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# Educational Research and Reviews



23 June, 2019  
ISSN: 1990-3839  
DOI: 10.5897/ERR  
[www.academicjournals.org](http://www.academicjournals.org)



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*Full Length Research Paper*

# **Comparative analysis of psychometric properties of mathematics items constructed by Waec and Neco in Nigeria using item response theory approach**

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Received 7 July, 2019; Accepted 5 December, 2019

**West Africa Examination Council (WAEC) and National Examination Council (NECO) are the two major examination bodies saddled with the responsibility of awarding Senior Secondary School Certificate in Nigeria. This study examined the comparability of the psychometric properties of the items constructed by the two examination bodies using Item Response Theory (IRT) approach. Three parameters (difficulty, discriminating and distractor Indices) logistic model was adopted for the study. The study employed descriptive research design of the survey type. The population for the study comprised all Senior Secondary School Students who enrolled for 2019 WAEC and NECO examinations in South West, Nigeria. The sample for the study consisted of 1,200 Senior Secondary School Students selected using multistage sampling procedure. The instruments for the study were objective items constructed by the examination bodies. The findings of the study showed that the difficulty and guessing indices of the mathematics items constructed by the two examination bodies are comparable while the discriminating powers not comparable. It is, therefore, recommended that certificates issued by WAEC and NECO could be used for same purposes without any discrimination since the items constructed by the examination bodies are of comparable standard in terms of their qualities.**

**Key words:** Difficulty levels, discriminating powers, guessing indices, Item Response Theory (IRT), West Africa Examination Council (WAEC), National Examination Council (NECO).

## **INTRODUCTION**

West Africa Examination Council (WAEC) and National Examination Council (NECO) are the two major examination bodies in Nigeria that have mandate to award Senior School Certificate. WAEC was established in the year 1952 to conduct examinations for Anglophoric Countries of West Africa (Ghana, Sierra Leone, Liberia, Gambia and Nigeria) while NECO were established in

Nigeria in year 2000. The two examination bodies conduct parallel Senior School Certificate Examinations in various subjects, such as Mathematics, English Language ect cetera. However, at inception, there was criticism against NECO examinations, some say its questions are too tough than those of WAEC (Anigbo, 2018; Awogbemi et al., 2015). Since WAEC and NECO

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have similar syllabi and award certificate for same purposes, their examinations are expected to be of comparable standard in terms of the psychometric properties of the items constructed by the examination bodies. The set of students that took these examinations are expected to be of comparable ability because the students that took the examinations were exposed to the same course contents and curriculum within the same time frame. Therefore, they are expected to have equal possibility of success in NECO and WAEC examinations but this is not so in reality which shows that it is probable that some technical weaknesses exist in the test constructed by the examination bodies.

To this end, the study did a comparative analysis of the psychometric properties of items constructed by the examination bodies. Psychometric characteristics of examinations refer to certain attributes inherent in tests upon which an assessment of candidates is based. These characteristics include the difficulty index, the discriminating index, distractor index, validity and reliability indices of the test items. Items that are correctly answered by students do not convey any message about individual differences in performance. Item difficulty tries to estimate how easy or difficult is the item, the higher the value, the easier the item or lower the difficulty.

The ability of an item to discriminate between higher ability examinees and lower ability examinees is known as item discrimination. There are several methods being used to assess item discrimination. These include, finding the difference in the proportion of high and low achieving students who score the item correctly. Therefore, it is necessary to know the psychometric properties of examination items constructed by these examination bodies to ascertain its effectiveness.

Oshkosh (2002) stated that Item Analysis is probably the most important tool to increase test effectiveness, it is a scientific way of improving the quality of tests, and test items in an item bank. An item analysis provides three kinds of important information about the quality of test items. Item difficulty is a measure of whether an item was too easy or too difficult. Item discrimination is a measure of whether an item discriminated between candidates who knew the test well and candidates who did not. Distractor Index measures the effectiveness of alternatives, that is, to determine whether distractors (incorrect but plausible options) tend to be chosen by the less able examinees and not by the more able examinees. Therefore, since test item affects the vital psychometric properties of measuring quality of examinations, examination bodies are expected to construct test items in such a manner that items are free from writing errors to ensure that the items measures what it exactly want to measure without any ambiguity. In view of this there is the need to embark on this study in order to examine the comparability of the items constructed by WAEC and NECO since they award certificates use for similar purposes.

## Statement of the problem

Knowledge of mathematics is fundamental to the success of several subjects in school curriculum and it is, also indispensable for national technological growth. In a developing country such as Nigeria, performance of student in Mathematics which is bedrock of nation's technological advancement should be given complete attention. The performance of students in WAEC and NECO are not comparable for instance, according to examiners reports, in year 2018 NECO Mathematics examination 82.32% pass at credit level while 49.98% of the students who sat for WAEC Mathematics examinations in the year passed at credit level. Since the examinations were attempted by same set of students taught by the same teacher, and WAEC and NECO have similar syllabi, and award certificates for same purposes their items are expected to be of comparable standard with comparable performance. It is probable that some technical weaknesses exist in the tests developed and administered by the WAEC and NECO. Therefore, it is necessary to examine and compare the quality of the items constructed by the examination bodies.

## Purpose of the study

The purpose of the study was to examine the comparability of the psychometric properties (difficulty levels, discriminating powers and guessing indices) of the Mathematics examination items constructed by WAEC and NECO in Nigeria using item Response Theory (IRT) approach.

## Theoretical framework

The theoretical framework for the study focuses on 3-parameter Logistic model Item Response theory (IRT) developed by Lord, (1980). The model has basic assumptions of un-dimensionality and Local Independence. In the 3-parameter Logistic model, the probability of a correct response to a dichotomous item. Usually, a multiple –choice item is presented mathematically as follows:

$$P_i(\theta) = C_i + \frac{1 - C_i}{1 + e^{-D a_i(\theta - b_i)}}$$

Where:

$\theta$ : is the test taker's ability

$a_i$ : is the item discrimination index

$b_i$ : is the difficulty parameter

$C_i$ : is the guessing index

$e$ : is the base of natural logarithm and is approximately equal to 2.714

$D$ : is the arbitrary constant (normally  $D = 1.7$ )



IRT which is also known as latent response theory is the probability of answering an item correctly or of attaining a particular response level in relation to individual ability and characteristic of the item. The goal of IRT is to predict the probability at which a testee of a given ability level responds to an item correctly. In IRT ability level is measured on a transformable scale having a mid-point of zero, a unit measure of one with the theoretical range of ability from negative infinity to positive infinity, however, practical consideration usually limit the range of values from -3 to +3 (Hambleton et al., 1991).

According to Zaman et al. (2008). The ability range in IRT estimates is between  $-\infty$  to  $+\infty$  theoretical but typically they range from + 3.0 for examples with high abilities on the test to -3.0 for examples with low abilities. The difficulty estimates in IRT for items range from +3 to -3 the item with difficulty level +3 and -3 are labelled as "very difficult" and "Very easy" respectively. There are three IRT model for test items that are dichotomously scored known as three, two and one - parameter IRT models to describe the psychometric properties of an item. The distinction among the model is the number of parameter used to describe the items the parameter are a-parameter (discriminating power), b-parameter (difficulty level) and c-parameter (guessing factor). The value of item difficulty denoted by b-parameter is a location parameter that indicate the position of the item characteristic curve in relation to the ability that is required for a testee to have 50% chance of getting the item right the item discrimination denoted by a-parameter provides information on how will an item separate testee with high and low ability level while guessing factor denoted by c-parameter indicates the ability level at which testee guess answer correctly that is the effect of guessing on the probability of a correct response. The values of these parameter indicates the ability level at which they occur which practically ranges from -3 to +3. IRT provides a framework for evaluating how well individual item in a test or examination function. IRT enables the psychometricians to develop and design examination items, maintain item banks and equate the difficulties of items for successive version of examination which allow comparison between result overtime.

According to Yu (2008), IRT address the weakness of Classical Test Theory (CTT). CTT does not provide information about how examinees at different ability level perform on the item. IRT is a necessary tool which has to be at any testing centers for a valid instrument (Tshering, 2006). According to Adedoyin (2010), for more objective educational measurement, IRT theoretical frame work should be incorporated by examination bodies in Africa for the construction of examination items.

Some authors who have worked on psychometric properties of examination items constructed by WAEC and NECO have identified difference in psychometric properties of the items constructed by the examination bodies. Olutola (2015) in his study discovered that WAEC

multiple – choice Biology examination have more difficult items than NECO multiple choice Biology examination and that the higher mean difficulty index discovered in WAEC may be cause by the number of options in WAEC multiple choice Biology examination. As the four options formats in WAEC have a higher difficulty than five options format in NECO. Olatunji (2007) reported that four options for WAEC multiple choice tests have better discriminating indices than NECO multiple choice test in Economics.

### Research question

How comparable are the psychometric properties of Mathematics items constructed by WAEC and NECO?

### Research hypotheses

The following research hypotheses were postulated for the study at 0.05 level of significance:

- (1) There is no significant difference between the difficulty indices of the mathematics examination items constructed by WAEC and NECO
- (2) There is no significant difference between the discriminating indices of the Mathematics items constructed by WAEC and NECO
- (3) There is no significant difference between the guessing indices of the Mathematics items constructed by WAEC and NECO.

### METHODOLOGY

The study employed a descriptive research design of survey type. The population of the study comprised all public senior Secondary School Students in the final year who enrolled for 2019 WAEC and NECO mathematics examinations. A sample of 1,200 students were selected for the study using multistage random sampling procedure. The instruments used for the study consisted of mathematics objective test items constructed by WAEC (50 items) and NECO (60 items) for year 2017 examinations. The instruments were administered on the 1,200 sampled students in 24 public secondary schools randomly selected for the study under similar conditions as given by the examination bodies. The data collected were analysed using Bilog MG software statistical analysis to generate item difficulty levels, discriminating powers and guessing indices of the examination items. Hypotheses formulated were analysed using student's independent t-test.

Three parameter IRT was adopted in this study because the study examined all the three parameters. That is, difficulty levels discriminating factor and guessing index of each item. The three IRT model are based on the logistics (cumulative) distribution function. The logistics equations when graphed produced plot that are called Items Characteristics Curves (ICC) ability levels the X - axis while the probability of an examinee correctly answering the equation is denoted  $p(\theta)$  on the Y - axis which produced values for each item. The linchpin of IRT is the item characteristics curve produced for each item which generated difficulty levels,

**Table 1.** Descriptive statistics of difficulty parameter for WAEC and NECO.

Type of examination	N	Mean (X)	Standard deviation	Maximum value	Minimum value
WAEC difficulty	50	5.11	3.47	10.42	0.88
NECO difficulty	60	6.07	3.51	15.61	-0.01

**Table 2.** Descriptive statistics of Discriminating parameter for WAEC and NECO.

Type of examination	N	Mean (X)	Standard deviation	Maximum value	Minimum value
WAEC discrimination	50	1.11	1.76	6.62	0.06
NECO discrimination	60	0.74	1.05	3.54	0.08

**Table 3.** Descriptive statistic of guessing parameter for WAEC and NECO.

	N	Mean (X)	Standard deviation	maximum Value	Minimum value
WAEC guessing	50	0.17	0.12	0.30	0.31
NECO guessing	60	0.16	0.09	0.05	0.00

discriminating power and guessing index for each item.

The two basic assumptions of IRT are unidimensionality of latent ability and local independence. Unidimensionality implies that items in a test must be developed to measure one and only one area of ability knowledge. This assumption is sometimes empirically assessed by investigating whether or not a dominant factor exists among all items of the test (Oloda, 2017). Local independence states that the probability of an examinee answering a test item correctly is not affected for better or for worse by his/her performance in any other item will not give a clue to the knowledge of another. Unidimensionality is the most important assumption common for all IRT models. Consequently, IRT model is adopted in this study to ensure the unidimensionality of each item constructed by the examination bodies. Validity of a test is strengthened by ascertaining the unidimensionality of its items.

#### Test for unidimensionality and local independence

The method used to ascertain unidimensionality for the items used for the study was confirmatory factor analysis to determine whether or not a dormant factor existed among all the items used in the study. The local independence of the items were assessed using tetra – chronic correlation between items with exactly the same ability. The items were found to meet the conditions for unidimensionality and Local Independence.

## RESULTS

### Research question

How comparable are the difficulty levels, discriminating powers and distractor indices in the mathematics

examination items constructed by WAEC and NECO?

To assess comparability of item parameters of WAEC and NECO mathematics test items, descriptive statistics of their indices were established using Bilog MG software statistical analysis for NECO and WAEC Examination items. Tables 1 to 3 present the descriptive statistics of item parameters of WAEC and NECO test items. It can be observed from Table 1 that overall difficulty mean and standard deviation for WAEC test items was 5.11 (SD = 3.47), and 6.07 (SD = 3.51) for NECO test items. It can be observed from Table 2 that overall discrimination indices mean and standard deviation for WAEC test items was 1.11 (SD = 1.76), and = 0.74 (SD = 1.05) for NECO test items. It can be observed from Table 3 that overall guessing mean and standard deviation for WAEC test items was 0.17 (SD = 0.12), and 0.16 (SD = 0.09) for NECO test items.

### Testing of hypotheses

Ho<sub>1</sub>: There is no significant difference between the difficulty index of the examination items constructed by WAEC and NECO. Table 4 show that the mean difference was -0.96 but NECO test items was a bit difficulty compare to WAEC test. Independent samples t-test statistics further showed that the mean difference was not statistically significant (t = 1.44, df = 108, p = 0.26). This result further reveals that on the overall, the difficulty index of WAEC and the NECO mathematics test

**Table 4.** Independent sample t-test of difficult parameters for WACE and NECO.

		Levene's test for equality for variances			t-Test for equality of means		
		F	Sig	t	Df	Sig (2- tailed)	Mean differences
Difficulty	Equal variance assumed	1.283	0.260	-1.435	108	0.154	-0.959
	Equal variances no assumed			-1.436	104.814	0.154	-0.959

**Table 5.** Independent sample t-test of discriminating parameters for WACE and NECO.

		Levene's Test for equality for variances				Mean difference
		F	Sig	t	Df	
Discrimination	Equal variance assumed	9.864	0.002	1.351	108	0.366
	Equal variances no assumed			-1.436	76.826	0.363

**Table 6.** Independent sample t-test of guessing parameters for WACE and NECO.

		Levene's test for equality for variances				Mean difference
		F	Sig	t	Df	
Guessing	Equal variance assumed	5.474	0.021	0.224	108.000	0.005
	Equal variances no assumed			0.220	95.724	0.005

items are comparable.

Ho<sub>2</sub>: There is no significant difference between the discriminating power of the examination items constructed by WAEC and NECO. Table 5 shows that the mean difference was 0.36, which shows that WAEC tests items distinguish very well between testees with low and high ability compare to NECO items. Independent sample t-test of discriminating indices show that the mean difference was statistically significant ( $t=1.351$   $df = 108$ ,  $P = 0.002$ ). The implication of these results was that on the whole there was the difference in the discriminating power of WAEC and that of NECO mathematics test items.

Ho<sub>3</sub>: There is no significant difference between guessing index of the examination items constructed by WAEC and NECO. Table 6 shows that the mean difference was 0.005 which shows that the guessing indices of WAEC and NECO items are comparable. Independent sample t-test statistics showed that the mean difference was not statistically significant ( $t = 0.22$ ,  $df = 108$ ,  $p = 0.82$ ). This result further reveals that on the overall, the guessing index of WAEC and that of NECO mathematics test items are comparable.

## DISCUSSION

The result of the study shows that there were no

significant difference between WAEC and NECO item parameters except for discrimination index that proved otherwise. Despite this, the two examining bodies are not inferior to one another since their items are of equal quality, and certificate issued by them can be on the same metric scale. More importantly, results from the hypotheses suggests that there was no significant difference between the difficulty indices of WAEC and NECO test items. It implies that their test consist of sets of items with comparable difficulty which could be used to examine the testees. This is against the public outcry that NECO items are more difficult than WAEC. Thus, the two public examining bodies produced test items with comparable difficulty and one is not superior to other. This findings lay credence to the findings of studies carried out by Kolawole (2007); Alfred (2013); Metibemu (2016) and Ogbebor (2017) which says that there was no significant difference between the difficulty level of WAEC and NECO multiple-choice items in mathematics. However, the study disagrees with the submission of Adewale (2008); Bandele and Adewale (2013) and Thomas et al. (2016) that NECO examinations are more difficult than WAEC test items. More so, the study disagree with the findings of Abiri (2006) and Olutola (2015) which say 10 difficulty indices of multiple choice test with a fewer number of options say four differ significantly to anyone with a larger number of options.

Nevertheless, their item discrimination shows a

significant difference. Items of WAEC distinguish better between examinees with high and low ability. The higher discrimination of WAEC items might be due to the fact that WAEC adopt fewer options (4 options) as against NECO items with 5 options. Olatunji (2007) reported that test item with fewer options had the best discriminating index. Findings from this study were consistent with the earlier work by Olatunji (2007); Olutola (2015); Thomas et al. (2016) that items constructed by WAEC have more discriminating items than NECO test items. However, researchers including Alfred (2013); Metibemu (2016) and Ogbebor (2017) concluded in their different studies that there was no statistically significant difference in the slope of test items constructed by public examining bodies in Nigeria such as WAEC, NECO etc. that is, their test items discriminate equally while their asymptotic parameter showed insignificant difference. It can be said that the reliability of the estimate requires assumption that the tendency for an examinee to guess on any item is entirely a quality of the item which has exactly the same fixed effect on all examinees. However, examinees vary in their tendency to guess, some examinees guess a lot, some a little, and some hardly ever. The findings of this study agree with the work by Alfred (2013); Metibemu (2016) and Ogbebor (2017) that there was no statistically significant difference in the guessing parameter of test items constructed by public examining bodies in Nigeria.

## Conclusion

It can be concluded that mathematics examination items constructed by WAEC and NECO have comparable difficulty and guessing indices but differ in discriminating index. The disparity in the performance of the examinees might be as a result of difference in method of computation of results by the examination bodies and other variables but not the difference in the quality of their items.

## Recommendations

Based on the findings of the study, the following recommendations are made:

- (i) Certificates issued by WAEC and NECO could be used freely for same purposes without any discrimination since the items of the examinations are of comparable standard.
- (ii) The examination bodies should ensure that their items are constructed in a way to ensure high discrimination between brilliant and dull examinees
- (iii) Government should constitute a joint examination evaluation team to ensure that examination items constructed by different examination bodies but for same

purposes are of comparable standard.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# **The relationship between teacher self-efficacy beliefs and educational beliefs of pre-service teachers**

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Received 9 September, 2019; Accepted 5 December, 2019

**The purpose of this research is to determine the relationship between ‘educational beliefs’ and ‘teacher self-efficacy perceptions’ of pre-service teachers in the faculty of education. A total of 1002 pre-service teachers, 463 final year undergraduate and 539 certificate program students, participated in the study voluntarily at the Necatibey Faculty of Education in Balıkesir University. ‘Educational Beliefs Scale’ developed by Yılmaz and ‘Turkish Teacher Self-Efficacy Scale’ developed by Tschannen-Moran and Hoy which was adapted to Turkish by Çapa were applied on the participants. As a result of the research, a significant difference was found in pre-service teachers’ self-efficacy opinions regarding gender variable in favor of men. Besides that, a significant difference was found in favor of women in terms of progressivism and existentialism in education beliefs and in favor of men in terms of essentialism. Other results of the research are as follows: when the beliefs of education and self-efficacy beliefs of teacher trainees were examined in terms of academic discipline variable, there was no significant difference in self-efficacy beliefs of teacher candidates. In terms of educational belief variable, only a significant difference was observed in existentialism dimension. According to sources of teacher education variable, a significant difference was found in favor of formation students in self-efficacy dimension related to classroom management. Lastly, according to the source of teacher training, it was seen that the students of the faculty of education adopted the philosophy of existentialism more, whereas the formation students adopted the essentialism more.**

**Key words:** Teacher education, pre-service teachers, self-efficacy beliefs, educational beliefs.

## **INTRODUCTION**

Philosophy is a field of study that teaches how to think, inquire and look at events from different perspectives but unfortunately loses its prestige in today’s world, especially in Turkey. Philosophy is the general understanding of the world; it explains the universe and analyzes universal questions (Politzer, 2018). Philosophy is an area of

knowledge originating from human’s systematic, in depth, and speculative thinking over the universe and its relationship with people (Gutek, 2014). Philosophy of Education, on the other hand, is a discipline of philosophy, which discusses what education is, the problem, and solves activities that determine it and the

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concepts that engender it (Cevizci, 2014). Philosophy of Education is a philosophical analysis of education and problems of education. The main subject of Philosophy of Education is education, and the method it uses is that of philosophy. Philosophers of education approach problems of education through the lens of philosophy. They focus on analyzing and explaining the concepts and problems at the center of education. What should be the target and goals of education? Who should be educated and how? Should education vary according to natural interests and talents? What kind of role should the state play in education? (Noddings, 2016). Nevertheless, the answers to these questions play a crucial role at defining the educational systems and curricula of countries; therefore constructing the desired student profile.

Philosophy of Education is the philosophy which takes education as its subject matter. It first asks whether education is possible from a philosophical perspective. Then it undertakes a thorough philosophical questioning of what will be taught to whom by whom (Çüçen, 2007). Philosophy of education takes interest in many elements within the framework of education. First and foremost, it investigates student or person who are educated, teacher or the person who educates or the curriculum, educational activities and their goals, values, and perspectives gained through education. In its approach to the phenomenon and subject of education, Philosophy of Education tackles what education is and discusses the criteria for education. It brings up questions about the course of education, the kind of individual to be raised, and about which knowledge, skills, and values should be transferred to the student (Cevizci, 2014). When developing the curriculum, the discipline consults with philosophy on explaining the main premises, contributing to prospective goals, sustaining consistency within and outraises the goals, and sequencing the goals according to their priority (Demirel, 2017). When determining the curriculum, factors such as considering the goals of education, their practice, and determining their exact clarity are involved. When instruction is being planned, philosophy of education asks questions as such: what knowledge is more important/valuable? What knowledge should be taught to the students? What knowledge is more beneficial for the learner as a member of a society and an individual? Answering these questions is not only limited to determining what knowledge should be excluded from and included in the curriculum, but it also provides the curriculum with the most current information about the nature of a good living, society and people (Guttek, 2014). When determining the curricular design models to develop the curriculum, education makes decisions according to the dominant philosophy within the target society and state. In the states with fundamentalist and perennial philosophy of education, policy makers choose models that centralize the subject focus; whereas in educational systems where progressive philosophy is dominant, preference is for student-centered models.

Within the scope of educational beliefs, this study is based on the educational philosophies of Perennialism, Essentialism, Progressivism, Reconstructivism and Existentialism. The mentioned philosophical schools are explained below:

In *Perennialism*, which is based on Classical Realism and Idealism, human is overall an intelligent creature (Sönmez, 2002). According to perennialists, school is a societal institution founded to improve human's intellectual potential. First problem of the educational thinker is to explain the human nature and build a curriculum based on the universal characteristics of the human nature (Guttek, 2014). In Perennialism wherein lies the permanence of human nature and moral principles, foundational curricular models do not change either. That is why people need be raised according to these permanent realities. Education should be the same for all; a common curriculum should be used for all students. Proponents of this philosophy defend universal and intellectual education. Educators should prioritize universal and recurring subjects in human life; students' psychological and mental potential should be developed with a subject focused curriculum centralizing disciplines such as history, language, math, literature, humanities and science (Guttek, 2014; Demirel, 2012; Arslan, 2017; Ornstein and Hunkins, 2004).

*Essentialism* is based on Realism and Idealism. According to this philosophy, although human is a social and cultural entity, she is not equipped with any information at birth (Sönmez, 2002). For this reason, the main target of education-school is to provide the individual's socialization, to have them gain dominant values in the society as well as main components of the culture of human, to protect the origin of these values and its permanence (Ergün, 1996; Guttek, 2014; Sönmez, 2002). Essentialism represents an educational understanding governed by a predetermined curriculum, a specialist teacher who represents the authority, and by discipline.

*Progressivism* stands on pragmatics. In this philosophy, the student is at the center. The main goal of education is to teach students research and learning methods, in addition develop their intellectual growth so that students construct their own knowledge and comprehension (Sönmez 2002; Guttek, 2014; Cevizci, 2014). Education should be tailored to students' interests; school should be life itself and not only a preparation for it. Education should include such approaches as problem-solving, project, stages of scientific method and cooperative learning. According to this view which claims that there is no permanent and absolute information, a democratic classroom environment is prepared for students where they will experience real life and adapt to society in a cooperative atmosphere (Cevizci, 2014; Çüçen, 2007; Demirel, 2012). Guttek (2014) summarized the characteristics of Progressivist education as follows: 1.

Learner is more important than the subject. 2. It sides with direct experience and practice than oral and writing skills. 3. It emphasizes group learning and encouragement more than individualized learning. 4. It criticizes inherited perspectives and values as it adopts cultural and moral relativity.

As a continuation of Progressivism, *Reconstructivism* claims that education is a tool for balance as well as change because life continually changes (Sönmez, 2002, 94). Education is not only life but future. Education's responsibility is to give shape to and organize the society. Education will realize a social reform. The main responsibility falls on the school to change the society. Power lies in the teacher. Reconstructionists state that the main function of schools is to diagnose crises of the modern society. According to them, teachers should not be afraid to indoctrinate into the students the idea of a reconstructed society; they should tell students the goal of education. Students are to rebuild the society and the world peace. Students should be educated in a way to help them reconstruct the society and oversee it. Classroom environment should be democratic and education should concentrate on practice, and new methods and technics should be executed (Çüçen, 2007; Ergün, 1996; Gutek, 2014; Sönmez, 2002).

In *Existentialism*, existence comes before essence. According to existentialists, human creates her own essence, and she is the only object who does so (Hançerlioğlu, 1999). Therefore, it rejects an understanding of human nature that is preconstructed; and related practices of directing education, sequencing its duties, foreseeing the fate, and identifying human's role in the universe (Bilhan, 1991; Noddings, 2016). Although existentialism oftentimes falls apart with traditional religious philosophy, there have been religious existentialists, and both clusters have emphasized human freedom (Noddings, 2016). Existentialism tries to improve the human's power to choose; student is more important than the teacher and curriculum. Curricula should encourage individuals' absolute freedom, enrich their worldview, teach them how to make choices and take responsibility, and how to use these freedoms provided for themselves (Ergün, 1996; Sönmez, 2002).

This study also analyzes teachers' perceptions of *self-efficacy* in relation to educational beliefs. Bandura (1997) defines self-efficacy as teacher's own judgment related to her capacity to successfully plan and execute necessary activities to display a specific performance (As cited in Senemoğlu, 2018). Senemoğlu (2018) explains it as teachers' own judgments and beliefs about themselves regarding the degree of success in difficult conditions students will face in the future such as taking a test, entering a competition, teaching in a classroom, speaking in public. Erdamar (2007) proposes that perception of self-efficacy has an effect on choosing activities, the time to spend on an activity, period of patience when faced with hardship, and on emotions of anxiety and trust. Self-

efficacy trust influences people's goals for themselves, how much effort they will spend to reach those goals, how long they will endure hardships to reach their goals, and their reactions towards failure (Bıkmaz, 2004).

According to Klausmeier and Allen (1978), one of the factors of success in educational setting is self-efficacy trust. A teacher's trust in self-efficacy influences the quality of education, her methods, techniques, student participation and student comprehension, and this determines students' success accordingly. Well prepared candidate teachers thus are expected to have high trust in self-efficacy (As cited in Üredi and Üredi, 2005). Plourde (2001) argues that teachers with high self-efficacy trust use student-centered teaching techniques in their classrooms. Henson (2001) explains that such teachers are also inclined to do research to improve the educational methods they use (As cited in Arslan and Sağır, 2008).

While Ashton (1984) describes teachers' beliefs in self-efficacy as "beliefs about the capacity to influence student performance," they claim that no other teacher quality has this much consistent correlation with students' success (As cited in Bıkmaz, 2004). Self-efficacy beliefs mostly emerge in areas of private space. One of the most important among these private spaces is teacher self-efficacy. It is an important element in teacher education and is fundamental in order to determine how self-efficacy improves, which components it involves, which factors contribute to strong and positive teacher sufficiency, and how to develop which curricula targeted to improve teacher sufficiency (Pajares, 1997; As cited in Çapri and Çelikkaleli, 2008). Hoy and Woolfolk (1993), Pajares and Miller (1994), point out that teachers' belief in self-efficacy is an important variable in constructing a productive school or reconstructing schools (As cited in Çapri and Çelikkaleli, 2008). Bıkmaz (2004) purports that for the last two decades; self-efficacy beliefs become one of the significant research topics of specialists who have expertise particularly in teacher education.

While educational beliefs significantly affect self-efficacy beliefs, teacher self-efficacy beliefs affect their in-class performances. Therefore, it is believed that portraying the relationship between educational beliefs and self-efficacy will highly contribute to the literature and teacher education curricula.

The aim of this study is to identify the relationship between "educational beliefs" and "perceptions of teacher self-efficacy" of candidate teachers who study at colleges of education. In order to achieve this goal, the study seeks to answer these following questions:

- 1) Is there a meaningful difference between candidate teachers' levels of educational beliefs and self-efficacy beliefs in terms of variables (sex, field, source of teacher education)?
- 2) Are candidate teachers' educational beliefs related to their self-efficacy beliefs?



## METHODOLOGY

### Research design

In this research, as it was aimed to investigate the relationship between teacher beliefs and self-efficacy perceptions of the teacher candidates, correlational research design is used. Research models that aim to determine the existence of mutual change and/or the degree of such change between two or more variables are called "correlational research models (Gay and Airasian, 2000). In addition, ex post facto research design is preferred as the research aims to define whether there is a difference in terms of various variables (teacher training source, department and gender).

### Participants

The study group consisted of 4th grade pre-service teachers who have attended School of Education in Turkey during 2017-2018 academic year and students who have attended the teacher certificate program during the same academic year. The study included students who participated in the classes and participated in the research voluntarily during the 2017-2018 academic year. Of the 1002 students who volunteered to participate in the study, 463 (46.2%) were students enrolled in the Necatibey School of Education and 539 (53.8%) were students of the pedagogical formation program. Of these, 739 (73.8%) were female and 263 (26.2%) were male. Of the students in the study group, 199 (19.9%) were hard science (Mathematics, Science, Physics, Chemistry, etc.) and 803 (80.1%) were students in soft science (Pre-School, Social Studies, Turkish, Geography, etc.).

### Data collection instrument tools

The research data is collected via "Educational Beliefs Scale (EBS)" developed by Yılmaz et al. (2011), and "Turkish Teacher Self-Efficacy Scale (TTSES)" developed by Tschannen-Moran and Hoy (2001) and adopted to Turkish by Çapa et al. (2005). EBS contains 40 items of Likert type in order to determine the educational beliefs adopted by teachers in the study. EBS consists of 5 factors: "Perennialism", "Essentialism", "Progressivism", "Reconstructivism", and "Existentialism". The distribution of the 40 items in the scale to the subscales is as follows: 8 items in Perennialism, 5 items Essentialism, 13 items Progressivism, 7 items Reconstructivism, and 7 items Existentialism. The items in the scale are scored from 1-Strongly Disagree to 5-Strongly Agree. The scale does not contain any items that are rated as reverse. A total score is not obtained from the scale, and it tried to determine how much the participants adopt each education philosophy. According to the analyses carried out by Yılmaz, et al. (2011) determine the reliability of EBS, the internal consistency coefficients calculated for each dimension are as follows: Progressivism "0.91", Existentialism ".89", Reconstructivism "0.81", Perennialism "0.70", Essentialism "0.70". According to the the internal consistency coefficients obtained from the analyses our research are as follows: Progressivism "0.88", Existentialism "0.87", Reconstructivism "0.79", Perennialism "0.74", Essentialism "0.79".

On the other hand, TTSES contains 24 items to determine teachers' self-efficacy. TTSES consists of 3 factors: "Self-Efficacy for Student Participation", "Self-efficacy for Class Management", and "Self-Efficacy for Teaching Strategies". The first dimension called "ensuring student participation" consists of items related to what extent teachers can assure students that they can do well in school activities. The second dimension called "class management" consists of items related to what extent teachers can control unwanted behavior in the classroom. The third dimension called "Instructional Strategies" consists of items related to what extent

teachers can make use of different teaching and evaluation strategies. Each factor in the scale consists of 8 items. According to the analyses to determine the reliability of TTSES, the internal consistency coefficients calculated for each dimension are as follows: "Self-efficacy for Class Management" is calculated as "0.84", "Self-Efficacy for Student Participation" "0.82", "Self-Efficacy for Teaching Strategies" "0.86". According to the internal consistency coefficients obtained from the analysis, the research are as follows: "Self-efficacy for Class Management" ".85", "Self-Efficacy for Student Participation" "0.84", "Self-Efficacy for Teaching Strategies" "0.85".

### Data collection and analysis

Before starting the study, permission was obtained from Necatibey Faculty of Education, where the research was conducted in accordance with ethical rules. In the study, before the questionnaires were given to the students, they were informed about the aims of the research and asked whether they would participate voluntarily. A total of 1040 students who volunteered for the study were informed about how to fill in the questionnaires and data collection process was completed. In addition, it was stated to the volunteer students that the results obtained from the research will be used only for scientific purposes and it is not necessary to write their names. The data collection process was carried out in the first thirty minutes of the course as it was thought that the students were not exhausted yet; thus, reliability and validity were not negatively affected. It took approximately 20-25 minutes for the students to fill in the questionnaires. Later on, 38 of the questionnaires were excluded due to incomplete and inappropriate answers.

In this study, descriptive statistics calculations are carried out to evaluate the gathered data. As a result of the analysis, it is concluded that the distribution of the answers given by the participants is normal. Normal distribution test is applied in this research. Since the sample population is high (1002), Skewnes and Kurtosis values are investigated rather than applying Kolmogorov-Smirnov test (Denis, 2018; Morgan et al., 2004; Stevens, 2012). After determining that the variances are homogeneous, t-test is conducted for independent groups in order to determine whether pre-service teachers differ in "Educational Beliefs" and "Teacher Self-Efficacy" according to gender, field of science, and teacher training source variables, and Pearson correlation analysis is conducted in order to determine the level of the relationship between educational beliefs and self-efficacy of the pre-service teachers.

It is interpreted that the correlation coefficient, when examining relationships between factors, indicates very weak relationship if  $r < 0.2$ , weak relationship if between 0.2-0.4, medium level of relationship if between 0.4-0.6, high level of relationship if it is between 0.6-0.8, very high level of relationship if  $> 0.8$  (Cohen, 1988).

## FINDINGS

In this study, firstly data are investigated in terms of following a normal distribution or not. Hence, mode, median, skewness, and kurtosis are calculated. Based on means and standard deviations, explanations about self-efficacy and educational beliefs of teacher candidates were given a place (Table 1). At the end of the analysis, if the range of the skewness and kurtosis values is (+ -1.5), this refers to the data to be normally distributed (Morgan et al., 2004; Tabachnick and Fidell, 2013). As seen in

**Table 1.** Level educational belief, Self-Efficacy and test of normality.

Parameter	N	Mean (M)	Sd	Mode	Median	Skewness	Kurtosis
SEFCM	1002	3.88	0.56	3.88	4.00	-0.49	0.74
SEFSP	1002	3.87	0.54	3.88	3.88	-0.46	0.54
SEFTS	1002	3.83	0.55	3.88	4.00	-0.38	0.58
TTSES	1002	3.86	.50	4	3.87	-.44	.81
Progressivist	1002	4.57	0.42	4.71	5.00	-1.17	1.48
Existentialist	1002	4.44	0.39	4.46	4.62	-0.93	1.31
Reconstructionist	1002	3.90	0.66	3.86	3.86	-0.50	0.49
Reconstructionist	1002	3.86	0.65	3.88	4.00	-0.63	0.97
Essentialist	1002	2.38	0.86	2.20	2.20	0.69	0.54

Table 1, teacher candidates have a mean of 3.86 in the entire scale as follows: SEFCM (mean=3.88, sd= 0.56), SEFSP (mean= 3.88, sd=0.54) and SEFTS(mean=3,83, sd=0,55). Based on these findings, it can be stated that teacher candidates have high self-efficacy. Furthermore, when the philosophical beliefs of teacher candidates are taken into consideration, Table 1 also demonstrates that the highest belief level is progressivism (mean= 4.57, sd=0.42) and the lowest belief level is essentialism (mean=2.38, sd=0.86).

Findings are related to the first sub-problem (Results obtained from the first part of the questionnaire): The findings related to the beliefs of pre-service teachers regarding education and self-efficacy are listed below in the order of independent co-variances.

#### **The assessment of the beliefs of pre-service teachers regarding education and self-efficacy in terms of the gender covariance:**

The t-test results to determine whether the beliefs of pre-service teachers regarding education and self-efficacy differ by gender covariance are listed in Table 2.

As shown in Table 2, self-efficacy related to class management demonstrates a significant difference in favor of male gender. When the effect of gender on philosophical beliefs is considered, progressivism and existentialism dimensions show a substantial difference in favor of females while essentialism shows a difference in favor of males.

#### **The assessment of the beliefs of pre-service teachers regarding education and self-efficacy in terms of the academic field covariance**

The t-test results to determine whether the beliefs of pre-service teachers regarding education and self-efficacy differ by academic field covariance are listed in Table 3.

As shown in Table 3, only educational beliefs demonstrate a significant difference in existentialism

dimension. It was observed that the graduates of Soft Sciences adopt the existentialist education philosophy more than the students continuing to study in Hard Sciences.

#### **The assessment of the beliefs of pre-service teachers regarding education and self-efficacy in terms of the teacher education background covariance:**

The t-test results to determine whether the beliefs of pre-service teachers regarding education and self-efficacy differ by teacher education background covariance are listed in Table 4.

As shown in Table 4, a statistically significant difference was observed in self-efficacy dimension related to class management and in existentialism and essentialism dimensions of adopted educational beliefs. Students of the teacher certificate program found themselves more adequate about class management related self-efficacy dimension compared to students of the School of Education. Looking at the findings regarding existentialism, students of the School of Education adopted this philosophical belief more than students of the teacher certificate program while it was observed to be reversed for essentialism dimension.

Findings related to second *sub-problem* (Results obtained from the first part of the questionnaire): The findings related to the relationship between educational beliefs and self-efficacy perceptions of pre-service teachers are described below (Table 5).

#### **The relationship between educational beliefs and self-efficacy perceptions of pre-service teachers**

The secondary sub-aim in this study is the determination of the extent of the relationship between educational beliefs and self-efficacy of pre-service teachers. With this aim, the Pearson correlation analysis was performed as shown in Table 5. When the relationship between the whole and the dimensions of the self-efficacy scale and

**Table 2.** The assessment results for the beliefs of pre-service teachers regarding education and self-efficacy in terms of the gender covariance.

Parameter	Groups	N	M	sd	Se $\bar{x}$	t Test			Cohen's d	Diff
						t	Df	p		
SEFCM	F	739	3.85	0.55	0.02	-3.189	1000	0.001*	0.23	M>F
	M	263	3.98	0.57	0.04					
SEFSP	F	739	3.86	0.52	0.02	-.288	419.883	0.774	-	
	M	263	3.88	0.58	0.04					
SEFTS	F	739	3.81	0.54	0.02	-1.690	429.115	0.092	-	
	M	263	3.88	0.59	0.04					
TTSES	F	739	3.84	0.50	0.02	-1.904	1000	0.057	-	
	M	263	3.91	0.54	0.03					
Progressivist	F	739	4.41	0.50	0.02	2.421	361.158	0.016*	0.18	F>M
	M	263	4.30	0.71	0.04					
Existentialist	F	739	4.56	0.52	0.02	3.131	372.974	0.002*	0.25	F>M
	M	263	4.41	0.69	0.04					
Reconstructionist	F	739	3.90	0.62	0.02	-.405	398.786	0.685	-	
	M	263	3.92	0.75	0.05					
Perennialist	F	739	3.84	0.63	0.02	-1.371	415.356	0.171	-	
	M	263	3.91	0.71	0.04					
Essentialist	F	739	2.33	0.82	0.03	-2.530	409.849	0.012*	-	M>F
	M	263	2.50	0.95	0.06					

\*p&lt; .05.

**Table 3.** The assessment results for the beliefs of pre-service teachers regarding education and self-efficacy in terms of the academic field covariance.

Parameter	Groups	N	M	Sd	Se $\bar{x}$	t Test			Cohen's d	Diff
						t	df	p		
SEFCM	Hard Sci.	199	3.84	0.51	0.04	-1.135	1000	0.257		
	Soft Sci.	803	3.89	0.57	0.02					
SEFSP	Hard Sci.	199	3.81	0.50	0.04	-1.702	1000	0.089		
	Soft Sci.	803	3.88	0.55	0.02					
SEFTS	Hard Sci.	199	3.81	0.50	0.04	-.698	1000	0.485		
	Soft Sci.	803	3.84	0.57	0.02					
TTSES	Hard Sci.	199	3.82	0.46	0.03	-1.267	1000	0.205		
	Soft Sci.	803	3.87	0.52	0.02					
Progressivist	Hard Sci.	199	4.35	0.55	0.04	-.970	1000	0.332		
	Soft Sci.	803	4.39	0.57	0.02					

**Table 3.** Contd.

Existentialist	Hard Sci.	199	4.43	0.58	0.04	-2.412	1000	0.016*	0.19	SS>HS
	Soft Sci.	803	4.54	0.57	0.02					
Reconstructionist	Hard Sci.	199	3.83	0.61	0.04	-1.849	1000	0.065		
	Soft Sci.	803	3.92	0.67	0.02					
Perennialist	Hard Sci.	199	3.83	0.64	0.05	-0.899	1000	0.369		
	Soft Sci.	803	3.87	0.66	0.02					
Essentialist	Hard Sci.	199	2.42	0.79	0.06	0.740	1000	0.460		
	Soft Sci.	803	2.37	0.88	0.03					

\*p&lt; .05.

**Table 4.** The independent group t-test results to determine if the grades differ due to the teacher education background covariance.

Parameter	Groups	N	M	Sd	Se $\bar{x}$	t Test			Cohen's d	Diff
						t	df	p		
SEFCM	Sch. of Edu.	463	3.84	0.51	0.02	-2.114	999.883	0.035*	-	C>S
	Cert. Prog.	539	3.92	0.59	0.03					
SEFSP	Sch. of Edu.	463	3.85	0.50	0.02	-0.954	999.678	0.340	-	
	Cert. Prog.	539	3.88	0.57	0.03					
SEFTS	Sch. of Edu.	463	3.82	0.52	0.02	-0.624	997.568	0.533	-	
	Cert. Prog.	539	3.84	0.58	0.03					
TTSES	Sch. of Edu.	463	3.84	0.46	0.02	-1.335	999.599	0.182	-	
	Cert. Prog.	539	3.88	0.55	0.02					
Progressivist	Sch. of Edu.	463	4.41	0.50	0.02	1.685	996.057	0.092	-	
	Cert. Prog.	539	4.36	0.62	0.03					
Existentialist	Sch. of Edu.	463	4.56	0.52	0.02	2.205	999.746	0.028*	0.14	S>C
	Cert. Prog.	539	4.48	0.62	0.03					
Reconstructionist	Sch. of Edu.	463	3.90	0.62	0.03	-0.393	997.264	0.695	-	
	Cert. Prog.	539	3.91	0.69	0.03					
Perennialist	Sch. of Edu.	463	3.86	0.61	0.03	-0.150	999.655	0.881	-	
	Cert. Prog.	539	3.87	0.69	0.03					
Essentialist	Sch. of Edu.	463	2.30	0.76	0.04	-2.796	996.879	0.005*	.18	C>S
	Cert. Prog.	539	2.45	0.94	0.04					

\*p&lt; .05.

the educational beliefs is investigated, the whole and the dimensions related to progressivism, existentialism, reconstructionism and perennialism show a weak and

direct correlation at 0.01 level. A weak inverse correlation was found between essentialism and self-efficacy related to student attendance at 0.05 level.

**Table 5.** The Correlation between Scores of Teacher Self-efficacy Scale and Education Beliefs Scale.

Parameter	Progressivism	Existentialism	Reconstructionism	Perennialism	Essentialism
SEFCM	0.213**	0.212**	0.236**	0.231**	0.009
SEFSP	0.267**	0.251**	0.259**	0.207**	-0.062*
SEFTS	0.218**	0.206**	0.266**	0.212**	-0.010
TTSES	0.251**	0.240**	0.274**	0.234**	-0.023

\*\* 0.01 significance \* 0.05 significance.

## DISCUSSION

The aim of this study was to examine the relationship between the “educational beliefs” and “self-efficacy perceptions of pre-service teachers” of the students at an education faculty. Findings indicated that there is a significant difference in the self-efficacy in class management dimension according to gender, where the male students scored higher. Some other studies on self-efficacy conducted in Turkey showed significant difference according to gender, in some males (Dolapçı, 2013; Elkatmış et al., 2013; Yeşilyurt, 2013) and other females (Aydın et al., 2014; Özdemir, 2008; Ünlü et al., 2017; Yalçın, 2011) scored significantly higher. However, in contrast to these results, studies that show no difference according to gender are more (Altunçekiç et al., 2005; Azar, 2010; Bakaç and Özen, 2017; Berkant, 2017; Çocuk et al., 2015; Erişen and Çeliköz, 2003; Eroğlu and Ünlü, 2015; Gerçek et al., 2006; Ilgaz et al., 2013; Kahyaoğlu and Yangın, 2007; Özcan and Sert, 2017; Özkurt and Keçici, 2017; Uygur, 2010; Uzun et al., 2010; Ülper and Bağcı, 2012; Üstün and Tekin, 2009; Varol, 2007; Yıldırım, 2011).

When the results are investigated according to relation of gender to educational beliefs, female participants scored significantly higher in progressivism and existentialism dimensions, while male participants scored higher on essentialism. Alkın-Şahin et al. (2014) reported similar results. Çakmak et al. (2016) identified that female participants scored higher in existentialism and progressivism, while no difference was detected in perennialism, essentialism, and reconstructionism according to gender. In Kozikoğlu and Erden's (2018) study, however, it was shown that female participants scored higher on progressivism and existentialism, while male participants scored higher on perennialism and essentialism. No difference was detected in reconstructionism. Çelik and Orçan (2016) did not report any gender differences on reconstructivism and essentialism, while there were significant differences in existentialism dimension which female participants scored higher. Aslan (2017), on the other hand, found out that male participants scored higher on more traditional educational philosophies, essentialism and perennialism, but no gender difference was detected in the dimensions of progressivism, and reconstructivism. In a similar study,

Kumral (2015) also reported that male participants scored higher on more traditional educational philosophies, essentialism and perennialism, but female participants scored higher on more popular educational philosophies of progressivism, and reconstructivism. However, some other studies did not report any significant difference in educational philosophies according to gender (Bıçer et al., 2013; Çetin et al., 2012; Ilgaz et al., 2013; Yokuş, 2016). In an educational system that is based on constructivism, it is expected that teachers identify themselves with progressivism and existentialism which are known to underlie constructivism.

Study also investigated the relationship between self-efficacy and educational beliefs according to academic discipline of the pre-service teachers. Results showed no significant differences in self-efficacy according to their academic disciplines. However, Aydın et al. (2014) study which used the same scale showed that pre-service teachers at the Turkish Language Teaching programme significantly differed from the pre-service teachers in elementary school teaching and English language teaching. Moreover, Fine arts students performed significantly different from students in Mathematics, Special Education and Turkish Language Teaching departments in student participation dimension.

For the educational beliefs scale, there was a significant difference only on existentialism according to academic disciplines. It was observed that students from soft sciences identified themselves more with the existentialism compared to students from hard sciences. In a similar vein, Çetin et al. (2012) study found significant differences in educational philosophy dimension according academic disciplines. Pre-service teachers from Social Sciences Education Department scored higher on contemporary educational philosophies (Existentialism, reconstructivism, progressivism) compared to pre-service teachers from Science Education Department, while these students scored higher on more traditional educational philosophies (perennialism and essentialism). Kumral (2015) further investigated the educational beliefs within the soft science departments. Results indicated that pre-school education department students adopted a more traditional philosophy (essentialism and perennialism) compared to students from English language teaching and Turkish language teaching department who adopted more popular (progressivism

and reconstructivism) educational philosophies. Çelik and Orcan (2016), on the other hand, did not find any difference on educational philosophies of the pre-service teachers concerning their academic discipline. These different and somewhat contradictory results indicate that teacher education institutions do not provide training and education for pre-service teachers in line with the current and modern educational philosophies. Moreover, pre-service teachers did not internalize these educational philosophies regardless of their gender and their academic discipline.

The relationship between educational beliefs and self-efficacy of the pre-service teachers was also investigated according to the sources of teacher education. Results indicated that there was a significant difference on the class management dimension of the self-efficacy scale where students from certificate program scored higher. This indicates that students who were trained in other faculties rate themselves higher in class management compared to education faculty students. However, it is surprising that students who were coming from disciplines other than education perceive themselves more sufficient in class management compared to students who studied four years in educational faculties.

According to the sources of teacher education, a significant difference was found on existentialism and essentialism dimensions. When existentialism dimension was examined, results indicated that pre-service teachers who studied at education faculties adopted existentialism as their educational philosophy compared to pre-service teachers from certification program, and in the dimension "essentialism" students from certification program scored higher. In their study, Ilgaz et al., (2013) reported a significant difference in favor of pre-service teachers from other faculties in terms of perennialism and essentialism.

When the relationship between the whole and dimensions of self-efficacy scale and educational beliefs was investigated, the study discovered a linear weak relationship at 0.01 level between progressivism, existentialism, reconstructivism, and perennialism. A very weak negative relationship at 0.05 level was found out between the self-efficacy dimension towards student participation and essentialism. In their study, Ilgaz et al. (2013) found a significant relationship between educational beliefs and self-efficacy perceptions. The emergence of a weak relation between the self-efficacy perceptions and educational beliefs of pre-service teachers is one of the remarkable findings of this study.

This study examined the educational beliefs and self-efficacy perceptions of the pre-service teachers according to various variables and investigated the existence of a relationship among them. Self-efficacy belief serves as a key factor in the system of a productive person (Bandura, 1997). According to Pajares (1996), self-efficacy belief is a concept that acts as the determiner of human behavior and strengthens through choices made, effort given, and persistence towards difficulties by people as well as their

patterns of thought and emotional reactions. Pendergast et al. (2011) state that teachers' self-efficacy beliefs is an important factor in the construction of their teaching profession, and teachers with high self-efficacy levels are more flexible during teaching and tend to be more eager to make effort in order to help all students, while teachers with low self-efficacy levels make less effort to meet the learning needs of all students. Various research findings manifested that teacher self-efficacy has a direct effect on students' success, and teachers with high self-efficacy levels planned teaching on a superior level and allocated more time towards students' problems (Allinder, 1994; Caprara et al., 2003; Gibson and Dembo, 1984 as cited in Pendergast, et al., 2011; Moore and Esselman, 1992).

Educational belief determines the answer to the question of how students will learn based on the teaching method that the teacher will choose (Hermans et al., 2008). The belief system of the teacher determines whether his/her teaching approach will be teacher-centered or student-centered (Jackson, 1986). The beliefs and attitudes of pre-service teachers is a significant concept for understanding their in-class practices, teaching processes, and tendencies towards change (Richardson, 1996). Educational beliefs are constructed by previous learning experiences and influenced by professional context. When pre-service teachers proceed to the teacher training institutions, their educational beliefs have already been shaped by their previous learning experiences, and their beliefs are relatively steady and resistant to change as a result (Pajares, 1992). Therefore, teacher training institutions should lay stress on the development of pre-service teachers' educational beliefs and self-efficacy perceptions starting from the first years of their training, because teachers' educational beliefs and self-efficacy perceptions affect their teaching ways and teacher identities (Pajares, 1992; Kagan, 1992). Pre-service teachers with high level self-efficacy perceptions and educational beliefs will in the future educate students with high level self-efficacy perceptions and educational beliefs through using contemporary and student-centered approaches in the schools that they will serve as teachers.

With the establishment of The Council of Higher Education, there have been two sources of teacher training: Faculties of Education and Faculties of Science and Literature with their pedagogical training certificate programs. In the studies carried out in Turkey on pre-service teachers' educational and self-efficacy beliefs, there have been very few articles that include students both from faculty of education and Faculty of Science and Literature. This study was aimed to find out how effective the certificate program, which only lasts for one year, is on the educational and self-efficacy beliefs of the pre-service teachers, and to compare these results with the educational and self-efficacy beliefs of the students studying in the Faculties of Education. It is believed that this study will give an opinion on the practices of

certificate program in the future and the effectiveness of Faculties of Education.

## Recommendation

In line with the findings obtained from this research, the following recommendations can be made for researchers and practice. It is suggested that qualitative studies (interviews) should be conducted with both groups of students (those studying in Faculty of Education and having a pedagogic formation) in order to reveal the differences in the educational beliefs through using contemporary and student-centered approaches in the schools that they will serve as teachers.

With the establishment of The Council of Higher Education, there have been two sources of teacher training: Faculties of Education and Faculties of Science and Literature with their pedagogical training certificate programs. In the studies carried out in Turkey on pre-service teachers' educational and self-efficacy beliefs, there have been very few articles that include students both from faculty of education and Faculty of Science and Literature. In this study, it was aimed to find out how effective the certificate program, which only lasts for one year, is on the educational and self-efficacy beliefs of the pre-service teachers, and to compare these results with the educational and self-efficacy beliefs of the students studying in the Faculties of Education. It is believed that this study will give an opinion on the practices of certificate program in the future and the effectiveness of Faculties of Education.

Pre-service teachers' educational and self-efficacy belief levels are denoted in the existing studies in terms of some variables such as age, teacher training source, gender and department. It is believed that such studies can contribute to the development of teaching practices and learning environments used in teachers' training.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# Enhancing students' academic performance in Chemistry by using kitchen resources in Ikom, Calabar

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Received 20 August, 2019; Accepted 25 November, 2019

**This paper seeks to investigate how students' performance in Chemistry can be enhanced by using kitchen resources in Calabar. The kitchen resources used included a piece of white paper, a swab, lemon juice and candle. These were used to show that paper cellulose was oxidized by flame due to the catalysis of lemon juice acid. Other materials used were empty bottles of water, a balloon, a teaspoon, a glass, vinegar and sodium bicarbonate to inflate balloons without blowing. Volcano being made with a large glass, water, liquid dye, oil, effervescent tablet and a lantern was to demonstrate immiscibility, and carbon dioxide was formed because of effervescent tablet dissolution. The sample comprised 50 students drawn from two secondary schools in Ikom Education Zone of Cross River State. Two instruments were used to collect data: Chemistry Interest Questionnaire (CIQ) and Chemistry Achievement Test (Cat). Cronbach was used to establish reliability for CIQ and was found to be 0.78. Richardson formula 21 was used to establish reliability for Cat, 0.83. The research used a mixed design (quasi experimental and survey design). Data obtained were analyzed using independent t-test and Pearson product moment correlation coefficient. The results gave a significant t test of 4.96 and positive  $r = 0.90$  at 0.05 alpha level. The null hypothesis was not accepted which stated that there is no significant relationship between students' interest when taught with and without kitchen resources. The second null hypothesis with regard to Chemistry interest and academic achievement was also not accepted. Teachers are encouraged to use kitchen resources in the teaching of Chemistry to foster interest which will lead to high academic performance.**

**Key words:** Kitchen resources, academic achievement, interest students, teachers.

## INTRODUCTION

Science and technology advances are evident in every facet of our society. This can be seen even in the local as well as modern society. It can be found in the health care delivery system where humans no longer rely on herb for treatment of diseases and man has come to terms with the fact that diseases are not caused by witches and

wizard but by factors in the environments. This includes the presence of bacteria, virus and fungi in the environment. In the financial sector, even from the comfort of one's home with banks application, financial transactions can be carried out without visiting the bank. The society has become cashless. In the business

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sector, buying and selling are also done from the comfort of one's home. This is possible as all transactions are done online and door to door delivery is provided. In communication, science and technology has turned the world to a global village where distance is no longer a barrier to communication. With the invention of skypes, one can see his/her love one online without getting to travel. However, it is unrealistic to think citizens have fully harnessed the knowledge and products of science and technology since scientific belief and knowledge as numerous studies have been shown. Science is not given the prominent position that it requires in the society in terms of culture despite a key factor in the economic advancement of countries.

Students' academic performance is the extent to which students achieve their short or long-term educational goals. This is commonly measured through external or internal examination as well as continuous assessment in form of tests, assignments, projects, debates, practical as well as term papers. Two forms of evaluations are used to assess students' academic performance: formative and summative evaluations. Continuous assessment is a form of formative evaluation of students' academic performance that provides early indications of the performance of students. The essence is to provide remedial opportunities for those who did not perform well in the test. Continuous assessment also provides students with information that can be used to improve their academic achievement (Wikipedia, 2019).

It is no longer news to hear that student's academic achievement in Nigerian schools in both external examination and internal examination has been very poor. This situation if it remains unabated will further under develop the nation. Consequently, there is this burning desire to bring science closer to the society, and in so doing, a lot of creativities may be introduced into science education environment (Osborne et al., 2003). The concept of children's motivation and interest in science and scientific knowledge is paramount to bring about students that are involved in careers that have science basis to enable them to successfully impact knowledge acquired in the society "Nuffield Foundation" (Dsborne and Dillon, 2008).

The root of this ugly trend in poor academic achievement in science in general and Chemistry in particular in science is not connected to how science subjects are taught (Rocard et al., 2007). Hence, there is a requirement for a pragmatic change in the way science is taught. Science deals with knowledge of the universe and therefore should not be taught using lecture method; it should be taught with concrete things taken from the environments. Topics that have links with Chemistry concepts are found in every environment we find ourselves. Pinto (2003) commented on the benefits of science learning using activities that learners get involved with in their day to day life as a stimulator of students' motivation (Jiménez-Liso et al., 2013; Castro and Garcia,

2010). Parvin (2008) used a pool of 4,000 children in UK aged 9 to 14, who found that youngsters find the subject less inspiring and relevant to their lives as they move from primary to secondary school. The research discovered that there are several reasons for a fall in popularity in science including 'a curriculum that is often perceived by students as being too theoretical and not relevant', 'a poor understanding of the options offered by science based career in both students and some teachers and a shortage of specialist science teachers in secondary schools.

Students' record that shows the number of students who register in science classes in Nigerian secondary schools revealed that students' enrollment has been dropping on yearly basis (Akanbi, 2003; Bamidele, 2004). This scenario calls for urgent mitigating action to curb this problem if Nigeria must be at par with the world. Many of the problems that face Nigeria as a developing nation that ranges from food insecurity to poor medical health delivery can be solved to an extent with the knowledge of science and technology. This is so as new improved species of plants as developed by technology can take care of food insecurity. There is also the use of tractors, herbicides, fertilizes, to increase food supply with advances in science and technology. This cannot be achieved in Nigeria when the old method of students sitting down and passively learning science in schools is still in place (Omoesewo, 2009; Bhowmik et al., 2013).

A study done by Aina and Adedo (2013) showed that the causes of low enrolment in science included: Lack of trained science personnel in post primary schools. Schools also lacked instructional resources for teaching as well as textbooks written in a language that is not easily comprehended by students. The researcher also observed that Chemistry is difficult to assimilate and that solving of problems that require calculation was also an issue.

Teaching that will motivate students and build in them interest to learn should be one that makes sense to them. It should be delivered with instructional materials that explain the concepts to students in a simple and step by step presentation. When students cannot link what they are being taught with practical experiences, it brings about low interest in that subject which is manifested in their poor academic performance. When students' interest is captured, learning becomes very easy (Aina and Adedo, 2013; Hermitt 2007). Benjamin (2014) conducted a study on "The Impact of Performance Assessment on Students' Interest and Academic Performance in Science". The result obtained revealed a significant effect on the use of performance assessment as teaching strategy in the science classroom. This leads to increased students' interest in class and improved academic achievement of students.

Essien et al. (2015)'s study on the effect of interest on academic achievement in Social Studies revealed a strong positive relationship between interest and

academic achievement. The data analyzed showed that the  $r$  value of 0.15 calculated was greater than the critical value of 0.06 at 0.06 significance level.

A survey employing a Likert-based questionnaire consisting of 60 items was carried out, and documentary analysis was conducted on the students' final exam grades. The results show that interest and motivation had significant influence on students' learning outcomes, as shown by their final exam grades in the subject (Risa and Pupung, 2019).

Kusurkar et al. (2012) studied the effect of motivation on academic performance using a structural equation modeling analysis. The findings revealed a positive effect of interest on the academic performance of students.

A research was conducted on "Students' Motivation towards Science Learning and Students' Science Achievement. It was seen that, the female students were significantly more motivated than male students in learning science. The result of the study indicated that students' motivation towards science learning has a significant correlation with students' science achievement ( $r = 0.354^*$ ,  $r^2 = 0.125$ ,  $p = 0.000$ ) (Chan and Norlizah, 2017). In a similar vein, Sukor et al. (2017) observed a positive significant relationship score between motivations and academic performance of students.

A Master thesis on factors influencing poor performance in science subjects at Ingwavuma circuit reported that, motivation (interest) affected students' academic performance in science (Ngema, 2016). Ezike (2018) studied the correlation between students' interest and their academic performance in Chemistry. He found a significant positive relationship between the students' interest and academic performance in Chemistry. The result implied that as interest increases academic performance also increases.

Kpolovie et al. (2014)'s study on "Academic Achievement Prediction: Role of Interest in Learning and Attitude towards School" shows there is a significant correlation and multiple prediction of students' academic achievement with the predictor variables.

From the reviewed literature, interest in science/chemistry is very important for academic achievement. Some researchers have conducted researches and have found some of the methods to increase students' interest. Nhorvien et al. (2016) researched on "correlation between science learning motivation and students' academic performances"; they discovered that students who responded to the questionnaire that was administered had high motivation (interest) in science and that led to their high achievement in Science. This interest is extrinsic implying that the learning environment provided it.

Herzog et al. (2016) investigated how students in Science classes can be motivated to choose a career in science. The results of the research showed that action-based learning and relevance to their career choice can stimulate their interest in Science. In that regard, Cox

(2019), while writing on the topic "How to Motivate Students to Love Science" believes that if there is a connection between Science to Students' Everyday Life, they will be interested in science. This can be done by showing the science behind their daily activities for it will stimulate their interest.

Johnson (2005) is known as the father of kitchen Chemistry. It was borne out of his desire to make the teaching of Chemistry simple, to make students easily it and to make teaching of Chemistry easy for teachers. In using kitchen Chemistry, It was observed that that kitchen resources brought about collaborative learning and it was able to bring about increase in academic achievement of both low and high academic achievers. The entire universe is a laboratory that can be used to teach Chemistry. Using kitchen resources that learners are familiar with like cooking wares, storage and the Chemistry behind them make learning to be fun and not a difficult task to achieve (Home Experiments, 2011). This study aims to find out if the use of kitchen resources has any impact on students' interest in Chemistry and its effects on their academic performance in Chemistry.

## THEORETICAL FRAMEWORK

### Ausubel's theory of meaning learning and advance organizer

Ausubel (1968) said that if he had to reduce all educational psychology in just one principle, he would say that, the most important single factor influencing learning is what the learner already knows, ascertain this and teach them accordingly. Essentially, the theory has two components. First, there is the elaboration of what he called "advance organizer" that serves the purpose of increasing the clarity and stability of learning materials.

The second is a formulation of a procedure for the attainment of meaningful learning. Advance organizer, as defined by Ausubel, consists of those introductory materials that are presented in advance of an actual learning at higher level of abstraction and generality. The second component of Ausubel's postulation is the theory of meaningful verbal learning. The central key that explains the theory of meaningful verbal learning is subsumption, a process that describes the relevant knowledge already extant in the learner's cognitive structure and the new elements of information or concepts to be learned.

The implications of Ausubel's theory to the study are as follows: Concepts are meaningful only when the learner can visualize them and subsume them within a cognitive-structure. This means that the learners already understand more generic concepts that incorporate or include the concept one is trying to teach. This can be achieved when a Chemistry teacher uses resources from the environment (e.g. kitchen) as learners can view the

materials they already know as advance organizer in teaching and learning process.

During teaching, instructional resources should be presented such that the concept to be taught proceeds from the most generic (those in students kitchen) concepts to the most specific ones. Before trying to define activation energy for instance, first teach with materials that deal with more generic concepts for example, enthalpy of reaction which subsumes activation energy.

Learners can learn a concept only when they are "ready" for it (Learner readiness). It is from this theory that the principle of previous knowledge, which forms the background for learning, became very common. The implication here is that when resources from the kitchen that are familiar to the learner are used in the teaching/learning process, students' readiness can be enhanced.

### **Gagne's cognitive theory**

Gagne and Briggs (1977) maintains that new learning occurs through the combining of previously acquired and learned entities as well as upon their potentials for transfer. As a result of that, the rate of cognitive development does not depend on innate factors of maturational readiness only, but also on the mastery of simpler pre-requisite resources or materials around us. Gagne proposed five different kinds of learning and proceeded further to delineate how instructions may be used to facilitate the acquisition of each.

The implication of Gagne's theory of instruction to the study is that: Teachers must always state their learning objectives in clear behavioural term. This helps the Chemistry teacher to be focused and it also guides him to know the right resources in the kitchen to use in his teaching/learning process. When this is done, it may bring about meaningful learning outcome.

Learning units or tasks must be duly analyzed to identify their relevant components. For example, in the teaching of enthalpy, its component should include exothermic and endothermic reaction, activation energy, catalyst energy profile diagram, etc. When the relevant components are identified and arranged in a hierarchical form and relevant kitchen resources selected, that may bring about high academic performance of students.

The arrangement of relevant component should be in a manner that would ensure easy comprehension, effective and meaningful learning. This arrangement when backed-up with resources that are drafted from the learner's environment (kitchen) may increase their academic performance.

Gagne's theory of instruction can be of tremendous importance to the teacher teaching Chemistry. Materials to be presented to learner's need to be broken down into relevant components and teaching is to be in a

hierarchical order. Theories of instruction and learning reviewed provide the necessary frame work on which part of this study which has to do with academic performance of SS2 Chemistry students is supported.

### **Understanding a Brain-Base approach to learning and teaching (Emotions critical to patterning)**

Positive emotions such as love, excitement, enthusiasm and joy enhance the ability to process information and create "safe" environment (Sylwester, 1996). Stress and constant fear, at any age, can circumvent the brain's normal circuits. And yet, emotions are critical to learning. Emotion can improve memory. Teachers need to establish an environment that is free from intimidation and rejection, high in acceptable challenge and where the learner experiences active participation and relaxed alertness (Dwyer, 2002). Deutsch (2003) says, "How learners feel is very important to their learning process. If the learner is enthusiastic and does not feel stress, learning will take place". If the conditions are negative and the learner does not feel relaxed and safe in the learning environment, feeling threatened will shut down the learning process and as Goleman claims, "hijack" the rest of the brain (Viadero, 1996).

The result of students' responses showed that 1/3 of students believe students' emotions are very important in learning. Student A wrote, "I will introduce the topic, crack jokes to make the class lively and not boring to them and teach in the language they understand". Student B wrote, "I will always make students happy." Student C wrote, "I will teach with happiness and jokes to make the class interesting".

From the fore gone, students' emotion is very important in learning. When students are emotionally stable, the brain process will not shut down and interest is enhanced and as such learning takes place.

### **Understanding a Brain-Base approach to learning and teaching (Learning enhanced by challenges and inhibited by threat)**

A little bit of challenge makes learners to learn better. We remember having to go through the process more easily if the process is not so simple that it can be learned unconsciously. However, too much of a challenge or threat stops us from learning well. If a student feels anxious or threatened, she will be so busy processing and dealing with anxiety/threat and as such not much energy can be put toward processing the desired information. This means students must be comfortable and stimulated to learn (Bromley, 2017). Nunley (2019) says the environment inside the classroom must be more desirable than the environment outside the classroom. If students feel like being in the classroom is

punishment, then any behavior they can exhibit to get out of the environment is being reinforced when you force them to leave. Classrooms should be welcoming and be a place where students feel valued and encouraged, not belittled and degraded.

The students' responses to questionnaire agree with the above principle. Student X wrote, "I will teach it to the understanding of the students and find their areas of difficulties." Student Y wrote, "I will first be friendly to students." Student 2 wrote, "I will challenge my students with questions."

The principles of brain-based learning and students' responses analysis showed that teachers should be very careful with students' emotions if they are serious about learning. Teachers should not mock, belittle or abuse a student to make the student feel inferior as that will hinder learning. Teachers should also endeavour to use materials around the learning environment as resources for teaching. Teachers should as much as possible reduce rote memory method of knowledge. Teachers should strive to take students out for field trip in case the materials cannot be brought to the classroom. Teachers should try as much as possible to minimize threat in the classroom as that hinders the functioning process of the brain.

### Statement of the problem

Academic achievement of students in science subjects generally and in Chemistry in particular had witnessed a deplorable trend in the past decades. Observations from 2005 to 2014 have consistently revealed poor achievement in Chemistry in senior secondary school certificate examination organized by West African Examination Council. A lot of research work has been carried out on students' poor academic performance.

Empirical works reviewed indicated that in appropriate teaching methods, lack of instructional materials/resources as reasons for poor academic performance of students in sciences. Improvisation had been used to improve students' performance in physics. There are mainly opinions on the benefits of kitchen resources and if any few empirical works on the use of kitchen resources in the teaching of Chemistry. The present exercise is an endeavour to empirically find out if the assertions about the use of kitchen resource are true in senior secondary Chemistry students in Calabar Education Zone.

Against this background therefore, the problem of this study was to investigate what is the academic performance of Chemistry students when taught with kitchen resources? What will be its effect on students' interest.

### Purpose of the study

The purpose of the study is to determine if the use of

kitchen resources in teaching has any significant effect on Chemistry students' interest in chemistry and its effect on the academic performance of Chemistry students. How the use of kitchen resources in teaching affects chemistry students' interest in chemistry? How will students' interest in Chemistry affect their academic performance?

### Research questions

The following questions guided the study:

- (1) How does teaching with and without kitchen resources affect Chemistry students' interest in the subject?
- (2) How does students' interest in Chemistry affect Chemistry students' academic performance?

### Statement of hypotheses

These postulated hypotheses were utilized in this study.

- (1) There is no significant difference between the interest level of SS2 Chemistry students taught Chemistry using kitchen resources and those taught without kitchen resources.
- (2) Interest of students does not significantly relate to Chemistry students' academic achievement

### MATERIALS AND METHODS

A mixed method design was used for the study. This is a quasi-experimental research design for teaching with kitchen resources and expo facto design for the investigation of interest of the students. The research population was 200 students. This study was conducted using 50 students as the sample size. The sample size was selected using simple random sampling technique from a table of random numbers. Secondary 11 students were distributed in two classrooms. These two groups were named experimental and control. In both groups, students were grouped in fives. The experimental group was taught using kitchen resources while the control was taught using the conventional method. All resources and experiments carried out were developed by the researcher.

Details of the experiments carried out by the experimental group are shown in Appendix 1. Two instruments were developed by the researchers for this study: The Chemistry Interest Questionnaire (CIQ) and Chemistry achievement test (Cat). The CIQ had 10 items that used 4 Likert questionnaire scale. It was validated by experts in test and measurement department of the research area. CIQ was subjected to Cronbach Alpha reliability coefficient to ascertain the reliability of the instrument. The result of Cronbach Alpha was  $r=0.78$ .

Cat was an objective test made up of 25 multiple choice questions. The questions had one correct answer and three distractors. The questions were validated by standard examination body questions bank where they were drawn from. The results of the questions that were administered to a group of students that did not form part of the research but were similar in all respect to the students that formed part of the research were subjected to Kuder Richardson formular 21. The result was 0.83.

**Table 1.** Independent t test of the difference between treatment (with and without kitchen resources) and students' interest in chemistry.

Method of teaching	N	Mean	Std.	t- Cal
Taught with kitchen resources	26	35.81	4.60	4.96
Taught without kitchen resources	24	27.25	7.38	

Df = 48, t-critical = 2.02. The calculated t value of 4.96 is greater than the critical t value of 2.02. This means that the result is significant. The null hypothesis that stated that there is no significant difference in the interest level of Chemistry students when taught with and without kitchen resources was not accepted. The implication is that interest of chemistry students are enhanced when they are taught with kitchen resources.

**Table 2.** Pearson product moment correlation coefficient (r) analysis of the relationship between academic achievement and students' interest when taught using kitchen resources.

Variable	$\Sigma x$	$\Sigma x^2$	$\Sigma xy$	R	p-cal
	$\Sigma y$	$\Sigma y^2$			
Academic achievement	1821	10030.32	4327.22	-	-
Interest	1166	2662.70	-	0.90	0.72

P < 0.05, df = 49, Critical = 0.29.

In each micro-lesson for the experimental group, four experiments were done using Chemistry concepts. The students for this research used kitchen resources chemicals; this was to familiarize the students with the concepts to be taught. Prior to every practical exercise, students were given a document that contained the explanation of the practical to be carried out.

The teaching was done for eight weeks. After the teaching, interest questionnaire was administered to both the control group and experimental group. It had 10 items to measure students' interest (CIQ) in Chemistry. It had four Likert scale levels. A chemistry test (Cat) of 25 items covering questions in Chemistry from topics related to the experiments carried out was administered to the students for 30 min after instruction.

## RESULTS AND DISCUSSION

Most home kitchens hold the tools to dozens of fun experiments to expand the imagination of children in the classroom. Kitchen resources provide fun experiments to students thereby increasing their interest in Chemistry (Caroline, 2013) (Table 1).

This work was also collaborated by [https://www.guesthollow.com/homeschool/science/chemistry\\_highschool/chemistry\\_home.html](https://www.guesthollow.com/homeschool/science/chemistry_highschool/chemistry_home.html) (2019) that was of the opinion that most Chemistry curriculum were made thick and boring textbooks that make Chemistry students not to be interested in the subject chemistry. Guest hollow high school chemistry in the kitchen is for students who hate Chemistry and in tears because of the scaring Chemistry textbook. The kitchen Chemistry stimulates students' interest in Chemistry.

Chemistry is fun when kitchen resources are used. Fun kitchen projects, like making of ice cream, can be used to demonstrate what a chemical reaction is (<https://www.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/chemistry-teacher>, 2019).

Table 2 shows that the calculated r-value of 0.90 was greater than the critical r-value of 0.29, given 49 degrees of freedom at 0.05 alpha levels. This indicates that there was a significant relationship between academic achievement and interest of chemistry students. By this result, the null hypothesis of no significant relationship was rejected. From the analysis of data obtained, it was revealed that students' academic performance was dependent on their interest in Chemistry ( $r = 0.91$ ). This implies therefore that students who do well in a Chemistry class will have high interest. Low interest in Chemistry by students can therefore be said to be a contributing factor why secondary school chemistry performance is poor as there was a positive relationship between interest and academic achievement of students. The Pearson product moment correlation coefficient (r) value was 0.92. This high value of 0.92 and positive value means that there is a strong positive relationship between interest and academic achievement of students. By implication, when interest is high, academic achievement is high and when interest is low, academic performance is low. Benjamin (2014) conducted a study on "The Impact of Performance Assessment on Students' Interest and Academic Performance in Science". The result obtained revealed a significant effect on the use of performance assessment as teaching strategy in the science classroom. This leads to increase in students' interest in class and improves academic achievement of students.

Essien et al. (2015)'s study collaborated this study as data analyzed showed that the r value of 0.15 calculated was greater than the critical value of 0.06 at 0.06 significance level. This study agrees with the research carried out by Ngema (2016), Ezike (2018), Kpolovie et al. (2014) and Essien et al. (2015) that had a significant

result when interest of students was compared to their academic achievement. Nhorvien et al. (2016) study the correlation between Science Learning Motivation and Students' Academic Performances; they also found a significant difference in the relationship between the students' interest and their academic achievement.

Taking the students' individual result, it was obvious that a student who scored high in interest test also scored high in Chemistry performance. The positive correlation between chemistry achievement test and interest is in line with the fact that before performance can be achieved, the individual in question must be interested in the job. Inventions are products of interested brains. The working of the brain shuts down when there is no interest.

Interest is very important in how an individual performs a given task. To be successful students must be taught with material that can be seen (Caine and Caine, 2013). Materials around students' homes that they encounter daily can be used to stimulate students' interest (Cox, 2019). Teaching with kitchen materials/resources got students active in the teaching and learning. Students sourced for the materials and came to class with many questions as what the materials will be used for.

This study shows the importance and significant role played by instructional materials (Kitchen resources) in students' achievement, especially in Chemistry. They have positive influence in their achievement in Chemistry. This explains why a subject like Chemistry will require real objects and activities/experiment that can convert topics that seem imaginary to concrete for students' understanding. It was therefore observed that using kitchen resources assisted teachers economically and the government in general. It allowed students to interact better in their lesson. It made students to use their intellectual ability during the learning and teaching process. It encouraged creativity, bringing learning homewards and often improved and enhanced students' achievement.

## Conclusion

In view of the contribution of science and technology to the world at large and Nigerians, it benefits children that engage in scientific activities and prepares them for the future society. This research has shown that if kitchen resources are used to teach Chemistry and present science as a funny activity, which is even better if the experiments can be lived in a familiar way, interest of students in chemistry would be enhanced.

## Implication for the teaching of Primary Science and Mathematics

This study has revealed the importance of the use of kitchen resources in teaching. When materials from the

kitchen are used in primary science and Mathematics classrooms, it brings learning closer to the learner thereby enhancing academic achievement in primary Science and Mathematics.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# **The relationship between emotional literacy, cognitive flexibility and counseling self-efficacy of senior students in psychology and psychological counseling and guidance**

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Received 4 October, 2019; Accepted 10 December, 2019

**The aim of this study was to investigate the relationship between emotional literacy, cognitive flexibility and counseling self-efficacy among senior students studying in psychology and psychological counseling and guidance departments. Participants of the study were 397 (306 female and 91 male) undergraduate students enrolled in Medipol University, Trakya University, Ankara University, Pamukkale University, İstanbul Commerce University and NuhNaci Yazgan University. The age of the participants ranged from 20 to 38 with the mean age of 22.36 (SD 1.67). For data collection, the 34-item Emotional Literacy Scale, 12-item Cognitive Flexibility Scale and 41-item Counseling Self-Efficacy Scale have been used. The results of path analysis yielded that emotional literacy has positively direct correlations with helping skills self-efficacy and session management self-efficacy whereas cognitive flexibility has positively direct correlations with helping skills self-efficacy, session management self-efficacy and counseling challenges self-efficacy. The proposed model of emotional literacy and cognitive flexibility came by accounting for 21% of the variance of the helping skills self-efficacy, 17% of the variance of the session management and 12% of the variance of the counseling challenges self-efficacy in the current study.**

**Key words:** Emotional literacy, cognitive flexibility, counseling self-efficacy, undergraduate students.

## **INTRODUCTION**

Counseling is a collaborative psychological partnership which takes place between a client and counselor in a face-to-face interactive setting for the purposes of helping the client gain a greater understanding and awareness of

themselves in order to lead a more fulfilling life (Tan and Baloğlu, 2006). Its effectiveness depends on various or indeed all factors related to the counsellor, who plays an active role in the process (Cormier and Hackney, 2005).

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These factors include both the level of their theoretical knowledge and educational background (Larson, 1998) as well as experience in therapeutic practices (Büyükgöze-Kavas, 2011), mindfulness (May and O'Donovan, 2007), effective interpersonal communication skills (Anderson et al., 2009), and personality traits (Topolinski and Hertel, 2007). According to Kepçeoğlu (1999), it is essential that a counselor fulfills the role of a professional who possesses the expertise to take responsibility for and manage the counseling session, as well as an openness to ongoing professional development.

A counselors' determination to build upon and extend their professional training and personal and professional development is critical to the effectiveness of their abilities. Relevant research has shown that counselor training programs are important in that they significantly increase the effectiveness of counseling (Brott, 2006; Yager and Tovar-Blank, 2007). Mullen et al. (2015) have emphasized the importance of counselor training for the first counseling session, supervision period, and the identification of self-efficacy beliefs. In this vein, Hill et al. (2008), in particular, have forwarded the idea that counseling training programs increase counselor candidates' self-efficacy and self-confidence.

Self-efficacy is an important concept in regard to counselor's competency (Barnes, 2004; Larson and Daniels, 1998). Larson (1998) asserts that an individual's self-belief and self-acceptance are important factors influencing the effectiveness of the counseling process. Counseling self-efficacy is defined as "an individual's beliefs and judgments about his or her ability to effectively counsel a client in the near future" (Larson et al., 1992). This is largely considered an important criterion used to evaluate the development of counseling skills and an individual's counseling abilities (Larson and Daniels, 1998).

The importance of self-efficacy in the field of counseling is reported by the researches for various variables such as counselor supervision (Lambie and Sias, 2009; Kozina et al., 2010), emotional intelligence (Easton et al., 2008) and counselor personality (Larson et al., 1992). According to Lent et al. (2003), one's level of counseling self-efficacy can be gauged in terms of three competencies: helping skills, session management, and counseling challenges. Helping-skills self-efficacy entails the effective use of counseling skills (assisting discovery, insight, and action). During the *discovery* phase, the counselor helps their client focus on a particular problem and discover their thoughts and feelings about it. During the *insight* phase, they are tasked with helping the client develop new perspectives to their problems and to gain an awareness which enables them to reconsider these problems in a new light. Finally, during the *action* phase, counselors are charged with assisting clients in making positive changes to their emotions, thoughts, and behaviors relating to the problems into which they have

gained insight in the aforementioned phases. Counsellors must go through these stages together with the client by establishing a good therapeutic relationship (Hill and O'Brien, 1999). Session management relates to maintain counseling sessions effectively and smoothly. This requires the counselor to establish a therapeutic alliance with the client and get them actively and emotionally engaged (Skovholt and Ronnestadt, 2003). Clients may intrinsically encounter cases such as suicidal thoughts, abuse, and domestic violence. For many counselors, dealing with these kinds of cases can become overwhelming for obvious reasons. Thus, it is highly important that mental health professionals (counselors/therapists) be supportive of their clients in order help them deal with such states of consciousness and get to the bottom of their most urgent and outstanding underlying causes (Karakurt et al., 2014).

One of the key elements of counseling self-efficacy seems to come in the form of what is referred to as emotional literacy. Emotional literacy is defined as an understanding and awareness of one's own emotions as necessary in order to develop one's own personal capacity and life quality, as well those of others (Steiner, 2003). In a way, being emotionally literate involves the ability to regulate one's own emotions in order to derive satisfaction and pleasure from life. Emotional literacy develops interpersonal relations, reinforces love between human beings, and allows for more fruitful cooperation between individuals (Steiner, 2003). Emotional literacy involves self-awareness and personal skills in dealing with intense emotion and also covers having empathy, authorizing and respecting others, efficient communication and conflict management skills, having a positive and useful approach, building emotional resources (Nemec and Roffey, 2005)

According to Steiner (2003), emotional literacy requires five main skills: awareness of one's own emotions, empathy, knowledge of how to manage emotions, an ability to deal with emotional damage, and the development of emotional interaction. Similarly, Suhaly and Tiah (2005) maintain that emotional literacy entails such skills as empathy, emotional awareness, self-motivation, social skills, and self-regulation. A counselor who possesses these skills is likely to provide a more effective counseling service. Similarly, Corey (2013) claims that being a good counselor involves establishing and maintaining a good therapeutic relationship with the client, choosing the appropriate counseling techniques that best suit the clients' needs, and controlling one's own reactions and responses. Pearson and Wilson (2008) contend that receiving training on expressive art therapy is important for the counselor to better understand and manage their own emotions and increase their emotional self-efficacy.

In addition to emotional literacy, another critical attribute of a counselor, which may help them overcome the difficulties they face during counseling, is cognitive

flexibility. The construct of cognitive flexibility has been well examined. However, there is no consensus within the literature about how to define this construct definitely (Dennis and Vander Wal, 2010). Cognitive flexibility is an important structure of healthy individuals' cognitive processes (Doğan-Laçın and Yalçın, 2019). This enables individuals to understand that there are alternatives, and to be more sensitive to others' emotions (Martin and Rubin, 1995) and change the path of their thoughts according to the alternatives present (Asıcı et al., 2018). Cognitive flexibility is based on awareness of choices and alternative solutions to a given situation, willingness to be flexible under new conditions, and feeling of competence and confidence in these situations (Martin and Anderson, 1998). Dennis and Vander Wal (2010) define cognitive flexibility as the ability to convert one's cognitive system according to the changing environmental factors, produce solutions, and adapt to the new environment. A person with cognitive flexibility is aware of the possible alternatives, can effectively cope up with challenging and unusual situations by his ability to produce alternative approaches, and can easily adapt to a new environment and social life (Altunkol, 2011; Hill, 2008; Ionescu, 2012; Martin and Anderson, 1998; Martin et al., 1998). Several pieces of research have shown that cognitive flexibility interacts with other attributes, such as mindfulness (Moore and Malinowski, 2009), involving in diversifying events (Ritter et al., 2012), problem solving skills (Cañas et al., 2010), and well-being (Koesten et al., 2009).

The counseling process can be stressful for many counselors, especially for the novice, due to reasons related to session management, problems brought by the client, and the difficulties that emerge naturally within the counseling process. Improving counseling students' self-efficacy in relation to counseling skills is a significant developmental goal within counselor training programs (Larson and Daniels, 1998); as counseling process can be devastating, especially emotionally, for some counselor trainees. In order to be able to offer effective counseling services throughout their careers, counselor trainees have to overcome these difficulties. At such times, counseling students' levels of cognitive flexibility and ability to understand the client's emotions are considered instrumental in continuing the counseling process. Lastly, allowing to comprehend the effects of variables on counseling students' skills, this study aimed to analyze the effect of emotional literacy and cognitive flexibility on the self-efficacy of counselor trainees.

## METHODOLOGY

### Design

This study is a correlative-descriptive study that investigates the relationships between emotional literacy, cognitive flexibility, helping skill self-efficacy, session management self-efficacy and counseling challenges self-efficacy levels of senior university students in psychology and psychological counseling and guidance

departments. In the correlative model, emotional literacy and cognitive flexibility were the independent variables while helping skill self-efficacy, session management self-efficacy and counseling challenges self-efficacy were the dependent variables.

### Participants

The sample of the study consisted of 397 (306 female and 91 male) fourth grade students within the departments of psychology and psychological counseling and guidance of Medipol University, Trakya University, Ankara University, Pamukkale University, Istanbul Commerce University and NuhNaci Yazgan University. The ages of the participants ranged between 20 and 38 and the average age was 22.36 (SD= 1.67). The participants were selected via a purposive sampling method.

### Instruments

#### *Emotional literacy scale*

This is a 34-item scale developed by Akbağ et al. (2016). The scale consists of five sub-dimensions: emotional awareness, social competence, understanding emotions, emotional self-efficacy, and emotion regulation. The lowest score that can be obtained from the scale is 34, while the highest score possible is 170. The Cronbach  $\alpha$  coefficient of the scale was found to be 0.80 while test retest reliability came to 0.89.

#### *Cognitive flexibility scale*

This is a 6-point Likert-type scale developed by Martin and Rubin (1995) to determine a person's level of cognitive flexibility. This scale was adapted to Turkish by Altunkol (2011). The scale has 12 items, with the lowest score constituting 12 and the highest coming to 60. The internal consistency Cronbach  $\alpha$  coefficient calculated to test the reliability of the Cognitive Flexibility Scale was found to be 0.81 and the test-retest reliability was 0.73 in the adaptation study.

#### *Psychological counseling self-efficacy scale*

This was developed by Lent et al. (2003) to measure the levels of psychological counseling self-efficacy of psychological counselor candidates. The scale was adapted to Turkish by Pamukçu and Demir (2013). The scale has three factors along with 41 items. The first factor called "self-efficacy" consists of 15 items and consists of three sub-dimensions, insight, discovery and action skills. The second factor labeled "self-efficacy related to session management", consists of 10 items. "Self-efficacy related to the difficulties in the psychological counseling process" constituting the third factor consists of 16 items. There are two sub-dimensions in this factor: conflicts in relationships and client problems. The responses for each item range from (0) "I don't trust at any" to (9) "I totally trust all". The lowest score that can be obtained from the scale is "0" and the highest score is "369". High scores indicate a high level of self-efficacy in counseling. The McDonald's Omega ( $\omega$ ) coefficient of the scale was 0.92 for the self-efficacy subscale; 0.95 for self-efficacy related to session management subscale and 0.95 for the self-efficacy related to the difficulties in the psychological counseling process subscale.

### Data analysis

After the data collection process was completed, the data was

**Table 1.** Intercorrelations between the variables of the study.

Variable	1	2	3	4	5
1. Emotional literacy	-				
2. Cognitive flexibility	0.52**	-			
3. Helping skill self-efficacy	0.42**	0.40**	-		
4. Session management self-efficacy	0.36**	0.39**	0.70**	-	
5. Counseling challenges self-efficacy	0.25*	0.35**	0.57**	0.68**	-

**Table 2.** Model fit indices for the proposed model and criterion values.

Goodness of fit indexes	Model fit indices of the proposed model	Criterion ranges
$\chi^2$ , df	3.26; 1	Non-significant
$\chi^2$ /df	3.26	$\chi^2$ /df < 3
CFI	0.99	CFI > 0.90
TLI	0.97	TLI > 0.90
RMSEA	0.08	0.08 > RMSEA > 0.05

examined and cleared in terms of missing values, outliers and normality using SPSS 20 statistical program (Tabachnick and Fidell, 2006). Following this, the descriptive statistics and correlation analysis were performed with the same program. Subsequently, the AMOS 18 statistical program was used to determine the predictive effects of emotional literacy and cognitive flexibility on helping skill self-efficacy, session management self-efficacy and counseling challenges self-efficacy.

### Procedure

The data was collected from the students studying in psychology and psychological counseling and guidance departments of various universities in the 2017-2018 Spring Semester. After obtaining permission from the Ethics Committee of Istanbul Medipol University, the data was collected by the researchers in the classroom environment during the times negotiated with the instructor of the class. During the application of the scales, the purpose of the research was explained orally by the researchers. As the scales were applied in five different universities, the completion of applications was lasted for two months.

## RESULTS

### Descriptive statistics

In advance of the path analysis, the intercorrelations between the study variables were discovered, as presented in Table 1.

The results of the Pearson moment correlations displayed in Table 1 show that emotional literacy has significantly positive relations with cognitive flexibility ( $r=0.52$ ,  $p < 0.01$ ), helping skill self-efficacy ( $r=0.42$ ,  $p < 0.01$ ), session management self-efficacy ( $r=0.36$ ,  $p < 0.01$ ) and counseling challenges self-efficacy ( $r=0.25$ ,  $p < 0.01$ ). Likewise, cognitive flexibility also shows

significantly positive connections to the dependent variables such as helping skill self-efficacy ( $r=0.40$ ,  $p < 0.01$ ), session management self-efficacy ( $r=0.39$ ,  $p < 0.01$ ) and counseling challenges self-efficacy ( $r=0.35$ ,  $p < 0.01$ ).

### Path analysis

The predictive effects of emotional literacy and cognitive flexibility on the dependent variables of helping skill self-efficacy, session management self-efficacy and counseling challenges self-efficacy were tested through a path analysis. Based on the sufficient evidence for the assumption of normality, a Maximum Likelihood Estimation was conducted to test the proposed model (Kline, 2011).

As a first step, the goodness of fit for the proposed model was examined through a number of model fit indices. The model fit values, which emerged together with the criterion cut-offs, are presented in Table 2.

Based on the values given in Table 2, it can be concluded that the normed Chi-square value ( $\chi^2(1) = 3.26$ ,  $p = 0.07$ ) does not satisfy the criterion of being less than 3 but both (CFI=0.99) and Tucker Lewis indexes (TLI=0.97) that are above the expected 0.90 value as well as the RMSEA value of 0.08 that is in the assumed ranges of 0.05 to 0.08 indicate satisfactory results for the goodness of fit requirement of the proposed model to the data (Bentler, 1990; Browne and Cudeck, 1993; Kline, 2011; Schumacker and Lomax, 2004).

In the last phase of the path analysis, the standardized estimates for the proposed relations were detected and depicted in Figure 1. Based on the standardized parameters presented earlier, it can be considered that

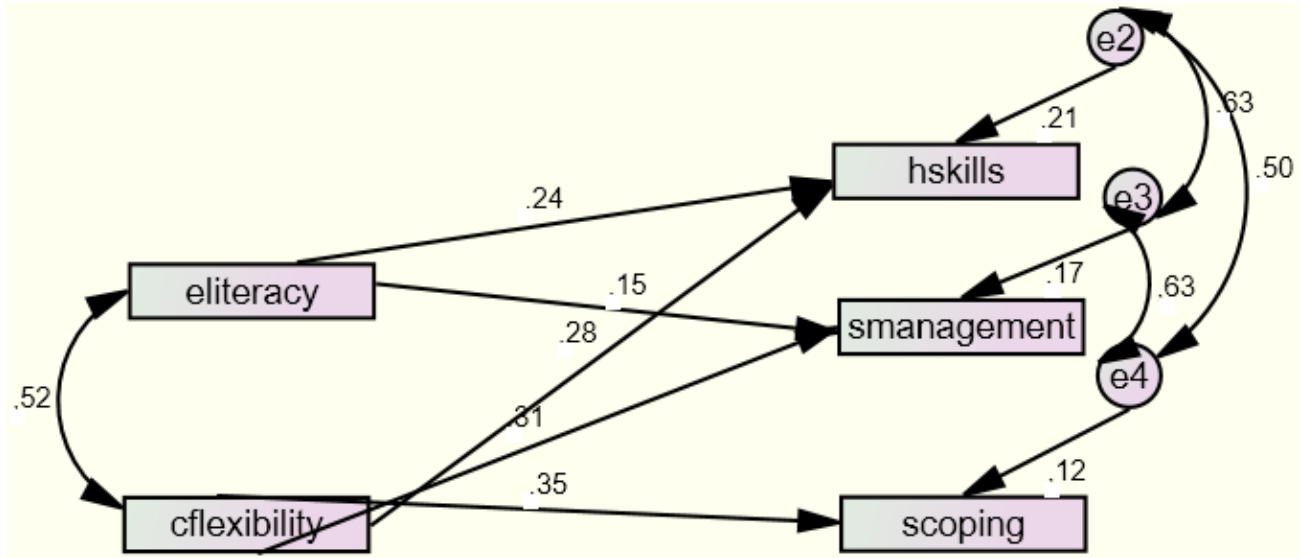


Figure 1. Standardized path coefficients for the proposed model.

emotional literacy has a positively significant effect on helping skill self-efficacy ( $\beta=0.24$ ,  $p < 0.001$ ) and session management self-efficacy ( $\beta=0.15$ ,  $p < 0.01$ ). As well, cognitive flexibility has positively significant effects on helping skill self-efficacy ( $\beta=0.28$ ,  $p < 0.001$ ), session management self-efficacy ( $\beta=0.31$ ,  $p < 0.001$ ) and counseling challenges self-efficacy ( $\beta=0.35$ ,  $p < 0.001$ ). Given the squared multiple correlation coefficient ( $R^2$ ) value emerged for the dependent variables, it must be concluded that the proposed estimators, namely emotional literacy and cognitive flexibility, explain 21% of the variance of helping skill self-efficacy, 17% of the variance of session management self-efficacy and 12% of the variance of counseling challenges self-efficacy of senior counseling and psychology students in the current study.

## DISCUSSION

This study has explored the role of emotional literacy and cognitive flexibility on counseling self-efficacy with particular emphasis on the sub-dimensions of counseling self-efficacy helping skills, session management, and dealing with the challenges in the counseling process. To this end, first the interactions between the variables were tested. The findings showed significant correlations between the variables. Then, a model which has the potential to theoretically explain the counseling self-efficacy was developed and verified statistically.

According to the verified model, the affective dimension of the emotional literacy has a significant effect on the counseling self-efficacy dimensions of helping skills and session management. In other words, emotional literacy is a significant predictor of helping skills and session

management, which are the two major sub-dimensions of counseling self-efficacy. Based on the model presented, it can be concluded that recognition and management of one's own emotions will allow a counselor to understand the other person's emotions and carry out the counseling sessions more effectively, as well as helping the client gain an insight into their own problems.

Another finding confirmed by the model is that cognitive flexibility directly affects the three sub-dimensions of counseling self-efficacy: helping skills, session management, and overcoming the challenges of counseling. Cognitive flexibility, which is a key element in individuals' cognitive processes, is one of the important attributes that a counselor should possess to provide effective counseling services. A counselor with a high level of cognitive flexibility can be considered as one able to tackle with a client's problems by considering various alternatives. Following the verification of the model, it can be concluded that both the cognitive and affective attributes of clients and the interaction of these attributes influence the counseling self-efficacy.

Human beings encounter distressing and challenging situations throughout their lives. Being able to deal with them is crucial for the individual's subjective well-being. Some individuals can be resilient in stressful situations and even turn them into opportunities, while others need psychological support. Getting psychological help enables individuals to cope more effectively with tough experiences and be more resilient, which is facilitated by counselors who are experienced in therapeutic practice and who have considerable self-efficacy.

The findings of this study are in concordance with those of the studies in the related literature (Easton, 2004; Martin et al., 2004; Easton et al., 2008); especially regarding competencies related to describing one's own

emotions, recognizing others' emotions, expressing one's emotions appropriately, helping others gain insight into emotions, and successfully employing emotions in problem solving, as significant predictors of self-efficacy of trainee counselors and professionals in practice. Meyer (2015) claims that, as counseling self-efficacy is important for counselor candidates' ability to use counseling techniques and the counseling supervision they must complete, then this must be considered a vital component of counseling training and the continuation of further professional development. Besides, the findings of the study conducted by Mullen et al. (2015) concur that counseling preparation programs remarkably increase the self-efficacy of counseling students. Likewise, Ivey et al. (2006) mentioned that counselor trainees develop competence by learning and showing skills such as clarifying the client's message through observing and mirroring and reframing feelings. These skills and empathic expressions are meant to help clients to analyze blended feelings related to others and situations.

An analysis of counseling literature (Wei et al., 2015) has shown that psychological flexibility and conscious mindfulness are closely related with counseling self-efficacy. Psychological flexibility, that is, the establishment of a good rapport with the client here and now, helping them gain an insight into situations which will benefit their personal development, and the ability to guide them through the adaptation of these skills into daily life (Hayes et al., 2006). Hayes et al. (1999) suggest that psychological flexibility is likely to improve mental health by decreasing the effect of negative internal events, and by helping individuals to plainly determine and achieve goals that are meaningful to them. Being psychologically flexible calls for consistency in terms of the values adopted by an individual, even in the face of undesirable internal experiences. Therefore, it is considered imperative that trainee counselors gain such flexibility. It has also been confirmed that psychological flexibility relieves a counselor's stress levels and increases their well-being in general (Littrell and Peterson, 2001), which can only contribute to their client's self-efficacy in this regard.

## RECOMMENDATIONS FOR FUTURE RESEARCHES

The results of this study have revealed that the higher the individual's emotional literacy and cognitive flexibility levels, the more effectively their ability to maintain the conditions needed for a smooth and effective counseling process, as well as helping them cope with challenges which naturally come about due to the nature of the counseling process. Conducting psycho-educational programs to improve the individuals' emotional literacy and cognitive flexibility may not only contribute to the development of a sound personality, but also help increase counsellors' psychological well-being and

increase the effectiveness of their methods. Thus, an integration of these findings within the curricula of counseling training during undergraduate education is of vital importance to train counseling professionals.

In terms of the content validity of the study, it should be considered that the findings presented are limited to the aforementioned universities. As counseling self-efficacy is important for professional satisfaction and counselor wellness in general, it is recommended that the study be replicated with students of other universities' psychological counseling and guidance departments. Existing studies in the literature related to counseling self-efficacy seem to be the regarded concepts such as psychological flexibility, mindfulness, acceptance, and commitment. The present study is theoretically significant in that, as opposed to other studies, it focuses on the relationship between cognitive flexibility and counseling self-efficacy. Further research should be conducted, which focuses on other influential factors such as emotional intelligence, empathy, application of counseling techniques in order to shed more light on the subject of self-efficacy. The findings of the study are highly significant in the field of psychological counseling and guidance.

Furthermore, researchers may explore the impact of specific interventions aimed to enhance counseling trainees' self-efficacy. Counselor educators and supervisors should pay attention to advance counseling trainees' professional competencies by improving their skills to provide effective counseling to clients. Research on counseling trainees' development is of vital importance for understanding students' both educational and supervisory needs.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# Preparation techniques for multiple-choice possibility measurement tools (MCPMT) in education

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Received 8 October, 2019; Accepted 10 December, 2019

**This study draws on the understanding that when the correlation between variables is not known yet the non-linear expectation in the correlation between the variables is present, non-linear measurement tools can be used. In education, possibility measurement tools can be used for non-linear measurement. Multiple-choice possibility measurement tools (MCPMT) can be prepared similarly to conventional multiple-choice measurement tools (CMCMT) utilized in quantitative measurements. In comparison with CMCMT, both more qualified measurements and more qualified evaluations can be carried out via possibility measurement tools; therefore, the preparation techniques of MCPMT, which is one possibility measurement tool, which can be used in information-centered and learner-centered measurements, are set forth in this study. MCPMT can resolve the problem of CMCMT in terms of the measurement of different variables with multiple options in one item. Additionally, the correlation between the variables can be determined by evaluating data obtained via MCPMT by means of two different new methods.**

**Key word:** Multiple-choice measurement tool (MCMT), multiple-choice possibility measurement tool (MCPMT), item techniques (IT), option technique (OT).

## INTRODUCTION

The brain is a complex system. The learning style of a complex system can be non-linear as well. The probability of learning to be linear can be as high as the probability of its being possible or functional. Learning can be correlated with a number of dependent and independent variables. The exact correlation of dependent variables of learning with independent variables has not been proven. Until today, it has not been proven that learning is linear, either. In education, the separation of learner-centered or the information-centered measurements can accelerate the determination of the correlation

between learning variables. Additionally, in the evaluations carried out with this separation, the improvement of the learning methods in these separation types can contribute to future studies.

When measurement tools are prepared without value sorting in answer options of their items/questions, they will be termed as MCMT. The measurement tools to be prepared by means of the possibility measurement tool techniques will be termed as MCPMT. The MCMT whose answer options have value sorting can be classified either as optional from a lower limit ( $0 \leq \text{lower limit}$ ) to an

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upper limit, or as optional from a negative limit to a positive limit.

By breaking the information into its “significant smallest piece (SSP)” “anlamli en küçük parça (AKP)” as suggested in the study carried out by Yılmaz (2011), it can be compared and evaluated quantitatively by means of secondary information and correlated with the dependent variables (for example success) of learning, as well. A linear correlation, as well as a non-linear correlation, can be utilized between the information and the dependent variables of learning. To cite an example, success can be considered as the dependent variable of learning. When there are ten items, five options for each item, and there is one correct answer among these five options in a test, the success can be measured linearly as  $2/10$  ( $1/5$ ) for two correct answers,  $5/10$  ( $1/2$ ) for five correct answers or  $8/10$  ( $1/1,25$ ) for eight correct answers. It is uncertain to settle the incorrect answers within the purpose of this measurement

When the incorrect options do not have a second meaning in the same measurement tool, it can be evaluated by means of the binary basis independent possibility. In a binary basis independent possibility evaluation, the correlation between information and success can be established via the sum of the symmetric possibilities by a combination equation, until (including the symmetric possibility whose symmetric situation number is equal to the number of correct answers) the symmetric situation number (when the symmetrical situation number is used as the number of correct answers) as symmetric from the zero symmetrical situation number becomes equal to the number of correct answers. When such a correlation is established, in the above given multiple-choice test, it is evaluated via the binary basis independent possibility by dividing the sum of the symmetrical possibilities by the possibility distribution number; the success for two correct answers is obtained as  $56/1024$  ( $1/18,29$ ), the success for five correct answers is obtained as  $638/1024$  ( $1/1,60$ ), and the success for eight correct answers is obtained as  $1013/1024$  ( $1/1,01$ ). The change in the success rate based on the number of correct answers is non-linear. This renders the binary-basis independent possibility as non-linear. As the evaluations can be carried out from a symmetrical possibility measurement and the symmetrical possibility can be altered non-linearly based on symmetrical situation numbers, based on this example, the measurement tools by which the possibility will be measured are rendered as non-linear. The measurement tool by which uncertainty can be eliminated should be prepared in the evaluation of the multiple-choice test given in this study, as the questions that are answered incorrectly are uncertain. However, in the binary-basis independent possibility measurement, whether the questions are being answered correctly or incorrectly is irrelevant. The evaluation can be carried out via the symmetrical possibilities of binary-basis

independent possibility distributions, and the information content can be evaluated via the Shannon equation. When the possibility measurement tool is prepared in accordance with the sole internal variable option technique (OT) or internal variable OT it is irrelevant whether the questions are being answered correctly or incorrectly. The evaluation of the example given in this study can be carried out by means of independent possibility distribution of five situations to ten events. In a multiple-choice measurement, carrying out possibility evaluations may be more suitable via an independent possibility measurement tool instead of linear measurement and evaluation.

In the cases where it is important to know the questions that are answered or in which order questions are answered, the measurement can be interpreted better by carrying out the evaluation via the equations of regular symmetric, irregular symmetric, event-based symmetric, symmetrical contiguous and symmetrical discrimination possibilities instead of symmetrical possibilities in the possibility distributions. The MCMT can be prepared similarly to CMCMT, which includes one correct answer (internal variable) in their item options, and it can also be prepared by referring to a meaning (internal variables) of the options of each item. The items of the measurement tool can be prepared without obligation to standardize the number of correct answers as well as with multiple correct answers. It can be prepared by referring meaning (external variable) to the items of the-MCPMT, as well.

The importance of possibility has shown an increase within the latest measurements and evaluations, and the possibility measurement tools are used in various disciplines. The possibility theories are utilized for explaining various measurements results (Mauris, 2013; Ryguła et al., 2018). The possibility measurement tools are used for identifying the lipid markers in medicine (Sumino et al., 2016). However, there are certain challenges and uncertainties in the use of possibility theories within the scope of measurement and evaluation. Ferrero et al. (2014) suggested the following with regards to use of possibility theories in measurement and evaluation within the study they carried out:

“The evaluation and expression of uncertainty in measurement is one of the fundamental issues in measurement science and challenges measurement experts especially when the combined uncertainty has to be evaluated. Recently, a new approach, within the framework of possibility theory, has been proposed to generalize the currently followed probabilistic approach. When possibility distributions are employed to represent random contribution to measurement uncertainty, their combination is still an open problem. This combination is directly related to the construction of the joint possibility distribution, generally performed by means of t-norms.”

It is of vital importance for the measurement tool to be suitable for using the possibility theories within the scope

of carrying out evaluations with possibility theories. In this study, the rules for preparation of possibility measurement tools will be developed as in compliance with the use of possibility theories within the scope of multiple-choice measurement tool (MCMT)s used in measurement and evaluation in education.

In this study, the MCPMT preparation techniques which can be used in order to determine the non-linear correlations that can be established in one external variable, in the interaction between the external variables, in one internal variable, in the interaction between the internal variables or between the pieces of the information will be given. Similarly to all the measurement tools, in the evaluations of the MCPMT, both the evaluation method through symmetrical possibilities and probabilities and the evaluation method in which the information contents can be determined through Shannon equations can be used.

### **Preparation techniques for MCPMT**

MCPMT can be prepared by means of item and OT. The MCPMT can be prepared in order to determine the possibility structures of variables and the non-linear correlations between the variables. In item techniques (IT), the variables to be measured by means of multiple items can be termed as external variables. The options of evaluation of the MCPMT, the evaluation can be carried out by means of symmetric, regular symmetric, irregular symmetric, symmetric with regard to the situation at which the distribution begins, event-based symmetric, symmetrical contiguous and symmetrical discrimination possibilities. The measurement tools can be evaluated more qualitatively by means of, above all, regular symmetric, irregular symmetric, symmetric with regard to the situation at which the distribution begins, for event-based symmetric, symmetrical contiguous and symmetrical discrimination possibilities.

#### ***Item techniques (IT) (External Variable Technique)***

The measurement tool can be prepared by defining the different learning fields, different discipline information, different information types, different information content or different epistemological levels to the items of the measurement tools as external variables. Additionally, different epistemological levels or different information content of the different discipline information and different information types can be defined as external variables. The possibility measurement tool can be prepared by means of these definitions. In a measurement tool, the items are separated into external variables in order to determine the effect of the other variable(s) (of the other group(s)) to an external variable (to a group of items) via simultaneous measurement. The preparation principles

for an external variable MCPMT are used in order to prepare such a measurement tool. The measurement tool preparation technique with external variables, and by means of preparation principles for an external variable MCPMT, will be termed as IT or external variable technique. The measurement tools prepared via this technique will be termed as MCPMT with IT. In the IT, all of the items or each item separately of external variables can be evaluated. Also in the IT, as to the preparation technique of the options, the evaluation method respective to that technique is used.

#### ***Option techniques (OT)***

The option preparation techniques by means of possibilities of selection among the options of an item are termed as OT. OT comprises a sole internal variable OT, internal variable OT, significant internal variable OT and internal variable ordering technique. The OT determines the evaluation method which can be applied to the measurement tool.

***Sole internal variable OT:*** The measurement tool preparation technique which is performed by using the preparation principles for sole internal variable option MCPMT without referring to a second meaning for the options apart from a correct one will be termed as the sole internal variable OT. The measurement tool to be prepared via this technique will be termed as the sole internal variable option technique multiple-choice possibility measurement tool OTMCPMT. The variable which is measured via this technique is termed as the sole internal variable. The two different techniques can be used in the evaluation method of the measurement performed by the sole internal variable OT. In the first technique to be used in evaluations, the number of correct options is correlated with the evaluation method. In the second technique to be used in evaluations, the possibility distributions of the correct options are correlated with the possibility evaluation method used. In the evaluations carried out by correlating the number of correct options with the evaluation method, binary basis independent possibility evaluation method can be used. In the evaluations carried out by correlating the correct options with possibility evaluation method, the other possibility evaluation methods apart from binary basis independent possibility evaluation method (when there are multiple options) can be used. If the incorrect options are to be evaluated in this technique, each option is evaluated separately.

***Internal variable OT:*** The measurement tool preparation technique which is performed by using the preparation principles for internal variable option MCPMT in the simultaneous measurement of the multiple internal variables' or singular internal variable's effect to each

other will be termed as the internal variable OT. The measurement tool to be prepared via this technique will be termed as the internal variable OTMCPMT. The variables which are measured via this technique are termed as internal variables. The evaluation methods of the sole internal variable OT can be used in the evaluation carried out via an internal variable OT.

**Significant internal variable OT:** The measurement tool preparation technique which is performed by using preparation principles for significant internal variable option MCPMT in the simultaneous measurement of the different internal variables, and which is prepared by defining an interval variable as relevant to the option's item to each option in accordance with the measurement purpose, will be termed as the significant internal variable OT. The measurement tool to be prepared via this technique will be termed as the significant internal variable OTMCPMT. All of the options are termed as internal variables in this technique. Via the measurement tool prepared in accordance with the evaluation method set forth in the study carried out by Yılmaz and Yalçın (2011), the given evaluation method can be used in the evaluations of the measurement performed by means of significant internal variable OT.

**Internal variable ordering technique:** The measurement tool preparation technique which is performed by using the preparation principles for internal variable ordering MCPMT in the simultaneous measurement of the different internal variables, and with which ordering of each item's internal variables (each item's options) can be carried out in accordance with the measurement purpose, will be termed as the internal variable ordering technique or option ordering technique. The measurement tool to be prepared via this technique will be termed as the internal variable ordering technique MCPMT. All of the options are termed as internal variables in this technique. The options of this measurement tool can comprise the information pieces given in the item. In the measurement evaluations carried out via an internal variable ordering technique, a binary basis independent possibility evaluation method can be used.

### Preparation principles for MCPMT

#### **Preparation Principles for the Sole Internal Variable Option MCPMT**

- 1) An internal variable should be found.
- 2) A second meaning should be referred to as the options apart from the internal variable.
- 3) Each item may not have the same option number.
- 4) When each item does not have the same number of options, the evaluation of the options, apart from the internal variable, should not be carried out.
- 5) Where all the options are to be evaluated, the

measurement analysis of the options should be carried out without referring to a different meaning than the options, apart from the internal variable.

- 6) If all the options are to be evaluated, each item should have the same option number.
- 7) The other options of an item should not comprise a particular part of the internal variable.
- 8) A different meaning for the internal variable in the same discipline should not be found.

#### **Preparation principles for the internal variable optional MCPMT**

- 1) There should be more than two options.
- 2) If there is a correlation between the internal variables, the other internal variables, apart from the first internal variable, should be used in the solution of the first internal variable.
- 3) The internal variables of an item can also be correlated with the item, without being correlated with each other.
- 4) There should be at least two internal variables in multiple items.
- 5) There should be at least one option whose internal variable is not defined in an item.
- 6) The internal variable number of each item may not be equal.
- 7) A second meaning should not refer to the options which are not defined as internal variables in an item.
- 8) The options which are not defined as internal variables in an item should not comprise a particular part of the internal variable.
- 9) Two internal variables of an item should not have the same values.
- 10) When the other internal variables, apart from the first internal variable, are not used in the solution of the first internal variable, or they are not correlated with the item, the item should be divided into at least two different items.

#### **Preparation principles for the significant internal variable option MCPMT**

The internal variables, based on both the measurement purpose and evaluation purpose, are defined in all options of the items. In preparation for such a measurement tool, the principles to take into consideration are as follows:

- 1) An internal variable is defined in all options of an item.
- 2) Each item should have the same internal variables.
- 3) All items of the measurement tool should have the same number of internal variables.
- 4) An internal variable should be present in an item once.
- 5) The correlation of an internal variable with the item should be established in an item.
- 6) For the purpose of the measurement, the correlation

between internal variables should be meaningful.

7) The evaluation correlation of the internal variables with each other should be established.

8) The same internal variables should be evaluated together.

10) The evaluation method with which the different internal variables can be evaluated. separately should be used.

In the study carried out by Yılmaz (2011), it is set forth that by comparing the data obtained via qualitative measurement tools with the right data, the obtained data can be classified as correct, incorrect, correct which is present in incorrect data, unrelated and zero (absent). In this classification, by breaking the data obtained by the measurement into their SSP and comparing these SSP to the SSP of the right data (the solution of the measurement tool), they are classified by means of assigning one positive score, one negative score and a zero score to the SSP which are not present in the data. When all the scores of a phase are positive, it is defined as a positive phase. When all the scores of a phase are negative, it is defined as an unrelated phase. When the scores of a phase are both negative and positive, it is defined as a negative phase. The positive scores in the negative phase are defined separately as positive scores in negatives. The SSPs which are not present in the data are defined as zero score. The evaluation methods of these phases and scores are given out, as well (Yılmaz and Yalçın, 2011). In this study, the principles given out for qualitative measurement tools can be set forth for a quantitative MCPMT with exemplary question and answer options.

An example of a proper question: What is the unit of force in the SI system?

- a) dyn (incorrect)
- b)  $\text{kg} \cdot \frac{\text{m}}{\text{s}^2}$  (positive in negatives)
- c)  $\text{kg} \cdot \frac{\text{m}}{\text{s}^2}$  (correct)
- d)  $\text{kg} \cdot \frac{\text{m}^2}{\text{s}^2}$  (unrelated)

1) One item should have one correct option. When there is  $\text{kg} \cdot \frac{\text{m}}{\text{s}^2}$  in the example, Newton, which is the unit of

force in SI system, should not be included in the options.

2) One item should have one incorrect option.

3) The correlation of the incorrect option with the correct option should be found in an item. Although the unit of force is dyn in the cgs system, as the unit of force in the SI system is asked in the example, the option is incorrect and the different meaning usage of dyn is not present in the same discipline or in the different disciplines.

4) When there is an incorrect answer within an item, the different meaning of the incorrect option situated in another option should be found with respect to the same discipline. A new meaning with regard to the item should

be referable to this option. In the example, the unrelated meaning was referred.

5) The option to which a meaning is referred should not have a different meaning in the same discipline. In the example, an incorrect option definition should not be made, as option “d” is the unit of the work and energy.

6) The option definition should be used for absence or lacking situation.

In the evaluations of the measurement tools which will be adapted via the principles of this technique, the binary basis independent possibility VDOİHI method can be used.

**Preparation principles for the internal variable ordering MCPMT**

- 1) The internal variables of an item should be in accordance with the ordering.
- 2) Numerical value should not be referred to the orderings.
- 3) One internal variable with the same order should be involved in the one item.
- 4) The measurement of each item should be carried out by two possibilities, such as correct and incorrect.
- 5) The scale, which is in accordance with the ordering, should be involved in the measurement tool.
- 6) The internal variable number of each item may not be equal.
- 7) The internal variables of the items should be in accordance with different ordering.
- 8) An item should not have an internal variable which is not in accordance with the ordering.
- 9) A second ordering should not be done by means of the internal variables of an item.
- 10) A binary basis independent possibility evaluation should be carried out.
- 11) In an evaluation, the analysis should be carried out via the possibility which is in accordance with the measurement purpose or via the Shannon equation.

Proper question example 1: Order the equation of torque with the options given below.

- a = b) F c) x d)  $\mathcal{J}$  e) r

Correct answer ordering: d, a, e, c, b

Measurement tool example

Ordering No	1	2	3	4	5
	d	a	e	c	b

Correct answer ordering: 2, 5, 4, 1, 3

Measurement tool example

Scale option	a	b	c	d	e
	2	5	4	1	3

A wrong question example: Carry out the ordering of the force equation with the options given below:

a = b) F c) m d) a e)

Although the force formulas tend to be written as  $F = m \cdot a$ , the same result can also be obtained by the operation  $F = a \cdot m$  in scalar multiplication. In this situation, “a” and “m” have the same ordering. As two options with the same ordering (one internal variable with the same ordering should be involved in an item) are present, it is a wrong measurement item.

A wrong question example: Carry out the ordering of the force equation with the options given below:

a = b) F c) m d) a e) . f) V

In this question, option “f” is not related to the question.

As an option which is not in accordance with the ordering is present (one internal variable which is not in accordance with the ordering should not be involved in an item), it is a wrong measurement item.

A wrong question example: Carry out the ordering of the force equation with the options given below:

a = b) F c) m d) a e) . f) V g) t h) /

The two different orderings,  $F = m \cdot a$  and  $F = m \cdot V/t$ , can be carried out in the answer. Since the options are accordant with two different orderings (a second ordering should not be carried out with the internal variables of an item), it is a wrong measurement item.

### **Preparation principles for the external variable MCPMT**

- 1) Multiple external variables should be present.
- 2) Multiple options should be present by which each external variable can be measured.
- 3) The item numbers of the external variables may not be equal.
- 4) The external variables should have a meaningful measurement correlation between them for the purpose of measurement.
- 5) The order with which the external variables are present in the measurement tool should be determined by the purpose of measurement.
- 6) Options should be prepared in accordance with the OT.
- 7) The same OT should be used for all the external variables (one of the following techniques should be

used: the sole internal variable OT, internal variable OT, significant internal variable OT or internal variable ordering technique).

The same evaluation method should be used for external variables.

### **Conclusion**

The five different MCPMTs can be developed by defining the external and internal variables to the item and/or its options via the techniques set forth in this study. By means of MCPMT with the IT, the measurement of an external variable can be carried out, and also the correlation between the variables can be determined by measuring the different external variables simultaneously. The quantitative measurements can be deepened by using different OT. The correlations between internal variables can be determined simultaneously via internal variable OTMCPMT or significant internal variable OTMCPMT. The correlation, which can be established between the pieces of information, can be determined simultaneously via the internal variable ordering technique MCPMT. Non-linear correlations between the variables can be determined by performing information-based measurements via the measurement tool to be developed.

In comparison with the CMCMT, the more qualified measurement tools can be prepared by means of the preparation techniques for MCPMT. Possibility measurement tools can be evaluated more qualitatively than conventional quantitative measurement tools by means of regular symmetric, irregular symmetric, symmetric with regard to the situation at which the distribution begins, event-based symmetric, symmetrical contiguous and symmetrical discrimination possibilities. Additionally, in comparison with conventional quantitative measurement tools, both more qualified and more quantified evaluations can be carried out by preparing the options with different meanings and levels of information, especially for the options of the possibility measurement tools which can be prepared via OT.

### **Suggestions**

The MCPMT can be used when the correlation between variables is not known yet and the non-linear expectation in the correlation between the variables is present. In the possibility measurement tools, the evaluation method by which information content can be determined via Shannon equation can be used, as well as the evaluation method through symmetrical possibilities and probabilities.

Information-based and learner-centered measurements can be performed with possibility measurement tools. Information-centered new evaluation methods of the possibility measurement tools, which can be prepared via

the techniques given out in this study, can be developed. Additionally, learner-centered evaluation methods of the possibility measurement tools can be developed. The learner-centered evaluation methods can be developed via alteration of the symmetrical situation numbers, which are determined by means of different measurements.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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