

**THE EFFECTIVENESS OF THE BRAINSTORMING TECHNIQUE TOWARD
ENHANCING CREATIVE AND CRITICAL THINKING SKILLS AMONG
SECONDARY IRAQI PHYSICS STUDENTS**

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ABSTRACT

Past research has established that Iraqi education lacks integration of creative and critical thinking skills in the classroom. Thus, the main purpose of this study was to investigate the effectiveness of the brainstorming technique towards enhancing creative and critical thinking skills among secondary Iraqi physics students.

First, the existing procedures for the brainstorming technique which comprised three original steps, problem identification, idea generation and idea evaluation were identified through a literature review. Three new steps, namely selection of the best idea, implementation and problem solving were added in this study. A mixed-method methodology was employed in the study. For the quantitative aspect, a quasi-experimental design was utilised. A total of 80 students from two intact classes in the Iraqi Saba School participated in the study. One class was taken as the control group (N = 41) who were taught physics via the traditional method while the other class was the experimental group (N = 39) who were taught physics via the brainstorming technique for four months. The Physics achievement test was prepared specifically for this study for the purpose of establishing homogeneity between the control and experimental groups. The independent variable was the method of instruction, either the brainstorming technique or traditional method. The dependent variables were performance in creative and critical thinking tests. The Torrance Test of Creative Thinking (TTCT) and the Watson Glaser Critical Thinking (WGCT) were modified and adapted to measure the respective dependent variables. The problem solving tasks in these tests were based on four physics topics namely, reflection of light, refraction of light, thin lenses, and color and electromagnetic spectrum. In the TTCT, there were three dimensions of creative thinking, fluency, flexibility and originality. For the WGCT, the five dimensions were inference, recognizing assumptions, deduction,

interpretation and evaluating arguments. Additionally, students' perceptions about the brainstorming technique were captured through qualitative interviews and open-ended questionnaires.

Results of the t-test showed that the experimental and control groups were equal in the TTCT, WGCT and in physics achievement tests before the intervention. After the four months intervention, results of the multivariate analysis of variance (MANOVA) and analysis of covariance (ANCOVA) showed that there were significant differences in creative thinking overall and in the sub skills of fluency, flexibility, and originality between the groups. Results for the critical thinking test showed that there were statistically significant differences in critical thinking overall and in the sub skills recognizing assumptions, interpretation, and evaluating arguments between the groups. However, analysis showed there was no significant difference for the two sub skills of critical thinking which were inference and deduction skills.

The study revealed that the brainstorming technique could create scaffolds for the enhancement of creative and critical thinking, as the students proceeded through the various steps of the technique. Furthermore, students characterized brainstorming as an effective teaching technique for learning physics. Nonetheless, the Iraqi students also suggested several ideas to improve the brainstorming technique for the teaching and learning of physics.

KEBERKESANAN TEKNIK *BRAINSTORMING* DALAM PENINGKATAN KEMAHIRAN BERFIKIR KREATIF DAN KRITIKAL DALAM KALANGAN MURID FIZIK SEKOLAH MENENGAH IRAQ

ABSTRAK

Kajian lepas telah menunjukkan pendidikan di Iraq kurang dari aspek integrasi kemahiran berfikir kreatif dan kritikal dalam bilik darjah. Oleh itu, tujuan utama kajian ini adalah untuk menyiasat keberkesanan teknik *brainstorming* dalam peningkatan kemahiran berfikir secara kreatif dan kritikal dalam kalangan murid Fizik sekolah menengah Iraq.

Pertama, prosedur tiga langkah yang sedia wujud untuk teknik *brainstorming* di kenal pasti dari ulasan literatur iaitu kenal pasti masalah, janaan idea dan penilaian idea. Tiga lagi langkah baru iaitu pemilihan idea yang terbaik, implementasi dan penyelesaian masalah ditambah dalam kajian ini. Pendekatan kaedah *mixed-method* digunakan dalam kajian ini. Untuk aspek kuantitatif, reka-bentuk kajian adalah kuasi-eksperimental. Sejumlah 80 orang murid dari dua kelas *intact* dari Sekolah Saba di Iraq mengambil bahagian dalam kajian ini. Satu kelas diambil sebagai kumpulan kawalan (N=41) dan diajar Fizik dengan menggunakan pendekatan tradisional, dan satu kelas lagi di ambil sebagai kumpulan eksperimental (N=39) dan diajar Fizik melalui teknik *brainstorming* selama empat bulan. Ujian pencapaian Fizik disediakan, khusus untuk menentukan sampel kumpulan kawalan dan eksperimental adalah homogenus. Pembolehubah tidak bersandar adalah kaedah pengajaran, iaitu teknik *brainstorming* atau keadah tradisional. Pembolehubah bersandar adalah prestasi kemahiran berfikir kreatif dan kritikal. Dua ujian iaitu *Torrance Test of Creative Thinking (TTCT)* dan *Watson Glaser Critical Thinking (WGCT)* diubahsuai dan diadaptasikan untuk mengukur dua pembolehubah tersebut. Tugas penyelesaian masalah dalam kedua-dua

ujian ini adalah berdasarkan empat topik fizik iaitu pantulan cahaya, refraksi cahaya, lensa nipis dan spektrum elektromagnetik. Dalam TTCT, tiga dimensi kemahiran berfikir kreatif dinilai iaitu *fluency*, fleksibiliti, keaslian. Untuk ujian WGCT lima dimensi kemahiran berfikir dinilai iaitu inferens, *recognizing assumptions*, deduksi, interpretasi dan *evaluating arguments*. Di samping itu persepsi murid terhadap teknik *brainstorming* di kenalpastikan melalui temu bual kualitatif dan soal-selidik terbuka.

Keputusan ujian-t menunjukkan bahawa kumpulan kawalan dan eksperimental adalah sama taraf dalam TTCT, WGCT dan ujian pencapaian fizik sebelum intervensi. Selepas intervensi empat bulan, keputusan analisis multivariate (MANOVA) dan analisis covariance (ANCOVA) menunjukkan terdapat perbezaan signifikan untuk kemahiran berfikir kreatif secara keseluruhan dan juga dalam sub-sub kemahiran iaitu *fluency*, fleksibiliti and keaslian antara kumpulan eksperimental dan kawalan. Keputusan untuk kemahiran berfikir kritikal menunjukkan bahawa juga terdapat perbezaan signifikan secara keseluruhan dan dalam sub-sub kemahiran iaitu *recognizing assumptions*, interpretasi, dan *evaluating arguments*. Namun, tiada perbezaan signifikan antara kumpulan kawalan dan eksperimental untuk sub-sub kemahiran inferens dan deduksi.

Kajin menunjukkan bahawa teknik *brainstorming* mewujudkan *scaffolds* untuk peningkatan kemahiran berfikir kreatif dan kritikal, apabila murid-murid melalui langkah-langkah teknik *brainstorming*. Murid-murid juga berpendapat teknik tersebut adalah efektif dalam pembelajaran fizik. Namun demikian murid-murid Iraq telah mencadangkan beberapa idea untuk menambahbaikkan lagi teknik *brainstroming* untuk pengajaran - pembelajaran fizik.

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