The Effect of Challenge-based learning program in Improving Creative Self-efficacy and Cognitive Engagement among University Students[1]

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Abstract:

The current research aimed to identify the effect of challenge-based learning in improving creative self-efficacy and cognitive engagement among students at college of education, Kafrelsheikh University . It also aimed to reveal the presence of differences due to gender (male or female) in creative self-efficacy and cognitive engagement. The sample consisted of 70 students with an average age of 21.87 years and a standard deviation of 1.63±., divided into two groups: experimental and control. Each group consisted of 35 students. To measure the research variables, the scales of creative self-efficacy and cognitive engagement were used. The appropriate statistical methods were used for data analysis. The results indicated that there are statistically significant differences between the mean scores of experimental and control group students in the post-test in creative self-efficacy and cognitive engagement among students in favor of the students of the experimental group. The results also show statistically significant differences between the mean scores of the experimental group in the pre-post-test in creative self-efficacy and cognitive engagement in favor of the post-test. whereas no statistically significant differences due to gender (males or females) were found in creative self-efficacy or cognitive engagement in experimental group students. Some recommendations and suggested research were provided considering the research results.

Keywords: *challenge-based learning, creative self-efficacy, cognitive engagement.*

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1. Introduction

University students play a crucial role in society through self-development, critical thinking, research, social projects, and participation, fostering innovative thinking, leadership, and a collaborative environment for exchanging ideas. Challenge-based learning offers 21st-century skills development through multiple approaches and solutions, focusing on global challenges with local solutions. It allows students to use web tools for organizing, collaborating, and publishing, connecting with multiple disciplines, and accessing modern technology resources. It fosters collaborative, hands-on learning by involving students, teachers, families, and community members in identifying big ideas, solving challenges, gaining knowledge, and developing 21st-century skills. (Nichols & Cator, 2008). Challenge-based learning generates new ideas, enabling students to transform their creativity into valuable, practical experiences. (Yang et al., 2018). As well as enhances students' skills, engagement, and understanding of materials; improves information management and group interaction; and enhances key skills like leadership, creativity, media literacy, and problem-solving. It promotes critical thinking, flexibility, and adaptability across various learning environments (Johnson & Adams, 2011).

Creative self-efficacy plays a significant role in the student’s academic excellence and the growth of his emotional and social personality, mediating between the student’s creative skills and his real achievement in educational situations (Redmon, 2007). Since creative self-efficacy is a fundamental conviction about one's capacity to act, think, and generate creatively in a variety of contexts, it can be correlated with creativity (Beghetto et al., 2011; Tierney & Farmer, 2002). Furthermore, students with high creative self-efficacy are able to direct their own internal motivation, cognitive processes, and action plans in order to satisfy the needs of a given circumstance. In sum, creative self-efficacy is a powerful indicator of students' behavior in the classroom in these kinds of situations (Hsu et al., 2011; Tan et al., 2011).

Cognitive engagement refers to students' psychological investment in learning, encompassing memorization, rote learning, and self-regulation strategies for deep understanding. (Fredricks et al., 2004). It is a key aspect of effective university education, promoting active learning and communication between students and faculty, and is directly linked to academic achievement. (Greene, 2015). As deep cognitive processing enables the kind of mental connection and knowledge building that promotes cognitive learning outcomes at a higher level, students must transition from superficial to meaningful cognitive processing in order to increase cognitive engagement. (Christopher et al., 2005). In the same context, Biggs and Tang (2011) explained the relationship between cognitive engagement and deep learning, where cognitive engagement contributes to deep learning when students actively participate in processing information, making connections, and applying knowledge.

1.1 Problem of the Research

In light of the changes and challenges that the world is witnessing, this situation requires a revolution against the current educational conditions and a transition to a stage that elevates the student from an information gatherer to a contemplative, deeply thinking student who has his own style of searching for knowledge.

Challenge-based learning focuses on real, open-ended problems rather than imaginary problems, connects students to actual issues present in their communities, which can enhance their engagement and leadership, and promotes the habit of thinking back on one's experiences and the results of one's decisions (Gaskins et al., 2015). As pointed out by Vilalta-Perdomo et al. (2022), challenge-based learning is distinct from other approaches to learning in that it extends learning beyond the classroom, is less restricted by conceptual, physical, or temporal boundaries, and there is an expectation that sustained engagement between students and their society will continue beyond the end of the formal academic period. In contrast to a final, product-oriented approach, he continues, challenge-based learning emphasizes sustainability issues and the requirement for an immediate and verifiable solution (Garay-Rondero et al., 2019).

Creative self-efficacy can support the adoption of a mastery goal orientation and the application of metacognitive or self-regulatory learning methods associated with creative activity (Beghetto, 2006, 2007; Nickerson, 1999; Stevens & Gist, 1997). According to Petkus (1996), extremely effective creators possess what Bandura (1997) called "invincible self-efficacy," or a high degree of confidence.

Cognitive engagement depends on the idea of investment. It involves thinking and the willingness to put in the effort necessary to understand complex ideas and master difficult skills and involves active mental processes such as attention, perception, reasoning, and memory during learning activities (Fredricks et al., 2004).

Based on the above, it is clear that challenge-based learning works to actively engage students in real-world challenges, promotes deep thinking and problem solving, develops their ability to analyze information, encourages continuous mental effort and cognitive integration, and also provides fertile ground for creativity by presenting real challenges that require thinking. Creatively, which builds their confidence in their creative abilities, enhances creative self-efficacy, and provides attractive and relevant challenges that attract students' focus during challenge-based learning.

The research problem can be addressed as follows:

(1) What is the effect of a challenge-based learning program in improving creative self-efficacy and cognitive engagement among university students?
(2) Does the effect of a challenge-based learning program in improving cognitive engagement and creative self-efficacy differ according to gender (males/ females)?

1.2 Objectives of the Research

The research aims to identify the effect of a challenge-based learning program in improving creative self-efficacy and cognitive engagement among students at the college of education. It also aims to reveal the presence of differences due to gender (male/ female) in the studied variables.

2. Literature Review

2.1 Challenge-Based Learning

Challenge-based learning is a learning experience where learning occurs by identifying, analyzing, and designing a solution to a socio-technical problem. Finding a cooperative, cutting-edge solution that is environmentally, socially, and economically sustainable is the goal of the learning process (Malmqvist et al., 2015). Furthermore, according to Johnson et al. (2009), challenge-based learning is a relatively recent strategy for getting students to engage in original and creative thinking. Challenge-based learning incorporates technology, group projects, peer and self-directed learning, real-world problem solving, and reflective learning into learning activities that can take place outside of the classroom and in the community (Johnson &Adams, 2011). As well, the framework is informed by cutting-edge concepts from education, media, technology, entertainment, the workplace, and society, and is built upon a foundation of experiential learning informed by a long history of progressive ideas (Nichols et al., 2016).

Challenge-based learning is an interdisciplinary approach where students apply technology to real-world issues in collaboration with instructors, professionals, and classmates to develop deeper knowledge, accept challenges, and share expertise. (Nichols & Cator, 2008). It is also defined as a collaborative learning experience that involves educators and students identifying challenges, providing solutions, acting, considering learning outcomes and consequences, and sharing with a wider audience (Johnson & Adams, 2011). Furthermore, it is defined as the educational framework that encourages participants to develop practical social and technical projects, interdisciplinary awareness, and professional skills while navigating local and global societal challenges. (De Stefani & Han, 2022).

Also, challenge-based learning involves group project collaboration among students, focusing on seven components: the big idea, key question, challenge, guiding questions, solution and implementation, assessment, and publishing. The big idea is a significant topic; the key question represents student demands and interests; the challenge involves intangible, meaningful actions; and the solution and implementation involve practical solutions in real-world settings; Assessment of a solution includes its connection to the challenge, content accuracy, communication clarity, implementation applicability, and idea efficacy, as well as the process of individuals and teams developing 21st-century skills and publishing, which involves learners utilizing various tools like blogs, videos, and assessments to document and share their experiences. (Apple Inc., 2009).

In addition, challenge-based learning, a variation of project-based, problem-based, and inquiry-based learning, involves real, open-ended problems, connecting students to real community issues. This approach enhances leadership, participation, and reflection on learning outcomes (Gaskins et al., 2015). As pointed out by Vilalta-Perdomo et al. (2022), note that challenge-based learning stands out from other teaching methods because it transcends the classroom, is less constrained by conceptual, physical, or temporal boundaries, and assumes that students and the community will continue to engage in meaningful ways long after the official academic year ends. In contrast to a final, product-oriented approach, he continues, challenge-based learning emphasizes sustainability issues and the requirement for an immediate and verifiable solution (Garay-Rondero et al., 2019).

Thus, Johnson et al. (2009) and Nichols et al. (2016) highlight the advantages of challenge-based learning, as it is an adaptable, customizable framework that offers flexibility, scalability, and responsibility for students. It focuses on universal concepts, significant problems, and regionally relevant solutions. It connects academic fields with practical practice, improves technology use, and encourages in-depth thought. It allows learners to make changes and establishes a genuine link between academic and practical fields.

The studies by Gallagher and Savage (2023) and Graham (2018) point out the main characteristics of challenge-based learning, which emphasizes the importance of authenticity, interdisciplinary learning, a student-centered approach, inquiry, critical thinking, collaboration, contextual learning, application of knowledge, innovation, continuous thinking, and societal and community impact in a learning environment, promoting a student-centered, innovative, and creative mindset.

Within the framework of some studies that dealt with challenge-based learning, Yang et al. (2018) conducted a study involving 48 university students and found that challenge-based learning significantly improved their courage, flexibility, perseverance, creativity, and innovation effectiveness. This approach also improved their curiosity, pattern-breaking skills, ability to feed ideas, and willingness to experiment and take risks. According to Membrillo-Hernández et al. (2019), students who took part in a challenge-based learning program performed better than their counterparts who stuck with traditional classroom instruction. They also showed higher levels of academic engagement, achievement, and performance indicators. A study by Colombelli et al. (2022) examined how a challenge-based learning program affected the growth mindset and entrepreneurship abilities of 127 college students. The outcomes showed that the course had a favorable and noteworthy effect on the students' growth attitude, financial culture, inventiveness, and planning, as well as their entrepreneurship abilities.

From the above, it is clear that challenge-based learning is a pedagogical approach that relies on students' active participation in a real, relevant situation related to their environment and enables learners to confront local and global challenges while acquiring content knowledge in mathematics, science, social studies, language arts, medicine, technology, engineering, and computer science. It is used in universities, schools, and institutions around the world and relies on shared big ideas such as feelings, issues, and problems to help define actionable challenges, a learning path, and personalized design to identify solutions.

2.2 Creative self-efficacy

Creative self-efficacy represents the self-judgment of an individual's specific abilities and affects his choice of activities, his perseverance and effort, and the presented outcomes. Creativity is a high-level human expression that involves reorganizing knowledge into innovative thinking and behavior, requiring cognitive facilities, effectiveness, perseverance, and continuous innovation. (Bandura, 1997). Bandura (1997) believes that creative self-efficacy is a form of self-efficacy that involves reorganizing knowledge into new thinking and behavior, requiring cognitive facilities and perseverance. It is a high form of human expression that requires effectiveness, perseverance, and the ability to produce innovative outputs.

Tierrary and Farmers (2002) define creative self-efficacy as an individual's belief in his or her ability to produce creative output. Abbott (2010) refers to the concept of creative self-efficacy as the extent to which an individual realizes his ability to express or perform creatively. Bandoura (2007) pointed out that the effectiveness of the creative self is influenced by an individual's beliefs about their abilities, which can increase with personal achievement and peer success while decreasing with failure and emotional arousal. People who are seeking creative results should be aware of the possible obsta cles they may face and try to plan for them. They should also not give up wh en they feel successful (Bandura, 1997).

According to Abbot (2010), creative self-efficacy is a belief in an individual's ability to generate new ideas, expressed through fluency, flexibility, originality, and detail. It also encompasses self-efficacy related to creative performance in authentic environments, involving readiness, influence, and personality, which depend on the individual's preparation, influence, and maintaining their creative personality.

2.3 Cognitive Engagement

Engagement in specific behaviors students exhibit in the learning environment indicates their quality of engagement or investment in the learning process. (Pace, 1998). Engagement is a multifaceted concept, encompassing behavior, emotion, and cognition. It involves participation in educational tasks, emotional commitment, and psychological investment in the learning process

(Fredricks et al., 2004), and then a fourth component was added to student engagement, which is effectiveness (Reeve, 2013; Sinatra et al., 2015). Cognitive engagement refers to a student's willingness and ability to complete a learning task, measured by their completion of homework, attendance, participation in extracurricular activities, interactions with teachers, and motivation in class discussions. (Appleton et al., 2006; Richardson & Newby, 2006).

Zimmerman (2008) defines cognitive engagement in learning as the extent to which students invest mental effort, critical thinking, and deep processing in educational tasks. In addition, Rotgans and Schmidt (2011) define cognitive engagement as students' significant effort and persistence in studying a topic over a prolonged period. Chi (2009) also adds that active cognitive engagement involves learners' intentional engagement in mental processes, which require effortful thinking and problem solving.

Cognitive engagement is influenced by the task and the level of independence they have. Tasks like group work, discussions, internet searches, and lectures can lead to different levels of engagement. Listening to a lecture is less engaging, while autonomous information-seeking behaviors increase engagement. Group dynamics, including controlling peers, can also impact cognitive engagement. The level of independence is directly linked to the task and its degree of engagement. (Rotgans & Schmidi, 2011). Chi & Wylie (2014) proposed the "interactive-constructive-active-passive" cognitive engagement model, which is a framework that identifies different dimensions of cognitive engagement in students. It suggests that higher levels of cognitive engagement lead to better educational outcomes. The model is used to design learning activities that promote active and interactive participation, enhancing understanding and retention of information. The model consists of three modes: interactive, constructive, active, and passive. Interactive learning involves meaningful interactions with peers or teachers, while constructive learning involves actively constructing new knowledge.

2.5 Research hypothesis

1 .There are no statistically significant differences in the average scores of students in the experimental and control groups in the post-measurement of creative self-efficacy and cognitive engagement among university students.

2 .There are no statistically significant differences in the average scores of students in the experimental group in the pre- and post-measurements of creative self-efficacy and cognitive engagement among university students.

3. There are no statistically significant differences in the average rank scores of the experimental group students in the post-measurement of creative self-efficacy and cognitive engagement according to the gender variable (males/ females).

3.Methods and procedures

3.1 Method

The quasi-experimental design for the experimental and control groups was presented as a challenge-based learning program for the experimental group in this study. As well, homogeneity between the experimental and control groups was confirmed before starting the program sessions.

3.2 Research Sample

The research sample was selected using a random approach and included 70 students with an average age of 21.87 years and a standard deviation of 1.63±. The research population included fourth-year students at College of Education, Kafrelsheikh University, in the academic year 2023-2024. Both the experimental and control groups included fifteen male and twenty female students, respectively.

3.3 Measurements

3.3.1 Creative Self- Efficacy Scale

The scale aims to measure creative self-efficacy in adolescents and adults and was developed by Karwowski et al. (2018). It consists of 11 statements, each measured on a 5-point (1 = definitely not to 5 = definitely yes) Likert scale, and all the statements on the scale are in the positive direction, so the participant’s score on the scale ranges from 11 to 55. The author translated the scale into Arabic and presented it to specialists in educational psychology and the English language to ensure its translation validity, as the correlation coefficient was 0.81 between the original and translated forms. In addition, the author applied the original version of the creative self-efficacy scale and the translated version to calculate content validity for 50 students in the

English department at the college of education, where the correlation coefficient between the original and translated versions reached 0.83 .The validity of the items was calculated by calculating the correlation coefficient between the item and the total score of the scale. All correlation coefficients between each item and the total score after deleting the item’s score from the total score were statistically significant at 0.05, where the values of the correlation coefficients ranged between 0.731 and 0.812. Also, the correlation coefficients of the internal consistency ranged between 0.701 and 0.824. In addition, the author applied the scale to the students of the exploratory sample of 50 students at the college of education to verify the reliability of the scale by half-splitting (r =.798 and Cronbach's alpha coefficient (r =.701), as well as calculating a re-test of the scale two weeks after the first measurement, and the correlation coefficients were.754. From the above, it is clear that the measure of creative self-efficacy achieves a high degree of validity, reliability, and internal consistency.

3.3.2 Cognitive Engagement Scale

The scale aims to measure the cognitive engagement of university students during lectures and was developed by Barlow et al. (2020). It consists of 18 statements divided into five dimensions: interactivity with peers, constructive notetaking, active notetaking, active processing, and passive processing. The student answers each statement on a five-point Likert scale. (1 not at all), 2 minimally, 3 somewhat, 4 mostly, 5 Very descriptive of my in-class activity Thus, the participant’s score on the scale ranges from 18 to 90. The higher the score on the scale, the greater the indicator of the participant’s possession of a high level of cognitive engagement. The cognitive engagement scale was translated into Arabic by the author; however, because the correlation coefficient between the two forms was 0.83, experts in educational psychology and the English language amended it to assure translation validity .

In addition, the author applied the original version of the cognitive engagement scale and the translated version to calculate content validity for 50 English major students at the college of education, where the correlation coefficient between the original and translated versions reached 0.85. To ensure the scale’s reliability, the author calculated the correlation of test-retest (r =.83) and half-split reliability (r =.79). Thus, the scale demonstrated good psychometric properties to measure students’ cognitive engagement.

3.3.3 Challenge-Based Learning Program

The challenge-based learning framework is divided into three interconnected phases: the engagement phase, the investigate phase, and the act phase, which include: Each stage of activities prepares learners to move on to the next stage. The three stages are explained in detail below:

First, the engagement stage: Through the process of asking basic questions, learners move from a big, abstract idea to a concrete and implementable challenge through:

(a) The big idea, such as identity, sustainability, creativity, violence, peace, and power, are crucial for high school students and the broader community. (b) Essential question: The proposed solution should align with the interests of students and the needs of their community. (c) The challenge: to generate specific answers or solutions to essential questions, promoting concrete and purposeful action.

Second: The investigation phase: All learners plan and engage in a journey that develops the framework for solutions and addresses academic requirements through:
Guiding Questions: These student-generated questions indicate the knowledge students need to learn to properly accomplish the challenge. (a) Guiding Activities: Students can respond to guiding questions and establish the groundwork for developing original, perceptive, and feasible solutions by using these lessons, simulations, games, and other activities. (c) Guiding Resources: This narrowly targeted collection of materials can include experts, databases, websites, videos, audio files, and more that enhance learning activities and assist students in coming up with answers.

Third: The implementation stage, wherein evidence-based remedies are created, put into practice with actual users, and then assessed in light of the outcomes, such as:
(a) Solutions: Every challenge is stated in a way that allows for a range of approaches, and every answer needs to be well-considered, specific, doable, and provided in a publishable multimedia format, like an improved podcast or brief video. (b) Evaluation: Among other things, the solution can be assessed for its appropriateness to the execution, correctness of the content, clarity of communication, and idea efficacy in relation to the difficulty. Apart from the solution itself, the steps that individuals and groups used to arrive at the solution can also be evaluated, which illustrates how crucial skills have changed in the twenty-first century. (c) Publication: The challenge process

offers several chances to record the encounter and share it with a wider audience. Students are urged to share their findings online and ask for comments. The goal is to increase the size of the learning community and promote dialogue about issues that are significant to the students.

The challenge-based learning program aims to improve creative self-efficacy and cognitive engagement among university students. The program is designed in five steps: defining learning objectives, identifying relevant challenges, designing learning activities, evaluating learning outcomes, and reflecting on and improving the program. The process involves defining learning objectives, identifying challenges, designing interactive activities, evaluating learning outcomes, and involving students in the evaluation process. The program is designed to be dynamic, interactive, and based on technology, ensuring its effectiveness and sustainability. The program consists of 18 sessions, in addition to the beginning and final sessions. The program implementation took seven weeks, with three sessions per week. The scheduled time for each session was one hour, and each session contains a different challenge that contributes to developing the lives of students in the present and future, and students offer a set of solutions to meet the different challenges. Fostering collaboration by encouraging discussions, brainstorming, and sharing Results were necessary in each session. Table 1 shows a summary of the program sessions. The program is evaluated through performance, self-assessment, peer, formative, and summative assessments. Performance assessments measure students' application of knowledge; self-assessment encourages reflection; peer reviews provide feedback; formative assessments provide ongoing feedback, and summative assessments measure learning outcomes at the end of the program.

Table 1: Big ideas, objectives, and changes of challenge-based learning sessions

Session	Big Idea	Objectives	Challenge
1	A general introduction to challenge-based learning and the pre-measurement of research tools.		
2	Traffic congestion and air pollution	Design a transportation system that reduces traffic congestion and air pollution and come up with a plan to create an efficient, sustainable, and accessible transportation system for everyone.	How can we design a transportation system that reduces traffic congestion and air pollution?
3	Clean energy sources	Defining the concept of clean energy and its importance and proposing sustainable solutions to reduce carbon emissions and promote clean energy.	How can we activate the concept of clean energy?
4	The housing problem	To think of various solutions to the housing problem at affordable prices for low-income families.	How can we confront the housing problem?

5	Food security	Explore local and global food systems, identify gaps, develop strategies to ensure everyone has access to food, consider agriculture, distribution, and community engagement, encourage participants to explore relevant resources, and research food safety guidelines.	How can food security be achieved?
6	Creating a more inclusive and diverse university community.	To come up with strategies to promote understanding, respect, and appreciation for different cultures and identities on campus.	How can we create a university community that is more inclusive, diverse, and culturally respectful?
7	Providing health care in remote rural areas.	To think of solutions to provide appropriate health care in remote rural areas.	How can health care in rural areas be improved?
8	Health Literacy	Access to Health Care: Investigate disparities in access to health care, especially in underserved communities. Develop solutions to improve healthcare delivery, telemedicine, and health literacy.	How can we create a system to improve universal health care and health literacy?
9	Facing environmental challenges and climate change	Environmental conservation and addressing environmental challenges such as deforestation, pollution, or endangered species, proposing conservation strategies, raising awareness, and taking necessary actions	How do we address environmental challenges, climate change, and conserve endangered species?
10	Digital transformation in education	To explore the digital divide and its impact on education, develop initiatives to bridge the gap, provide access to technology, and promote digital literacy	How can we promote digital learning and digital literacy?
11	Designing Sustainable Communities	Develop an understanding of the principles of sustainable community design, apply knowledge of sustainable community design to real-world challenges, collaborate with stakeholders to find sustainable community solutions, and develop 21st century skills such as critical thinking, problem solving, and communication.	How to we design a sustainable society?
12	Cybersecurity	To achieve online safety, responsible use of social media, or protection of personal information, learners can create workshops, develop online safety guidelines, or raise awareness about digital rights.	How can we achieve cybersecurity?
13	Water security	Water conservation and access, investigating water scarcity, water efficiency, and access to clean water, and proposing strategies for water conservation, rainwater harvesting, or community water management.	How can we achieve water security?

14	Reducing pollution resulting from plastic waste	Addressing the environmental impact of plastic waste, recycling, alternatives, organizing plastic clean-up campaigns, creating awareness campaigns, or proposing policies to reduce plastic consumption.	How can we reduce plastic pollution?
15	Awareness of mental health .	Mental health awareness, stress management, promoting well-being, employing mindfulness, or coping strategies, peer support, and organizing mental health workshops	How can we achieve mental health?
16	Climate Changes	Investigate the impact of climate change on communities, extreme weather events, adaptation strategies, or disaster preparedness, propose community resilience plans; conduct risk assessments; or participate in climate action projects.	How can we adapt to climate change?
17	Safe and optimal use of artificial intelligence	Promote the safe and optimal use of AI, how to benefit from different applications of AI, privacy settings, responsible online communication, and creating appropriate resources.	How do we achieve safe and optimal use of AI?
18	Quality of Life	Enhancing the quality of life and achieving psychological and social empowerment, which contributes positively to the individual and society.	How can we improve our quality of life?
19	Skills required for job competition.	To provide the student with the skills required for future competition in the labor market.	What skills are required to compete for a distinguished job in the future?
20	Final evaluation of the program and post-measurement of research tools.		

3.4 Research Procedures

(1) Determining the research population, which is the fourth-year students at the college of education, Kafrelsheikh University, in the academic year 2023- 2024.

(2) Collecting literature related to challenge-based learning, creative self-efficacy, and cognitive engagement.

(3) Translating and verifying the psychometric properties of the tools used to measure variables.

(4) Ensuring equality as the experimental and control groups are equal and guaranteeing that there are no variations between the two groups, male and female members are the same.

(5) Collecting the data and using appropriate statistical methods to verify research hypotheses.

(6) Discussing and interpreting the research results and presenting recommendations and proposed research in light of the research results.

3.5 Statistical Methods

The author used statistical methods represented by arithmetic means, standard deviations, correlation coefficients, analysis of variance, and Mann-Whitney test through the program (SPSS v25).

4. Results and discussion

4.1 Hypothesis 1:There are no significant differences in the average scores of students in the experimental and control groups in the post-measurement of creative self-efficacy and cognitive engagement among university students.

As indicated in Table 2, the author employed a t-test to compare the post-measurements of creative self-efficacy and cognitive engagement across the two groups in order to assess the validity of this hypothesis.

Table 2: Results of the t-test and effect size values for the significance of the differences in creative self-efficacy and cognitive engagement between the average scores of students in the experimental and control groups in the post-measurement.

Variables	Control group N = 35		Experimental Group N = 35		Differences significance		η^2	
	Mean	Std. deviation	Mean	Std. deviation	T value	Level of sign.	Value	Sig.
Creative self-efficacy	25.02	2.05	37.11	3.20	18.78	0.01	0.766	High
Cognitive Engagement	36.77	4.06	52.25	10.42	12.42	0.01	0.823	High

As shown in Table 2,

(1) There are significant differences in the average scores of students between the control and experimental groups in the post-measurement of creative self-efficacy. Also, the effect of the challenge-based program was 0.766.

(2) There are significant differences in the average scores of students between the control and experimental groups in the post-measurement of cognitive engagement. Also, the effect of the challenge-based program was 0.823

These results are in line with the study of O'Mahony et al. (2012), which examined the differences between lecture and challenge-based learning and found that participants in the challenge-based group interacted more. Furthermore, the challenge-based group outperformed the control group on posttest items that required conceptual synthesis and integration. More opportunity for participants to make connections between concepts was offered by the task's increased engagement, which may have helped challenge participants to synthesize newly learned concepts more effectively. In addition, the study by Membrillo-Hernández et al. (2019) indicated that the challenge-based learning experience was 20 to 40% more efficient than the experience of students who remained in traditional classroom education and contributed to improved collaborative work, flexibility, critical thinking, academic challenge, engagement, increased student commitment, as well as interaction between staff and students, rich learning experiences, supportive learning environments, and interactive learning at work, which were also significantly higher. The study by Alon and Petiluna (2020) indicated that challenge-based learning encouraged STEM students to think creatively and critically by creating research projects that aim to address real-world issues such as environmental degradation. Furthermore, a noteworthy distinction exists between the experimental and control groups concerning creativity, scientific reasoning, meticulousness, and proficiency. Additionally, research demonstrated that students had pleasant interactions with the subject.

These results can be explained by the fact that challenge-based learning increases the student's perseverance and insistence on learning. As well as increasing students' motivation (Simón-Chico et al., 2023). It also stimulates the student's awareness, attention, and creative abilities, which increases engagement within the classroom and reduces opportunities for his thoughts to wander outside of the lesson.

Thus, based on previous results, the null hypothesis can be rejected, and the alternative hypothesis can be accepted.

4.2 Hypothesis 2: There are no significant differences in the mean scores of students in the two experimental groups in the pre- and post-measurements of creative self-efficacy and cognitive engagement among university students.

The author employed a t-test to investigate the differences between the experimental group's mean rank scores in the pre- and post-measures of creative self-efficacy and cognitive engagement among college of education students in order to test the validity of this hypothesis, as indicated in Table 3.

Table 3: Results of t-test and effect size values for the significance of the differences between the mean rank scores of students in the two experimental groups in the pre- and post-measurements in creative self-efficacy and cognitive engagement.

Variables	Experimental group N= 35				Differences significance		η^2	
	Pre-Test		Post- Test					
	Mean	Std. deviation	Mean	Std. deviation	T value	Level of sig.	Value	Sig.
Creative self-efficacy	25.22	2.17	37.11	3.20	18.16	0.01	0.753	High
Cognitive Engagement	36.02	4.07	52.62	5.46	23.09	0.01	0.764	High

As shown in Table 3

(1) There are significant differences in the mean rank scores of students in the experimental group in the pre- and post-measurements of creative self-efficacy among university students. Also, the effect of the challenge-based program was 0.753.

(2) There are significant differences in the mean rank scores of students in the experimental group in the pre- and post-measurements of cognitive engagement among university students. Also, the effect of the challenge-based program was 0.764.

These results are similar to those of Simón-Chico et al. (2023), who indicated that challenge-based learning increases students' engagement, and the students' scores in the experimental group were higher than those in the control group. They recommended that challenge-based learning might be an effective method for students to achieve behavioral, motivational, and learning outcomes. Nichols and Cator (2008) pointed out that challenge-based learning fosters collaboration among students and teachers through the use of well-crafted questions, in-depth subject matter knowledge development, acceptance and resolution of difficulties, action taking, and experience sharing. In addition to, The results of Yang et al. (2018) showed that creative consciousness, levels of curiosity, pattern-breaking skills, idea nurturing ability, willingness to experiment and take risks, courage and resilience, and energetic persistence of creativity and innovation effectiveness were significantly higher in the posttest than the pretest, and highlighted that challenge-based learning increases students' innovation and creativity and helps them to be self-directed, innovative, and creative. Nichols (2023) indicated that challenge-based learning centers instruction around personally relevant real-world problems, leading to deep engagement and internal motivation. Understanding the significance (or relevance) of what was learned during the engagement phase gives the subsequent learning opportunities a framework and an intention to be investigated, thought through, and remembered. The meaning and applicability of the big idea are specifically explored during the crucial questioning process in the engagement phase. These results can be explained by the fact that challenge-based learning increases the student's perseverance and insistence on learning. It also stimulates the student's awareness, attention, and creative abilities, which increases engagement within the classroom and reduces opportunities for his thoughts to wander outside of the lesson. Thus, based on the previous results, the null hypothesis can be rejected and the alternative hypothesis can be accepted.

4.3 Hypothesis 3: There are no statistically significant differences in the average rank scores of the experimental group students in the post-measurement of creative self-efficacy and cognitive engagement according to the gender variable (males/ females).

To find the differences and investigate this hypothesis, the author employed Mann-Whitney test; the outcomes are displayed in Table 4.

Table 4. Differences between the average ranks of the experimental group's scores in creative self-efficacy and cognitive engagement between males and females

Variable	group	N	Mean	St. Deviation	Mean Rank	Sum of Ranks	Z	U	Sig. level
Creative self-efficacy	Males	15	36.60	3.11	17.40	261.0	1.82	.309	Non sig.
	Females	20	37.50	3.30	18.45	369.0			
Cognitive engagement	Males	15	58.60	4.45	10.60	159.0	1.69	3.73	Non sig.
	Females	20	60.65	4.04	21.55	371.0			
	Females	20	11.65	.933	18.15	18.15			

As shown in Table 4,

(1) There are no differences at the level of (0.01) between males and females in creative self-efficacy and cognitive engagement in the experimental group.

These results. This result is in accordance with the study of Hashim et al. (2022), which indicated no significant differences between male and females in creative self-efficacy and creative ability. This result is in accordance with Mohammed et al.'s (2014), which indicated no gender differences in students's engagement. Whereas differ from the results by He& Wong (2021; Karwowski, 2011; Karwowski et al., 2013), which addressed that males score higher levels of creative self-efficacy than females.

(2) There are no differences at the level of 0.01 between males and females in cognitive engagement in the experimental group. This result is in accordance with the study of Amir et al. (2014), which indicated no differences between males and female students in cognitive engagement level. While this result differs from Santos et al. (2021), which showed that females addressed higher scores in student engagement than males, and Kinzie et al. (2007), which detected male engagement in learning activities was less than females, It also differs from Zhao et al. (2023), which indicated that males perceived higher scores of cognitive perception than females. Thus, based on the previous results, we should accept this hypothesis.

5. Recommendations

- The necessity of replacing traditional teaching methods with challenge-based learning in various educational institutions

- Preparing teachers to use challenge-based learning in enrichment and guidance programs and workshops.

- Train students during challenge-based learning to choose the challenge carefully and make it real.

- Providing appropriate technological support for students to help them practice active learning.

6. Suggested Research

- The effect of a challenge-based learning program in improving the cognitive and academic engagement of high school students.

- The effectiveness of a challenge-based learning program in improving the academic achievement of academically struggling university students.

- The effect of a challenge-based learning program in improving working memory of students with attention deficit hyperactivity disorders.

- Challenge-Based Learning of gifted, normal, learning disables students.

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أثر برنامج للتعلم القائم على التحدي في تحسين فاعلية الذات الإبداعية والاندماج المعرفي لدى طلاب الجامعة

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المستخلص:

هدف البحث الحالي إلى التعرف على أثر برنامج للتعلم القائم على التحدي في تحسين فاعلية الذات الإبداعية، والاندماج المعرفي لدى طلبة كلية التربية بجامعة كفر الشيخ. كما هدف إلى الكشف عن وجود فروق تعزى للجنس (ذكر/ أنثى) في القياس البعدي للمجموعة التجريبية في فاعلية الذات الإبداعية، والاندماج المعرفي. وتكونت العينة من ٧٠ طالباً وطالبة متوسط أعمارهم ٢١,٨٧ سنة وانحراف معياري ±١,٦٣، مقسمين إلى مجموعتين: تجريبية وضابطة. وتتكون كل مجموعة من ٣٥ طالبا وطالبة. ولقياس متغيرات البحث تم استخدام مقياسي فاعلية الذات الإبداعية، والاندماج المعرفي (تعريب وتقنين الباحثة). وتم استخدام الأساليب الإحصائية المناسبة لتحليل البيانات. أشارت النتائج إلى وجود فروق ذات دلالة إحصائية بين متوسطي درجات طلاب المجموعة التجريبية والضابطة في الاختبار البعدي في فاعلية الذات الإبداعية، والاندماج المعرفي لصالح طلاب المجموعة التجريبية. كما أظهرت النتائج وجود فروق ذات دلالة إحصائية بين متوسطات درجات المجموعة التجريبية في الاختبار القبلي والبعدي في فاعلية الذات الإبداعية، والاندماج المعرفي لصالح الاختبار البعدي. بينما لم توجد فروق ذات دلالة إحصائية تُعزى للنوع (ذكور/ إناث) في فاعلية الذات الإبداعية، أو الاندماج المعرفي في القياس البعدي لدى طلاب المجموعة التجريبية. وتم تقديم بعض التوصيات والأبحاث المقترحة في ضوء نتائج البحث.

الكلمات المفتاحية: التعلم القائم على التحدي، فاعلية الذات الإبداعية، الاندماج المعرفي.