The Effect of Cognitive Modeling in Mathematics Achievement and Creative Intelligence for High School Students

https://doi.org/10.3991/ijet.v18i09.39413

Ban Hassan Majeed[1](✉), Areej Khuder Hassan[1], Sabah Saeed Hammadi[2]
[1]College of Education for Pure Science, Ibn Al-Haitham, University of Baghdad, Baghdad, Iraq
[2]General Directorate of Education Baghdad Governorate, Karkh First, Baghdad, Iraq
ban.h.m@ihcoedu.uobaghdad.edu.iq

Abstract—To identify the impact of the cognitive modeling in mathematics achievement, creative intelligence for secondary school students during the 2022/2023 academic year. To achieve the aim of research, the researchers adopted the experimental research method with two groups (experimental; control) with a post-test. Community of research was identified, which represented by the students of second intermediate grade/first KED. (70) male students were intentionally chosen as a sample study, and they were divided into two groups: an experimental who were taught according to the cognitive modeling, and the other was a control group who were studied according to the usual method. Equivalence was made between the two groups in chronological age, level of intelligence, and previous achievement in mathematics. For the purpose of collecting data for the experiment, an achievement test was built in its final form (20) and also the creative intelligence test out of (25) of test paragraph from thematic type for both of them. Appropriate statistical analyzes were carried out, besides done making sure of the psychometric properties for the two tests. Based on the findings, students of experimental group who studied according to cognitive modeling excelled over those who studied by the traditional.

Keywords—effect, cognitive, modeling, mathematics, achievement, creative, intelligence students, secondary

1 Introduction

Educational systems in the modern era suffer in front of the knowledge revolution and complex and accelerating technological developments, thus requires that these systems work to provide learners with the skills to deal with technological and cognitive development and complexity and to control matters. This does not come except by providing the learners with mental capabilities that are compatible with the nature of this era, including the capabilities of creative intelligence that It helps learners to face complex problems, whether inside or outside the school besides paying attention to all its elements, linking its details to reach a creative solution [1]. Therefore, cognitive modeling is considered one of the modern and highly effective strategies, as it helps

learners to learn the methods of thinking from the model in front of them here as the learner imitates the model in the way of thinking about the problem in front of him, discussing ways of solving and correcting mistakes [2].

Research problem can be summarized as: What's the effect of cognitive modeling in mathematics achievement, creative intelligence among secondary school students?

1.1 The importance of the research, its aim, and its limits

The importance of this research can be manifested in knowing the impact of the cognitive modeling in achievement, creative intelligence for the students of the research sample. Shedding light on how to activate the cognitive modeling, since the learning process does not take place in isolation from its social environment. Adopting it with an age group that is going through a distinct stage of developing perceptual abilities and social skills, and thus providing students with extra-cognitive skills that have an effective impact on their development. Creative intelligence helps solve academic and non-academic problems. So, it raises the academic achievement of the learners because it combines the divergent and convergent abilities of thinking. Also helps learners to choose the most appropriate alternatives available to them. It enables learners to see the relationships between different elements, components, and things, and helps them to positively confront life's variables and situations. Provides a plan for how to apply a cognitive modeling scenario. Last but not least, it provides a mathematical test to measure creative intelligence for middle school age. Research determined the students / 2d intermediate grade / GDE of Al-Karkh Al-Awwal / Baghdad. 1st chapter (Relative Numbers), 2nd chap. (Real Numbers) and 3rd part (Boundaries) of the content of mathematics text-book for second intermediate students, 4th Ed. 2020 authored by a committee in the Ministry of Education. 1st semester / academic year (2022–2023).

2 Theoretical framework

2.1 Cognitive modeling

The modeling strategy is one of the well-known strategies in teaching, especially for young age groups. As social theory or learning by modeling is considered one of the important learning theories that emphasized the importance of social interaction and how to learn through different situations because individuals tend to imitate the behavior of those in their surroundings, so the teacher models the required skill or behavior in front of his students while giving an explanation of how to perform the skill Or behavior, and then the student is asked to imitate the model as he saw it [3]. Cognitive modeling strategy is an educational strategy to convey knowledge to learners in which the teacher presents his methods of processing information out loud while performing the procedures involved in order to learn a specific task and focus on highlighting the teacher's ways of thinking about learning and working to put the learners themselves in the teacher's frame of reference [4–8]. It procedurally define as a set of procedures that teacher performs in front of students / second intermediate grade through which he

presents his way of thinking to solve a problem and the way of processing information in a clear and loud voice to be a model for them in his way of thinking [9–11].

It is considered one of the powerful and effective strategies and has a great impact because the phrase (think as you see me thinking) is stronger than the phrase (do what I say) [12], and students tend to imitate their teacher, especially young ages and adolescents, so the teacher must be a model He is good in his thinking and his attitudes to set a good example for his students and guide them towards the skills of sound thinking and equip them with the right attitudes in their behavior to face different life situations [13–16]. What is meant by cognitive modeling is to imitate the way of thinking and how to solve problems, and it is effective because it helps in learning thinking skills in an easier way, because the teacher explains in clear language and in a voice that his students hear about solving a problem and shows the various meta-knowledge skills of planning, monitoring, and evaluation, using self-questioning to guide his behavior [17–19]. The teacher modeling his thinking, clarifying the planning processes, solving problems, and evaluating the solution out loud in front of his students makes the learners realize the management of their thinking processes as the teacher did (imitating the teacher). This strategy aims to develop self-awareness, self-control and self-regulation [20, 21]. The researchers believe that this strategy is very important and plays an effective role, especially with the category of adolescents who resort to imitating the behaviors of people affected by them. A solution to the problem presented, following the skills of planning and evaluation solution, will have a strong impact and be the best model for his students.

Steps of the cognitive modeling.

1. Preparation: in which the purpose of the lesson is clarified, its topic is linked to the students' previous experiences, and the learner is alerted to the mistakes that may make.
2. Modeling by the teacher: The teacher plays the role of a model for students to follow in solving a specific problem, understanding a specific concept, or carrying out an educational task, and presents his behaviors in thinking processes and problem-solving through verbal expressions aloud as they revolve in his mind.
3. Modeling by the student: One of the students plays the role of a model to solve a problem or discuss a specific topic out loud. He may conduct an experiment or draw some explanations according to the situation. If he makes a mistake, he corrects it out loud.

In some cases, another student can participate and play the role of an observer for the model, following it up and alerting it in the event of an error and the model not realizing that error, and in other situations it is possible to exchange roles [22, 23]. The researchers adopted these steps when teaching.

Strategy implementation scenario. There are specific roles for those involved in the strategy, which are as follows:

1. The model student: asks and talks to himself. Speaks in a clear voice, showing his way of thinking and the solutions he thinks of evaluative the solution he finds and justifies his choices.

2. The role of the observer: listens, observes and records what the model is doing. Alerts the model by pointing, hinting and suggestions in the event that there is an error that the model does not realize. Directs the model and offers corrections and alternatives.
3. The role of the teacher: He plays the role of the first model, and then works to organize the work and give appropriate instructions and recommendations. [24, 25]

Achievement is proving the ability to accomplish what has been acquired of knowledge and educational experience that has been set for [26–28]. It procedurally defined as "mathematical knowledge acquired by students of second intermediate grade during the period of the experiment, and its measured with the degree that they obtain in ACHIV. T." [29, 30]. The subject of intelligence was and still is one of the most controversial topics in the field of psychology and psychometrics since the identification of the intelligence coefficient and the appearance of its first test in (1904) by Alfred Binet until now, and research in this field is not easy at all, because it is considered as one entity It has been criticized for a long time that IQ does not mean one thing, but rather a group of different mental abilities [31]. The terms creativity and intelligence have been studied deeply and for centuries, but many debates are still going on about the relationship between them. Often, scholars associate both terms with relationships that allow us to understand the relationship between intelligence and creativity. In fact, both terms are required to deal with difficult problems. A better understanding of the relationship between them helps. On success and distinction in all fields, and although computers have exceeded the speed and capabilities of humans in a number of fields, human creativity is still in the foreground unchallenged [32]. It is as the ability to apply higher mental processes in relatively new situations, tasks and problems [33]. Its procedurally defined as a type of mental ability enables students of the second intermediate grade to solve verbal creative problems, quantitative creative problems, and formal creative problems, and its measured by degree obtained in the test prepared. Philosophers mention that creativity is rearranging what you know in a way that leads to what you do not know, and creative ideas are often met at the beginning of their presentation with disapproval, disapproval, and rejection from others, due to their abnormality at times or their strangeness at other times, but they turn into acceptance, appreciation, and admiration for what you have created. These ideas are subject to change. Creative intelligence depends on Sternberg's investment theory of creativity, which sees creativity as a decision in which the creative individual creates an idea that is not very popular at first, then turns into something high and desirable, then moves on to another creative idea when the first idea becomes more common, and according to this theory, the resources necessary for creativity are (intelligence – knowledge – thinking styles – personality – motivation – data) [26, 34, 35]. All problems that require "Creativity"; require "C. I.", but not all of them that require creative intelligence require creativity. Creativity, according to "Investment Theory" requires more than just creative intelligence, as it requires knowledge, some thinking patterns, a specific personality property, and some adjectives motivational. Accordingly, individuals can be creatively intelligent, but not creative. They may think in new ways, but lack persistence or inclination towards risk. Or the desire for growth one needs in order to be fully creative. Thus, problems that require complete creativity tend to be more complex than problems that

require only creative intelligence [36–40]. There are four types or styles of creative intelligence:

1. Intuition: which is based on previous experience to guide behavior or action.
2. Innovation: focuses on solving systemic and data-driven problems.
3. Imagination: uses visualization to create opportunities.
4. Inspiration: which focuses on the emotion to change something. [41, 42]

Its indicates that creative intelligence has three dimensions: (verbal, mathematical, and formal (artistic) intelligence) [43, 44]

The development of mental abilities is one of the important educational goals that all educational institutions in the world seek to achieve in order to enable new generations to confront and solve the problems they encounter. There are a number of methods and strategies that develop creative intelligence among learners, including:

1. Exemplary example: It is considered one of the most powerful ways to develop creative intelligence in children because they do not need someone to tell them about creative intelligence, but rather they need someone to teach them how to be creatively intelligent, and to act in a creative way. Therefore, teachers and parents must be creative role models for them to be able to develop the intelligence of their children.
2. Encouraging questions about assumptions: Creative people are by nature suspicious of assumptions that appear to the public to be natural and logical, so teachers and parents must accept all questions and encourage them to ask more questions.
3. Mistakes acceptance: It is usual today not to accept new ideas or that appear unfamiliar and may be outwardly inappropriate and abnormal, so teachers must accept and discuss all the ideas that the learners put forward.
4. Bearing the results of risk: Creativity does not come from comfort, but requires some calculated risk, so the teacher and guardian must allow this calculated risk and accept its results, not complain and encourage them to repeat the attempts to reach the desired goal [45, 46]. The researchers believe that creative intelligence is one of the important abilities that we need to develop among learners, because it helps them solve problems that may seem impossible to solve in front of them, and this is reflected in their self-confidence, improving their personal characteristics, and being more able to face the challenges of the modern era [47, 48]. The process of measuring mental abilities is very difficult and requires many conditions, and the more the ability to be measured is new, the more difficult it is to measure. It is important to emphasize that there is an overlap between tests of creative intelligence and some traditional tests of intelligence such as verbal skills and analysis of ideas. However, creative intelligence tests go beyond analytical intelligence tests in that they do not only measure an individual's ability to deal with relatively new situations, but exceed them in measuring creativity at the same time [49]. According to "Theory of Successful Intelligence", (C. I.) is specifically measured by presenting new problems to measure the individual's ability to deal with relative novelty. Therefore, the problems presented in the test must be relatively new and can measure convergent or divergent thinking or problems related to inductive reasoning. Problems that require divergent thinking It measures the creative side of intelligence [50].

In order to measure creative intelligence, several aspects are measured, namely:

1. Verbal creativity: where some verbal analogies are presented and the examinations are asked to complete according to these analogies.
2. Quantitative creativity: it requires good dealing with numbers, mathematical operations and numerical series.
3. Formal creativity: it requires presenting series of forms and asks the examinee to complete.

The researchers adopted these aspects to measure creative intelligence in mathematics on the research sample.

3 Experimental methodology and data

Researchers adopted the experimental research style, including the experimental design of (2 groups) experimental plus control with a post-test, which is one of the real designs. Cognitive modeling represents (independent vari.); achievement and creative intelligence (dependent variables) [51, 52]. The research community consisted of all the second intermediate grade students / (Gen. Dir. Ed.) / K. 1st. As for research "sample", researchers intentionally chose "The New Iraq Intermediate School for Boys" to conduct the experiment for several reasons; the closeness of the students in terms of the social, economic and cultural segment besides it contains four classes for the 2 intermediate grade [53]. Randomly class (B) was chosen to be the experimental group which formed from (35) students; and division (C) to be the other group which is also (35). Both internal, the external safety of the design has been calculated, as in Table 1.

Table 1. Internal safety

Variable	Group	No.	SMA	Std. Dev.	t-Test		Significance Level (0.05)
					Cal.	Tab.	
Age	Exp.	35	210.82	4.49	0.8	2	Not significant
	Con.	35	209.62	6.88			
Intelligence	Exp.	35	30.94	6.88	0.558	2	Not significant
	Con.	35	30.02	6.70			
Previous Achievement	Exp.	35	71.97	8.67	0.741	2	Not significant
	Con.	35	70.45	8.23			

3.1 The tools

Achievement test. Educational content was identified and (68) behavioral objectives were formulated according to Bloom's taxonomy. A specification table was done to specify questions for each of the (6 Bloom) levels, and based on opinions of arbitrators, the total questions was determined (20) of the objective type; Table 2 shows the details.

Table 2. Test map (specification table) for achiev. test

Behavioral Goals			Remember	Understanding	Application	Analysis	Sum
			17	22	24	5	68
Content							
Chapter	No. of Hours	Relative Weight	25%	32%	35%	7%	100%
One	14	30%	1	2	2	1	6
Two	15	32%	2	2	2	0	6
Three	18	38%	2	2	3	1	8
Sum	47	100%	5	6	7	2	20

Statistical analysis of the paragraphs of the achievement test was carried out to obtain statistical indicators, and all of them were acceptable and it is recommended to keep them.

Then was verified from:

1. **Validity:**
   - A. **"Face validity":** Test was presented to arbitrators from the disciplines of mathematics and its teaching, who confirmed that the test items are appropriate for the purpose for which they were set, and thus the final form of test obtained an agreement of (80%), and therefore it considered valid to measure achievement.
   - B. **"Validity of content":** A (test map) was approved by (82%) from arbitrators. Thus, the test is valid in content.
2. **"Reliability":** Using the Kuder-Richardson 21 Equation, and the reliability coefficient was (0.78) which is considered an acceptable stability.

Creative intelligence test. The researchers looked at the theoretical background of the research presented in defining the theoretical concept of "creative intelligence". In light of this, the test was built and consisted of (25) items of the objective type, which are in the form of mathematical forms, verbal analogies and numerical series. The correction key (0,1) was based on the consideration that the paragraph is either correct or incorrect.

Difficulty coefficients were checked and they ranged (0.28–0.71) plus discrimination coefficients (0.22–0.67) and they are considered acceptable percentages. Then was verified from:

- A. **Face validity:** Presentation of the test to the arbitrators who confirmed that the test items are appropriate for the purpose for which they were set, and thus the test is considered valid outwardly.
- B. **Reliability:** Using the Kuder-Richardson 20 Equation, and the reliability coefficient (0.78) which is an acceptable.

4 Results and discussions

To achieve the objectives of the research (find out effect of cognitive modeling on achievement, creative intelligence of second-grade intermediate students in mathematics) and to answer its hypotheses, the data was analyzed to find out the signifycance of the statistical differences between the arithmetic mean using the statistical bag (SPSS). The results related to the research hypotheses will be presented and interpreted in the light of what has been reached.

4.1 Achievement

First null hypothesis: "There is no statistically significant difference at the level of significance (0.05) between the average scores of students of experimental group who studied the subject of math. assigned to them according to cognitive modeling, and students of the control group who studied the same subject in the usual method in achievement test". See "Table 3".

Table 3. Achieve test

Group	Sample	Mean	Variances	t-Value		Statistical Significance at Level (0.05)
				Cal.	Tab.	
Exp.	35	69.714	16.198	2.875	2	Sig.
Con.	35	57.914	17.614			

Note: Degree Freedom = 68.

It is noted from the above table that the calculated value of the t-test is higher than the tabular value at the significance level, which indicates a statistically significant difference in achievement. Therefore, the null hypoth. is rejected; so, it means that the experimental group was superior to the control one in the achievement test. Researchers believe the reason may be the organization of the mathematical material and its division on parts and in successive steps that had a great impact on understanding and assimilation of the topics.

4.2 Creative intelligence

Second null hypothesis: "There is no statistically significant difference at the significance level (0.05) between the mean scores of the students of the experimental group who studied the subject of mathematics assigned to them according to cognitive modeling and the students of the control group who studied the same subject in the usual way in the creative intelligence test" was tested, as shown in Table 4.

Table 4. CIT

	N	SMA	SD	t-Value		Indi.
				Cal.	Tab.	
Exp.	35	30.91	5.94	5.76	2	Signifier
Con.	35	22.69	5.83			

Note: Indication level = 0.05; DF = 68.

Obviously that calculated t-value is bigger than the tabular one; so the null hypothesis is rejected and the alternative is accepted. This means experimental group was superior to the control in creative intelligence. The researchers believe that the reason may be the adoption of cognitive modeling encourages students on explore solutions, mathematical connections through interaction with the educational situation.

5 Conclusions

There is an existence of an impact of cognitive modeling in "achievement" and "ci". Its use helped in the development of linguistic performance skills among students from the research sample. Increase self-confidence and the ability to discuss ideas out loud without shame or fear; and discuss problems and determine their details and the relationship between their elements.

6 Recommendations; suggestions

In the light of the results, the researchers recommend holding training courses for mathematics teachers on cognitive modeling, which have proven effective. Recommending to the general directorate of curricula to reconsider the method of presenting mathematical problems which can be presented as a model for learners. Recommending to colleges of education the need to adopt modern teaching strategies in which students have an effective role inside class.

Conducting a study with the same variables for females and comparing the results. Knowing the impact of cognitive modeling in practical intelligence. Conducting an analysis of the content of mathematics books according to the dimensions of creative intelligence.

7 References

[1] H. Salim, "Tactical Thinking and its Relationship with Solving Mathematical Problems Among Mathematics Department Students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, no. 9, pp. 247–262, 2021. https://doi.org/10.3991/ijet.v16i09.22203

[2] L. Jawad and M. Raheem, "The Effectiveness of Educational Pillars Based on Vygotsky's Theory in Achievement and Information Processing Among First Intermediate Class Students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, no. 12, pp. 246–262, 2021. https://doi.org/10.3991/ijet.v16i12.23181

[3] L. Harasim, *Learning Theory and Online Technologies*. Routledge, 2017. https://doi.org/10.4324/9781315716831

[4] D. A. Al-Malah and S. I. Hamed, "The Interactive Role Using the Mozabook Digital Education Application and its Effect on Enhancing the Performance of eLearning," *International Journal of Emerging Technologies in Learning*, vol. 15, no. 20, pp. 21–41, 2020. https://doi.org/10.3991/ijet.v15i20.17101

[5] L. Jawad, "The Impact of CATs on Mathematical Thinking and Logical Thinking Among Fourth-Class Scientific Students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, no. 10, pp. 194–211, 2021. https://doi.org/10.3991/ijet.v16i10.22515

[6] J. Q. Kadhim and I. A. Aljazaery, "Enhancement of Online Education in Engineering College Based on Mobile Wireless Communication Networks and IOT," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 1, 2023. https://doi.org/10.3991/ijet.v18i01.35987

[7] S. H. Hassan Al-Taai, H. A. Kanber, and W. A. Mohammed al-Dulaimi, "The Importance of Using the Internet of Things in Education," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 1, 2023. https://doi.org/10.3991/ijet.v18i01.35999

[8] H. Sabah, "A Detection of Deep Fake in Face Images Using Deep Learning," *Wasit Journal of Computer and Mathematics Sciences*, vol. 1, no. 4, pp. 94–111, 2022.

[9] N. A. Jasim, B. H. Majeed, A. Z. Abass, and I. R. N. ALRubee, "Smart Learning Based on Moodle E-learning Platform and Digital Skills for University Students," *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, vol. 10, no. 1, pp. 109–120, 2022. https://doi.org/10.3991/ijes.v10i01.28995

[10] H. A. Kanber, S. H. H. Al-Taai, and W. A. M. Al-Dulaimi, "Recruitment of Teachers for Cooperative Education in Educational Institutions," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 3, 2023. https://doi.org/10.3991/ijet.v18i03.36815

[11] D. M. Abd Ali, D. F. Chalob, and A. B. Khudhair, "Networks Data Transfer Classification Based on Neural Networks," *Wasit Journal of Computer and Mathematics Sciences*, vol. 1, no. 4, pp. 207–225, 2022.

[12] M. E. Seligman, T. Rashid, and A. C. Parks, "Positive Psychotherapy," *American Psychologist*, vol. 61, no. 8, p. 774, 2006. https://doi.org/10.1037/0003-066X.61.8.774

[13] B. Majeed, "The Conceptual Mathematical Knowledge and Analytical Thinking for the First Sage Students at Math Sciences Department, Faculty of Education for Pure Sciences, IBN Alhaithem, University of Baghdad," *International Journal of Science and Research (IJSR)*, vol. 6, no. 12, pp. 1379–1392, 2017. https://doi.org/10.21275/ART20178962

[14] N. S. Alseelawi, E. K. Adnan, H. T. Hazim, and K. Nasser, "Design and Implementation of an E-Learning Platform Using N-Tier Architecture," *International Journal of Interactive Mobile Technologies*, vol. 14, no. 6, pp. 171–185, 2020. https://doi.org/10.3991/ijim.v14i06.14005

[15] R. Asgarnezhad, S. S. A. Majeed, Z. A. Abbas, and S. S. Salman, "An Effective Algorithm to Improve Recommender Systems using Evolutionary Computation Algorithms and Neural Network: Using Evolutionary Computation Algorithms and Neural Networks, an Effective Algorithm to Improve Recommender Systems," *Wasit Journal of Computer and Mathematics Sciences*, vol. 1, no. 1, pp. 27–35, 2022. https://doi.org/10.31185/wjcm.Vol1.Iss1.20

[16] J. Kh-Madhloom, "Dynamic Cryptography Integrated Secured Decentralized Applications with Blockchain Programming," *Wasit Journal of Computer and Mathematics Sciences*, vol. 1, no. 2, pp. 21–33, 2022.

[17] A. T. Beck and E. A. Haigh, "Advances in Cognitive Theory and Therapy: The Generic Cognitive Model," *Annual Review of Clinical Psychology*, vol. 10, pp. 1–24, 2014. https://doi.org/10.1146/annurev-clinpsy-032813-153734

[18] L. F. Jawad and B. H. Majeed, "The Impact of Teaching by Using STEM Approach in The Development of Creative Thinking and Mathematical Achievement Among the Students of The Fourth Scientific Class," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 15, no. 13, pp. 172–188, 2021. https://doi.org/10.3991/ijim.v15i13.24185

[19] A. M. Mohammed, H. A. K. Al-Saadi, and S. H. H. Al-Taai, "Information Sources and their Role in E-learning from Iraqi College Students' Viewpoint," *Webology*, vol. 19, no. 1, pp. 1128–1150, 2022. https://doi.org/10.14704/WEB/V19I1/WEB19077

[20] L. F. Jawad, "Computational Thinking (CT) Among University Students," *International Journal of Interactive Mobile Technologies*, vol. 16, no. 10, 2022. https://doi.org/10.3991/ijim.v16i10.30043

[21] H. A. Hassan, "Review Vehicular Ad hoc Networks Security Challenges and Future Technology," *Wasit Journal of Computer and Mathematics Science*, vol. 1, no. 3, 2022.

[22] D. Al-Malah and H. H. K. Jinah, "Enhancement of Educational Services by Using the Internet of Things Applications for Talent and Intelligent Schools," *Periodicals of Engineering Natural Sciences*, vol. 8, no. 4, pp. 2358–2366, 2020.

[23] G. T. Frischkorn and A.-L. Schubert, "Cognitive Models in Intelligence Research: Advantages and Recommendations for Their Application," *Journal of Intelligence*, vol. 6, no. 3, p. 34, 2018. https://doi.org/10.3390/jintelligence6030034

[24] N. A. Jasim and M. S. Farhan, "Internet of Things (IoT) Application in the Assessment of Learning Process," in *IOP Conference Series: Materials Science and Engineering*, vol. 1184, no. 1: IOP Publishing, p. 012002, 2021. https://doi.org/10.1088/1757-899X/1184/1/012002

[25] B. Majid, "Mathematical-Procedural Knowledge ant its Relation to Logical-Mathematical Intelligence among Students at the Third Stage in Mathematics Department," *Journal of Educational and Psychological Researches*, vol. 15, no. 58, pp. 478–498, 2018.

[26] M. Al-Haydary, "Impact of ASSURE Model on Mathematical Correlation and Achievement in Mathematics," *European Journal of Humanities and Educational Advancements (EJHEA)*, vol. 2, no. 11, pp. 62–68, 2021.

[27] A. Hassan, "The Impact of a Scenario – Based Learning Model in Mathematics Achievement and Mental Motivation for High School Students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 18, no. 07, 2023. https://doi.org/10.3991/ijet.v18i07.39263

[28] A. Alaidi, O. Yahya, and H. Alrikabi, "Using Modern Education Technique in Wasit University," *International Journal of Interactive Mobile Technologies,* vol. 14, no. 6, pp. 82–94, 2020. https://doi.org/10.3991/ijim.v14i06.11539

[29] B. M. Kasim, I. M. Ali, and S. S. Hammadi, "The Effect of the Negotiation Strategy on Mathematical Originality and Achievement of Sixth Grade Female Students in Mathematics," *Alustath Journal for Human and Social Science*, vol. 2, no. 204, pp. 75–104, 2013.

[30] A. K. Hassan, "The Effect of Finks Model in Lateral Thinking and the Grades of First Year Students in the Department of Computer Science/Morning Study," 2018.

[31] F. Fellmann and E. Redolfi Widmann, "Aspects of Sex Differences: Social Intelligence vs. Creative Intelligence," vol. 7, pp. 298–317, 2017. https://doi.org/10.4236/aa.2017.74017

[32] F. Fernández de Vega, P. Dahlstedt, and C.-K. Ting, "Special Issue on Creative Intelligence," *Evolutionary Intelligence,* vol. 8, pp. 1–2, 2015. https://doi.org/10.1007/s12065-014-0124-4

[33] J. A. Bargh and M. J. Ferguson, "Beyond Behaviorism: On the Automaticity of Higher Mental Processes," *Psychological Bulletin*, vol. 126, no. 6, p. 925, 2000. https://doi.org/10.1037/0033-2909.126.6.925

[34] S. B. Kaufman and J. L. Singer, "Applying the Theory of Successful Intelligence to Psychotherapy Training and Practice," *Imagination, Cognition Personality*, vol. 23, no. 4, pp. 325–355, 2004. https://doi.org/10.2190/TJEJ-K6GE-AUAV-EEYC

[35] B. Majeed, "The Relationship Between Conceptual Knowledge and Procedural Knowledge among Students of the Mathematics Department at the Faculty of Education for Pure Science/Ibn Al-Haitham," *International Journal of Innovation, Creativity and Change (IJICC)*, vol. 12, no. 4, pp. 333–346, 2020.

[36] T. W. Malone and M. R. Lepper, "Making Learning Fun: A Taxonomy of Intrinsic Motivations for Learning," in *Aptitude, Learning, and Instruction*: Routledge, pp. 223–254, 2021.

[37] B. Majeed and H. Salim, "Effect of Augmented Reality Technology on Spatial Intelligence among High School Students," *International Journal of Emerging Technologies in Learning*, vol. 17, no. 24, pp. 131–143, 2022. https://doi.org/10.3991/ijet.v17i24.35977

[38] S. Nalbantian and P. M. Matthews, *Secrets of Creativity: What Neuroscience, the Arts, and Our Minds Reveal*. Oxford University Press, 2019. https://doi.org/10.1093/oso/9780190462321.001.0001

[39] H. T. Alrikabi, "Enhanced Data Security of Communication System using Combined Encryption and Steganography," *International Journal of Interactive Mobile Technologies*, vol. 15, no. 16, pp. 144–157, 2021. https://doi.org/10.3991/ijim.v15i16.24557

[40] H. Al-ogaili and A. M. Shadhar, "The Finger Vein Recognition Using Deep Learning Technique," *Wasit Journal of Computer and Mathematics Sciences*, vol. 1, no. 2, pp. 1–11, 2022.

[41] E. Kurilovas, "On Data-Driven Decision-Making for Quality Education," *Computers in Human Behavior*, vol. 107, p. 105774, 2020. https://doi.org/10.1016/j.chb.2018.11.003

[42] L. Chen *et al.*, "An Artificial Intelligence Based Data-Driven Approach for Design Ideation," *Journal of Visual Communication Image Representation*, vol. 61, pp. 10–22, 2019. https://doi.org/10.1016/j.jvcir.2019.02.009

[43] D. Al-Malah, B. Majeed, and A. Abass, "The Influence E-Learning Platforms of Undergraduate Education in Iraq," *Int. J. Recent Contributions Eng. Sci. IT*, vol. 9, no. 4, pp. 90–99, 2021. https://doi.org/10.3991/ijes.v9i4.26995

[44] Z. Isnain, "The Impact of Intelligence Quotient on the Learning Outcomes of Musical Art in State Schools," *Catharsis*, vol. 10, no. 2, pp. 130–141, 2021.

[45] R. A. M. Alairaji and I. A. Aljazaery, "Abnormal Behavior Detection of Students in the Examination Hall from Surveillance Videos," in *Advanced Computational Paradigms and Hybrid Intelligent Computing*: Springer, 2022, pp. 113–125. https://doi.org/10.1007/978-981-16-4369-9_12

[46] A.-M. Duha Khalid Abdul-Rahman, "Enhancement the Educational Technology by Using 5G Networks," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 18, no. 01, pp. 137–151, 2023, https://doi.org/10.3991/ijet.v18i01.36001

[47] A. D. Al-Malah and H. A. Mutar, "Cloud Computing and its Impact on Online Education," *IOP Conference Series: Materials Science and Engineering*, vol. 1094, p. 012024, 2021. https://doi.org/10.1088/1757-899X/1094/1/012024

[48] Z. H. Ibrahim, "Computer Literacy with Skills of Seeking for Information Electronically among University Students," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 17, no. 07, 2023. https://doi.org/10.3991/ijim.v17i07.38751

[49] R. J. Sternberg, J. C. Kaufman, and A. M. Roberts, "16 The Relation of Creativity to Intelligence and Wisdom," *The Cambridge Handbook of Creativity*, pp. 337–352, 2019. https://doi.org/10.1017/9781316979839.018

[50] R. J. Sternberg, "Theories of Intelligence," 2018. https://doi.org/10.1037/0000038-010

[51] H. Sabah Saeed, "The Impact of a Proposed Strategy According to Active Learning in Achievement of Mathematics and Visual Intelligence Among Intermediate Students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 17, no. 24, pp. 101–113, 2022, https://doi.org/10.3991/ijet.v17i24.35983

[52] Ban Hassan Majeed, "Impact of a Proposed Strategy According to Luria's Model in Realistic Thinking and Achievement in Mathematics," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 17, no. 24, pp. 208–218, 2022, https://doi.org/10.3991/ijet.v17i24.35979

[53] S. S. Hammadi, "Impact of Deep Learning Strategy in Mathematics Achievement and Practical Intelligence among High School Students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 18, no. 06, 2023. https://doi.org/10.3991/ijet.v18i06.38615

8 Authors

Ban Hassan Majeed; She is presently Asst. Prof. in Mathematics Education and one of the faculty members in the College of Education for Pure Science/Ibn Al-Haitham, Computer Department, University of Baghdad, Iraq. E-mail: ban.h.m@ihcoedu.uobaghdad.edu.iq

Areej Khuder Hassan; She is presently Asst. Prof. Dr. in Methods of Teaching Mathematics and one of the faculty members in the College of Education for Pure Science/Ibn Al-Haitham, Computer Department, University of Baghdad, Iraq. E-mail: areej.k.h@ihcoedu.uobaghdad.edu.iq

Sabah Saeed Hammadi; He is presently Asst. Prof. Dr.; Teacher at Mutamayzi Al-Khadra High School/Karkh First Education, Baghdad province, Baghdad, Iraq. He is interested in methods of teaching mathematics. He is the author of a book called Ordinary Differential Equations. E-mail: dsabah159@gmail.com

Article submitted 2023-02-05. Resubmitted 2023-03-10. Final acceptance 2023-03-12. Final version published as submitted by the authors.