Bahria Journal of Professional Psychology, July 2020, Vol. 19, No. 2, 17-59

# Psychosocial Factors Involved in Opting Engineering as Career: Qualitative Analysis

*** Fatima Afsar and Dr. Humaira Jami**
National Institute of Psychology, Quaid-i-Azam University
Islamabad, Pakistan

To explore factors influencing students at their high school level to pursue engineering as a career or not, current study aimed to explore students' perception of psychosocial factors involved in their academic satisfaction, and persistence intention to pursue career in engineering while studying at pre-engineering level. Twelve focus group discussions of students from BS engineering (*n*=7) and non-engineering (*n*=5) educational fields from different public universities of Islamabad were conducted. Thematic analysis was used. There were some major group differences among engineering and non-engineering student's perceptions. The major themes emerged were academic and vocational interest, motivation, social support, personality characteristics, barriers etc. The result suggests the importance of these factors in pursuing career in engineering where there must be interest of the students in the field opted; they must be motivated to learn in context of social support. Beside this, there are some barriers from different sources like academia, parents, teachers, etc. that restrain the students from perusing and getting into engineering field.

*Keywords:* Psychosocial factors, qualitative, academic satisfaction, burnout, persistence intension, engineering, non-engineering.

The modern world and the lives of an enormously growing population and technology are dependent on the field of engineering and technology for productivity, effective feeding, save lives, increase efficiency, and promote technology.

Although there are a number of engineering universities in Pakistan, but it is observed that trained engineers produced often lack the practical approach needed to solve real industrial problems for which the deficiencies and barriers can be traced back to the beginning of the education in the area that is in pre-engineering at high school level when students make major decision of what to opt for in their career (McMullin, & Reeve, 2014; Mosley, Liu, Hargrove, & Doswell, 2010).

Pakistan is facing plethora of challenges including poverty, corruption, high rates of illiteracy, overpopulation, terrorism, gender inequalities both in education and the workforce (United Nations Development Programme, 2013). There is a clear need to make advancements in Science, Technology, Engineering, and Mathematics (STEM), given that the country lags behind in the number of proficient scientists, mathematics, and engineers compared to industrialized nations to meet growing need of the population to make available basic necessities of life.

In Pakistan, the field of STEM is still neglected. The need of integration of various aspects of STEM fields be studied in the context of Pakistan through practical and theoretical consideration. Research employed inductive approach to analyze multiple data sources of interviews, STEM perception responses, reflective learning team conversations, pre-post surveys and artifacts produced in online teacher professional development in STEM fields. Design based directions were applied as an implication of the study findings, revolutionized the understanding of STEM by sharing participant teacher's STEM model for Pakistani context. The research further suggested a school-wide online teacher professional development for interdisciplinary collaboration through support for learner-centered practices (Anwar, 2017).

Researches (such as Fouad & Smith 1996; Holmegaard, Madsen, & Ulriksen, 2014) confirmed the importance of expectancy in predicting career intension/persistence intention. Moreover, Social Cognitive Career Theory has declared it as a

mediator of career and academic interest. Although, there are vast number of researches on STEM education, as well as career aspirations and factors affecting STEM fields, but factors affecting decision to choose engineering are still emerging research domain (Banning, & Folkestad, 2012). More than three out of four high school students who rest in the top mathematics quartile does not continue engineering as major in their careers. In 2011, considering the decline in the interest of the students, educators and experts worked on the interest, and attitude towards engineering to increase their proficiency, interest and positive attitude of the students towards engineering (Carnevale, Smith, Melton, 2011; National Research Council, 2011; President's Committee of Advisors on Science and Technology, 2010).

A number of studies have been conducted to find out the factors influencing the field choice (DeMarie & Aloise-Young, 2003; Kuechler, McLeod, & Simkin, 2009; Schwartz, 2004; Tan & Laswad, 2009). Research (such as Beggs, Bantham, & Taylor, 2008) identified that career decision making is a major decision in a students' life and wrong decisions has been one of the life-long regrets. Therefore, currently, a qualitative study was done for undergraduates to identify the basic psychological processes for selecting their majors. Malgwi, Howe, and Bunaby (2005) surveyed undergraduate students concerning their choice of major fields and described that subject interest was the most important factor regardless of gender and for girls, it was aptitude too. Whereas for boys, potential for advanced career and job opportunities (referring to the outcome expectancy) were more important factors. They all identified interest as the key factor for a field choice (Beggs et al., 2009; Kuechler et al., 2009).

Interest development is referred to as a process occurring within the individuals, but can be influenced by the social mechanisms which include messages from other people, comments, and compliments, (Jackson, Leal, Zambrano, & Thoman, 2019). Interest is observed to be a critical component for persisting in science fields (Renninger & Bachrach, 2015). The

development of interests is dependent on the individual characteristics (for example personality traits) within a socio-cultural context (e.g., Bergin, 2016; Hulleman, Kosovich, Barron, & Daniel, 2017; Hulleman, Thoman, Dicke, & Harackiewicz, 2017; Master, Cheryan, Moscatelli, & Meltzoff, 2017; Renninger, & Hidi, 2016).

As interest develops, a separate but interrelated process of identity development can occur. While, students deepen their interest in science; identification with science and those whose work involves their interest (e.g., scientists) may develop (Krapp, 2007; Renninger, 2009). With respect to educational interests, talking with others about emerging interests is an important social process for negotiating whether that new interest will be recognized and accepted as reality by others (Sansone & Thoman, 2005; Thoman, Smith, & Silvia, 2011).

Research identified that the number of engineering graduates are declining day by day from past two decades which has become the major concern of U.S who believes that the physical sciences and engineering are at particular risks (Jones, Paretti, Hein, & Knott, 2010; Ohland et al, 2008; National Research Council, 2005; Weiss, 2009). Unfortunately, this most important decision of life is not made on the basis of their abilities or skills but considering many other psychosocial factors influencing career decision making.

Current study is aimed to identify psychosocial factors, perceived by student that inhibited or facilitated them to pursue their careers in engineering field. Social cognitive career theory (SCCT; Lent, Brown, & Hackett, 2002; Lent, 2005) is anchored in Bandura's self-efficacy theory (1977, 1997), which postulated a mutually influencing relationship between people and the environment. SCCT offers three segmental, yet interlocking process models of career development seeking to explain (a) the development of academic and vocational interest, (b) how individuals make educational and career choices, and (c)

educational and career performance and stability. The social cognitive career theory provided the foundation for the research because of its immense contribution in explaining mechanisms influencing both career orientation and academic satisfaction. It assesses the interplay between interest and satisfaction in predicting student's persistence in engineering (Lent & Brown, 2006, 2008; Nugent, Barker, Welch, Grandgenett, Wu, & Nelson, 2015) as well as the interplay between cognitive, behavioral, contextual, and personality factors within the process of educational and vocational adjustment (Lent et al., 2013).

This study is focused on exploring whether the factors identified by the theorist are perceived by the students or not and whether these are the important factors or some other factors are responsible for pursuing the field of engineering. The actual perceptions and experiences of students are rarely investigated which are focused in the current study. Gaining data qualitatively from engineering and non-engineering students to compare the perceptions students in their interest, motivation, and aptitude for engineering as a career. Multicultural evidences of the theory are available in college and university students (e.g., Dutta, Kang, Kaya, Benton, Sharp, Chan, & Kundu, 2015; Kong, Ding, & Zhao, 2015; Menéndez, Calvo & Caro, 2016), so these are explored qualitatively in Pakistani context. It is being aimed to explore students' perception of psychosocial factors involved in academic satisfaction, and persistence intention to pursue career in engineering while studying at pre-engineering level and to compare psychosocial factors involved in academic satisfaction, and persistence intention to follow career in engineering at pre-engineering level among students who pursued engineering and did not pursue engineering later.

## Method

### Research Design

The current study is Qualitative in nature in which data was collected through Focus Group Discussion (FGD's) and was analyzed through thematic analysis.

### Participants

Seven Focus Group Discussions (FGDs) were conducted with students of bachelor's degree program of first semester in engineering from different universities in different fields in engineering. Each FGD consisted of 6-8 students, having ages from 19 to 23 years. Among 44 participants girls were less than boys ($N$=44; Male $n$=35, Female $n$=9). Five FGD's were conducted with students of bachelor's degree program of first semester in non-engineering. Each FGD consisted of 6 students, having ages from 19-21 years. Girls were less in number as compared to boys ($N$=30; Male $n$=23, Female $n$=7) among total 30 students.

The participants were from different public universities including National University of Modern Languages Islamabad, COMSATS University Islamabad campus, Quaid-i-Azam University Islamabad, and National University of Science and Technology Islamabad.

Participants were students of undergraduate level and they were asked to report in them in retrospect because they had gone through that phase of high school and could better guide what they and their class fellows faced while opting engineering as field of study. They were asked to relate problems which caused them trouble in their persistence and achievement in high school and then pursuing engineering or not at undergraduate level. The students at pre-engineering in high school level may not be able to report in detail as they actually were in high schools and did not know about the future outcomes of pursuing engineering and be persistent and successful in getting admission.

## Focus Group Guide

A focus group guide was prepared for data acquisition. Questions were generated in the light of existing literature. In the focus group guide, questions related to personality, interest, decision making, aptitude, attitude, achievement, social support, motivation, self-efficacy, values, satisfaction, burnout, and barriers with reference to opting career in engineering were asked.

It included 28 total and 41 probing questions formulated in what, why, and how format to make respondent respond in detail. Focus group guide was updated after each FGD. Same guide was used for both engineering and non-engineering students.

## Procedure

FGD's were conducted to get the first-hand knowledge on psychosocial factors for students opting or not opting engineering as career and related facilitators and barriers that they faced during high school to secure admission in engineering in university.

Study was approved by Advanced Studies Research Board. Permission from the concerned authorities was sought. Sample was selected conveniently. Study was introduced to the participants and confidentiality was ensured. They were informed of the purpose of the study and consent was taken from them. Each session was started with a broader question following probing questions in the guide. The sessions were audio-recorded with the consent of the participants. A moderator in each session helped and facilitated the research. The data were transcribed, coded, and analyzed by using thematic approach. The key stages in the thematic analysis were followed given by Patton and Cochran (2002) incorporated with the steps/stages given by Miles and Huberman (1994).

The explanations of the results based on focus group discussions along with the emerging themes are given in detail. The candidates first gave a brief introduction about them and type of engineering course they are enrolled in.

## Data Analysis

Thorough scrutiny of the transcriptions helped in generating meaningful themes. The five major techniques proposed by Kekeya (2013) were used including data organization, generating meaningful units, construction of categories, developing themes and writing a theory.

### *Organization of Data*

It is very important for analyzing extensive qualitative data and quality management of the data from the recordings into the written account (Best & Kahn, 2006; Creswell, 2007; Patton, 2002). The researcher organized the each FGD separately and prepared documents for each focus group to represent the discussion in each focus group in word format. The documents were copied and photocopied after revisiting several times so that the chance of error or misinterpretation or missing data could be dealt with in time.

### *Generating Units of Meanings*

It refers to the discussion in parts, like the wordings used, the statements, expressions, symbols, etc. For example to explain the term resilience, a student narrated that a person's hard work is important if knocked down he must know how to stand up again and face the situation which is important for the successful life. This was narrated by the participant as,*"yeh cheezain honi chahea zindagi k lea yeh chezain zaruri hain..hard work to chahea hota hay, lekin apko kisi ne knock out kia hy to ap kaho gay nahee ma wapis uthu ga to us k lea apko hard work chahea.. [These should be included in life, these things are important in life, hard work is compulsory, but if you are knocked down by someone, you will stand again for which you need hard work]".* Here hard work doesn't literally mean hard work but the courage to with-stand the hardships of life that was later explained by the participant. This coding of concepts were from participants' verbatim and created as statements by the researcher, conserving the original meaning what

the participant wanted to convey.

***Constructed Categories***

It is the third level. Categorization was defined as "a process whereby previously, unitizing data are organized into categories that provide descriptive or inferential information about the context or setting from which the units were derived" (Lincoln & Guba, 1985, pg. 204). The research under goes the transcript several times and the units of concepts/codes to extract the categories according to the aims and objectives of the research.

The categorization is basically done on the basis of similarities and differences in units determined initially through grouping together, linking concepts, and integration of the units on the basis of similar characteristics and recorded in a separate category if it is distinct in nature from the already defined categories. Modification was done several times to fit in the best category and their linkage with units is well defined as devised by Birks and Mills (2011). Ordering the categories are also beneficial to have more sense of the data and organization of the data (Mathews & Ross, 2010, p.401) so it was done after completing categorization.

1. **Developed themes** is that the units and the categories are merged in respective themes (where they seem to fit in). It is actually a broad category that is developed by liking together the common categories on the basis of characteristics (Hodkinson, 2008).

2. **Theory Generation** was not done as it was not the aim of the study.

## Results and Discussion

### Part I: Focus group discussion of engineering students

The current research was based on the qualitative exploration of the factors associated with the students opting

engineering field. It was really needed to explore these factors to promote the engineering in education and profession as a whole (Commission on Professionals in Science and Technology –CPST, 2007). The major themes emerged in the current study was academic and vocational interest, motivation, social support, personality characteristics, barriers etc. which are explained below.

FGD was started with a general question of career choice was asked that if they willingly chose engineering or not and were asked about their interest and choices where majority of the participants reported that they opted for engineering because of parental pressure not by their own interest. Participants from Electrical Engineering were more dissatisfied with their choice and majority were forced to opt for engineering while those from Software domain were more interested in the field and were more satisfied with their choices despite of some concerns with the curriculum, administration, and teaching etc. The students from mechanical engineering were equal at both ends half of them were satisfied and chose their field while other half were forced to take admission in the field although their priorities were different in the career choices such as media, arts, photography, business etc.

The below mentioned themes are explained with their respective discussion to support with the literature existed. Some of the verbatim of the respondents are shared and the other responses are summarized in the codes and description of the themes.

***Interest and Skills***

The first theme which was derived from the data was academic and vocational interest. The major categories as described in the Table 1 are skills, vocational interest and interest in other fields. Choice was also included under the theme of interest as it closely relates to it. Most of the students complied with their parents or siblings and chose engineering just to achieve degree.

The literature mentioned above shows that interest is very important in the career persuasion, success, achievement etc. This indicates that if the students are interested in the field, they will pursue the field although not opted for their selves e.g., in the case of computer engineering and IT related engineering domains.

Few of the responses from the participants are given below. A male respondent said; *"…mere pas to koi option he nahee tha, abba ne kaha kar lo to.., mera erada flying karnay ka tha.." [I didn't have any option, father recommended this so I did it.., I wanted to fly planes (pilot)]*.

Another participant responded on the same question as,*"Mixed tha, ammi abbu ka to dil tha lekin ma physics ma acha tha, thora tajassus tha k chezain kese hoti hain..phir thora push mila to agaya yahan" [it was my choice as well as my parents wanted me to join engineering, I was good in physics, I was curious about working/operation of things then I got support so I came here]*.

These responses stated above are contradictory in their choices, one was totally not interested and wanted to join either air force or become a pilot but parental force ended up with enrollment in engineering field and the 2nd participant had many supportive factors such as support from family, his own interest, curiosity as a factor of personality, skill of physics for pursuing engineering.

Parental pressure could be evidently seen in the above response where the student wanted to go for other field but to fulfill his father's wish he accepted with a deal to pursue his passion after the completion of engineering degree. Such examples could be seen in our society in abundance which was clear from the student's responses too. Majority of them had a forced choice for engineering compromising their passion and interest of the fields they wanted to join.

Participants from Electrical Engineering were more dissatisfied with their choice and majority were forced to opt for engineering while those from Software domain were more interested in the field and were more satisfied with their choices despite of some concerns with the curriculum, administration, and teaching etc. The students from mechanical engineering were equal at both ends half of them were satisfied and chose their field while other half were forced to take admission in the field although their priorities were different in the career choices e.g. some wanted to join forces, some were interested to opt for sports, some were interested in geography etc.

Another interesting but unfortunate information that was collected was that majority of the students had their alternate plans in future after the completion of the degree as this was only a commitment with their family. They wanted to switch career with army, business or some media related jobs. Many of them had no plans to pursue career in engineering rather they were more inclined towards arts, entrepreneurship, gaming, etc. While the students of software engineering were more satisfied with their career as they found more scope in market and they always has an edge to secure themselves by online services if they do not get a job (even if not of their choice).

In the skills domain, the students who chose engineering reported that they possess the skills of engineering and they knew they were god in engineering related subjects but they were not fully aware as how they knew they possessed these skills. Some of

the students identified they were good in calculations, programming, circuiting and IT operations. These were computer engineering/software engineering skills reported by the students of computer engineering.

The students of engineering chose engineering as an alternate option. Some of them wanted to avoid medical so they chose engineering because biology of totally out of their scope and engineering being technical and practical was more favored relatively. Students reported that they wanted to join forces but were not selected in armed forces and hence joined engineering. Some of the student's primary interests were architecture, media, photography, arts, etc.

Factors important in developing interest in the field were ascertained in the study specifically in high school students which were found out to be under parental influence and the knowledge of parent or significant others in that specific field which was also determined in the current study, highlighting the importance of parental factors in influencing a student in pursuing any field or profession.

The primitive factors in the persuasion of a field were the person's interest, their parents, the earning potentials (which are indicated in the value domain), and teachers respectively (Beggs et al., 2009; Kuechler et al., 2009). According to or developing interest in a student, an encounter with that domain is necessary, if a person has no interaction with the people from their field, the interest has little or no chance to develop. Knowledge of the field can make the decision easy for the student (Beggs et al. 2009; Malgwi et al., 2005).

Knowledge acquisition about a particular field was observed to be directly related to the person's own interest. If a student was not interested in a field he would have never been searched for the knowledge about that field. So with every other factor personal interest enhances the worth and achievement in a field (Beggs et al., 2009; Hall, Dickerson, Batts, Kauffmann, &

Bosse, 2011; Kuechler et al., 2009).

Extra-curricular activities such as field trips, exhibitions, workshops, etc. and peers' attitude influences a student's motivation and career aspirations too (Lee & Shute, 2010; McInerney, 2008; Olitsky, Loman, Gardner & Billiups, 2010; Vedder-Weiss & Fortus, 2013).

***Motivation***

Motivation is important enabling and disabling factor to pursue any career. The consensus was on the stance that motivation leads to achievement, satisfaction, and boost energy in context of support provided by teachers, friends or family. Their de-motivation limits or retard the growth and achievement by lowering their zest towards understanding, gaining knowledge, and achieving their particular goals in life or academia.

STEM fields have numerous of lacking at different levels like educational, career, and opportunities available and also the stereotypic attitudes of the people. Believing STEM field to be associated with men, majority limits the scope and educational growth of the field among girls.

Motivation can be measured at the beginning of a course to assess students' motivation to learn engineering major subject that is mathematics. Students who are meta-cognitively aware of their motivation are better equipped to self-regulate their science/engineering-learning behavior (Schunk, Pintrich, & Meece, 2008).

Three major domains were identified by the students as intrinsic, extrinsic, and demotivation. Intrinsic motivation was more positively related to achievement, satisfaction, and success. Source of extrinsic motivation is parents, teachers, and peers. Extrinsic motivation is more related to external factors like prestige, social recognition, and values as an outcome. Demotivating factors are negative factors serving as barriers that

cause hindrance in the path of engineering education were coded under the themes of barriers.

Among the intrinsic motivation, mostly students identified that high achievement (was a source of motivation for them. Internal satisfaction by securing admission in engineering is another factor as was a dream and passion for them to join engineering. Extrinsic motivation was subject specific achievement in math and physics that one required for entry test to acquire admission. People around them such as friends, family, and teachers provided encouragement and support to get motivated which is an external source of motivation.

Parental pressure was a key factor throughout the study and most of the students joined engineering to fulfill the wishes of the parents. Studying engineering is much appreciated as it is a renowned field that symbolizes dignity and honor; it has a good impression on others in society. It may help in gaining a high status in the society and may help in good marriage proposals. These were all the extrinsic motivation factors reported by the students for studying engineering.

Demotivation, on the other hand, has a negative impact as it limits growth, achievement, and goal orientated behavior. Significant others such as friends, family, and teachers are considered highly motivating which leads to depressiveness, low energy for coping with stress and retards growth significantly if motivation is not available.

***Barriers***

Responses identified as barriers were of two types, one that were related to pre-engineering and the second were related to Engineering after passing pre-engineering or after joining engineering field. As our scope of study was to identify the barriers faced in pre-engineering so the themes and categories were purely extracted for pre-engineering related issues. Categorically, the domains of barriers faced were support, involvement, teaching

efficacy, and skills, course content, institutional barrier, career oriented, and non-academic barriers. The lack of support as established in the study referred to the constraints faced by students due to the lack of support from friends, family and teachers, considered as the significant others in the area of career selection, aspiration and selection. Non-involved parents in the educational affairs such as lacking supervision in educational affairs, pressure of opting a particular field against the student's will were some of the aspects that limited the growth of the student and affected academic hence acting as a barrier. Some of the participants were of the view that the existing stereotypes that the only respectable and renowned fields are medical, engineering, and IT also served as a barrier to success, students cannot go for the fields which they are interested in and may guarantee success for them.

Field work, effective guidance and updated course can reduce the barriers and can play some part in achievement of the participant. Among the challenges faced by the students that could be considered as barriers were time management for the unlimited projects, lack of supervision, difference in annual and semester system, lack of (career) counseling, getting lower GPA, institutional choice, torturous environment (bombardment of projects leading to mental illness), and personal issues of the students. A few students reported that the barrier is mainly the marks in pre-engineering, they intend to take admission but they could not because of their ineligibility.

Extreme comments by some students reflecting their sufferings because of the barriers they face are given below. A student commented, *"Engineering ek torture cell hay or bus.[Engineering is a torture cell and that's it]"*.

One of the respondent from gave the opinion too while pointing out the barriers such as,*"Projects ko well-guided hona chahea or semester k shuru ma he dy dena chahea na k end ma sab dy dain ta k time ko manage kia ja sakay [Projects must have to be*

*well guided and should be given at the start of the semester not in the end so that time could be managed]".*

This response was mainly referring to the Engineering related issue for which a probing question was put that what were the problems while studying at pre-engineering level to which he explained many factors that referred to bombardment of work at the end of session.

Teachers' related factors were also important in view of the students as they reported that teaching skills and efficacy are important in the pre-engineering field. Ineffective teaching methods are barrier because it fails to produce spark in the students, and motivate them. They need to be trained for effective method, time management, content coverage, unbiased consideration of the students, promoting creative work rather than spoon feeding. These factors not only help at pre-engineering level but also in admissions for engineering as well as after joining universities.

Course content was also reported to be out-dated and not updated/upgraded since decades. The content and teaching scope is exam-oriented not career-oriented, cramming/rote memorization is mostly followed and conceptual clarity is lacking. Major content of the course that is based on numerical analysis are skipped and practical orientation is scarce.

Education system itself, can be a barrier, it focuses at some selected topics and ignore others, giving importance to the board marks not the understanding for which students shifts to academies. Students reported that teachers only covered the content which appeared in the board exams repeatedly and ignored the numerical portion which was the basis of theoretical understanding. Lack of practical orientation by ignoring numerical portion led to rote memorization that cannot help the individual in getting admission in engineering universities and lack of practicality and conceptual clarity limit their approach and cannot get them to the level of achievement they want. The out-dated

course content which restrict knowledge and practicality, increase the risk of suffering in education and in practical fields in the long run.

The attendance policy is not very strict and students majorly bunk their classes and later on go to the academies to cover the content they missed in the schools/colleges. So attendance if not made mandatory for the students can make them suffer in academics which is compensated by the students by joining academies.

Field work, effective guidance, and updated course can reduce the barriers and can play some part in achievement of the participant. Among the challenges faced by the students that could be considered as barriers were time management for studies, lack of supervision, lack of (career) counselling, getting lower grades, institutional choice, and personal issues of the students. A few students reported that the barrier is mainly the marks in pre-engineering, they intend to take admission but they could not because of their ineligibility.

Research study suggested a comprehensive knowledge of the field at matriculation and higher school levels. They have discovered that about 300,000 students enter college without declaring their majors and this rate of non-declaration of the field and major domain is even higher in matriculation. Research findings also indicated that the persistence rate in pre-engineering is higher than the other field (Donnelly & Borland, 2002; Ohland, Sheppard, Lichtenstein, Eris, Chachra, & Layton, 2008) which was not the case in the current research where majority students clearly mentioned shifting the main field and preferring alternatives than pursuing the same field job.

Students from software according to literature (Ohland et al., 2008) came from different majors/fields which was opposite to the findings of the current research where the students of software were more interested to pursue the field, even if the students were

not willing to do jobs, they were persistent with the main field finding business or freelancing more appropriate for them.

The reason for this might be the increase in technology and more information available to the students, or the curiosity to have the knowledge of the mechanism behind the technology as mentioned by few students directly. Initially students are not much clear what to choose and how to pursue a specific field that might be the reason for the shift in the majors. The trend of guidance and counselling is not prevalent in Pakistan particularly which can guide students about the path to follow for attaining the degree in their relevant fields as per their interests.

The key motivators are the teachers and parents which is an effective support system. According to various studies (e.g., Jackson & Nutini, 2002; Kenny, Blustein, Chaves, Grossman, & Gallagher, 2003; Lent et al., 2002; Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011), a career support system in educational sector plays important role in maintaining negativity as parent do not suggest or guide but force to opt for a particular career or subject.

Research by Hall, Dickerson, Batts, Kauffmann, and Bosse (2011) indicated that the growing entrance in the fields of STEM are not keeping pace with the needs of the market (Commission on Professionals in Science and Technology –[CPST], 2007; Lowell & Regets, 2006) and suggested that counseling is needed to improve the understanding of the implementation of the fields. Career access can be improved in STEM fields by better guidance.

### *Social Support*

After the barriers were being identified, it was important to know the perception of the participants about their supporters or the support system in other words. Most of the students considered their family as the financial and moral supporters, friends as moral supporters and motivators and teachers as their guides. Support from all matters a lot to them. Moreover, they said that if parents,

teachers and friends de-motivate them can lead to poor academics and less energy to cope with the stress as discussed in de-motivation earlier. Some of the students hold teachers responsible for not motivating or de-motivating their students which can result into disasters. Authoritarian style perceived as display of love, warmth, concern in the collectivistic culture (Mousavi, Low, & Hashim, 2016).

Friends were supposed to support morally and encourage towards goal direction. Teachers provide the platform for growth and achievement. Reciprocal friendships contributed to the prediction of dropping out of high school, above and beyond the effects of academic motivation, or parent and teacher support for basic psychological needs (Ricard, & Pelletier, 2016; Song, Bong, Lee& Kim, 2015).

In the support system the major role of friends, family and teachers were identified. Family was the major influencer as they support morally as well as financially. Their influences are in subject choices majorly, they want renowned fields and specific subjects to be selected by their children. They negate or do not allow their children to choose subjects of their interests. Students identified that parents must have to be counseled besides students to know the worth of other fields and importance of interest in choosing an academic field.

Support system is a mandatory primitive factor in career aspiration of a student at crucial turning points like matric and F.Sc. level, without the encouragement and supportive parenting and teaching a student was never going to opt for STEM field (Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011; Daugherty, Reese, & Merrill, 2010; Daugherty, Westrick, Zeng, Merrill, & Custer, 2007). Teachers' qualification has a huge influence on the student's supportive system; their teaching method and effective guidance can act as support for achievement.

Social support and other social-contextual factors were also examined such as parental, peers and teacher's support which

enhances self-efficacy among the students of engineering fields (Lent et al., 2008; Bandura, Barbaranelli, Caprara, & Postorelli, 2001; Zildin & Pajares, 2000) based on social cognitive career theory, also confirming the involvement of parent leads to academic achievement (Byrnes & Miller, 2007; Clotfelter, Ladd, & Vigdor, 2007; Darling-Hammond, 2000; Fan & Chen, 2001; Rice, 2001; Rivkin, Hanushek, & Kain, 2005).

***Personality Characteristics***

Personality actually depicts the characteristics that are required by pre-engineering students to pursue engineering a s a carrier successfully. The personality characteristics identified by students are that they must be creative, curious to explore what is going inside the obvious, work hard to reach a particular goal. They must have to be resilient so that failure must not result in hopelessness and start with the same energy over again. Students also said that they need to be adaptable to adapt to the circumstances and need of the hour as circumstances may not be favorable. They must possess interest in programming, mechanics, numeric, electrical appliances etc. depending on their major field.

Few examples of the participants' responses are given. *"Zeada parhai ki taraf tawajah nahee dety thay q kay pata tha k abhi saal para hy akhir ma parh lain gay or nikal jayengy achy grades k sath. Sahi tarah 2 haftay bhi parthy hain to marks ajatya hain.. [Did not concentrate on studies as we knew that we have a year time and we will cover in the end and will get through will good grades even if we study for 2 weeks we can gain marks]".*

The above response explains the respondent's attitude towards studies at pre-engineering level. Annual system gives them the leverage to cover up all the content at the end of the session and pass through. This was the attitude of the majority students, some were satisfied with the attitude and some regretted that they wasted time when they had the opportunity to learn and achieve even more higher. This is depicted in a response *"Parhai ma koi interest nahee tha pehly to airforce colony ma rehty thay*

*sahii danday k zor ce seedhay rehty thay magar jab bahir nikly to maza aya doston k sath phir parhai ma interest khatam ho gaya jis ka pachtawa hy.[Did not have any interest in studies, lived in airforce colony initially so were forcibly right (studious) but when came out from there, enjoyed with friends, lacked interest in studies, which I regret]".*

Participant's regret meant that he wanted to achieve even higher and be in a right direction but he was involved with distracting friends (mentioned in the barriers) which limited their achievement and needed much more effort to secure admission in engineering college which would have been more easier if he got higher grades than the currently achieved grades at pre-engineering level.

**Values and academic achievement**

Values meant the reason behind favoring or approving something, in this case engineering. There are different values assigned to every career and field but what specifically was associated with engineering was the students' interest majorly, limited choices, parent's wish, high grades in FSc. etc. Some other different views about engineering were that it is a symbol of dignity and honor, is related to good impression management, high place in society, degree matters a lot and lastly but very amusingly that it helps in getting good partner (*Rishta*).

Examples of the responses are, *"Degree is worthless is ce hamain koi faida nahee hona is lea we have to go for alternate options.[Degree is worthless it does not give us any benefit that is why we have to opt other options".*

The above response shows that the participant does not perceive any value of engineering degree and is ready to choose alternatives as a career other than his main field of study.

Beggs et al., (2009) discovered various factors related to career or field choice which were personal interest (on the top), parental and teachers support (as mandatory factor in choosing a tough field), relatives, guides, friends, opportunities, salary expectations, advancements, benefits, the reputation of the staff, course content, and ease of earning a degree varyingly important for different students of college level.Academically grades are important specifically in the subjects related to engineering such as mathematics and physics.

## Part II: Focus group discussions with non-engineering students

The focus group discussions were analyzed using the same procedure as for focus group discussions in the previous section with engineering students. Different themes, categories, and codes were generated from the focus group discussions of the non-engineering students which are described in detail.

### *Interest and skills of the students*

In literature, researchers interchangeably use the word attitude, interest, and motivation to show inclination of students towards a particular field. The direction of the attitude (positive or negative) and the strength of the effect are co-related to cognitive structure; determine the behavior, affect perception, education and teacher education bring the change in attitude (Salta & Tzougraki, 2004). Attitude towards science denotes interest or feeling towards studying science. It is the student's disposition towards liking or disliking science (Anwer, Iqbal, & Harrison, 2012; Jack, 2013).

The categories emerged under the theme of vocational interest are field interests, alternative fields interest, and skills. Three students from non-engineering fields responded in their field related interests that their interest was primarily in physics, electronics and mathematics. A student explained that from very childhood he used to work as an electronic worker or electrician and he used to fix things at home and for other people. He was

interested in physics related equipment and used to work with keen interest in the laboratory. The lab attendant and the teachers also lend him keys of the laboratory to perform his activities whenever he wanted. All these sharing show his interest in the field of engineering but due to the lack of theoretical knowledge and some financial issues, and non-selection he could not pursue his field of interest. Other engineering related subjects of interest were computer science and Mathematics mainly.

Some students reported they were not interested in the field of engineering although they had good grades and opportunity to pursue the field of engineering but they were not interested. There was an intension to join social science as a field of study (specifically psychology) for majority of cases. The students from English department were all interested to appear in competitive exams and wanted to become Central Superior Services officer or join Armed Forces. Some of the students were interested in pure arts (like sketching, music etc.).

A student said, *"Mujhy engineer ban'na he nahee tha myjy to CSS karna tha bus maths achi the to is lea medical ki jaga F.Sc. Ma engineering li thee..[I never wanted to become an engineer, I wanted to do CSS, I was good in mathematics so I opted engineering instead of medical in F.Sc.]".*

The skills that were referred to by the students that they possessed for engineering were, that they had a highly intact practical knowledge, they participated in different sciences projects and won prizes, they has the skills to mend electrical appliances, they were curious and explorative and wanted to get the knowledge about the latent details of an appliance or equipment. Majority of them reported that they had mathematical skills and some of them even got 100% marks in mathematics but were not interested to pursue engineering as they did not like the field to be pursued as career.

Students from non-engineering fields, who studied pre-engineering and did not pursue the field of engineering, had

different opinions in interest from those of engineering students. Some were interested in persuasion of the field and majority decided earlier to pursue non-engineering fields besides having high grades. The domains of interest other than engineering were both scientific and non-scientific. Boys scored high in mathematics and physics, had high self-efficacy in engineering related fields but they did not pursue their career in engineering as they were not interested in becoming engineers.

The reasons for pursuing fields in engineering and non-engineering were different. Majority of the engineering students were forced to choose engineering which was less evident in the non-engineering students. Non-engineering students had different situation, some of them did not want to continue engineering, some were good in studies and wanted to join alternate fields and some other were suggested to join engineering but not forced for doing so. Those who wanted to join engineering were either hindered by the financial constraints or personal failures.

***Barriers***

Ali, Iqbal, & Akhtar (2013) found parents socio-economic status, and students' self-concept and gender as the important factors influencing students, attitude towards science. Most researchers (Osborne, Simon, & Collins, 2003; Nieswandt, 2005) consider the effects of curriculum on science attitudes.

In the present study, the categories identified from the focus group discussions of the non-engineering students are personal factors, family factors and institutional factors. The students reported that they faced certain barriers while studying engineering such as achieving lower grades in pre-engineering, poor theoretical knowledge which lead to non-qualification in admission test for engineering so they changed their subject. They accepted that they could not mange time properly for studies landing ultimately in trouble while securing grades. They only prepared for exams during vacations for preparation before board exams.

Few students identified some other personal factors that affected their grades in pre-engineering such as memory issues and their writing. For some students, solving physics and mathematical problems was a barrier in achievement. Family factors also contributed to the failure in achievement and persuasion in engineering fields. Financial constraints were among the most prominent factors. A student reported that his family did not have financial issues and they are well settled but financing studies are not preferred by the family.

Educational/institutional constraints were also held responsible for not pursuing engineering fields such as poor laboratory facilities in the institute, poor teaching method, and lack of rules for punctuality are the highlighted issues. The differences in the perspective of engineering and non-engineering students on the barriers also existed where the barriers in perspective of the engineering students were lack of support, poor parental involvement, teachers' related factors, content related, institutional, career orientation, and non-academic. On the other hand, personal factors, domestic issues and some institutional factors contributed as a barrier for non-engineering students. Hence, personal inclinations, personal weaknesses and failures were included in the non-engineering barriers.

Pakistan needs to draw on possible lessons and ideas that have proven to be of value such as innovations in science and engineering education and factors related to these fields (Marginson, Tytler, Freeman, & Roberts, 2013).

***Support system***

The students who did not pursue the field of engineering were either not interested or not supported by their parents. The major categories related to support system are influences, counseling, and role models. In the support system, parental non-support and pressure was much highlighted. Students reported that their parents were not in favor of choosing physics as a major

where they were getting admissions and the field was also related to the field of engineering.

Career counseling was accepted as having influence in one's career and career choices. Participants of the FGD's highlighted the importance of professional guidance not only for subject or career selection but also for schools and college selection. As some of them suffered due to lack of goal directedness and sometimes lack of decision power that made him comply to people's decision for him (like he went to join army as others suggested that it will suit him, but he wasn't selected and had to let go the idea).

Role models were found to be helpful in choosing the fields (Boucher, Fuesting, Diekman, & Murphy, 2017; Fuesting, & Diekman, 2017). A study examined the attitude of students toward social sciences in Sargodha city, Pakistan. They aimed at finding out the students' information regarding social science subjects and their attitude, as well as motivation towards for those subjects in the future education. Students had less information about social sciences because their teachers, parents and peers did not tell about those subjects and their worth in our society, so they were more interested to study natural science subjects in their future studies (Ahmed & Maryam, 2016).

Support system was different in the perspectives of engineering and non-engineering students. Lack of support from the family friends and teachers were identified by the engineering students which were more related to permitting the student to choose his field of interest and forcing him choose the field his parents wanted him to choose. Although there was no such forceful choices for the non-engineering students but certain other family related constraints were described by the non-engineering students.

***Motivation***

Most respondents said that their parents did motivate them to study natural science subjects because they claimed that those

who study natural sciences subject can get attractive and high paying job than social science subjects and the same have been identified in the researchers conducted earlier (such as Ahmed & Maryam, 2016). Student think natural sciences have more scope in society and are economically beneficent, and more than half of the students study natural sciences for the sake of earning money. Mostly this attitude is driven by the significant others in them and they think materialistically to attain extrinsic goals and motives (such as fame, wealth, power etc.).

The participant directly referred to the intrinsic motivation for studying and was very much satisfied with his academia because he was not in competition with others but to satisfy his own need for knowing and learning.

The participants identified their motivational factors which were categorized as extrinsic and intrinsic in the study. Some of the participants said for them having practical exposure motivated them intrinsically. Motivation was also different from the perspective of engineering and non-engineering students. The motivational factors were limited for the non-engineering students and confined to grades, learning, contribution to society and passing exams, but all were unrelated to engineering. There were a lot of factors contributing to the motivation of engineering students which were highly extrinsic than intrinsic.

### *Academic Satisfaction*

Students' satisfaction with their studies is an important matter for themselves, their teachers, their institutions, and public bodies. In their review of over 7000 publications, Richardson, Abraham, & Bond, (2012) classified 42 *non-intellective* correlates of academic performance into five classes: personality traits, motivational factors, self-regulatory learning strategies, students' approaches to learning, and psychosocial contextual factors. These, so-called non-intellective factors represent sites of psychological or educational interventions that aim to enhance students'

engagement and satisfaction with their studies (e.g., teaching study techniques according to approaches to learning).

A student from Psychology said that, "*Subject jo marzi ho engineering ho na ho agar us ma practicality ho to wo satisfaction ka bais banti hay phir samajh bhi ata hy k ye jo hum karay hain kis lea karay hain, hum ce pehly logo ne kese kia, naya kia kar sakty hain, to ye zaroori hy har field ma [Whatever subject it may be engineering or not but if it has practicality it is the basis of satisfaction, then we can understand what we are doing, why we are doing this, how did people do it before, how could we apply innovation, and this is important in every field]".*

The participant's above mentioned comment explains that the satisfaction is based on the intrinsic motivation, interest and practicality. The more a field is clear in its practicality the more it is satisfying as it clarify the goal and purpose of doing or studying a field.

Academic satisfaction of the non-engineering students was high except for the group of students from electronics. Satisfaction was more related to qualified teachers and updated equipment in pre-engineering studies by the students.

The satisfaction level of the engineering students was very low as compared to the non-engineering students except for the field of software engineering who were relatively more satisfied as the field was their primary choice. The students of non-engineering were more satisfied in their concerned field except for the field of electronics that was related to engineering but the choice was an alternate choice after the failure in the major engineering domains and also because of the non-recognition of the electronics field as engineering.

***Persistence Intension***

Factors for those "persisting" in engineering were intention to stay in engineering, determination, self-regulating behaviors, coping skills, grades and mental preparedness. Most students faced difficulties in the transition to a more academically challenging college program. Suggestions were made for the development of retention programs that would concentrate on helping students become better prepared mentally for the rigors of an engineering program and help students manage the transition to an engineering major (MacGuire, & Halpin, 1995).

The persuasion of an appropriate career is a big issue for adolescents seeking career counselling and guidance to choose appropriate career for them. STEM fields are said to be the major areas of concern in which a rapid decline of enrolment or attrition after enrolment is observed (Lam, Srivatsan, Doverspike, Vesalo, & Mawasha, 2005).

The clarity of choosing a field and intension for persistence is very clear from the above comment. Social science was chosen as the field of interest and a very determined intension is evident from the way of participant's comment. This intensity and clarity was missing in engineering students other than software engineering students. They were either forced or were not clear about their future career aspirations but somehow joined engineering.

The students from non-engineering fields other than electronics did not intend to persist in engineering fields and hence changed their majors despite of high achievement, motivation to studying, and high self-efficacy.

Persistence intension was similar in both the groups as both did not want to pursue their academic careers except few participants. The non-engineering students did not want to pursue the engineering fields (except electronics students) and the students of engineering besides doing engineering did not want to pursue

the field of engineering as a career as reported by the majority of students from engineering field.

### *Academic Achievement*

Researcher explained that when students fails to get admission in natural sciences subjects they go for social sciences subjects (Anwer, Iqbal, & Harrison, 2012), which was also determined in the present study. Three students from psychology and all the students in the focus group from electronics (n=8) opted alternative field because they failed to get admission in engineering universities which was not seen in the non-engineering group.

Different factors identified by the students who could not secure admissions that caused low achievement were lack of concentration, stress, involvement in non-academic activities, and non-serious attitudes etc. Some of the study habits identified by the participants were that they arranged the material systematically first to make them more comprehendible for them, then studied focusing on the study not the grades, because according to them striving for marks and grades build some mental pressure on mind and causes stress.

For the students of engineering grades were their achievement and that was the only goal while the non-engineering students studying, learning, gaining knowledge, helping others etc. were regarded as their achievements and they also pointed out the reasons for not achieving high.

### *Values*

The value actually refers to the expectations from a field as an outcome that may be extrinsic or intrinsic. Here extrinsic value for the participants was grades and the intrinsic values were that their education may contribute positively to the society and they can get internal satisfaction by studying in their fields of interest. Their values were not concerned with the pre-

engineering fields but rather more related to the fields they joined or wanted to join.

Students of electronics were not satisfied with the educational system where cramming was facilitated and accepted whereas understanding of the material was not important for them.

A participant commented that, *"Parhai to wo hoti hay jo itmenan dy sakay k kuch knowledge gain kia hay baqi to marks waghera ka soch kar parhain to tension he hoti hay bus [The thing which satisfies you that you have gained some knowledge is actually studying, otherwise thinking about marks can only give you tension]".*

Student from Electronics majorly reported their shortcomings which were the reason for their low achievement while the students from English and psychology were majorly happy with their academic achievements at pre-engineering level and reported a more organized way of studying.

In the perspective of the engineering students, extrinsic motivation, extrinsic values, extrinsic forces were more reported as compared to the non-engineering students who wanted a well reputed contribution to the society and were working more for their internal satisfaction.

## Conclusion and implications

Both groups differed in their interest, motivation, support and barriers although students from non-engineering academic fields had high grades and potential to continue engineering but barriers caused hindrance in pursuing field, interest and motivational factors were lacking. Hence, the qualitative study highlighted the importance of the factors such as interest, motivation, self-efficacy, support, and barriers in pursuing the field of engineering.

The need of engineers and engineering technology is undeniable but often lack the practical approach to solve real industrial problems for which the deficiencies and barriers can be traced back to the beginning of the education in the area, i.e. in pre-engineering when students make major decision what to opt for in their career. Student's lack of interest in the fields of engineering and technology has rendered unanswerable question marks for the educationists, companies, and policy makers about underlying psychosocial factors which need to be addressed by having evidence-based approach.

This study may help in devising a protocol based on the identified factors that could be offered to schools and colleges for career counselling of their students. This study may help in devising a protocol based on the identified factors that could be offered to schools and colleges for career counselling of their students either to pursue career in the field of engineering or not. It may also in policy formulation process as well as assist in need assessment of the students and teachers of pre-engineering studies to excel in engineering.

## Limitations and future recomendations

The major limitation of the study was lack of diversity in the sample, which hampers the generalizability of the research findings. Most of the sample was taken from the Universities of Rawalpindi, and Islamabad. Hence a bigger sample taken from the

general population of Pakistan can contribute a lot in overcoming this limitation. Proportionate sample of both genders could not be identified for the study.

## References

Ahmed, T., Raza, S. H., Maryam, A., Setzer, W. N., Braidy, N., Nabavi, S. F., ... & Nabavi, S. M. (2016). Ginsenoside Rb1 as a neuroprotective agent: A review. *Brain Research Bulletin*, *125*, 30-43.

Ali, M. S., Iqbal, A., & Akhtar, M. M. S. (2013). Students' attitude towards science and its relationship with achievement score at intermediate level. *Journal of Elementary Education*, *25*(2), 61-72.

Anwar, T. (2017). *Design-based online teacher professional development to introduce integration of STEM in Pakistan* (Doctoral dissertation, University of Minnesota). Proquest LLC.

Anwer, M., Iqbal, H. M., & Harrison, C. (2012). Students' attitude towards science: A case of Pakistan. *Pakistan Journal of Social & Clinical Psychology*, *9*(2), 3-9.

Ayre, G., & Callway, R. (2013). *Governance for sustainable development: A foundation for the future*. Earthscan.

Baillie, C. & Fitzgerald, G. (2000). Motivation and attrition in engineering students. *European Journal of Engineering Education*, *25*(2), 145-155. doi:10.1080/030437900308544

Beggs, J. M., Bantham, J. H., & Taylor, S. (2008). Distinguishing the factors influencing college students' choice of major. *College Student Journal*, *42*(2), 381-395.

Bergin, D. A. (2016). Social influences on interest. *Educational Psychologist*, *51*(1), 7-22.

Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: Young people's achievement-related choices in late-modern societies. *Studies in Science Education*, *47*(1), 37-72.

Boucher, K. L., Fuesting, M. A., Diekman, A. B., & Murphy, M. C. (2017). Can I work with and help others in this field? How communal goals influence interest and participation in STEM fields. *Frontiers in Psychology*, *8*, 901-930.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *44*(8), 1187-1218.

Carr, P. B., & Walton, G. M. (2014). Cues of working together fuel intrinsic motivation. *Journal of Experimental Social Psychology*, *53*, 169-184.

Cochran, M., & Patton, M. Q. (2002). *A Guide to using qualitative research methodology.* London: Medecins Sans Frontieres.

Commission on Professionals in Science and Technology - CPST (2007, Oct 9). Is US science and technology adrift? STEM Workforce Data Project: Report No. 8. *Washington, DC: CPST.*

Daugherty, J. L., Reese, G. C., & Merrill, C. (2010). Trajectories of mathematics and technology education pointing to engineering design. *Journal of Technology Studies*, *36*(1), 46-52.

Daugherty, J., Westrick, M., Zeng, Y., Merrill, C., & Custer, R. (2007). Delivering core engineering concepts to secondary level students using the STL. Paper presented at the meeting of the *International Technology Education Association Conference*, San Antonio, TX.

DeMarie, D., & Aloise-Young, P. A. (2003). College students' interest in their major. *College Student Journal*, *37*(3), 462-470.

Donnelly, D. L., & Borland Jr., K. W. (2002). Undeclared Students' Patterns of Declaration: Practical and Political Implications for Orientation and Transition Programs. *Journal of College Orientation & Transition*, *10*(1), 5-13.

du Toit, R., & de Bruin, G. P. (2002). The structural validity of Holland's RIASEC model of vocational personality types

for young black South African men and women. *Journal of Career Assessment*, *10*(1), 62-77.

Dutta, A., Kang, H. J., Kaya, C., Benton, S. F., Sharp, S. E., Chan, F., ... & Kundu, M. (2015). Social-cognitive career theory predictors of STEM career interests and goal persistence in minority college students with disabilities: A path analysis. *Journal of Vocational Rehabilitation*, *43*(2), 159-167.

Eccles, J. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist*, *44*(2), 78-89.

Eccles, J. S., & Roeser, R. W. (2009). *Schools, academic motivation, and stage-environment fit.* In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology: Individual bases of adolescent development* (p. 404–434). John Wiley & Sons Inc. https://doi.org/10.1002/9780470479193.adlpsy001013

Fouad, N. A., & Smith, P. L. (1996). A test of a social cognitive model for middle school students: Math and science. *Journal of Counselling Psychology*, *43*(3), 338-346.

Fouad, N. A., Guillen, A., Harris-Hodge, E., Henry, C., Novakovic, A., Terry, S., & Kantamneni, N. (2006). Need, awareness, and use of career services for college students. *Journal of Career Assessment*, *14*(4), 407-420.

Fuesting, M. A., & Diekman, A. B. (2017). Not by success alone: Role models provide pathways to communal opportunities in STEM. *Personality & Social Psychology Bulletin*, *43*(2), 163-176.

Goulet, L. R., & Singh, P. (2002). Career commitment: A reexamination and an extension. *Journal of Vocational Behavior*, *61*(1), 73-91.

Haag, S., Hubele, N., Garcia, A., & McBeath, K. (2007). Engineering undergraduate attrition and contributing factors. *International Journal of Engineering Education*, *23*(5), 929-940.

Hall, C., Dickerson, J., Batts, D., Kauffmann, P., & Bosse, M. (2011). Are We Missing Opportunities to Encourage Interest in STEM Fields?. *Journal of Technology Education*, *23*(1), 32-46.

Hall, W. M., Schmader, T., & Croft, E. (2015). Engineering exchanges: Daily social identity threat predicts burnout among female engineers. *Social Psychological & Personality Science*, *6*(5), 528-534.

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899-906.

Holmegaard, H. T., Madsen, L. M., & Ulriksen, L. (2014). To choose or not to choose science: Constructions of desirable identities among young people considering a STEM higher education programme. *International Journal of Science Education*, *36*(2), 186-215.

Hulleman, C. S., Kosovich, J. J., Barron, K. E., & Daniel, D. B. (2017). Making connections: Replicating and extending the utility value intervention in the classroom. *Journal of Educational Psychology*, *109*(3), 387.

Hulleman, C. S., Thoman, D. B., Dicke, A. L., & Harackiewicz, J. M. (2017). The promotion and development of interest: The importance of perceived values. In *The science of interest* (pp. 189-208). Springer, Cham.

Huo, Y., & Leung, J. Y. T. (2005). Minimizing total completion time for UET tasks with release time and outtree precedence constraints. *Mathematical Methods of Operations Research*, *62*(2), 275-279.

Isaac, J. D., Sansone, C., & Smith, J. L. (1999). Other people as a source of interest in an activity. *Journal of Experimental Social Psychology*, *35*(3), 239-265.

Jack, G. U. (2013). The influence of identified student and school variables on students' science process skills acquisition. *Journal of Education & Practice*, *4*(5), 16-22.

Jackson, M. A., & Nutini, C. D. (2002). Hidden resources and barriers in career learning assessment with adolescents vulnerable to discrimination. *The Career Development Quarterly*, *51*(1), 56-77.

Jackson, M. C., Leal, C. C., Zambrano, J., & Thoman, D. B. (2019). Talking about science interests: the importance of social recognition when students talk about their interests in STEM. *Social Psychology of Education*, *22*(1), 149-167.

Jackson, S. (2004). *The quiet crisis: Falling short in producing American scientific and technical talent*. San Diego, CA: Building Engineering Science and Talent (BEST). Retrieved from http://www.bestworkforce.org/ PDFdocs/Quiet_Crisis.pdf

Kenny, M. E., Blustein, D. L., Chaves, A., Grossman, J. M., & Gallagher, L. A. (2003). The role of perceived barriers and relational support in the educational and vocational lives of urban high school students. *Journal of Counseling Psychology*, *50*(2), 142.

Kim, B., Jee, S., Lee, J., An, S., & Lee, S. M. (2018). Relationships between social support and student burnout: A meta-analytic approach. *Stress & Health*, *34*(1), 127-134.

Kong, F., Ding, K., & Zhao, J. (2015). The relationships among gratitude, self-esteem, social support and life satisfaction among undergraduate students. *Journal of Happiness Studies*, *16*(2), 477-489.

Krapp, A. (2007). An educational–psychological conceptualisation of interest. *International Journal for Educational & Vocational Guidance*, *7*(1), 5-21.

Kuechler, W. L., McLeod, A., & Simkin, M. G. (2009). Why don't more students major in IS?. *Decision Sciences Journal of Innovative Education*, *7*(2), 463-488.

Lam, P. C., Srivatsan, T., Doverspike, D., Vesalo, J., & Mawasha, P. R. (2005). A ten year assessment of the pre-engineering program for under-represented, low income and/or first generation college students at the university of Akron. *Journal of STEM Education: Innovations & Research*, *6*(3 & 4), 14-20.

Law, K. S., Wong, C. S., & Leong, F. (2001). The cultural validity of Holland's model and its implications for human resource management: the case of Hong Kong. *International Journal of Human Resource Management, 12*(3), 484-496.

Lent, R. W. (2005). *A social cognitive view of career development and counseling*. In S. D. Brown & R. W. Lent (Eds.), Career development and counseling: Putting theory and research to work (pp. 101-127). New York: John Wiley

Lent, R. W., Brown, S. D., & Hackett, G. (2002). Social cognitive career theory. *Career Choice & Development, 4*, 255-311.

Lowell, B. L., & Regets, M. C. (2006). *A half-century snapshot of the STEM workforce, 1950 to 2000*. Washington, DC: Commission on Professionals in Science and Technology.

MacGuire, S., & Halpin, G. (1995). *Factors related to persistence in engineering: Results of a qualitative study*. Paper presented at the Annual Meeting of the Mid-South Educational Research Association. https://files.eric.ed.gov/fulltext/ED398052.pdf

Malgwi, C. A., Howe, M. A., & Burnaby, P. A. (2005). Influences on students' choice of college major. *Journal of Education for Business*, *80*(5), 275-282.

Marginson, S., Tytler, R., Freeman, B., & Roberts, K. (2013). STEM: Country comparisons: International comparisons of science, technology, engineering and mathematics (STEM) education. *Final Report*. Australian Council of Learned Academies, Melbourne, Vic. http://dro.deakin.edu.au/eserv/DU:30059041/tytler-stemcountry-2013.pdf

Master, A., Cheryan, S., Moscatelli, A., & Meltzoff, A. N. (2017). Programming experience promotes higher STEM motivation among first-grade girls. *Journal of Experimental Child Psychology*, *160*, 92-106.

McMullin, K., & Reeve, E. (2014). Identifying perceptions that contribute to the development of successful project lead the way pre-engineering programs in Utah. *Journal of Technology Education*, *26*(1), 22-46.

Memon, G. R., Joubish, M. F., & Khurram, M. A. (2010). Education in Pakistan: The key issues, problems and the

new challenges. *Middle-East Journal of Scientific Research, 6*(6), 672-677.

Menéndez, M. D. C. R., Calvo, J. V. P., & Caro, M. D. L. M. I. (2016). " Esto es lo que me gusta y lo que voy a estudiar": Un estudio cualitativo sobre la toma de decisiones académicas en bachillerato 1/" This is what I like and what I am going to study": A qualitative study of academic decisions in high school. *Revista Complutense de Educación, 27*(3), 1351.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: A sourcebook of new methods* (2nd ed.). Thousand Oaks, CA: Sage.

Mosley, P. H., Liu, Y., Hargrove, S. K., & Doswell, J. T. (2010). A pre-engineering program using robots to attract underrepresented high school and community college students. *Journal of STEM Education: Innovations & Research*, *11*(5). https://www.jstem.org/jstem/index.php/JSTEM/article/view/1281

Mousavi, S. E., Low, W. Y., & Hashim, A. H. (2016). Perceived parenting styles and cultural influences in adolescent's anxiety: A cross-cultural comparison. *Journal of Child & Family Studies*, *25*(7), 2102-2110.

Nathan, M. J., Atwood, A. K., Prevost, A., Phelps, L. A., & Tran, N. A. (2011). How professional development in project lead the way changes high school STEM teachers' beliefs about engineering education. *Journal of Pre-College Engineering Education Research, 1*(1), 15–29. http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1027&context=jpeer

Nauta, M. M., Kahn, J. H., Angell, J. W., & Cantarelli, E. A. (2002). Identifying the antecedent in the relation between career interests and self-efficacy: Is it one, the other, or both?. *Journal of Counseling Psychology*, *49*(3), 290 – 301. https://doi.org/10.1037/0022-0167.49.3.290

Nieswandt, M. (2005). Attitudes toward science: A review of the field. In *Beyond Cartesian Dualism* (pp. 41-52). Springer, Dordrecht.

Nugent, G., Barker, B., Welch, G., Grandgenett, N., Wu, C., & Nelson, C. (2015). A model of factors contributing to STEM learning and career orientation. *International Journal of Science Education*, *37*(7), 1067-1088.

Ohland, M. W., Sheppard, S. D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R. A. (2008). Persistence, engagement, and migration in engineering programs. *Journal of Engineering Education*, *97*(3), 259-278.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049-1079.

Renninger, K. A. (2009). Interest and identity development in instruction: An inductive model. *Educational Psychologist*, *44*(2), 105-118.

Renninger, K. A., & Bachrach, J. E. (2015). Studying triggers for interest and engagement using observational methods. *Educational Psychologist*, *50*(1), 58-69.

Renninger, K. A., & Hidi, S. (2016). Interest, attention, and curiosity. *The Power of Interest for Motivation & Engagement*, 32-51.

Renninger, K. A., & Riley, K. R. (2013). Interest, cognition and case of L-and science. *Cognition & Motivation: Forging an Interdisciplinary Perspective*, 352-382.

Ricard, N. C., & Pelletier, L. G. (2016). Dropping out of high school: The role of parent and teacher self-determination support, reciprocal friendships and academic motivation. *Contemporary Educational Psychology*, *44*, 32-40.

Ricard, N. C., & Pelletier, L. G. (2016). Dropping out of high school: The role of parent and teacher self-determination support, reciprocal friendships and academic motivation. *Contemporary Educational Psychology*, *44*, 32-40.

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, *138*(2), 353.

Rounds, J., & Tracey, T. J. (1996). Cross-cultural structural equivalence of RIASEC models and measures. *Journal of Counseling Psychology*, *43*(3), 310.

Sagiv, L., & Schwartz, S. H. (2004). Values, intelligence and client behavior in career counseling: A field study. *European Journal of Psychology of Education*, *19*(3), 237-254.

Salta, K., & Tzougraki, C. (2004). Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education*, *88*(4), 535-547.

Sansone, C., & Thoman, D. B. (2005). Interest as the missing motivator in self-regulation. *European Psychologist*, *10*(3), 175-186.

Schunk, P. Meece (2008) Schunk, D. H., Pintrich, P. R, & Meece, J. L. (2008). *Motivation in education: Theory, research and applications (3rd ed.)*, Upper Saddle River, NJ: Merrill-Prentice Hall.

Song, J., Bong, M., Lee, K., & Kim, S. I. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. *Journal of Educational Psychology*, *107*(3), 821.

Spokane, A. R., Meir, E. I., & Catalano, M. (2000). Person–environment congruence and Holland's theory: A review and reconsideration. *Journal of Vocational Behavior*, *57*(2), 137-187.

Šverko, I., & Babarović, T. (2006). The validity of Holland's theory in Croatia. *Journal of Career Assessment*, *14*(4), 490-507.

Swann Jr, W. B. (2011). Self-verification theory. *Handbook of theories of social psychology*, *2*, 23-42.

Tai, R. H., Liu, C. Q., Maltese, A. V., & Fan, X. (2006). Planning early for careers in science. *Science*, *312*(5777), 1143-1144.

Tan, L. M., & Laswad, F. (2009). Understanding students' choice of academic majors: A longitudinal analysis. *Accounting Education: An International Journal*, *18*(3), 233-253.

Thoman, D. B., Smith, J. L., & Silvia, P. J. (2011). The resource replenishment function of interest. *Social Psychological & Personality Science*, *2*(6), 592-599.

Tracey, T. J., & Darcy, M. (2002). An idiothetic examination of vocational interests and their relation to career decidedness. *Journal of Counseling Psychology*, *49*(4), 420.

Wigfield, A., & Cambria, J. (2010). Achievement motivation. *The Corsini Encyclopedia of Psychology*, 1-2.