

Attribution Factors of Chemistry Anxiety: What are they?

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Abstract

Chemophobia is supposedly to be known as chemistry anxiety. Chemistry anxiety will influence the development of holistic students to be as part of competent experts in scientific and technology arena in the near future. Chemistry anxiety that exist among science stream students at secondary school level tends to impairs performance and cause the low student enrollment in science field at the tertiary level. The attribution factors of chemistry anxiety that can be studied comprise of chemistry anxiety in learning, chemistry anxiety in evaluation and chemistry laboratory anxiety. Indeed, chemistry anxiety in learning aspect is anxious feeling that exists among students when they learn chemistry in classroom or laboratory while chemistry anxiety in evaluation is described as an arousal of undesirable feeling when sitting for assessment or test that related to chemistry subject and chemistry laboratory anxiety is fear of chemical substances or handling laboratory apparatus that perceived by the students when conducting experimental tasks. Determination of undesirable apprehension towards chemistry is required to be studied in order to discover preventive interventions that consequently help in cultivating science stream students' interest towards chemistry.

Keywords: chemophobia, students' anxiety, chemistry anxiety, chemistry education)

1.0 Introduction

In the period of 20th century, the study of anxiety attracted the interest of psychologists group since that time and profoundly known as the 'age of anxiety' (Spielberger, 1983). Based on literature, the interest study on anxiety was emphasized for the reason that it was typically experienced by the whole society (Yilmaz-Tuzun and Karisan, 2013). A well-known definition of anxiety developed and described by Spielberger et al. (1983) as subjective feelings that involved emphasis added of tension, apprehension and worry and also by arousal of the autonomic nervous system. In other definition, anxiety was defined as a state in which an individual is unable to make a clear pattern of behavior to change the situation that is threatening (Power and Dalgleish, 1997); Twenge (2000) presented overall anxiety model whereby level of anxiety directional proportional to environmental threat.

Anxiety is a fundamental human emotion consisting of apprehension that typically appears when a person perceives an occurrence as being threat to the ego or self-esteem (Harris et.al, 2003). According to Muris et al. (2010) anxiety can be defined as subjective feelings and thoughts and observable behavior, but also in physical symptoms such as feeling of heart beating too fast, unsteady, and shortness of breath.

An individual face a normal reaction of anxiety when it occurred was under control condition and it may cause an individual to face a challenging condition in a positive manner to deal with it, otherwise it became serious influence when a person cannot manage it as a normal reaction appropriately (Hartley and Phelps, 2012). In term of learning, anxiety problems are among the most common emotional difficulties that youth face and are associated with academic difficulties and negative developmental path (Weems et al., 2013). The person tends to think and react negatively if they out of control on that feeling. Another study on anxiety by Eklof and Nyroos (2012), they revealed that students behave in their learning process through several elements in term of psychological aspects which are knowledge, motivation and anxiety domain. Indeed, even though a student possesses their sufficient knowledge and motivation as the booster to do their best; the presence of anxiety may affect their study performance. The high level of anxiety caused the students to be might unable to demonstrate their true proficiency level in their learning process and may impair their performance as well.

According to Spielberger's Trait-State Anxiety Theory, anxiety can be categorized into two forms; the state anxiety and trait anxiety. Generally, state anxiety signified to anxiety that occurs in specific situations and typically had a clear trigger. Indeed, a person who had high state anxiety may not have high trait anxiety, nevertheless those who had high trait anxiety are tends to experience state anxiety. Moreover, trait anxiety referred to anxiety that is long-lasting and widespread across circumstances and it was not triggered by specific events. Trait anxiety is the basis for assortment of anxiety disorders mainly as generalized anxiety and social phobia (Spielberger, 1973).

In the field of chemical education, findings revealed the issues of perception and attitudes towards chemistry (Hong, 2010; Lin 2007; Mallow, Kastrup, Bryant, Hislop, Shefner and Udo, 2010; Woldeamanuel, 2013), attainment and performance of students in chemistry (Sirhan, 2007), student enrollment in chemistry, the importance of pedagogical skills of chemistry teachers (Kurbanoglu and Akim, 2010; Tan and Arshad, 2011; Yusuf, 2014) has been correlated to one of the affective variables known as anxiety.

Anxiety towards chemistry typically existed among secondary school students when they feel worried towards chemistry and students perceived that it was a challenging subject to be learned and to become expert at theoretically and practically in nature. Certainly, the summary of Eddy (2000) was the prior researcher who studied on *chemophobia* in educational setting. He reviewed *chemophobia* as occurrence of "fear of chemicals" and "fear of chemistry as a learning course". Chemophobia supposedly known as chemistry anxiety that perceived by the student who enrolled chemistry subject. Turney and Lindsay (2003) stated that chemistry anxiety represented students' feelings such as fearfulness, uneasiness and physical appearances of these emotions towards chemistry. Indeed, due to many obstacle that perceived by the students in chemistry, they tends to look upon chemistry as a burden to be endured than as experience of meaningful subject to be valued. While the students possess this negative attitude, learning chemistry becomes stressful and this leads to chemistry anxiety or known as *chemophobia* (Chen, 2013). It was demonstrated that anxiety has become the emphasis of many different fields included chemistry courses as well. Most of students considered chemistry as a challenging subjects nevertheless it was a crucial

physical science subject stated in secondary level curriculum and also in tertiary level in aspect of prerequisite requirements related to chemistry courses (Erdal and Mustafa, 2014).

Chemistry has been intimidated by the public specifically the students by the thought of it is a dangerous subject to be learned, exposure to hazardous chemicals, it is about the study of explosion, facing difficulties in solving numerical problems and understanding the principles of chemistry, memorization of abstract facts and concepts and the result of students' anxiety towards chemistry learning leads to loss of interest in the sciences (Woldeamanuel et al., 2013). This kind of destructive mindsets influenced the low interest and apprehension towards chemistry among the secondary students consequently.

In science stream field, anxiety was indicated as a profession barrier; students eludes from registering and engaging in courses that required fulfilling prerequisite courses explicitly in chemistry (Karisan, 2013; Udo, Ramsey and Mallow, 2004). Indeed, anxiety towards chemistry includes an individual's apprehension regarding the aspect of learning chemistry, evaluation in chemistry and chemistry laboratory correspondingly (Eddy, 1996, 2000; McCarthy, 2009).

Chemistry anxiety is one of the obstacles contributed to retarding of outstanding growth of excellent students in chemistry discipline (Erdal and Mustafa, 2014). Yet, there is still lack of publishing paper that presented the reviews on the interest study of chemistry anxiety. Hence, determination of the extents of undesirable apprehension towards chemistry is required to be reflected in order to discover preventive interventions that consequently help in cultivating science stream students' interest towards chemistry onward.

2.0 Chemistry Anxiety in Learning

Past research in time of few decades ago, numerous of research has been underlined significantly anxiety issues on learning and retaining process respectively (Gaudry and Spieberger, 1971). A research conducted by Wsterback and Primavera (1992) discovered that, profoundly lower levels of anxiety results in successful learning in chemistry as well as promote to higher chemistry grades of the students. Cuceloglu (1997) and Gall (1996) stated that the effect of anxiety in learning demonstrated that medium level of anxiety enhance to high level of productivity. In order to maximize the learning process, there is necessity for preventive effort of negative effects of anxiety itself. In chemistry learning, there are three important components in chemistry scope of study which are macroscopic, microscopic and representative. Students are likely to be anxious in learning chemistry when they cannot effectively interpreted the abstract knowledge of chemistry in term of theories, concept, principle or problem solving calculation. The misconception of students in learning chemistry occurred when they fails to make a connection or relationship between these three content domains of chemistry learning subject (Sirhan, 2007).

Anxiety in learning chemistry is one the undesired circumstances that can paralyze students learning process and impaired student's performance as well. The progression of students' learning will be interrupted when the students cannot control their anxiety or fear towards learning chemistry with a good manner and it tends to give negative effect to those students who by intelligence and hard work that should otherwise perform well. Besides that, learning chemistry anxiety acts as a profession filter that preventing students from entering certain fields in term of chemistry discipline because of fear to further their study or learning process in prerequisite and more specific chemistry courses (Hong, 2010). Chemistry learning anxiety mainly related to students undergoing anxiety feel worried over

academic tasks. Indeed, students probably feel anxious related to their chemistry task. Many of students suffered from anxiety when facing difficult tasks in their chemistry task (Nelson and Harwood, 2011).

Other than that, difficulties in understanding the abstract concepts have been interrelated to working memory space of an individual. Usually, students faced a learning situation that is excessively ample thing to handle in the limited working space; they tend to have difficulty in deciding on the main information that required from the other less important information. Consequently, without the advanced organizer of learning input provided by the experienced teacher, the student frequently has directed to rote learning as a result of undesirable type of learning. In future, this problem may affect students to be anxious when they need to use the necessary information of knowledge due to unorganized function of working memory. School tasks that include the usage of additional working memory are prominently affected by anxiety and depression (Owens et al., 2012).

Indeed, the significant features of chemistry learning were required for attainment in comprehending chemical concepts. Consequently if students possess difficulties at one of the chemistry levels either in macroscopic, microscopic or representative, it may give impact the other. As a result, they look upon chemistry as a burden to be endured than as an experienced to be appreciated. When students possess to this negative attitude, learning chemistry becomes stressful and this leads to chemistry anxiety (Chen, 2013). Secken and Zan (2013) identified that each student experienced anxiety in various lessons due to particular reason as well during their educational years. This condition might affect their learning to be positively or vice versa. In their finding, it showed that students with lack ability to use graph in chemistry courses in proceeding mathematical functions may cause students to develop anxieties towards using graphs.

A previous research which implemented by Yusuf (2014) illustrated that the student-oriented learning context such as collaborative approach was discovered that the students' anxiety towards chemistry was lesser than as compared to students that have been taught using teacher-centered learning approach. Correspondingly, all those research studies revealed that higher anxiety level in learning chemistry undesirably affect accomplishment in chemistry courses in aspect related to students' learning process (Eddy, 2000; Hong, 2010; Erdal and Mustafa, 2014).

3.0 Chemistry Anxiety in Evaluation

Chemistry evaluation can be considered as the measure score of students in their learning process particularly in chemistry subject. Based on the finding of previous research, chemistry evaluation anxiety factor can be investigated among students were included of feeling extremely anxious in the situation of taking the final chemistry examination, being given on the spot chemistry quiz during a chemistry class, taking a regular chemistry test, working on homework that consists of many difficult chemistry problems, and solving difficult problems on a chemistry test (Eddy, 2000). Abendroth and Friedman (1983) claimed that lower level of anxiety contributed in higher chemistry grades.

Other than that, most students generally have perceived different situation of anxiety during the evaluation in term of quiz, test or general examination. As an outcome, their performance on written examinations is frequently poorer than the result that they supposedly achieved and school are surprised because a students' score on a particular examination does

not reflect the school's assessment of the student's ability (Steve and Donald, 2003). Aris and Heng (2007) informed that their study on chemistry learning anxiety on chemical bonding topic among electrical engineering students showed that there was a significant correlation between chemistry anxieties and students' achievement.

A research conducted by Chamberlain et al. (2011) verified that the students' views on anxiety could be disseminated into two time frames which are pre-examination and examination day. They perceived that pre-examination anxiety became triggers due to substantial revision assignments and frequency of teachers in mentioning about examination and addressing to their students to be aware and fear if they do not prepared enough (Putwain and Roberts, 2009) and this condition causing to the effect of unpredictably substandard examination results accordingly. On the day the students sit for examination, those students' levels of anxiety were affected by scheduling matters and time duration available for them to complete the examination.

In addition, sometimes the students get lower achievement in chemistry evaluation, it is does not mean that they are less intelligent; possibly it happened due to the factor of chemistry-evaluation anxiety commonly known as test anxiety (Ali and Mohsin, 2013). Anxiety in evaluation had influenced the students and peoples in various field of life. Many present research studies point out the effects of anxiety on students' achievement in science courses (Kaya, 2004; McDonald, 2001; Putwain, 2009; Putwain, 2008 and Segool, 2014). Hence, a study about the factor of chemistry-evaluation anxiety is required to investigate in the step to improve the students' achievement effectively.

Nyroos and Eklof (2013) described test anxiety is a psychological aspect of test-taking that can affect achievement in a given assessment situation as well as future attitudes and feelings towards assessment and evaluation more generally. With a high level of test anxiety, students might be unable to demonstrate their true proficiency level even if they possess sufficient knowledge and sufficient motivation to do their best. They also mentioned that it is important to explore how particular test are perceived by students, how students behave in the test situation and these perceptions and behaviors interact with the performance in particular evaluation. The resilient students that prepared physically and psychologically are anticipated to perform better compared to the student who is not having a tendency to fit (Md Aries and Mariam, 2011). Seligmen and Wuyek (2007) found that extremely-anxious students were expressively more expected to score lower in academic achievement.

4.0 Chemistry Laboratory Anxiety

g outcomes. Students practically approved their theoretical concept or principle of chemistry by conducting the experimental investigation in laboratory room. The performance of students in chemisBasically, chemistry laboratory activities practically introduced to students in order to extent chemistry learnintry education is must with the engagement of practical work respectively. The learning environment of chemistry laboratory is a learning place that supplied with laboratory equipment's in term of apparatus and materials, where the rules that need to be fulfilled in laboratory are clearly specified and the setting that allows learning process among students to be occurred either by individual tasks or in group studies (Lang, Wong and Fraser, 2005; Quek, Wong and Fraser, 2002). Keeves and Morgenstern (1992) mentioned that anxiety perceived by the students towards

chemistry laboratory activities makes students to have low interest in that study space. In other words, student's performance also had been influenced by the chemistry laboratory anxiety that presented among students (Bowen, 1999; Eddy, 2000; Wynstra and Cumming, 1993).

According to Bowen (1999), considering students' scale scores for each category will increase the effectiveness of the laboratory work. For instance, if a student is anxious about the time-management, that student needs support in managing time, rather than focusing on other anxiety categories. Eddy (2000) described that anxiety associated with handling chemicals is unique to chemistry. His finding showed the students were closed to moderately worried about handling chemicals when conducting an experiment and the findings exposed that students were between a little bit and moderately anxious about spilling a chemical in laboratory, using acidic chemicals, handling unknown chemicals and mixing chemical reagents in the laboratory. Most students that perceived anxiety while doing chemistry laboratory tasks was recognized by dissatisfaction that they showed towards chemistry subject (Jedege, 2007).

There were many study demonstrated the researchers' interest on the extent of chemistry anxiety in aspect of chemistry laboratory anxiety existed among college students (Erokten, 2010; Jegede, 2007; Karisan and Yilmaz-Tuzun, 2013; McCarthy and Widanski, 2009). Indeed, there were various sources that triggered students to be anxious in chemistry laboratory setting such as disgusting experiences in chemistry courses, having experience with displeasure chemistry teacher, facing difficulties in handling chemicals and apparatus and others (Kurbanoglu and Akim, 2010). The interest of students in chemistry was reduced gradually due to these kinds of factors contributing to chemistry laboratory anxiety. Moreover, laboratory anxiety is one the affective variables that influenced the students' academic achievement (Eddy, 2000; Kaya and Cetin, 2012; Oner Sunkur, 2015). Kurbanoglu and Akim (2010) informed chemistry laboratory anxiety affected by self-efficacy as well. Karisan and Yilmaz-Tuzun (2013) suggested that by implementing interventions in reducing anxiety in laboratory setting may inspire students towards learning of multidimensional laboratory skills and also lead to more positive attitude towards chemistry courses.

On the other hand, Alkan and Erdem (2013) revealed that self-directed learning exposed a significant influence in overcoming students' chemistry laboratory anxiety by adapting student-centred learning approach. Besides that, Can (2013) informed that there was a significant decline in anxiety levels after the implementation of appropriate activity's instructions. Additionally, previous review of research reported by AcarSesena and Mutlu (2014) stated that application of 3E and 5E learning cycle discovered a huge descent of anxiety levels as the result of the proposed treatment that was proficiently implemented.

5.0 Conclusion

In conclusion, this paper intended to inform that determination of the extent of chemistry anxiety mainly emphasized on chemistry anxiety in learning, chemistry anxiety in evaluation and chemistry anxiety in laboratory setting based on the 21th century researchers that put effort in this interest scope of anxiety study. In short, it was observed that the research trending of chemistry anxiety was moving from general discussion to specific scope

of factors and extending the aim in developing preventive interventions through various approaches. Generally, the study of chemistry anxiety factors in aspect of chemistry-evaluation anxiety was demonstrated the major interest among researchers and followed by chemistry laboratory anxiety and chemistry anxiety in learning respectively.

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