The Effect of a Proposed Strategy according to the Design Thinking Model in Mathematics Achievement and Personal Intelligence among Students of Sixth-Class Scientific

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Abstract—Researcher adopted the experimental research method with two groups (experimental; control) with a posttest; to know the impact of a proposed strategy according to the design thinking model on the achievement of mathematics and personal intelligence among students sixth-class scientific. The null hypotheses were made "there is no statistically significant difference at the significance level (0.05) between the mean scores of students sixth-class scientific (biology) who learned the mathematics subject assigned to them according to proposed strategy (the experimental group) with students who learned the same material by usual way (control group) in test of achievement". Community of research represent students sixth-class scientific (biology) from the General Directorate of Education of Karkh First. Research sample was selected (60) students, and the sample was divided into two groups (experimental) and (control). The equivalence of both groups was made in (previous achievement in "Mathematics", "level of intelligence", "chronological age"). For collecting data to the experiment, an achievement test was built in of (10) test paragraphs of essay type, plus a scale to measure personal intelligence with five test paragraphs. Analyzes were conducted the appropriate statistic, and the psychometric properties of the test were confirmed. Results indicated that students of the experimental group who studied according to the proposed strategy were superior to the students of control group who studied by usual method.

Keywords—proposed strategy, design thinking model, mathematics, personal intelligence, students sixth-class scientific

1 Introduction

Despite the continuous calls for the adoption of modern strategies in teaching to make new generations able to keep pace with the rapid developments of the era and face new challenges, we still notice a decrease in the level of achievement among students and to some extent students still have aversion to mathematics as it is dry, difficult, and incomprehensible, and despite Continuous emphasis on making the student's

role active and active, and avoiding memorization and indoctrination, but in fact, the student was not focused on the personal aspect [1]. What are his capabilities? and his feelings about the study? What do you accept to study mathematics? Is he clear and frank with himself to identify his weaknesses and strengths? Rather, these matters were implicitly addressed with the modern trends calling for renewal and attention to teaching thinking without focusing on the internal and external personality of the student. Design thinking is one of the modern models that have proven its efficiency in the field of business and engineering [2]. Therefore the problem of the current research can be summarized by answering the following question: Does the proposed strategy according to the design thinking model affect the achievement of mathematics and personal intelligence among students sixth – class sciences biological? The importance of the research, the theoretical aspect is determined by the fact that design thinking model is one of the most recent models that have been used recently in education. This model develops students' creative and imaginative abilities without restrictions or limits. Develops design capabilities to create new products. Employing scientific knowledge with practical practices helps to find practical and creative solutions to solve problems. The Design Thinking model helps students think outside the box. Interpersonal intelligence is one of the important intelligences that students should be trained on. Students' possession of personal intelligence increases the motivation to stand out and excel. Personal intelligence helps to increase self-confidence and thus confidence in personal abilities to face all challenges.

As for the practical side, to know if there is an effect of the proposed strategy according to the design thinking model and the achievement of students. Providing a measure of personal intelligence for students of the sixth scientific class that can be used in the educational field or by other researchers. Directing the attention of mathematics teachers to adopting new and modern models in teaching that focus on thinking and analysis in order to design solutions. Draw attention to the importance of students' personal intelligence and its role in increasing self-confidence. The research is limited on students sixth class science (biological) in General Directorate of Education/Karkh First in Baghdad Governorate. Chapter one (complex numbers) from the content of the mathematics book scheduled for them; edition 1 for the year 2021 and composed by a committee in the Ministry of Education. The 1st semester/year (2021–2022). Finally, the problem of current research can be summarized by answering the following question:

Does the proposed strategy according to the design thinking model affect in the achievement of mathematics and the personal intelligence of students sixth-class science?

2 Theoretical background

2.1 Design thinking

Educators and teachers have been so involved in design thinking that it has been used in more than sixty USA Universities and Colleges, in the form of lessons, courses,

workshops, as well as within degree programs, and to promote the development of 21st century skills for the K+16 class, with support from "IDEO" and "Hasso Blattner" Institute for Design [3]. So concept of design thinking within academic design dialogue has been under discussion for more than thirty years, and it's recent adoption as a method of innovation and creativity have led to its popularity across disciplines [4, 5]. Is a way of thinking that uses the designer's methods and feelings to analyze problems and find appropriate solutions to them, by finding tangible creative products [4, 6]. Also it is an action plan for sixth-class students (the experimental group) to study based on five stages (identifying the problem, then collecting information, proposing a method for solving, implementing the chosen solution, and then providing feedback) [7]. As mentioned, design thinking means different things to different societies and has two sides; descriptive models of the design process, based on observational research of real-life or laboratory design activities by individuals or teams. It is a method to be practiced in industries that strive to provide innovation products or services [8, 9]. According to [10, 11], the term Design Thinking has roots across disciplines, and is not exclusively associated with engineering, architecture, and related design disciplines in the early literature that focused on Design, and thus Promoting civic literacy, tenderness, adventure, and cultural awareness. It has been noted by [12, 13] change from discussing, studying "design thinking" as cognitive processes which designers use, to a specific way in which non-designers use design methods—a shift "from design as a science to design as a mindset". Thinking, because its core lies in placing participants in contexts that make them think, act like an expert designer. Design thinking mindset in education; people who want to innovate and create better experiences, products and services for their users or customers may benefit from applying certain situations that can enhance their thinking and creativity, so the design thinking mindset can focus on modifying, changing, or enhancing the mindsets of students, or even teachers in building the concept of complex thinking in In the classroom, in the context of teaching and learning. The design thinking mindset (DT Mindset) based on cognitive psychology that provides guidance for achieving learning goals through teaching activities and encourages a culture of thinking in education. The teaching process requires students to develop creativity and innovation through computing skills and build a set of Skills that balance the expert workers of the future [14–16]. Goal of Design Thinking goes beyond immediate boundaries of a problem to ensure that the right questions are addressed. Process predicts steps allow participants to analyze, synthesise, divergent, and generate insights from different domains by prototyping and telling stories. In the process of "Design Thinking" teachers encourage learners seeing limitations as inspiration [17–20]. The researcher believes that the goal of introducing design thinking to education is to make students think with the mentality of a designer in order to solve complex problems that they encounter in the classroom or in daily life, which we aspire to be creative solutions, as well as early detection of talented designers to prepare them for the labor market, and this is what all major countries seek to continue the wheel of progress Keeping abreast of developments in all fields [21, 22]. Design thinking models; there are a number of models put forward by thinkers and educators, including the model which consists of three linear sequential stages (understanding, exploration, and application). A model

it consists of six stages between which there is interaction, namely (understanding, observation, viewpoints, visualization, model building, and testing); it can be applied as a teaching method [23, 24]. A model which consists of seven stages (brief definition, research background, ideas solutions, first model solution, determine the rationale, implement delivery, learning feedback) which is a linear model. The model consists of five stages (discovery, interpretation, visualization, experimentation, and observation). Finally, a model was presented at Stanford University in 2016 and it consisted of five interactive stages (empathy, identification, perception, model building, and testing) [25–29]. Researcher thinks that these models, no matter how many and varied their stages, whether they are linear or circular, the main goal of them is to train students on the process of identifying the problem, how to collect information, and how to build a model for the solution in which we are marked by a creative solution. Based on these models, the researcher suggested an educational strategy that consists of five stages they are (Defining the problem: at this stage, the problem and the goal to be reached are identified). (Information collection: Information is collected about the problem in all its details and searches for similar problems that were previously solved). (Presenting ideas and discussing proposed solutions: The process of developing ideas and putting forward solutions that the designer deems appropriate to solve the problem begins). (Implementation: At this stage, the implementation process for the chosen solution begins). (Feedback: At this stage, implementation is followed up to ensure the correctness of the solution steps, with the possibility of modification or development in a way that enables us to reach creative ways in the solution) [30, 31].

2.2 Intelligence

Intelligence is a hypothetical concept, and that is why scholars differed about defining specific definitions of it, and because of this difference and controversy, it has received extensive and extensive study. Rather, it is considered one of the abilities that was most focused on in the last century because it examines the individual differences between individuals, and despite the discussion of this concept by psychologists, education, sociology, and heredity, they did not reach a clear and agreed upon definition, and this difference It led to a difference in the way it was studied and measured. There are many trends that have been adopted in the study of intelligence, including the philosophical concept, the biological and physiological concept, and the social concept. This difference may be due to the fact that the nature of intelligence is not materially sensible [32]. Howard Gardner sees according to his theory of multiple intelligences that every human possesses all kinds of intelligences, but the difference between humans by the percentage or level of each intelligence depending on the environmental and living conditions and the genetic genes of individuals. According to the intelligence they possess, Gardner considers that all traditional theories of intelligence do not adequately estimate human intelligence due to the weakness of their tests that require the individual to solve the problems presented in verbal or verbal formulas only, and they are suitable for school performance. He also sees that relying on paper

and pen in measuring performance Intelligent for life tasks, and considers success in life requires various intelligences, and believes that our best contributions are to know the intelligences and talents that children possess in order to focus on them [33, 34]. Personal intelligence; Gardner was not the first to talk about interpersonal intelligence. But rather; Hunt preceded him in (1928) and followed him by Walker & Foley [31], then Gardner addressed it in (1983). The follower of educational and psychological literature finds that personal intelligence has roots in educational psychology theories such as the theory of ability on Thorndike's Social Adaptation and Guilford's Mental Formation Theory [35]. Interpersonal intelligence is a central institution for other's intelligences because it depends on internal pivotal processes that enable individuals to distinguish between their feelings and thus can build a mental model for themselves. Introspection of his thoughts and emotions, and the individual becomes aware of his inner mood and self-esteem, and this helps him in arranging his lifestyle and planning his future. Those with this intelligence tend to reflect on their problems and capabilities. This intelligence is considered a certain good for those who possess it to persevere and face obstacles and frustrations because they are able to determine what they can do and what they cannot do [36]. Characteristics of personal intelligence: It focuses on the emotional aspect of the response, as it is a basis for understanding the emotional life of the human being. It is a mental process that appears through the individual's understanding of himself and the formation of an effective model for it and relying on this model in organizing his life and behavior. The lowest level is the individual's ability to distinguish his inner feelings in terms of pain and pleasure, those in the light of which the individual's personal characteristics such as introversion or extroversion are determined, while the highest level is the individual's ability to discover and organize his feelings. Individuals who possess this intelligence are able to understand their emotions and direct their behaviors, and tend to be contemplative and private. Personal intelligence is linked to self-reflection through contemplation and awareness of metacognition and is linked to focus and individual evaluation of his ideas [23, 37]. Researcher believes that personal intelligence shows the individual's ability to understand himself, determine his goals, this helps him in meeting his needs and helps him adapt to the reality in which he lives. Training students on this type of intelligence helps them understand themselves and determine their capabilities and helps them identify their weaknesses and thus work to strengthen them. It also generates incentives for them to improve their academic performance and excel in order to satisfy themselves [38, 39].

2.3 Previous studies

Researcher obtained a few of previous studies that are compatible with nature of the variables to benefit from them as shown in Table 1.

Table 1. Studies dealing with research variables

No.	Name; Year; Country	Educational Level	Sample	Subject	Curriculum Type	Independent Variable	Dependent Var.	Results
1	Hunter, 2006, Australia	College	11 male & female students	Mathematics	experimental	Learn & teach successful mathematics	Multiple Intelligences; Achievement	no effect of teaching & learning mathematics on multiple intelligences and achievement
2	Tabuk & Ozdemir, 2009, Turky	Primary	144 Male students	Mathe.	Exp.	Multiple intelligences	Project based learning; Achievement	there were no statistically significant differences in the dependent variables
3	Painter, 2018, USA	teachers	20	Math.	Case study			Employing design thinking strategies for middle school students led to mastery of mathematical concepts

3 Research methodology and procedures

Researcher choose the "Experimental Research Method", including experimental design of two groups (experimental plus control) with a post-test, which is one of real designs, as it represents proposed strategy (independent vari.) and personal intelligence with achievement (dependent variables) as shown in Table 2. The research community consisted of all students sixth class (biological sciences) in the General Directorate of Education of the First Karkh in the province of Baghdad. The researcher chose the distinguished high school – Al-Khadra for boys from the first Karkh Education Directorate to conduct the experiment on three study divisions, and (B) section was randomly selected as the experimental group and (C) section as the control group. The experimental group consisted of (30) students, the control group consisted of (30) students [40]. As for the control procedures (internal safety), groups of research were equalized in (age of chronological, intelligence, previous achievement in mathematics). The external integrity of the design, as the researcher trained the subject teacher to teach the proposed strategy and for the experimental and control groups. The class was taught to both groups; where the time period was equal for both of them which is (45) days within the 1st semester/academic year (2021–2022). The number of lessons scheduled for students is (5 lessons) per week in attendance, and it is equal for the experimental and control groups. The research tools, both measure of personal intelligence, achievement, were applied to the two groups. The classrooms of the two research groups in the same place on the first floor were close and similar in terms of physical characteristics such as lighting, ventilation and seating. As for experimental extinction; it is the impact that results from leaving a few of students within the research sample or interruption through work, so "no student" left the study or interrupted work except for the absences that two research groups were exposed to in approximately equal proportions.

Table 2. Equivalence of the two research groups in chronological age, intelligence, and previous achievement

Variable	Group	Students	SMA	Standard Deviation	T Value		Indication Level
					Cal.	Tab.	
age	1	30	213.22	6.57	1.15	1.97	Not statistically significant
	2	30	214.18	5.83			
intelligence	Exp.	30	48.4	4.35	0.17	1.97	
	Con.	30	47.3	4.29			
previous achiev.	1	30	70.4	10.43	0.769	1.97	
	2	30	69.3	9.89			

Notes: Exp. = 1; Con. = 2; significance level (0.05).

3.1 The achievement test

After determining the educational content, which is the third chapter of the mathematics book (combined numbers), the behavioral objectives were formulated and their number was (23) behavioral objectives according to Bloom's six levels of behavioral

objectives. A test map was developed to determine the questions for each of the six levels of Bloom, based on the opinion of the arbitrators, the total number of questions (10) paragraphs of the essay type were determined, they were (4) for the level of remembering, (3) for the level of comprehension, (3) the level of application. Test was given to a group of academic in a area of mathematics and its teaching methods in order to take their opinions and observations, after taking their opinions, it was ready to be applied to the exploratory sample. Table 3 shows the test map with the preparation of behavioral objectives for each chapter. For clarity, understanding of paragraphs, instructions of answer, calculating the time taken to answer, test was applied to a sample of (100) students from the research community and from outside the experiment sample (Al-Mutamayizeen High School – Al-Harithiya for Boys). To calculate the weighted mean among first and last three students who took test, (90) minutes was enough [41–44]. In order to obtain statistical indicators for examining the achievement test. First of all; calculating the coefficient discrimination for each items by adopting its own equation, and it was found that its value ranges between (0.32–0.69), which they are a good indicator of the acceptance of the items. Difficulty coefficient for the item; the results ranged between (0.27–0.64) and are acceptable, as the sources indicate that any paragraph within the distribution of the difficulty coefficients ranges between (0.20–0.80). Extracting the psychometric properties of the achievement test; validity coefficient, two types of honesty were extracted Face Validity which the test was presented to a number of arbitrators in mathematics disciplines and it's teaching methods. The opinions of the arbitrators were taken into account in reformulating and amending some paragraphs, and none of them were deleted. The paragraphs in their final form reached agreement (80%), and thus all returned. The test items are valid to measure the students' achievement from the sample. Content validity: a test map was drawn up in which the objectives were explained at their levels with the number of lessons needed to study each topic, and it was presented to a number of arbitrators and was approved by (80%). One of the content validity indicators in addition to what was indicated in the test map.

The Reliability; extracted the stability using the Kuder Richardson Equation – 21, the value of it was (0.82) considered an acceptable stability.

Thus, the achievement test has acceptable sincerity and stability.

Table 3. (Table of specifications) for the achievement test

Behavioral Goals		**Remember**	**Comprehension**	**Application**	**Analysis**	**Sum**
First semester	Relative weight / Number of lessons	32%	21%	36%	11%	100%
	20	3	2	4	1	10

3.2 Personal intelligence scale

Researcher reviewed a number of studies that dealt with multiple intelligences, including interpersonal intelligence to build a scale of personal intelligence consisting of (17) items with five options (strongly agree, agree, neutral, reject, strongly reject)

according to Likert scale, instructions were put in place to answer, they were taken into account to be clear; to indicate that the results obtained are for scientific research purposes only not used for other purposes. The sample members were asked not to leave any paragraph unanswered, in case; they are treated as error and write the solution on a piece of paper. Scale was introduced to arbitrators in methods of teaching math., with psychology, in light of their observations, the modifications were made and they were approved by 80%. Finding out clarity of scale paragraphs and their understanding by the sample of the exploratory application. Test was applied to (100) students who are not from the research sample (Al-Mutamayizin High School – Al-Harithiya for boys) from the research community. It turned out that all instructions were clear; (45) minutes was ok to finish test. Statistical analysis for scale items; the discrimination coefficient was extracted, so the t-test was applied for two independent samples, because it is an indicator that achieves distinction between paragraphs by comparing the calculated value with the tabular value (2) with a degree of freedom (58), and a level of significance (0.05) and it was accepted. Confirming the psychometric properties; the scale presented to a number of experts in math. & Its teaching methods, who agreed that scale's paragraphs are appropriate for which they were done for it. So, scale was apparently valid. The Reliability; He proceeded to extract the stability using the Alpha Cronbach Equation, its value was (0.79) and considered an acceptable.

4 Results and their interpretation

4.1 Achievement test results

The validity of the first null hypothesis "there is no statistically significant difference at the significance level (0.05) between the mean scores of the sixth-class biological science students who learned the mathematics subject according to proposed strategy and students who learned by traditional way in test of achievement test" was tested. The results were shown in Table 4.

Table 4. "Achievement test"

Groups	No.	Mean	Variance	Std. Dev.	t-Test		Indication Level
					Cal.	Tab.	
Exp.	30	70.8	202.49	14.23	2.186	1.97	Statistically significant at the (0.05) level
Con.	30	62.8	186.32	13.65			

From the above table, it's very clear that (2.186) higher than the tabular one at the significance level with degree of freedom (58), which indicates a statistically significant difference in achievement; thus the null hypothesis is rejected and the alternative hypothesis is accepted. The researcher believes that the reason may be the adoption of a proposed strategy according to design thinking model, which stimulated the minds of students to think with the mindset of the designer and search for creative solutions outside the box, with an emphasis on making the problems presented from the reality of the students' lives, which led to their retention of information for long periods.

4.2 Results related to personal intelligence test

The null hypothesis "there is no statistically significant difference at the significance level (0.05) between both mean scores of the sixth-class biological science students who learned the mathematics subject assigned to them according to the proposed strategy and between the students who learned by usual way at Personal Intelligence scale" and it was verified as Table 5.

Table 5. "Personal intelligence scale"

Groups	No.	Average	Var.	Standard Deviation	t-Test		Indication Level
					Calculated Value	Tabular Value	
Exp.	30	3.97	0.048	0.22	5.21	1.97	significant
Con.	30	3.71	0.017	0.13			

Noted that the (5.21) is greater than tabular, which indicates existence of statistically difference in personal intelligence. Therefore, the null hypothesis is rejected; the hypothesis accepted alternative. The reason may be the adoption of the proposed strategy according to the design thinking model has affected on personality of the students because it allowed them to start thinking freely and this made them realize their weaknesses and strengths and work on them and thus increase their self-confidence, also break the barrier of boredom, dryness of mathematics as a subject for them to be more fun with increased confidence their abilities and personalities.

5 Conclusions

Teaching, according to the proposed strategy, contributed to improving the achievement of students. The use of the proposed strategy contributed to generating positive impressions in mathematics among students as a new method of teaching. Students were able to reveal their strengths and weaknesses and face difficulties, thus increasing their self-confidence. The use of modern teaching strategies has an impact on raising students' achievement and improving their personal intelligence.

6 Recommendations

Recommending teachers to adopt the design thinking model in education because of its role in developing students' abilities; also paying attention to the personal intelligence (internal and external) of students and paying attention to the importance of making students confident in themselves and their abilities. Orientation Curriculum Designers in Ministry of Education to reconsider "Mathematics" curricula for the secondary stage and its content, presenting them in fun and an interesting manner, presenting them in the form of leading students think, research, not to be bound by known methods only, move away from memorization. Conduct training courses for teachers on the design thinking model and the possibility of suggesting multiple strategies to be applied in the classroom.

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