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Developing a Creative Thinking Test for Iraqi Physics Students

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Abstract: **It can be said that developing creative thinking skills is the key to educational success. "Creativity is the ability to imagine or invent something new. Creativity is not the ability to create out of nothing, but the ability to generate new ideas by combining, changing, or reapplying existing ideas" (Harris, 1998). In science education, there are several general creative thinking tests which have been designed to evaluate how much students have gained the three creative thinking skills (fluency, flexibility and originality) from learning. There are no specific creativity tests for subjects such as Physics. This paper will describe as part of a bigger study a Physics creativity test was prepared for Iraqi second-grade intermediate students. Building upon the Torrance Test of Creative Thinking Tests (TTCT) and various other creative thinking tests in science education creative thinking test was prepared specifically for Iraqi physics students in the second-grade intermediate level. This test of creative thinking has been examined in terms of validity and reliability. The result indicated that the creative thinking test has appropriate validity and reliability and the test can be applied successfully.**

Keywords: **Creative thinking tests; Creativity in physics, second-grade intermediate students.**

I. INTRODUCTION

There is no consensus on the definition of creativity in the literature (BacanlI, DombaycI, Demir, & Tarhan, 2011). Therefore, there are a diversity of creativity definitions such as Torrance (1966) defined creativity as: a process of becoming sensitive to a problem, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating a hypothesis about these deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results (p.6). Furthermore, creativity has been described as "the ability to solve problems and fashion products and to raise new questions" (Gardner, 1993); Cropley (2001) characterized creativity by 'novelty, effectiveness and ethicality'. Davis (1992) documents four "Ps" for understanding creativity: person, product, process and press (i.e., environment or climate).

Creativity can also mean the ability to imagine or invent something new. Creative thinking skills are essential for success in learning and success in life (Fisher, 2006). Creative thinking skills equips students to go beyond the information given, to deal systematically, flexibly with problems and situations, to adopt a critical attitude to information and arguments as well as to communicate effectively (McGuinness, 1999). Guilford (1950) proposed creativity as the ability to produce a new idea into existence via divergent thinking or arrive at many solutions to a problem, and offered three dimensions to describe creativity: (i) fluency: ability to generate lots of ideas; (ii) flexibility: ability to look at a question or topic from multiple perspectives; and (iii) originality: is the crux of creativity. Creativity can also mean to generate unique or unusual and unexpected ideas.

To evaluate creativity, there must be measurable indicators to determine how much students have gained from learning. The formal psychometric measurement of creativity is usually considered to have begun with Guilford (1950). Guilford's group constructed several tests to measure creativity in 1967 such as: plot titles; quick responses; figure concepts; unusual uses; remote associations; and remote consequences.

Building on Guilford's work, Torrance developed the Torrance Tests of Creative Thinking (TTCT) in1966. They involved simple tests of divergent thinking and other problem-solving skills, which were used to assess three mental characteristics: fluency, flexibility and originality for a student. The TTCT test has been modified four times since its original version. Wallach and Kogan also developed a test to measure creativity for students (Wallach & Kogan, 1965). In a more recent study, Carson, Peterson, and Higgins, (2005) developed a new self-report measure of Creative Achievement Questionnaire (CAQ) that assesses achievement across 10 domains of creativity. The CAQ test has been shown to be reliable and valid when compared to other measures of creativity and can be an independent evaluation of creative output. Torrance's research and the development of the TTCT have provided groundwork for the idea that creative levels can be measured and then increased through teaching and practice (Kim, 2006; McIntyre, Hite, & Rickard, 2003; Scott, Leritz, & Mumford, 2004).

Science is a creative subject; it provides many opportunities to motivate students' creative thinking skills. In science education, several creative thinking tests have been developed (Hu & Adey, 2002; Pekmez, Aktamis, & Taskin, 2009). The field of Physics has a sufficient range to promote creativity in its own domain, and therefore creativity can be brought up in the context of learning physics. This paper will describe how by taking into account all the existing tests and the unique features of physics; a test appropriate for physics to measure three pertinent skills of creative thinking was developed.

II. THE CREATIVE THINKING TEST FOR PHYSICS

The preparation of this creative thinking test is part of a larger study to investigate the construction of creative and critical thinking skills among selected Iraqi second grade intermediate level physics students. The preparation of the test underwent several steps. First, selected features and ideas which could be derived from existing tests were identified. Then, the items were constructed. Some items were adapted from existing tests and other items were original and constructed specific to physics. Once this was completed, a pilot test was conducted and the validity and the reliability were determined.

Ideas from existing instruments

After the researcher had reviewed the various creative thinking tests (Cheng, 2011; Guilford, 1950; Hu & Adey, 2002; Pekmez, et al., 2009; Rabari, Indoshi, & Okwach, 2011; Torrance, 1966; Wallach & Kogan, 1965), it was clear that three creative capabilities were fluency, flexibility and originality. The researcher then prepared six tasks for the creative thinking test based upon these capabilities. The tasks included three adapted from Hu and Adey (2002), one adapted from Perkmez et al. (2009), one adapted from Torrance (1966) and one task was original. Based upon Torrance's idea, each of the tasks addressed one of the following types of questions:

(i) Asking Questions: Students are requested to generate the largest possible number of questions based on the picture given;

(ii) Guessing the Cause: Students are requested to write all the reasons or introductions that led to what appears in the picture given;

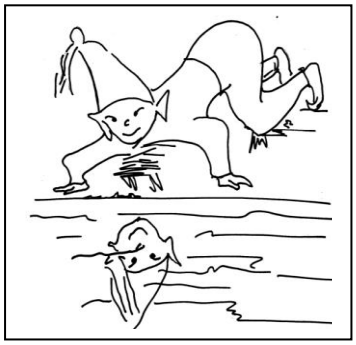
(iii) Guessing the cause of an occurrence or an event: Students are requested to write all that could entail or resulting from the situation or incident;

(iv) Improving Products: Students are required to write all amendments or additions that can be added to improve the product;

(v) Alternative Uses of Common Materials: Students are requested to write the largest possible number of scientific uses for empty plastic bottles that people usually throw; and

(vi) Supposing: Student displays a default position is impossible to happen and asked him/her to write everything that can result from the occurrence of this situation on the assumption it is possible to do so, and students have to write all the ideas and guesses that can arise from this event occurs.

Tasks 2 and 3 are shown in Figure 1 that addresses type (ii) and type (iii) questions.



TASK 2: Guessing the Causes

List down as many incidents as you can think might be the cause related to the picture below. List your answer in the blanks available.

For example, the person sees his image on the water because the phenomenon of reflection.

Source: (Torrance, 1966)

TASK 3: Guessing the Effect of an Incident

List down as many effects as you can think of in the blanks available caused by the event in the picture given

Figure.1. Tasks 2 and 3

To score the answers given by the students in the tasks, the scoring criteria of Torrance (1990) was referred to. A list of criteria for the skills fluency, flexibility and originality for the test is as shown in the Table 1.

Table 1: Scoring criteria of creative thinking skills for each student

Skills	Statement
Fluency	Number of responses by each student to each task; Each answer (every correct idea or an appropriate response) has been allocated one score, and the exclusion of inappropriate ideas; The total score of all the six tasks reflect the creative fluency skill.
Flexibility	Number of varied responses by each student to each task; The answers will be checked and categorised based on similarity; Each category of answer will be allocated one score; The total score of all the six tasks will reflect the creative flexibility skill.
Originality	The answers will be scrutinized and one score for all original answers for all the tasks. The total score of all six tasks will reflect the skill of creative originality.

To determine the total score of a student in the creative thinking test, the scores obtained in each of the skill fluency, flexibility and originality will be totalled.

Pilot Study of Creative Thinking Test

Pilot studies are a crucial element of a good study design. Therefore, a pilot study was conducted with the creative thinking test to a sample of (30) students in the Al-Atemad school in Iraq in order to find out the validity and reliability of the test. The pilot study facilitated the refinement of the tasks (van Teijlingen & Hundley, (2001) and led to the development of better questions for the larger study.

Validity of Creative Thinking Test

A valid test is one that measures what it is supposed to measure. The validity of the creative thinking test was verified in two methods:

a) Content Validity

After preparing the test, the researcher offered the creative thinking test to a group of experts to find out the clarity, suitability and to verify the adequacy of the questions for the targeted sample of the larger study. Then test was introduced to five experienced physics teachers in different Iraqi schools to verify the appropriateness of the test to the level of the student sample. Based on experts' feedback, the test was modified and finalised

b) Internal Consistency

Internal consistency is the strength of correlation scores between different items on the same test . The internal consistency of the test was verified via application of the test on an exploratory sample consist of 30 students in a pilot study. The Pearson's correlation coefficient for each item was calculated using the statistical program SPSS and results are as shown in Table 2 below.

Table 2: Correlation coefficients between each creative thinking skill and the total score of the test

Skills	Correlation Coefficients
Fluency	0.751
Flexibility	0.671
Originality	0.552

The correlation coefficients in Table2 are acceptable.

Reliability of the Creative Thinking Test

A reliable test is one where the results are similar or the same results are obtained if applied to the same sample more than once under the same conditions. The researcher ensured the reliability of the creative thinking test and suitability for the Iraqi environment by conducting the pilot study.

The researcher utilized the method of (test - re-test) on the pilot sample after two weeks from the first application. The correlation coefficient was calculated between the two applications of the tests via using Cronbach's alpha equation for consistency procedure through the program (SPSS) statistical. The results are given in Table 3.

Table 3: Cronbach's alpha coefficient for creative thinking skills

Skills	Cronbach's alpha coefficient
Fluency	0.79
Flexibility	0.739
Originality	0.570

The values of Cronbach's alpha coefficient are appropriate to achieve the objectives of this study, which confirms the reliability of the use of the creative thinking test in judging the creative abilities of the respondents.

III. CONCLUSION

This paper has presented an attempt to prepare and validate a physics creativity test for second grade intermediate Iraqi students as part of a larger study. Six tasks based upon theoretical situations to elicit creativity skills were refined through a pilot test. Internal consistency, and face validity were found to be satisfactory. The test re-test method was applied to confirm the reliability of creative thinking test. The results of these investigations suggest that this test can be useful in assessing creativity of second-grade intermediate Iraqi students. However, more empirical studies need been done to further validate the test.

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