DESIGN AND MATHEMATICS EFFICACY AS CORRELATES OF ENGINEERING STUDENTS' EXPOSURE TO CAREER INTEREST INVENTORY ASSESSMENT AND TESTING VIA VOCATIONAL COUNSELLING IN EDO STATE

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Abstract

This study investigated design efficacy and mathematics efficacy as correlates of engineering students' exposure to career interest inventory assessment and testing via vocational counselling in Edo State. Using a correlation survey design, 185 engineering students that have had vocational career counselling experience either at secondary school level before their transition to tertiary institution or at their University or Polytechnic Counselling Centre were purposively selected for the study. The Federal Ministry of Education Career Interest Inventory (CII) ($\alpha = 0.86$). Design Self-Efficacy Scale (0.82) and Mathematics Self-Efficacy Scale (MSES) (0.80) were used for data collection. Two research questions were answered and two hypotheses tested. Data collected were analyzed using Pearson Product Moment Correlation (PPMC) and Multiple regression at 0.05 level of significance. The result revealed that design efficacy ($r = .244^{**}$, $N= 185$, $P < .05$) and mathematics efficacy ($r = .337$, $N= 185$, $P < .05$).positively and significantly correlated with engineering students' exposure to career interest inventory assessment and testing via vocational counseling. Also, relative impact of engineering students' exposure to career interest inventory assessment and testing via vocational counsellingwashigher on

expressed mathematics efficacy of engineering students (β=0.325) followed by design efficacy (β=0.232). Likewise, engineering students' exposure to career interest inventory assessment and testing via vocational counseling significantly correlates with engineering students design efficacy(r = .244**, N= 185, P < .05) and engineering students mathematics efficacyin the study (r = .337***, N= 185, P < .05). Therefore it was recommended that students should be exposed to vocational career counselling enlightenment programmes that will help them to be aware of the strength and weaknesses and the potential capabilities they possess to adapt in their choice of career.

Keywords: Assessment, career interest inventory, Counselling, Design, Efficacy,Mathematics Efficacy, Engineering and Testing.

Introduction

Technological innovation enhances dynamic change and it creatively supports wealth creation, economic growth and developmental sustainability. Engineers play vital role within this context.Engineering as a career plays a momentous role in societal development as it serves as a pragmatic spring board for innovative change for the comfort of humanity and modern civilization in different strata of human lives and activities. This showcase the fact that engineering is a very challenging and tasking career whose training curriculum would definitely require students studying engineering to have the needed resilience, passion, interest, skills, commitment and readiness to learn. This makes engineering a critical career for focus (National Academies of Sciences, Engineering, and Medicine, 2018).Students' success in completing engineering training programme in an innovative and creatively productive manner lies not only in their accomplishment and ability but also in their social cognition and self-beliefs (Aleta, 2016).

The consciousness of these is one of the prime focuses of vocational career counselling which is to help students' belief in their ability to organize and function most effectively in their degree programmes in view of their career choice.This made the Federal Ministry of Education in Nigeria in 2011 to make concerted effort to develop Career Interest Inventory (CII) to be used as career assessment and testing tool to help student make suitable career choice inclined with their

interest, passion, aptitude, strength and weaknesses for optimum capacity development and value orientation. Pick (2023) affirmed that making career choice is a vital project in everybody's life across cultures because people's career choice influences every aspect of their lives and societal development and safety. Thus, to help people develop the capacity to make valuable career choice, the use of career assessment testing tool serves as a great mechanism. These tests have already made successful impacts in developing careers of many individuals (Chaudhuri, 2023). This makes investigating design efficacy and mathematics efficacy as correlates of engineering students' exposure to career interest inventory assessment and testing via vocational counselling in Edo State a necessity.

Isik (2013) posit that using career interest inventory as an assessment and testing tool is a vital part of career counselling procedure and process because of its uniqueness in helping students explore their level of interests, values, potential abilities and integrate attain information with the needed characteristics within the world of work. Thus, during career counselling, with the use of career assessment and testing tools, counselling psychologist are committed to helping students enhance their confidence in learning(Aleta, 2016). Nolte, Berdanier, Menold and McComb (2021) averred that expressed engineering design efficacy by engineering students enable them keep pace within a shifting and dynamic technological landscape considering the fact that technology has helped the world to experience radical change in the ways businesses are conducted.

Engineering design (ED) is globally recognized as a prototypical process that can help solve a wide range of problems globally and across the globe, many engineering education programmes have built their curricula to include courses and laboratory that teach students the essential skills of ED (Nair-Bedouelle, 2021).Thus, the outlined expectations of the United Nations 2030 sustainable development goals agenda, projects that global societies are to develop innovative initiatives from the labour sector and the government to create equal opportunities for all learners and invest critically in science and technology (objective 5) (United Nations, 2015). If global societies want to fulfill this goal, they should be more committed to reversing the stereotyped perception that science, technology, engineering, and mathematics (STEM) related career areas are difficult through vigorous vocational career counselling projects that will help

prepare the mind set and consciousness of students for success in STEM related career (Kim, Sinatra & Seyranian, 2018). Thus, many countries are employing diverse vocational career counselling strategies to attract and retain engineering students regardless of societal stereotypic perception that engineering courses are difficult due to its heavily based mathematical approach (Kouvela, Hernandez-Martinez, & Croft 2018; Razali, 2021; United Nations, 2015). This becomes necessary as some students intending to study engineering as a career are most times uninformed of the fact that engineering is mathematically tasking.

Similarly, it has been observed that students, who show self-confidence in science and mathematics, as well as having an ability and passion for solving technical problems, will be more inclined to choose STEM-related majors and professional paths (Suh, Upadhyaya & Nadig, 2019). Literature suggests that self-efficacy feelings of students' towards mathematics related activities have been shown to be one of the most important factors influencing the selection and persistence on STEM careers (De las Cuevas, García-Arenas & Rico, 2022; Razali, 2021). Mathematics efficacy was found to have positive effect on engineering students' deep approach to learning mathematical concepts and a negative effect on the surface approach to learning(Zakariya, Nilsen, Goodchild & Bjørkestøl, 2022).

Literature opined that high mathematics efficacy is related to increased interest in pursuing a mathematics related major such as engineering (Morán & Benson, 2018). Students with high mathematics efficacy persist in mathematics related tasks (Zakariya, Goodchild, Bjørkestøl & Nilsen, 2019). The influence of mathematics efficacy on engineering students' cognitive performance in mathematics courses is well-documented (Grigg, Perera, McIlveen, & Svetleff, 2018). Although there are profuse studies about mathematics efficacy, there is very little research focusing on if exposure to vocational career counselling influence engineering students' mathematics efficacy and their performance in engineering mathematics courses and their motivation to successfully complete their engineering programme in Edo State Nigeria. This issue is vital because mathematics efficacy is a significant factor that could influence students' performance in their engineering mathematics courses, which eventually could affect their decision to continue with their

engineering programme in case they find themselves struggling to excel (Van Dyken & Benson, 2019).

Therefore, based on this context, the theoretical framework of this study is anchored on Albert Bandura's self-efficacy theory. Bandura explicitly affirmed that an individual's self-belief in their capacity to succeed in attaining specified goals in a given task projects their manner of self-efficacy. People with high self-efficacy see challenges as normal things that are supposed to be mastered rather than threats to avoid (Bandura, 2010). This makes the focus of this study germane. However, it is of note that some students decide to study engineering without good background information of what it entails to study and excel in engineering. This is often due to lack of exposure to vocational career counselling experience. The consequence is often their inability to adapt and adjust fravourably to challenges associated with studying engineering. This development could have untold discomfort on the psycho-social, emotional, educational and general wellbeing of such students. And it could further cause unprecedented feeling of anxiety, fear and uneasiness. Therefore, the main objective of this study is to investigate design efficacy and mathematics efficacy as correlates of engineering students' exposure to career interest inventory assessment and testing via vocational counselling in Edo State.

The following research questions and hypotheses will guide the study

1. What relationship exists between the independent variables (design efficacy and mathematics efficacy) and engineering students' exposure to career interest inventory assessment and testing via vocational counselling?
2. What relative impact do engineering students' exposure to career interest inventory assessment and testing via vocational counselling have on their expressed design efficacy and mathematics efficacy?
3. There is no significant relationship between design efficacy and engineering students' exposure to career interest inventory assessment and testing via vocational counseling
4. There is no significant relationship between mathematics efficacy and engineering students' exposure to career interest inventory assessment and testing via vocational counseling

Methods

The study adopted a correlation survey design and utilized purposive sampling technique to select 185 engineering students that have had vocational career counselling experience either at secondary school level before their transition to tertiary institution or at their University or Polytechnic Counselling Centre. These engineering students were selected from three tertiary institutions. They comprised of University of Benin, Ambrose Ali University Ekpoma and Auchi Polytechnic.

The Federal Ministry of Education **Career Interest Inventory (CII)** was used to measure students' interest, passion, motivation and resilience to study engineering. It is a 215 item self-report inventory designed to elicit information about the testees' level of interest in a variety of occupational activities. The CII is presented in 13 sections and it response pattern ranges from highly interested (4), moderately interested (3), marginally interested (2) and not interested (1). It has a high reliability coefficient $\alpha = 0.86$.

Carberry et al (2010) **Design Self-Efficacy Scale** was used to measure participants level of design efficacy. Items reflect students' perceptions of their: confidence, motivation, ability to succeed, and anxiety to conduct engineering design as well as sub-categories for each design self-efficacy construct. The questions are responded on a 10 point scale anchored from 0 and 100. It has Alpha Coefficient's value of 0.82.

Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1983) was used to measure mathematics self-efficacy of participants. The MSES asks participants to rate their confidence on a scale from 0 to 9 in their ability to perform 18 mathematics tasks, to correctly solve 18 mathematics problems, and to get a B. It has an internal consistency of 0.80.

The researchers obtained the consent of the participants and having sought and obtained the consent of the participants, the researchers personally administered copies of the instruments with some explanation on how to complete them and the purpose of the research to the participants.

Results

Data were analyzed with Pearson Product Moment Correlation and multiple regression statistical tools at 0.05 level of significance.

Research Questions One: What relationship exists between the independent variables (design efficacy and mathematics efficacy) and engineering students' exposure to career interest inventory assessment and testing via vocational counselling?

Table 1: Correlations Matrix showing relationship exists between the independent variables (design efficacy and mathematics efficacy) and engineering students' exposure to career interest inventory assessment and testing via vocational counselling

Variables	N	Mean	Std Dev	1	2	3
Engineering students' exposure to career interest inventory assessment and testing via vocational counseling	185	7.1946	1.5931	1.000		
Design Efficacy	185	8.0832	2.3027	.244**	1.000	
Mathematics Efficacy	185	11.8486	4.3114	.337***	256	1.000

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 1 shows the relationship that exist between the independent variables (design efficacy and mathematics efficacy) and engineering students' exposure to career interest inventory assessment and testing via vocational counselling. The results in the table revealed that design efficacy (r = .244**, N= 185, P < .05) and mathematics efficacy (r = .337, N= 185, P < .05).positively and significantly correlated with engineering students' exposure to career interest inventory assessment and testing via vocational counselling. The implication of this result is that vocational career counselling enable students to develop the capacity to overcome challenges associated with their academic and professional pursuit as they are able to excel in engineering design and mathematics tasks. Therefore, the research question is answered.

Research Questions Two: What relative impact do engineering students' exposure to career interest inventory assessment and testing via vocational counselling have on their expressed design efficacy and mathematics efficacy?

Table 2: Showing Relative impact of engineering students' exposure to career interest inventory assessment and testing via vocational counselling have on their expressed design efficacy and mathematics efficacy

Variable	Unstandardised Coefficient		Standardised Coefficient	Rank	T	P
	B	Std. Error	Beta			
Constant	2.648	.445	-		7.317	.000
Design Efficacy	.342	.021	.232	2nd	12.153	.000
Mathematics Efficacy	.411	.027	.325	1st	15.311	.000

Table 2 reveals that the relative impact of engineering students' exposure to career interest inventory assessment and testing via vocational counselling was higher on expressed mathematics efficacy of engineering students (β=0.325) followed by design efficacy (β=0.232). This implies that vocational career counselling via the use of career interest inventory assessment and testing helped engineering students exposed to it to have a good insight and positive orientation of the intellectual demand associated with studying engineering. This made them have a positive mindset to excel. Therefore, the research question is answered.

Research Hypotheses One: There is no significant relationship between design efficacy and engineering students' exposure to career interest inventory assessment and testing via vocational counselling

Table 3: PPMC summary table showing significant relationship between design efficacy and engineering students' exposure to career interest inventory assessment and testing via vocational counselling

Variable	**Mean**	**Std. Dev.**	**N**	**R**	**P**	**Remark**
Engineering students' exposure to career interest inventory assessment and testing via vocational counseling	7.1946	1.5931	185	.244**	.000	Sig.
Design efficacy	8.0832	2.3027				

** 0.05 Level of Sig.

The result in table 3 reveals that engineering students' exposure to career interest inventory assessment and testing via vocational counseling significantly correlates with engineering students design efficacy in the study (r = .244**, N= 185, P < .05).The hypothesis is therefore rejected.

Research Hypotheses Two: There is no significant relationship between mathematics efficacy and engineering students' exposure to career interest inventory assessment and testing via vocational counseling

Table 4:PPMC summary table showing significant relationship between mathematics efficacy and engineering students' exposure to career interest inventory assessment and testing via vocational counselling

Variable	Mean	Std. Dev.	N	R	P	Remark
Engineering students' exposure to career interest inventory assessment and testing via vocational counselling	7.1946	1.5931	185	.337***	.000	Sig
Mathematics efficacy	11.8486	4.3114				

*** 0.05 Level of Sig.

The result in table 4 reveals that engineering students' exposure to career interest inventory assessment and testing via vocational counseling positively and significantly correlates with engineering students mathematics efficacy in the study (r = .337***, N= 185, P < .05).The hypothesis is therefore rejected.

Discussion of Findings

The answer to research question one revealed that design efficacy (r = .244**, N= 185, P < .05) and mathematics efficacy (r = .337, N= 185, P < .05) positively and significantly correlated with engineering students' exposure to career interest inventory assessment and testing via vocational counselling. The implication of this result is that vocational career counselling enable students to develop the capacity to overcome challenges associated with their academic and professional pursuit. In

support, Pick (2023) affirmed that making career choice is a vital project in everybody's life across cultures because people's career choice influences every aspect of their lives and societal development and safety. Thus, to help people develop the capacity to make valuable career choice, the use of career assessment testing tool serves as a great mechanism. With the aid of career assessment inventory tests, students can recognize their strengths and weaknesses and identify with their individual personalities. This would enable them appraise the most suitable career, work on the desired skills in accordance with the career assessment test results and estimate whether their personality and interest matches their chosen career. An assessment test can also reveal surprising facts about the student's personality that can motivate them to try something completely new (Pick, 2023).

The answer to research question two reveals that the relative impact of engineering students' exposure to career interest inventory assessment and testing via vocational counselling was higher on expressed mathematics efficacy of engineering students (β=0.325) followed by design efficacy (β=0.232). This implies that vocational career counselling via the use of career interest inventory assessment and testing helped engineering students exposed to it to have a good insight and positive orientation of the intellectual demand associated with studying engineering. This made them have a positive mindset to excel. This finding is consistent with assertions of Isik (2013) that using career interest inventory as an assessment and testing tool is a vital part of career counselling procedure and process because of its uniqueness in helping students explore their level of interests, values, potential abilities and integrate attain information with the needed characteristics within the world of work. It is of note that the effective interpretation of career interest inventory assessment results has revealed that students who partake in the interpretation process are found to increase their social cognitive career success beliefs as they take responsibility for their career development and working hard at attaining competence and expertise (Isik, 2013). For example, students via vocational career counselling are exposed to appraise the significance of possessing engineering design skill, mathematics capability, innovative and creative intuition, etc.

The findings of research hypotheses one reveals that engineering students' exposure to career interest inventory assessment and testing via

vocational counseling significantly correlates with engineering students design efficacy in the study (r = .244**, N= 185, P < .05). This corroborates the findings of previous studies. For example, Razali (2021); Kim, Sinatra and Seyranian (2018); United Nations (2015) reported that if global societies want to fulfill the expectations of the United Nations 2030 sustainable development goals agenda, they should be more committed to reversing the stereotyped perception that science, technology, engineering, and mathematics (STEM) related career areas are difficult through vigorous vocational career counselling projects that will help prepare the mind set and consciousness of students for success in STEM related career. It is clear that more engineering students must be exposed to vocational career counselling initiatives. Aleta (2016) study establishes that engineering design experience has direct relationship with the academic performance of engineering students.

The result of research hypotheses two reveals that engineering students' exposure to career interest inventory assessment and testing via vocational counseling positively and significantly correlates with engineering students mathematics efficacy in the study (r = .337***, N= 185, P < .05). This supports the assertions of the fact that many countries are employing diverse vocational career counselling strategies to attract and retain engineering students regardless of societal stereotypic perception that engineering courses are difficult due to its heavily based mathematical approach (Razali, 2021; United Nations, 2015). However, engaging students in vocational career counselling experience has proven to be effective as it enable them to develop the confidence they need to be resilient and excel in their career pursuit (Kouvela, et al., 2018).

Recommendations

1. Career counselling should be used as a means to ensure students' optimum capacity development and value orientation of students'.
2. students should be exposed to vocational career counselling enlightenment programmes that will help them to be aware of the strength and weaknesses and the potential capabilities they possess to adapt in their choice of career
3. Counselling interventions should be provided to students as a measure to help them develop the capacity to belief in their ability to organize

and function most effectively in their degree programmes in view of their career choice.

4. Government and its agencies should provide well equipped counselling centers in tertiary institutions to help support the developmental wellbeing of students positively.

Conclusion

This study revealed that exposure to career interest inventory assessment and testing via vocational counselling is a vital project in every student's life as it would help students make suitable career choice inclined with their interest, passion, aptitude, strength and weaknesses for optimum capacity development that would influences every aspect of their lives, societal development and safety.

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