perspective of cognition (Bruce & Hawes, 2015). In 2013, the theoretical model solving the complexity of science education problems was proposed: the study of random walks of working memory and mental ability (Zheng, Lawrence, Warschauer et al., 2015). In 2015, a research perspective of achieving self-regulating learning skills through social interaction in the environment of scientific and educational institutions was proposed (Montgomery, 2008). In 2016, the research on cognitive psychology was proposed (Rindermann, Hoang, & Baumeister, 2013). In 2017, the application of cognitive design principles based on cognitive psychology in mathematics teaching was proposed (Morris & Cobb, 2004). Information processing theory believes that every small process of the perception of human body for the outside world is an integral part of the processing process, of human body and its reaction and cognition are the result and conclusion of the processing (Windschitl, 2000). Therefore, it is difficult for students to learn. Students should be allowed to have some perceptual knowledge in the beginning, so when imparting theoretical knowledge, teachers should pay attention to combining it with students' perceptual concepts so that students will think that theoretical knowledge is the improvement, deepening and abstraction of their perceptual knowledge, and they will feel that theoretical knowledge and many theoretical concepts are not so profound and difficult to accept ([13-14]). However, at the same time, we also see that many college students do not attach enough importance to experiments. They fear experiments, lack the interest in experiments. Also, they have poor ability in discovering, analyzing and solving problems; many college students cannot compete basic jobs after a long time in their positions. The teaching based on cognitive psychology is an external condition for the change of students' internal abilities. The teaching should conform to the law of "learning", which is a basic principle (Abrami, Bernard, Borokhovski et al., 2008).

Cognitive research shows that attention plays an important role in human cognitive activities and attention is an important component of human information processing. It will be impossible to achieve coding, storage and extraction of information without the participation of attention (Biswa, Jeong, Kinnebrew et al., 2010). We think that information processing theory is the core part of cognitive psychology. Narrowly speaking, information processing theory is cognitive psychology, which represents the whole of cognitive psychology (Kodakos, Kaldi, & Konsolas, 2003). According to the motivation mechanism of learning motivation in cognitive psychology, the learning motivation, enthusiasm and curiosity of students are stimulated from the aspects of external motivation, social motivation, achievement motivation and internal motivation. Therefore, we must study and make full use of educational theory, especially the cognitive learning theory in educational psychology, using it to guide our experimental teaching so that the teaching model is consistent with the student's cognitive process. Cognitive activity is an important psychological factor affecting individual learning. The law of cognitive development restricts students' learning activities. In order to guide students' learning activities effectively, the teaching design of teachers must pay attention to students' cognitive activities and their laws so as to effectively promote the cognitive development of students. Teachers who carry out cognitive teaching should fully understand the students' cognitive strategies, so that the designed cognitive psychology teaching tools are more in line with the students' cognitive rules, which will be more conducive to students' learning and can better achieve the teaching effect.

APPLICATION OF COGNITIVE PSYCHOLOGY IN CONSTRUCTIVISM TEACHING

Constructivism learning theory emphasizes student-centered learning, whose main idea highlights the student's principal position. It enables students to construct their own experience actively in creating situations, without neglecting the leading role of teachers. At this time, the role of teachers, as helpers, promoters and guiders, is reflected in the construction process of students. In the study of cognitive psychology, we must use the method of connection to conduct research and analysis. On the basis of a deep understanding of the basic
theory and the basic theoretical framework, we should also study and analyze the relationship between other things. At the beginning of each course, the general situation of the course and its relevance to other courses are introduced, which arouses students' curiosity. The extensive application of the theory and technology of the course in social practice is introduced to mobilize the social motivation of students to learn the course, which can promote better learning, greatly improve the efficiency and quality of education and teaching and conform to the law of the occurrence and development of learning. If learners can clearly understand their expected results, thinking process, thinking mode, and problem-solving ideas during the learning process, they will be able to constantly adjust their learning strategies during the learning process, which is conducive to the knowledge consolidation and improvement of learners. Basic knowledge and skills are the core of the basic cognition of students and the basis for the cognitive development and improvement of students. In order to promote the cognitive development of students, the instructional design must follow the teaching and learning system based on the basic knowledge and skills of the cultural science. Based on the teaching method of cognitive psychology, relevant parameters of the teaching model of cognitive psychology are obtained by statistical analysis of social science software, and the statistical data are summarized, as shown in Table 1 and Figure 1.

The size of organizational inertia in cognitive psychology is influenced by organizational age, size and structure, as shown in Table 2 and Figure 2.

**Table 1. Statistical results of cognitive psychology teaching model parameters**

| Teaching method      | Standard deviation | Cognitive weight |
|----------------------|-------------------|-----------------|
| General teaching     | 2.96              | 3.36            |
| Cognitive Teaching   | 7.81              | 4.11            |

**Table 2. Factors affecting organizational inertia and their changing directions**

| Inertial influence factors | Factor change size | Inertial influence directivity coefficient |
|---------------------------|--------------------|-------------------------------------------|
| Age of organization       | 12.14              | 3.16                                      |
| Organization scale        | 2.78               | 2.11                                      |
| Organization structure    | 9.66               | 5.63                                      |

The process of constructivism learning also follows a certain design process. However, there is a general view that the whole design process is built closely around the "meaning construction", and there is no such word as teaching goal analysis. The teaching goal is replaced by meaning construction and it is not necessary to analyze the teaching goal. In the research object of psychology, behaviorism always pays attention to the observable and external things and behaviors, ignoring the psychological activities inside things, while cognitive psychology shifts the research focus to the internal psychological activities. In the
application design, there are slightly different requirements for students at different levels, so that each student can get a sense of self-efficacy at the end of the course and they can enhance their self-confidence in the further learning. Because the rhythm of curriculum experiment should be consistent with the progress of curriculum, the design of each experiment content is based on the knowledge points of corresponding chapters and sections of theoretical courses. Students are required to consolidate certain knowledge points in the experiment course, while ignoring the connection of knowledge points with other chapters. Teachers apply information derived from the environment, combined with experience stored in their memory, to guide future behaviors and shape the living environment. Interesting content will lead to the ideas and questions of learners, and then they will try to think and explore. In the teaching design based on cognitive psychology, it is necessary to use vivid and creative forms to effectively integrate teaching content into teaching tools so as to play a unique role in cognitive psychology teaching, which can solve the problems that students have more smartly.

In the teaching process of cognitive psychology, the learning record table is used to store some data generated by students in the specific learning process. These data will be used to calculate the students' own memory curve. The errors in student behavior are recorded in Table 3 and Figure 3 below.

The student information parameter table is used to store some commonly used parameters in students' learning process, including memory curve parameters and length parameters of learning record table. The value of these parameters will also change with the students' learning to achieve maximum convenience and efficiency for students. The following Table 4 and Figure 4 are the components and relevant parameters of students' learning.

Table 3. Components of the student learning record form

| Serial number | Interval time (s) | Number of errors |
|---------------|------------------|------------------|
| A             | 653              | 391              |
| B             | 276              | 181              |

The objective of traditional teaching is to determine the sub-goal at each level, further determine their relationship and the teaching content and sequence needed to achieve the goal on the basis of the general objective set out in the syllabus. The goal of constructivism curriculum is to determine the "subject" of current knowledge. The traditional teaching idea of simply imparting subject knowledge and modeled knowledge theory is no longer suitable.
for today’s social and economic demand for talents. The task of experimental teaching should be to help theoretical courses to transform the well-structured knowledge in books into knowledge suitable for students’ minds so that it will be easier for the acceptance and storage of students. At the same time, the same art designer only uses his own design to express ideas and thoughts. In the expression of abstract concepts or some unusual design details, the design of teaching methods using the cognitive psychology can achieve the purpose of communication and understanding, thereby achieving a good learning effect. A good cognitive psychology teaching situation should have a strong stimulating effect on learners. It is necessary to highlight the key points and arouse the attention of students in designing. Secondly, the teaching design should strengthen the effective guidance of students’ learning methods. The students’ diversified learning styles should be cultivated in teaching to enable students’ learning habits, learning methods and learning needs to be integrated into individual factors, thus cultivating students’ sense of happiness, independence and responsibility. Good cognitive habits can be cultivated and students can continuously learn all kinds of cognitive abilities and thus students can truly understand their role as cognitive subjects, which is very important for the acquisition and maintenance of knowledge. In the construction of the psychology teaching method model, the corresponding modification of the learning vocabulary of students is as shown in Table 5 and Figure 5. Only the score value and the number of errors is modified, while other values are kept as the original. The score value is set as the serial number.

Table 5. Vocabulary learning for test students

| Serial number | Score value | Error number |
|---------------|-------------|--------------|
| 1             | 6.31        | 9.14         |
| 2             | 7.88        | 4.63         |

Table 6. Analysis and comparison between teaching methods and traditional teaching methods based on cognitive psychology

| Evaluating indicator | Median | Saliency |
|----------------------|--------|----------|
| Appeal               | 6.37   | 1.37     |
| Dynamics             | 5.88   | 5.36     |
| Vividness            | 9.69   | 8.81     |

Compared with traditional teaching methods, the teaching method based on cognitive psychology has higher score than traditional teaching methods in evaluating the appeal, dynamics and vividness of the environment; while in terms of innovation and teaching quality, traditional teaching methods have shown more obvious shortcomings, as shown in Table 6 and Figure 6.

Figure 6. Vocabulary learning for test students

Two data sets in the learning database based on cognitive psychology model were used to test the teaching effect of the new teaching method. The information of these data sets is listed in Table 7 below, and the data analysis is shown in Figure 7.

Table 7. Experimental result

| Data set | Number of attributes | Number of instances |
|----------|----------------------|---------------------|
| Iris     | 138                  | 34                  |
| Letters  | 299                  | 71                  |
It can be seen from above that the scope of teaching objectives under the constructivism environment has been expanded, and specific goals are generated, that is, through the design of this theme, students are required to achieve those goals, while in the traditional teaching, the teaching content is determined by the teaching objectives. It is no longer a correct requirement in contemporary society to judge people's comprehensive quality solely by scores. Strengthening students' psychological cognitive ability becomes very important in the cognitive process of knowledge and the formation of cognitive styles. Students' cognitive activity is a dynamic process and many factors should be taken into account in the evaluation of students' cognitive ability. The establishment of a good cognitive ability evaluation system is conducive to reflecting on the learning process and results to find out existing problems and shortcomings. The application of the research results of cognitive psychology to teaching is conducive to optimizing the teaching mode and exerting its advantages. Mobilizing positive thinking is a prerequisite for students to successfully understand the content of teaching and it is conducive to the implementation of a large number of operations throughout the cognitive process. Therefore, cognitive psychology believes that cognitive strategies are very important for the effective implementation of cognitive activities. At present, cognitive psychology has achieved phased results in the study of cognitive strategies. The teaching method will vary according to different types of concepts. It is generally believed that the teaching of specific concepts needs to go through four stages, namely perceptual discrimination, hypothesis, test hypothesis and generalization, which is more suitable for discovery-based learning.

**Table 8. Comparison of average running time of one iteration training**

| Data set count | Average run time of training (s) | Average run time (s) |
|---------------|---------------------------------|---------------------|
| 199           | 35                              | 23                  |
| 361           | 26                              | 49                  |

To facilitate comparative analysis, we have separately recorded the average running time of an iterative training of the instructional model algorithm based on cognitive psychology and the average running time of the resulting hypothesis for the classification of test sets. The details are shown in Table 8 and Figure 8.

**DISPLAY DESIGN BASED ON THE ANALYSIS OF TEACHING TECHNOLOGY IN COGNITIVE PSYCHOLOGY**

According to the theory of cognitive psychology, learners always use their existing experience to deal with new stimulus materials, so they can create intuitive and vivid perceptual diagrams to stimulate their perceptual memory, awaken the knowledge and experience in long-term memory, and use them to learn new knowledge. With the rapid development of modern multimedia functions, the modern exhibition education has carried out all-round, network-based, multi-form, rich forms to impart knowledge. Establishing an environment of autonomous learning, in which the initiative of learning is in the hands of students, is not only conducive to the meaningful construction of knowledge, but also to students' initiative and enthusiasm, as well as to their active exploration.
and research learning. The teaching content is effectively integrated into the teaching tool of cognitive psychology, and play its unique role in teaching. When such knowledge situations are well provided, learners will try to solve problems with existing knowledge and strategies. In the classroom teaching, it is necessary to enable students to practice in various situations, and then students can have higher classification ability, so that the automatic production system can be achieved and students can obtain a higher level of programmatic knowledge. Cognitive psychology believes that learning is a hypothesis or test of any kind of rules, which is not in favor of the teaching method of listening or taking listening as the priority. It should be synchronized with the teaching of language skills, which is conducive to stimulating students' motivation. Different levels of instructional design should be made and the instructional design with different knowledge characteristics adapts to the process of students’ cognitive activities and can greatly improve the teaching effect.

Scenario creation also requires a disciplinary structure. A discipline with a rigorous structure must create a learning environment with rich resources and it should contain many different application examples and relevant information, so that learners can actively discover resources according to their own interests and hobbies. This rich form can also stimulate students' enjoyment and the enthusiasm of learning. Therefore, the use of such resources is very important for students to learn to display the design of this course and to stimulate their enthusiasm. Of course, the establishment of such learning environment and atmosphere requires certain conditions, including the provision of a variety of cognitive tools and rich learning resources so as to promote the interaction and communication in the learning process. Stable psychological tendency is the form and style favored by individuals in the process of perception, memory and thinking, which is expressed as a preference for a certain way of information processing. In order to train students to form a generation system of corresponding procedural knowledge, teachers should pay attention to enabling students to practice in various situations in classroom teaching. Cognitive psychology holds that presenting Chinese characters, as pictures of ideogram to students is the same as the representation of knowledge in students’ minds so that their memory can be strengthened. From superficial sensory analysis to deeper and more complicated abstract analysis, knowledge transfer can be promoted with special examples. Students can construct new knowledge on the basis of previous knowledge, transfer the knowledge reasonably, cultivate contact thinking, transform external assistance based on cognitive psychology into internal learning motivation, and transform external drive into internal drive, which is a very meaningful process. In the cognitive psychology model, a hypertext is composed of a group of elements and a set of links between elements. An element includes a basic information unit and information related to links in the basic information unit. Links are represented by source anchors, target anchors and the elements in which they are located. The model expression is as follows:

\[ w(x, y, d) = \exp\left(-\frac{d_x^2 + d_y^2}{r_s^2 + r_c^2}\right) \]  

(1)

The analysis factors of cognitive psychology can be subdivided according to the link structure and the smallest unit which can independently express certain information is called a basic information unit of hypertext. The mathematical expression is as follows:

\[ d(x, y) = ax + by + c \]  

(2)

The tail information set of all links of the basic information unit is called teaching target anchor set. X and y are set to represent the basic information unit set of hypertext and target anchor set. The formula is:

\[ d^{(i,j)}(x, y) = ax + by + c \]  

(3)

In the cognitive technology-based teaching technology model, a hypertext element is a triad that consists of a basic information unit and a source anchor subset and a target anchor subset inside the basic information unit, which is expressed as follow:

\[ E(x) = \sum_{j=1}^{n} E_j \]  

(4)
The set D is called the hypertext link set in the cognitive psychology teaching model. Among them, the link Z connects the source anchor x in the element h and the target anchor h in element y, which generates the formula:

\[
D_{ij}(x) = \frac{D_i(x)}{Z_i} \begin{cases} 
    e^{-a} & h_i(x) = y, \\
    e^{-a} & h_i(x) \neq y, D_i(x) \leq HW_i \\
    e^a & h_i(x) \neq y, D_i(x) > HW_i 
\end{cases}
\]  
(5)

A binary group H in the teaching model is called a hypertext, where N is the set of elements and D is the set of links. To express the directed link between elements, a mathematical formula is introduced:

\[
HW_t = \frac{\sum_{i=1}^{N} D_i(x)}{N}
\]  
(6)

For a hypertext V in cognitive psychology, X can only be obtained if and only if V=W. The link relationship in the element set can be expressed as the following formula:

\[
V_{id} = wV_{id} + c_1r_1(P_{id} - X_{id}) + c_2r_2(P_{id} - X_{id})
\]  
(7)

Between moderate-scale learning and harvest, people value harvest twice as much as learning. That is to say, there seems to be partial loss in people’s preferences (loathing). Figure 9 and Figure 10 illustrate the similarities and differences between these two theories of cognitive psychology and expected utility theory.

**Figure 9. Cognitive psychology theory**

![Cognitive psychology theory](image)

**Figure 10. Expected utility theory**

![Expected utility theory](image)

Cognition belongs to the scope of educational psychology. Psychologists generally believe that cognition refers to the process knowledge acquisition and application or information processing, which is the most basic psychological process of human beings. It includes feeling, perception, memory, imagination, thinking and language. Generative effect comes from memory processing theory, which means that when subjects learn the generated items, the memory effect will be superior to that provided by others. Display teaching does not fully play its role, but it is the knowledge originally written by teachers on the blackboard that is shown on the display tool instead of deepening the understanding of cognitive psychology. Cognitive psychology emphasizes meaningful discovery learning, while discovery learning focuses on the practicability of knowledge in daily life and learning, which been adjusted and corrected to further enhance students' cognitive ability. In the specific practice, the random results of of experimental process and results can be used to put the students' questions, discussions, operations, results, reports, etc. into the evaluation system, so that students can consciously improve their cognitive methods. Cognitive strategy design has become an inseparable part of teacher's instructional design so that it is necessary to consider the design, selection and application of cognitive strategies. Teachers should establish scientific teaching methods and learning methods according to the cognitive characteristics of students, and maximize the active thinking of students, so that multimedia teaching can show more vitality under the guidance of cognitive psychology. When an external link a of the cognitive psychology teaching model connects the source anchor u in
the learning state \( P \) and the target anchor \( b \) in another learning state \( P \), a mathematical formula can be obtained:

\[
D_i = a + \sum_{j=1}^{n} b_j p_j + r_i Y + u
\]

(8)

At the same time, when an internal link \( D \) in the above model connects the source anchor \( r \) in the learning state \( P \), and the target anchor \( Y \) in the \( P \), another mathematical expression can be obtained:

\[
D_i = a + \sum_{j=1}^{n} b_j \ln(p_j) + r_i \ln(Y) + u
\]

(9)

A set consisting of all internal links and external links of set \( D \) in the cognitive psychology learning model is called the link set \( Y \). The following formula expresses the interrelationship between knowledge points and learning states.

\[
\ln(D_i) = a + \sum_{j=1}^{n} b_j \ln(p_j) + r_i \ln(Y) + u
\]

(10)

A binary \( A \) in the teaching model of cognitive psychology is called a learning state space. If it satisfies the following conditions: there is and only one learning state \( P \), so that \( D=W \), that is, there is no external link \( r \) injected into \( P \), the following formula can be obtained:

\[
D(p_i) = A \cdot w_i \left[ 1 - \frac{p_i}{v_i} \left( \frac{p_i w_1 + p_i w_2 - m(1-r)}{w_1} \right) \right]
\]

(11)

In a learning state space \( D \), the binary relation describes the link relation in the learning state space, which can be expressed as follows:

\[
D(p_i) = A \cdot \frac{m(1-r)}{p_i}
\]

(12)

In a cognitive psychology learning state, only key knowledge points have external links to other learning states. If for any \( Q \) and \( I \), \( A \) is regarded as the key knowledge point. The formula is expressed as follows:

\[
AI_i = \frac{(I_i + Q_i) + (I_i + Q_i - D_i)}{2} = I_i + Q_i - \frac{D_i}{2}
\]

(13)

In the construction of cognitive psychology model, it is assumed that \( w \) is the average degree of knowledge points and \( t \) is the average degree of knowledge points. Each link leaves one knowledge point, so it must arrive at another knowledge point, with \( w=T \). The formula is expressed as follows:

\[
w(t) = w_2 + (w_1 - w_2) \frac{T - t}{T}
\]

(14)

Cognitive psychology tells us that if we use superficial retelling, it will only increase the retelling time, and will not have an impact on memory. Although we remember words, we do not know how to use them. With elaborate retelling, the increase in retelling time can achieve a good effect, during which more associations and more abundant memories of stimulation can be produced so that knowledge can really exert a significant influence on the reality of life. However, at present, the knowledge taught by schools is still based on theory and cannot be really applied to practice, which makes the knowledge that we have spent a lot of energy and money to learn not useful in practice and does not have a beneficial impact on our lives. What’s worse, it even has a negative effect on people’s mood. Students can be encouraged to make full use of the library and the network. Under such environmental conditions, it is conducive to the cultivation of students’ cognitive ability and their creative ability. This requires more cognitive psychology-based teaching methods to continuously increase the interest and flexibility of classroom teaching, overcome boring and abstract knowledge transfer, and increase the classroom capacity and improve the learning motivation, participation and enthusiasm of students. In accordance with the teaching method of cognitive psychology, in order to improve the effectiveness of teaching, teachers should formulate corresponding teaching strategies based on the classification principle of knowledge, so that it can be consistent with the cognitive psychology of students, so as to optimize the teaching process.
CONCLUSIONS

Cognitive psychology is a new branch of psychology that reveals the internal psychological mechanism of cognitive processes. This paper is to analyze the application of cognitive technology based on the application of teaching techniques. The existing theories mainly include learning theory, information technology theory, and educational theory. The curriculum development under these three theoretical themes focuses on how to develop high-quality curriculum resources, and how to use advanced technology to enable students to achieve autonomic learning, which is to allow students to adapt to this resource and technology. Therefore, using cognitive psychology to display design teaching, students’ cognitive structure ability and basic knowledge are strengthened in the stimulation and reaction process of students. The improvement of the cognitive ability of the knowledge structure is an excellent way of education. In the process of knowledge learning, the key to knowledge representation is whether the students have the original knowledge that can connect the new knowledge in their cognitive structure. The curriculum resources developed under the platform of cognitive psychology can start from the whole process of learners’ cognition and enable the development resources and methods to adapt to the cognitive development of students, that is, resource-technology adaptation. We should make good use of the teaching technology based on cognitive psychology in our teaching, combine the traditional teaching methods with the advantage of new teaching method, making full use of the advantages and avoiding the disadvantages, so as to really improve the teaching of Chinese as a foreign language to a new level.

REFERENCES

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. Review of Educational Research, 78(4), 1102-1134.

Biswa, G., Jeong, H., Kinnebrew, J. S., Sulcer, B., & ROSCOE, R. (2010). Measuring self-regulated learning skills through social interactions in a teachable agent environment. Research and Practice in Technology Enhanced Learning, 5(2), 123-152.

Bruce, C. D., & Hawes, Z. (2015). The role of 2D and 3D mental rotation in mathematics for young children: what is it? Why does it matter? And what can we do about it. ZDM, 47(3), 331-343.

Johnson, M. K. (2016). Cognitive neuroscience: applied cognitive psychology. Journal of Applied Research in Memory and Cognition, 5(2), 110-120.

Kodakos, A., Kaldi, S., & Konsolas, E. (2003). In-service teacher training programmes in the Hellenic education system: the case of the Aegean University.

Kucuk, S., & Sahin, I. (2013). From the perspective of community of inquiry framework: An examination of Facebook uses by pre-service teachers as a learning environment. Turkish Online Journal of Educational Technology-TOJET, 12(2), 142-156.

Montgomery, J. M. (2008). Emotional Intelligence and Resiliency in Young Adults With Asperger’s Disorder Challenges and Opportunities. Canadian Journal of School Psychology, 2008, 23(1), 70-93.

Morris, L., & Cobb, T. (2004). Vocabulary profiles as predictors of the academic performance of Teaching English as a Second Language trainees. System, 32(1), 75-87.

Noh, J., & Webb, M. (2015). Teacher learning of subject matter knowledge through an educative curriculum. The Journal of Educational Research, 108(4), 292-305.

Rindermann, H., Hoang, Q. S. N., & Baumeister, A. E. (2013). Cognitive ability, parenting and instruction in Vietnam and Germany. Intelligence, 41(5), 366-377.

Stamovlasis, D., & Tsaparlis, G. (2003). A complexity theory model in science education problem solving: Random walks for working memory and mental capacity. Nonlinear dynamics, psychology, and life sciences, 7(3), 221-244.

Teo, T., & Le Fevre, D. (2017). The development and validation of the Teachers’ Perception of Risk Scale (TPRS) in educational change. Current Psychology, 36(3), 649-656.

Verschaffel, L., Van Dooren, W., & Star, J. (2017). Applying cognitive psychology based instructional design principles in mathematics teaching and learning: introduction. ZDM, 49(4), 491-496.

Wall, K., Higgins, S., Remedios, R., Rafferty, V., & Tiplady, L. (2013). Comparing analysis frames for
visual data sets: Using pupil views templates to explore perspectives of learning. *Journal of Mixed Methods Research*, 7(1), 22-42.

Wang, Q. (2008). A generic model for guiding the integration of ICT into teaching and learning. *Innovations in Education & Teaching International*, 45(4), 411-419.

Windschitl, M. (2000). Supporting the development of science inquiry skills with special classes of software. *Educational technology research and development*, 48(2), 81-95.

Zheng, B., Lawrence, J., Warschauer, M., & Lin, C. H. (2015). Middle school students’ writing and feedback in a cloud-based classroom environment. *Technology, Knowledge and Learning*, 20(2), 201-229.