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SCHOOL OF ENVIRONMENT AND AGRICULTURE

TO EXPLORE THE EFFECT OF THE SAFETY & HEALTH COURSE IN CHANGING THE SAFETY LOCUS OF CONTROL OF THE VOCATIONAL EDUCATION STUDENTS

by

YAM Kwei Lam

A report submitted as partial fulfilment of the requirements for
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Declaration of Originality

The following work has been completed by the author as coursework research project report in the Master of Applied Science (Safety Management) at the University of Western Sydney in conjunction with The Hong Kong Polytechnic University under the supervision of Mr. Charles Kam Chi Kit.

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a University or other institute of higher learning, except where due acknowledgement has been made in the text.

Yam Kwei Lam

January, 2003

Abstract

Laboratory accidents occur frequently. Most are even serious and fatal. In 1995, a PhD student was killed in the Chemistry Laboratory in Hong Kong University of Science and Technology caused by an inappropriate handling of chemicals by his colleague. Other similar laboratory accidents are also found worldwide. According to Bird's accident ratio, a lot of minor accidents or incidents have happened but they are not recorded!

This reveals that current control measures in occupational and safety health are inadequate. Vocational education students always handle complicated experiments that are potentially dangerous. Safety should be placed in the first priority. Laboratory safety manual is not sufficient without a formal training. Unsafe behaviour is identified as the main cause to most laboratory accidents. A safety and health course offered by an Accredited Vocational Education Provider is introduced in order to in line with Hong Kong Government's mission to improve the safety and health situation in Hong Kong. This course is to provide all the essential safety aspects prepared for the students' future career. Most first-year Higher Diploma students enrolled in the course provided by the Department of Applied Science of the Accredited Vocational Education Provider must take this full-year course. To measure the effectiveness of the safety course and what determines the unsafe behaviour, the safety of locus has been chosen as a scale.

The locus of control, proposed by Rotter had been modified, consists of three dimensions which are internal safety locus of control, chance safety locus of control and powerful others safety locus of control. Subsequent questionnaires were modified based on the "Multidimensional Health Locus of Control" proposed by Wallston. The before-and-after effect was investigated by taking questionnaires before attending the safety and health course and after attending two lectures safety and health course. The duration time restricted to two lectures was due to the time limitation to submit the dissertation. Relevant statistical analysis confirmed the validity and reliability of the data. The result showed that students' belief on their academic standing, safety knowledge and past accident experience correlated with these three dimensions safety locus of control. The two lectures on the safety and health course could improve both the chance and powerful others safety locus of control, however, internal safety locus of control did not show a significantly change. In the author's opinion, these two lectures were not long enough to influence the intrinsically attributed internal safety locus of control.

Safety locus of control had been demonstrated to be an easy indicator to predict the unsafe behaviour of students. Recommendation was given to measure the safety locus of control of all first-year vocational students in order to estimate their personality towards safety. Subsequent training or course such as the introduction of safety and health should be offered to improve their safety locus of control. In return, their unsafe behaviour could be rectified and their health, safety or life in college could be guaranteed. Further studies should be directed to investigate how efficient safety and health course contributed in changing safety locus of control of students.

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1 Introduction

Occupational safety is an area of concern all over the world. According to the speech made by Mrs. Pamela Tan, the Commissioner of the Labour Department of Hong Kong, at the Safety Conference of Hong Kong Construction Association in December 2000, over 1 million work-related deaths occur annually in the world. In other words, 3000 people are killed at work every year or 2 every minute. Deaths in the workplace exceed the average annual deaths from road accidents (999,000 deaths a year), from war (502,000 deaths a year), from violence (563,000 deaths a year) or from HIV/AIDS (312,000 deaths a year) (Tan, 2000). In addition, workers suffer an estimated 250 million occupational accidents and 160 million occupational diseases each year. This means that there are, on average, 685,000 accidents every day or 9 every second.

Any accident or incident, no matter how minor is in nature, will incur a series of costs. These include employees’ compensation claims, fines and penalties from the Government, productive time loss of the injured worker, medical expenses and insurance costs. These costs the United States over $48 billion each year (Geotsch, 1999). One study showed that, in the organizations studied, uninsured costs from accidental loss were between 8 and 36 times greater than the cost of insurance premiums. There are, therefore, sound economic reasons for reducing work related accidents and ill-health, as well as ethical and regulatory reasons. Besides reducing costs, effective OH&S management promotes business efficiency (BSI, 1996).

1.1 Occupational Safety and Health Situation in Hong Kong

In Hong Kong, there were 67000 employee compensation cases reported in 1998. Amongst them, 62000 non-fatal cases with sick leave exceeding three days and 130 fatal cases were settled as the end of 1999. A sum of $1.1 billion was payable as compensation to the injured employees or dependents of decreased employees. The number of work days lost totalled 1.69 million (Tan, 2000).

Increasing affluence, rising educational standards and public awareness have contributed to the growing importance of occupational and health at the workplace. Safety and health at work has always been a major area of concern in Hong Kong. Over the years, the Labour Department in Hong Kong has spared no efforts in ensuring that risks at work are properly managed through legislation, education and promotion in order to minimize the financial loss as mentioned before as well as valuable lives. The body responsible for enforcing this piece of legislation and overseeing the formulation of industrial safety policies and strategies is the Factory Inspectorate established in the Labour Department in 1964. During the first decade or so, the work of Inspectorate was confined to checking simple "hardware" for accident prevention – such as machinery guarding, provision of fire-fighting equipment, etc. Actions were purely reactive and strictly enforcement in nature (Cheung, 2000).

Later, as Hong Kong became more industrialized, safety performance at work was given increasing attention, especially in the construction industry. More manpower resources and efforts were put into industrial safety and accident prevention. The importance of the ***"software"*** aspect of accident prevention such as safe system of work, instruction, training, supervision, programme for changing the safety attitude and means for promoting safety awareness of the workers, was gradually recognized. Promotion and education were considered to be an important supplement to enforcement and prosecution. Through the establishment of Industrial Safety Training Centre to provide training to the industry, Factory Inspectors began to

- encourage large industrial establishments and companies to formulate safety policies,
- develop safe systems of work,
- set up safety committees to tackle safety problems, and
- organize in-plant promotion programmes (Cheung, 2000).

1.2 "Software" legislations in Hong Kong

In 1989, the Factories and Industrial Undertakings Ordinance was amended to incorporate the "general duties" provisions which laid down a broad framework for the industry to practise self-regulation in a partnership between employers and employees to make their workplaces safe and healthy for all to work. This is the first initiative with legal backing towards the long-term goal of self-regulation (Cheung, 2000).

Following this direction, in September 1996, an "Occupational Safety Charter Programme" was launched to unite the Government, employers and employees in the pursuit of a safe work environment by setting out in a clear statement their respective safety roles, rights and responsibilities. The charter highlights safety as a "Shared Responsibility" among all parties in an organization to improve work safety (Cheung, 2000). In December 2001, over 550 organizations, including Hong Kong's major enterprises, trade associations and labour unions had subscribed to it (Tan, 2001).

Training and education are the critical elements towards a good safety and health. In views of exceptional high accident rate in construction and container industries, the Government introduced mandatory basic induction safety training in July 1999. The idea is to consolidate safety culture at the shop-floor level. Up to the end of 2001, over 470,000 workers have received basic safety training. Workers' safety awareness and safety culture in the workplace have been greatly enhanced (Tan, 2001).

However, no safety culture is sustainable unless it is underpinned by a system. On November 24 1999, the Legislative Council approved the Factories and Industrial Undertakings (Safety Management) Regulation which is to advocate the use of a system to manage safety and health at the workplace. Under the Regulation, employers in certain high-risk industries, who employ more than a certain number of workers, are required to adopt a safety management system of varying complexity. Such employers are required to engage the service of a registered safety auditor to conduct regular safety audits to ensure that safety management system is implemented effectively and efficiently (Cheung, 2000).

1.3 Encouraging result benefited from these "software" legislations

As discussed in section 1.2, most of the "software" legislations deal with the construction industry because the accident rate reveals that the safety and health condition is unacceptable. Table 1 shows the five years' accident numbers and accident rates in Hong Kong.

Industry	Number	1996	1997	1998	1999	2000
Construction	Accidents no.	16 469	18 559	19 588	14 078	11 925
	Rate / 1000 workers	219.9	227.4	247.9	198.4	149.8
Catering	Accidents no.	12 417	13 069	13 011	12 549	12 621
	Rate / 1000 workers	66.0	70.1	73.9	66.9	66.2
Manufacturing	Accidents no.	7 205	7 196	6 334	5 499	5 436
	Rate / 1000 workers	21.5	23.5	24.0	22.2	23.4
Others	Accidents no.	4 160	4 481	4 101	3 860	3 670
	Rate / 1000 workers	26.8	29.6	28.1	26.3	24.6
All Industries	Accidents no.	40 251	43 305	43 034	35 986	58 092
	Rate / 1000 workers	53.4	59.7	64.7	55.1	51.7

Table 1: Five years' accident numbers and accident rates in Hong Kong (Source: OSHC, 2001b:1)

It is obvious that the accident rate for all industries has dropped from the highest 64.7 in 1998 consecutively down to 51.7 in 2000. Concurrently, it is encouraging to note that the accident rate in construction industry has tremendously decreased by about 40% when compared with the highest in 1998. The trend of improvement continued in 2001 (Tan, 2001).

The Commissioner for Labour, Mrs. Pamela Tan said that (Tan, 2001:1)

> "*In the early days, we relied heavily on enforcement to drive home the message of safety performance. Prescriptive laws were passed and enforced. Poor and underperformers were prosecuted. However, we have all come to realize that*

> *regulation by the government alone is not the best way to achieve a high standard of safety and health at work. Experience in other parts of the world has shown that self-regulation is a more effective approach."*

With the help of "Occupational Safety Charter Programme", the mandatory basic safety induction training and safety and Safety Management Regulation, the improvement of accident rate especially in construction industry is clearly the result. A safety culture is becoming increasingly ingrained (Tan, 2001). The gradual transition from the traditional prescriptive to the new self-regulatory approach to safety management that calls for the concerted action of all major stake-holders, education and training in occupational safety and health have become more crucial than ever (Cheung, 2000).

1.4 What areas are uncovered by these safety and health legislations

These "software" legislations together with simple "hardware" regulations for accident prevention provide a very comprehensive protection for the safety and health of the workers. However, these regulations are only restricted in factory undertakings. According to F&IU (Safety Management) Regulation (2000),

> *"factory means any premises or place, (other than a mine or quarry), in which articles are manufactured, altered, cleansed, repaired, ornamented, finished, adapted for sale, broken up or demolished or in which materials are transformed, …"*

This excludes non-industrial area such as office, school, hospital and vocational institution. Although Occupational Safety and Health Ordinance, Chapter 509, extends the coverage of safety legislation from industrial sector to almost all workplaces, industrial and non-industrial including offices, laboratories, shopping arcades, educational institutions, it is basically an enabling ordinance setting out requirements in general terms (LD, 2002b).

1.5 The importance of safety and health in educational institutions

According to Education and Manpower Bureau (EMB) (2001), there are 519 secondary schools, 11 tertiary institutions and 9 vocational education institutes in Hong Kong with 465250, 112 473 and 54781 students respectively. This population counts for about 10% of total Hong Kong Population. Most of them frequently have the chance of performing experiment in the laboratory.

In order to improve the living quality in Hong Kong, Occupational Safety & Health Council (OSHC) was set up in 1988 following the enactment of the Occupational Safety and Health Ordinance on 21 July 1988. It is a statutory body responsible for upgrading safety and health standards in Hong Kong. Every year OSHC has many “Safety at Work” promotional campaigns including school safety day, seminars, carnivals and site visits which are organized for students and teachers to focus on specific laboratory safety in school. Its aim is to develop a risk-free environment to the students as well as to develop safety culture in Hong Kong nurtured in the younger generation to enable them to become safety-minded adults.

As guidelines set out by Education Department (ED), all the science and technology subjects with workshops or laboratories must comply with the materials stated in the handbook “Safety in School Workshops” (ED, 2001a). For the secondary school operation, the followings are the requirements set out by ED that should be followed in the laboratory or workshop safety.

- No instruction shall be given in the use of tools or the operation of machines or in science experiments except by a responsible teacher.
- A teacher shall be appointed to be in charge of every workshop, science laboratory and store room, and that teacher shall be responsible for ensuring that all necessary safety precautions are adopted.
- No student shall be permitted to enter any school workshop or science laboratory unless a teacher is present (ED, 2001b).

The Safety in School Laboratories in the “Schools Miscellaneous Circular No. 7, 2000” by Education Department clearly states the guidelines. The important guidelines are:

- using a Science Laboratory for Non-science Lessons,
- information of hazardous chemicals,
- personal protective equipment,
- fire precautions in school laboratories,
- experiments involving animal blood, cells and human saliva,
- experiments involving micro-organisms,

- handling and killing of rats for dissection,
- use of naphthalene in science experiment,
- use of radioactive sources for teaching purposes in schools,
- use of lasers,
- use of electrical equipment, and
- awareness of laboratory safety.

Every secondary school does have a set of safety rules in their laboratories as stated in the handbook "Safety in School Workshops" published by ED. There are some internal guidelines to be followed by science teachers. However, there is usually no laboratory safety manual to be given to secondary students in most secondary schools. In tertiary education, laboratory safety Handbook is issued to every student before they enter the laboratory. The Laboratory Safety Handbook prepared by the Department of Applied Science at the Hong Kong Institute of Vocational Education (Chai Wan) clearly defines the safety precaution and procedures in performing experiment (AS, 1998).

1.6 Laboratory Incidents/Accidents and Their Recommendations

The above rules, guidelines or laboratory safety handbook in chapter 1.5 are aimed to prevent the accident occurred by providing information and proper procedures to perform experiment. Nevertheless, serious fatal accidents are still observed.

On 4 April 1995, a tragic accident was happened in the Chemistry Department laboratory of Hong Kong University of Science Technology (HKUST). A PhD student was killed by the inhalation of hazardous chemical gas in the Chemistry Department laboratory (HKUST, 1995). Recommendations were given to the improvement of laboratory safety. A detailed laboratory safety manual had been re-written that can be downloaded from the Internet at the address http://www.ab.ust.hk/sepo/sm97/ch07.htm. From spring 1997, every HKUST student who uses the laboratory should receive a new safety training tailored to his or her specific laboratory environment (HKUST, 1997a). However, there were still 9 accidents occurred in related academic activities in 1997 which is a slight decrease compared with 1996 (HKUST, 1997b). Table 2 summarizes similar serious laboratory accidents found in other tertiary institutes in Hong Kong.

Venue	Incident or Accident
Hong Kong University	An explosion occurred in the Organic Research Laboratory. The experiment involved a post-graduate student performing an organic synthesis procedure which generated an organic azide as an intermediate. Three students were injured and one required hospitalization (HKUST, 1992).
Hong Kong University of Science and Technology.	A lab worker performed an experiment which involved the heating of N,N-Dimethylformamide (DMF), a chemical with evidence of mutagenicity and carcinogenicity. Owing to the insufficient fume cupboard, he performed the experiment on the open bench-top. The experiment was left unattended with evolution of toxic DMF gases. (HKUST, 1997a).

Table 2: Similar serious laboratory accidents found in other tertiary institutes.

It seems that the above accidents or incidents were caused by the carelessness of the students in performing experiment in laboratory. However, most tertiary educations do have provide detailed laboratory safety manual and specific safety training in prior of attending the specific laboratory as Hong Kong University of Science and Technology (HKUST) does provide since 1997. Still, accidents are found in HKUST. What are the things left behind?

There may be a false signal to say that tertiary institutes have a big problem with their laboratory safety as recorded accidents can only be found there. In fact, there were 546 and 590 occupational injuries in Education Services recorded in 1999 and 2000 respectively (OSHC, 2001a) which contain the accidents involving students in laboratories. As the nature of the complexity of experiments in secondary school, most experiments involve only less apparatus and chemicals and the procedure is simple. Minor accidents or incidents are seldom recorded and the importance of laboratory safety is less emphasized by most secondary school.

1.7 Area to be focused

Safety in laboratory must be highly emphasized. Inevitably, the provision of laboratory safety manual can help to improve the safety to certain extent. Last year, a student in the

Department of Applied Science in an Accredited Vocational Education Provider was struck by flying objects seriously. He opened an under-pressure glass bottle where the bottle was holding some fermentation enzyme. During the interview with the student, he did realize that there was some fermentation enzyme inside and the bottle might be under-pressure as gas was released during fermentation. He did receive a laboratory safety handbook in the starting of the academic year. He thought that even if the bottle was under-pressure, the force exerted would be too great. He could manage to handle it. The investigation report suggested the student lacked of safety perception. One of the recommendations was given to strengthen the safety perception through safety training.

Environmental Protection Office (SEPO) (1995) cites two explosions happened in foreign country where one wearing protective safety glasses only suffered a minor injury while the other one without wearing protective safety glass suffered a serious injury. This reveals that safety behaviour is very important in preventing accident happening. Thus, changing one’s attitude may alter one’s behaviour.

Training is a mean to change behaviour and attitude. The objectives of safety training stated by European Commission (EC) are

- to develop a sense of safety,
- to learn how to control the risks and
- to promote awareness of the rules of safety.

The first and third objectives emphasize the strong attitudinal component of safety training. This is reinforced by the Commission’s view that a ‘sense of safety’ should be developed during basic education – when attitudes are first formed – from the early years at school and followed through during vocational training (Glendon & McKenna, 1995).

Thus, recently, in line with the Hong Kong Government’s desire to provide a good safety and health to all Hong Kong Citizens, the Department of Applied Science in the Accredited Vocational Education Provider has introduced one unit module – Safety and Health Course to all full-time students studying all Higher Diploma offered since 1999. The aim of the module is to provide all the basic matters of safety and health to the students catering for the need of their future career.

1.8 Aim and Objectives of this study

This study explores whether such safety and health course can change the locus of control towards safety that influences the safety attitude of the students in a career-oriented education in Hong Kong. Or, it just provides all the background knowledge of safety and health to the students, which is essential to their future career. Locus of control refers to the tendency among individuals to attribute the events affecting their lives either to their own actions or to external forces (Steers & Black, 1994). It is a measure of how much you think you control your own destiny.

The aim of this study is to evaluate the effectiveness of the safety & health course offered by an accredited Vocational Education Provider by means of measuring the safety locus of control scales of the Vocational Education students. The objectives of the study attempt:

- to find out what the three safety locus of control scales are for of the students before and after attending the safety and health course provided by an accredited vocational education provider,
- to investigate what influences the three safety locus of control scales, and
- to study how to utilize these three safety locus of control scales to improve the safety situation in vocational education institutes.

Thus, three null hypotheses are formulated and will be tested in chapter 6 to justify the above objectives. These null hypotheses are:

- $H1_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the internal safety locus of control of the vocational education students
- $H2_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the chance safety locus of control of the vocational education students
- $H3_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the powerful others safety locus of control of the vocational education students

On the other hand, the alternative hypotheses have effect on the corresponding safety locus of control.

2 Literature Review

2.1 Why accidents happened

In order to prevent the accidents, the underlying causes to an accident should be well understood. The most widely known theories of accident causation are the Domino Theory, the Human Error Model, Epidemiological Models, Energy Damage Exchange Model and the "Swiss Cheese" Model of Human Error Causation. A review of these models provides a solid background to explain what causes accident from happening.

2.1.1 The Domino Theory

An early pioneer of accident prevention and industrial safety is Herbert W. Heinrich, an official with the Travellers Insurance Company. In the late 1920s, after studying the reports of 75,000 industrial accidents, Heinrich concluded that

- 88 percent of industrial accidents were caused by unsafe acts committed by fellow workers,
- 10 percent of industrial accidents were caused by unsafe conditions, and
- 2 percent of industrial accidents were unavoidable (Geotsch, 1999).

Five labelled dominoes – back of control by management, basic causes, symptoms, incident and loss of property and people that form the basis of the domino effect techniques. Each domino represents one event. When one domino falls, that in an event in the sequences occurs, the other dominoes will follow (Tan, 2000). The obvious preventive response is to remove the unsafe act or unsafe condition domino, preventing the fall of the accident condition domino (Woodcook, 1998). That is the main concept in this model to prevent accidents which is shown in Figure 1.

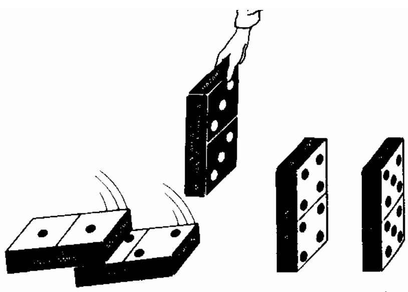


Figure 1: The removal of the central factor (unsafe act) makes the action of preceding factors ineffective (Source: Colling, 1990: 30).

Heinrich (1950) argues that most of accidents can be prevented. He emphasises that the unsafe acts is a major cause of accidents. Heinrich (1950) proposes the theorem '1:29:300 ratio' – before one major injury occurs, 29 minor injuries and 300 no-injury incidents have been happened. Heinrich concludes that more attention should be paid in 'incidents' but not injuries. In fact, from an analysis of 1,753,498 accidents reported by 297 organizations shows that "*one serious or disabling injury, 10 minor injuries, 30 property damage accidents and 600 incidents with no visible injury or damage occurred*" (Moodie, 2001:17). It is normally called the Bird's Accident Ratio. Unsafe act contributes most of the causes to accidents, which relates to personal factors.

2.1.2 Human Error Model

As pointed by Heinrich, 88% of all accidents are attributed to unsafe acts, it is logical that human errors which are the basis of unsafe acts (Colling, 1990). Figure 2 illustrates the idea.

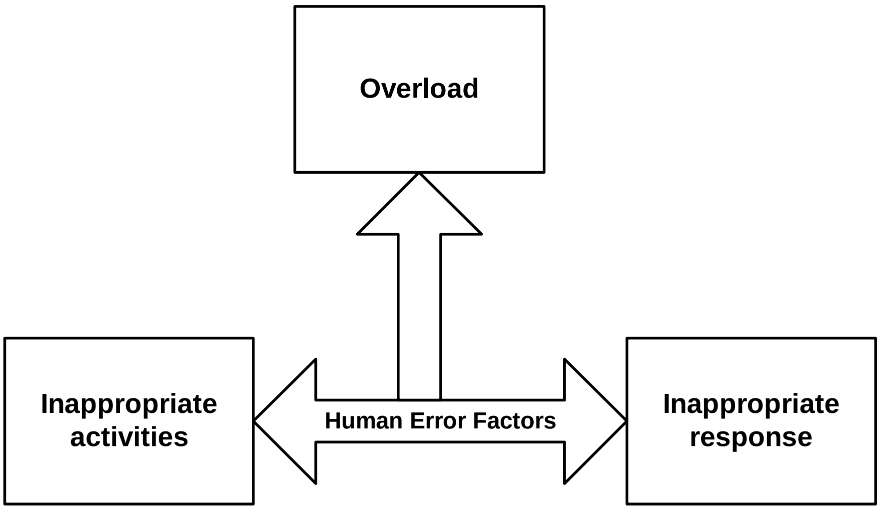


Figure 2: Factors that cause human errors (Source: Geotsch, 1999: 37).

The Ferrel Human Factors Model is one to look at the human errors in details. Ferrell has proposed three situations for human error:

- overload – the mismatch between the load and the capacity of the person at the time of action;
- incorrect response by the person to a situation; and
- improper activity (Colling, 1990).

Again, these three factors deal with personal factors.

2.1.3 Epidemiological Models

Epidemiology is the study of the causal relationship between disease and specific environmental factors (Coiling, 1990). An epidemiological model for accident has been proposed by Suchman and developed by Surry. In this model, predisposition characteristics consist of worker susceptibility, perception and environmental factors. They combine with situational characteristics such as risk assessment through cognitive processes, can lead to or avoid accident conditions. Figure 3 shows the theory (Geotsch, 1999). Again, attitude, perceptions and susceptibility of people components in the theory address the importance of personal factors.

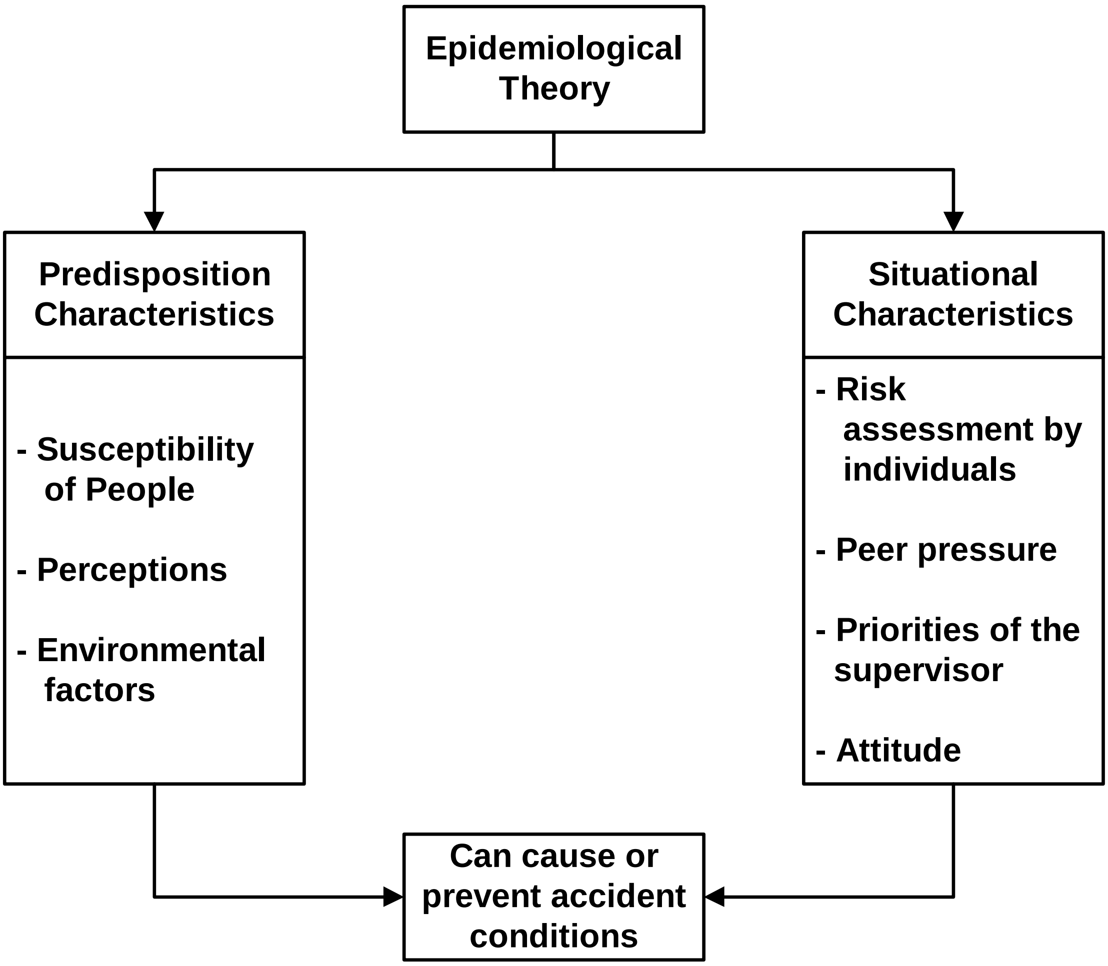


Figure 3: Epidemiological theory (Source: Geotsch, 1999: 42).

2.1.4 Energy Damage Exchange Model

The energy damage exchange model states that injury is a result of an incident energy whose intensity at the point of contact with the recipient exceeds the damage threshold of the recipient (Lam, 2000). Gibson (1961) considers that the 'safety problem' has two sides:

- the ecology of dangers and
- the psychology of the perceptions and reactions aroused by the signs.

Although Gibson defines danger as an external source of potential injury and can only be caused by an interchange of energy (Moodie, 2001), the psychology of the perceptions which relates to personal factor also contributes to the cause of an accident.

2.1.5 Human Factors Model

Person, task and environmental variables can combine to cause human error. The minimization of human error from whatever cause is the emphasis of human factors models of accident causation (Moodie, 2001). DeJoy (1990) proposes three categories of potential human error:

- person-machine communication,
- environment, and
- decision making.

This model again acknowledges that the importance of human factors that includes the interaction among human, machine and environment.

2.1.6 The "Swiss Cheese" Model of Human Error Causation

Among the above five models, all have personal factors included. A recent model proposed by Reason (1990), the "Swiss Cheese Model", illustrates that an accident is not the result of one, single failure. Figure 4 shows the model. When accident occurs, it is the result of a series of failures aligning that allows the mistake to reach the injured person (MHHP, 2000). Reason describes four layers of human failure, each influencing the next. They are

- unsafe acts of operators that ultimately led to the accident,
- preconditions for unsafe acts such mental fatigue and poor communication,
- unsafe supervise and
- organizational influences (Shappell & Wiegmann, 2000).

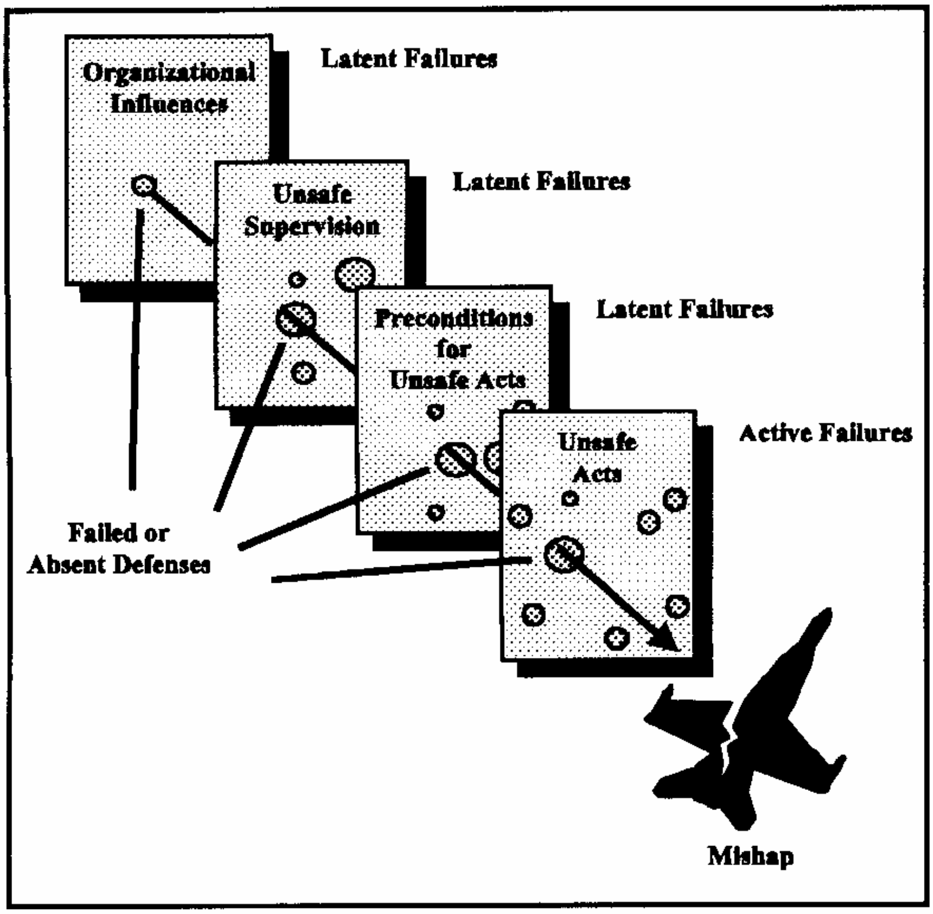


Figure 4: The "Swiss cheese: model (Source: Shappell & Wiegmann, 2000:2)

2.1.7 Human Behaviour is the most important

There are a lot of factors causing the accidents as reviewed in the above models. There are

- unsafe acts,
- human errors,
- perception and environmental factors,
- preconditions for unsafe acts such mental fatigue and poor communication,
- unsafe supervise and
- organizational influences.

Inevitably, all have a common characteristic - personal factors, or precisely human behaviours. The unsafe act, human error or mental fatigue that reflect in behaviour to drive to an accident. These factors affecting the way people behave in a potential accident situation that is largely associated with individual perception of risk. People perceive risk in many different ways. All of which are determined by psychological factors such as attitude, personality, perception, memory and motivation, training and in many cases, the skills available to the individual (Stranks, 1997).

Recall what the "Swiss Cheese Model" of Human Error Causation mentions that "It is only when the failures in these defences line up that an accident or incident results." Bird and Germain (1966:16) define '*accident as an unexpected or unplanned happening that may or may not result in property damage, personal injury, or both.*' Accidents are somehow unpredictable. Stricoff & Walter (1990) also pinpoint the importance of the human factors design criteria helps to reduce the accident rate. As mentioned in chapter 1.1, the introduction of the "software" legislations aims at changing the safety attitude through training, promoting safety awareness of the workers. It is to cover the pitfalls made by outdated "hardware" legislations. That implies the provision of laboratory safety manual simply is not enough to prevent accident from occurring without focusing on the psychological factors affecting behaviour.

2.2 Psychological Factors

Behaviour is the actions of people. Robbins & Coulter (2001) mention that individual behaviour is affected by one's attitudes, perception, personality, learning and motivation.

2.2.1 Attitudes

Attitudes can be defined as state of mind, disposition and feelings towards other persons or things (Webster's Encyclopaedic Unabridged Dictionary of the English Language, 1998). They consist of three components: cognition, affect and behaviour, which are:

- cognitive component of an attitude is made up of the beliefs, opinions, knowledge or information held by a person and the beliefs are the mental association with a concept,
- the affective component of an attitude is the emotional or feeling part, and
- the behavioural component of an attitude refers to an intention to behave in a certain way toward someone or something (Robbins & Coulter, 2002).

2.2.2 Perception

Perception is a process by which individuals give meaning to their environment by organizing and interpreting their sensory impressions. Research on perception consistently demonstrates that individuals may look at the same thing yet perceive it differently (Robbins & Coulter, 2002).

There are three factors influencing perception (Robbins & Coulter, 2002).

- The perceiver – When an individual looks at a target and attempts to interpret what he or she sees, the individual's personal characteristics will heavily influence the interpretation. These personal characteristics include attitudes, personality, motives, interests, experiences and expectations.
- The Target – The characteristics of the target being observed can also affect what's perceived.
- The situation – The time at which an object or event is seen can influence attention as can location, light, heat, colour and any number of other situational factors.

2.2.3 Personality

Greenberg & Baron (1995) describe that personality is the unique and relatively stable pattern of behaviour, thoughts and emotions shown by individuals. Personality theories utilize the trait approach to investigate behaviour. Allport insists that an understanding of individual behaviour can progress only breaking behaviour patterns down into a series of elements which are called traits (Steers & Black, 1994). There are five personality traits which have proved to be the most powerful in explaining individual behaviour mentioned by Robbins & Coulter (2002). They are locus of control, machiavellianism, self-esteem, self-monitoring and risk-taking.

Locus of control refers to the tendency among individuals to attribute the events affecting their lives either to their own actions or to external forces. It is a measure of how much you think you control your own destiny. Two types of individual are identified which are internal and external locus of control (Steers & Black, 1994).

Machievellianism is a measure of the degree to which people are pragmatic, maintain emotional distance and believe that ends can justify means (Robbins & Coulter, 2002).

Self-esteem is defined as one's opinion or belief about one's self and self-worth (Steers & Black, 1994). Research on self-esteem offers some interesting insights into organizational behaviour. It is believed that people with high self-esteem would like to more risks in job selection and are likely to choose unconventional jobs than those with low self-esteem (Robbins & Coulter, 2002).

Self-monitoring is a measure an individual's ability to adjust his or her behaviour to external situational factors. Individuals high in self-monitoring show considerable adaptability in adjusting their behaviour to external, situational factors. They are highly sensitive to external cases and can behave differently in different situations. They are capable of putting on different "face" for different audiences (Robbins & Coulter, 2002).

Risk-taking is a measure of the degree to which people are willing to take chances. High risk-taking people take less time to make decisions and use less information in making their choices (Robbins & Coulter, 2002).

2.2.4 Learning

Learning can be defined as a relatively permanent change in behaviour as a result of experience. Hodgetts (1991) comments that there are four facts about learning process.

- Learning involves a change in behaviour.
- A change in behaviour must be relatively permanent in order for it to be considered learning.
- Some form of experience or practice is necessary for learning to occur.
- Some of reinforcement is necessary for learning to take place. Without reinforcement, the learned behaviour will eventually disappear.

Two approaches are commonly adopted which are operant conditioning and observational learning or social learning theory (Jerald & Baron, 1995). In the operant conditioning approach, individuals learn to behave in certain ways based on the consequences of those actions. It increases the probability of desired behaviour through the antecedents, behaviours and consequences of behaviour relationships. By choosing correct antecedents and consequences, behaviour can be strengthened (George & Jones, 1996). Stimuli that increase the probability of the behaviours preceding it are known as reinforcers. Reinforcement may be either positive, if it is based on the presentation of a desirable outcome, or negative, if it is based on the withdrawal of an unwanted outcome. Paying extra money is a kind of positive reinforcement that may increase the probability of desirable behaviours. On the other hand, punishment is a kind of negative reinforcement which may be used to reduce the probability of undesirable behaviours. The link between behaviour and its consequences may be weakened by withholding a reward which is known as extinction (Jerald & Baron, 1995). Figure 5 shows the steps in the operant conditioning process.

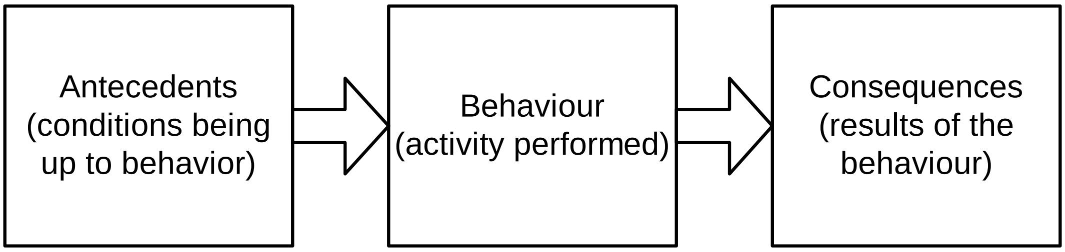


Figure 5: Steps in the operant conditioning process (Source: Jerald & Baron, 1995: 63)

Observational learning theory involves learning by modelling the behaviour of others. By paying attention to and rehearsing the behaviour of others, people can learn vicariously, that is, through the model's experiences resembling those found and allowing transfer of training. Figure 6 shows the process.

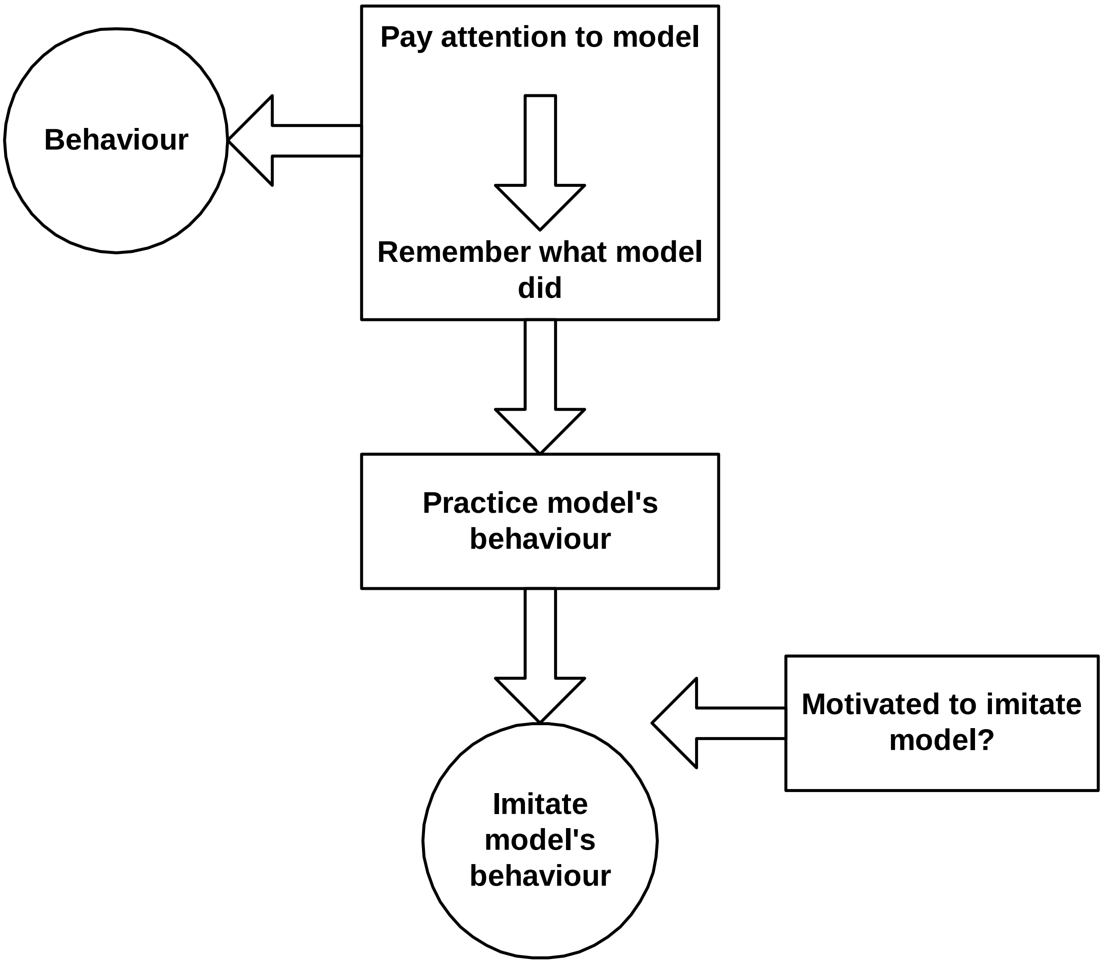


Figure 6: The process of observational learning (Source: Jerald & Baron, 1995: 67).

2.2.5 Motivation

Steers & Black cite motivation can be defined as that which energizes, directs and sustains human behaviour. Motivation represents an energetic force that drives people to behave in particular ways. This drive is directed towards something and it has strong goal orientation. Robbins & Coulter (2002) mention the motivation process which is shown in Figure 7.

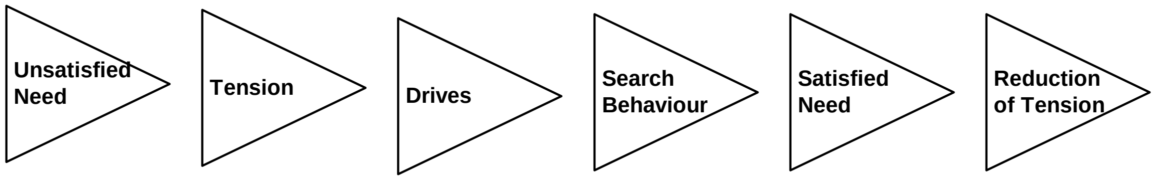


Figure 7: The Motivation Process (Source: Robbins & Coulter, 2002: 425).

A need refers to some internal state that makes certain outcomes appear attractive. An unsatisfied need creates tension that stimulates drives within an individual. These drives lead to a search behaviour to find particular goals that, if attained, will satisfy the need and reduce the tension.

2.2.5.1 Maslow's Hierarchy of Needs Theory

Abraham Maslow attempts to explain motivation in terms of what arouses, energizes, or initiates behaviour by postulating that everyone has five basic needs. They are:

- physiological needs that consist of such requirement as food, clothing and shelter,
- safety needs that include the desire for security, stability and the absence of pain,
- social needs that include affection, belongingness, acceptance and friendship,
- esteem needs that include internal esteem factors such as self-respect, autonomy and achievement and external esteem factors, and
- self-actualization needs that include growth, achieving one's potential and self-fulfilment; the drive to become what one is capable of becoming (Robbins & Coulter, 2002).

In terms of motivation, Maslow argues that each level must be substantially satisfied before the next is activated. Once a need is substantially satisfied, it no longer motivates behaviour. In other words, as each need is substantially satisfied, the next need becomes dominant (Robbins & Coulter, 2002). However, Hodgetts (1991) comments that there is a disagreement about whether the satisfaction of one need automatically activates the next need in the hierarchy. Some outcomes may satisfy more than one need and the existence of differences in the degree of needs among people. Brooks (2002) mentions that psychologists have debated whether or not humans are motivated to reduce stimulation or to optimize it. Some physiological systems try to seek reduction of stimulation while some feel accounts for exploratory behaviour as well as a human need for variety, aesthetics and curiosity.

2.2.5.2 Expectancy-Valence Theory

The most popular process theory in motivation perhaps is expectancy-valence theory. It postulates that individuals are thinking, reasoning beings who have beliefs and anticipations about future events in their lives (Hodgetts, 1991). The theory is a very cognitive, indeed rational, process. Essentially, when performing a task and deciding how much effort, enthusiasm and energy to put into which is called the E-factor, people will calculate the probability of each possible course of action leading to certain outcomes and the relative importance and value. Individual's motivational level is then calculated (Westwood, 1992).

This theory is proposed by Vroom and has certain key elements:

- outcome – people will anticipate the consequences or results of possible courses of action. There are two levels of outcome, namely first-level outcome following the effort and the second-level outcome after the first-level.
- expectancy – the subjective probability associated with the relationship between a line of action and the first-level outcome.
- instrumentality – the subjective probability associated with the relationship between a first-level outcome and a second-level outcome.
- valence – the strength of a person's preference for, or the value placed upon for a particular outcome (Westwood, 1992).

Thus, the motivational force can be calculated based on the expectancy, instrumentality and valence.

The theory assumes that the calculations will affect a person's intention to act and is based on the person's perception of the situation. This is entirely important since people may have different perception towards the same situation (Westwood, 1992).

2.3 Interactive influences between factors

2.3.1 A brief discussion among attitudes, perception, personality, learning and motivation

As mentioned in chapter 2.2, behaviour greatly depends on five major factors which are attitudes, perception, personality, learning and motivation. In fact, these factors are highly inter-related.

2.3.1.1 The relationship between attitudes and safe behaviour

Westwood (1992) comments that attitude acts as an antecedent of behaviour. Knowing someone's attitude does not always help us to predict what that person will do. The relationship between an attitude and behaviour can be very complex as it is moderated by a host of situational and dispositional variables. Fishbein & Ajzen (1975) propose that behaviour can be predictable only if the attitude and behaviour are at the same level of specificity. Hodgetts (1991) supplements that attitudes are a person's relatively enduring disposition towards people, objects, events or activities. These feelings can be either positive or negative, are typically learned over a period of time. However, attitudes may change subject to time. There are two ways to affect attitude changes including persuasion and consistency theory.

Persuasion includes the following processes:

- willingness on the part of the attitude holder to change,
- trust in the persuasive message or its source, and
- a strong convincing message (Hodgetts, 1991).

Consistency theory is based on the notion that people strive to see the world as orderly and consistent. They adjust their attitudes to maintain this consistency (Hodgetts, 1991).

Similar argument comes from the studies conducted by Adams Associates (2002). It indicates the attitudes tend to drive behaviour and are a result of people internal values and beliefs imprinted at a very early age through the development of habits of thought. That means changing attitudes should be done at early conditioning. The sequence is that our habits of thought drive our attitudes and our attitudes drive our behaviours. Sometimes, changing someone else's attitude may be an impossible task (Adam Associates, 2002).

2.3.1.2 The relationship between perception and safe behaviour

Although perception is mostly influenced by surroundings or environment, the perceiver's personal characteristics such as attitudes, motives, interests, experiences and expectations determine how they perceive the information. Glendon & McKenna (1995) mention that people differ in their reactions to perceived risk. Their risk perception determines their safe behaviour.

Harding (1998) further comments that different people have different value system. Personal beliefs and values determine the way they perceive situations and are closely related to the cultural and social influences to which they have been exposed. The generalized environmental worldviews or paradigms are like a pair of glasses which filter the way they receive and interpret information. Different groups and individuals within society have different filters. Adding them together gives the ultimate value position and drives their behaviours (Harding, 1998).

Bearing in mind, this perceptual process does not always yield accurate perceptions. George & Jones (1996) suggest that even though people can touch the things, their decisions are somehow based on their own thoughts, feelings and experiences. As a result, interpretations of reality vary among individuals. In fact, this is in line what Harding says.

Perception thus depends on situation or environment as well as the feeling and experience of individual.

2.3.1.3 The relationship between personality and safe behaviour

George & Jones (1996) mention the person-situation debate that personality accounts for regularities in people's attitudes and behaviours. Personality develops over time, responding to the experiences people have as children and as adults where half of the variation is inherited from their parents basically fixed at birth. Personality is quite stable over periods of time ranging from five to ten years. Thus, personality can be changed but in terms of years (George & Jones, 1996).

Some researchers support that personality is more important for understanding and predicting behaviour while others argue that situation offers the best explanation of attitudes and behaviours. Nevertheless, both personality and situation interaction can serve to determine feelings, thoughts, attitudes and behaviours where personality is relatively easy to measure (George & Jones, 1996).

2.3.1.4 The relationship between learning and safe behaviour

Obviously, learning is the general way to change both attitude and perception through accumulation of experiences to drive the aimed behaviour as mentioned in chapter 2.2.4. However, learning needs some kinds of reinforcement either by rewarding, punishment or extinction.

Learning utilizes the antecedents-behaviour-consequences relationship by strengthening or weakening both antecedents and consequences which influence the behaviour. In fact, the recent popular behaviour-based safety approach adopts this theory by changing the unsafe behaviour.

Krause (1996) has proposed so called antecedents-behaviour-consequences (ABC) analysis to study how to modify the unsafe behaviour. He has indicated the at-risk behaviour or unsafe behaviour is the base of the accident triangle or accident iceberg shown in figure 8 where at-risk-behaviour may cause incidences or even fatalities.

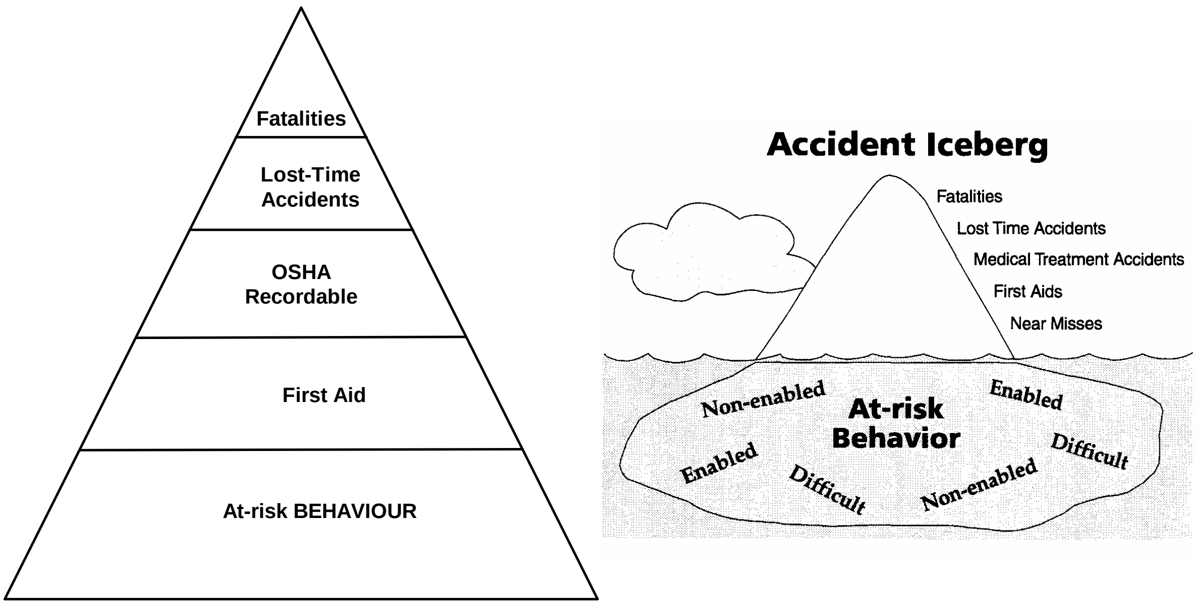


Figure 8: At-risk behaviour is the base of the accident triangle (Source: Krause, 1996: 33).

The behaviour-based approach to safety targets the critical behaviours that are the leading indicators of safety performance in the organization instead of accident rates. It shares the same approach as the incidence analysis and the Bird's Accident Ratios. The Bird's Accident Ratio indicates that if there is one major or fatal accident occurred, there will be 600 no-jury incidents happened (Kam, 2000). Incident investigation is a preventive measure of accident or a proactive approach. Behaviour-Based Safety Process has found its way in most safety leaders such as Monsanto, Shell Chemical Company, ARCO Chemical, ALCOA, Rohm and Haas, Scott Paper Company, Georgia Gulf Corporation, The Pillsbury Company, and Chevron U.S.A (Krause, 1996).

Steers & Black (1994) mentions that behaviour modification through learning requires five steps to:

- establish clear objectives,
- conduct a performance audit,
- set specific goals and remove obstacles,
- evaluate results against preset criteria, and
- administer feedback and praise for reinforcement.

Thus, learning provides structural ways to change behaviour but it requires to define clear goals and objectives, closed monitoring and evaluation. It relatively takes much resources and time.

2.3.1.5 The relationship between motivation and safe behaviour

Motivation needs a drive so as to satisfy the need, which has been illustrated in figure 7 - the Motivation Process. The drive depends on the outcome, expectancy, instrumentality and valence as stated in chapter 2.2.5.2.

Thus, the underlying causes to drive the safe behaviour should be known before a motivation can be put into practise. Sometimes, the drive can depend on situation that vary from person to person (Westwood, 1992) and the associated probability to achieve the target.

2.4 How to predict behaviour

2.4.1 The Performance-shaping factors

Stranks (1997) has listed out a number of factors influencing one's performance which he calls the performance-shaping factors. Figure 9 depicts the idea.

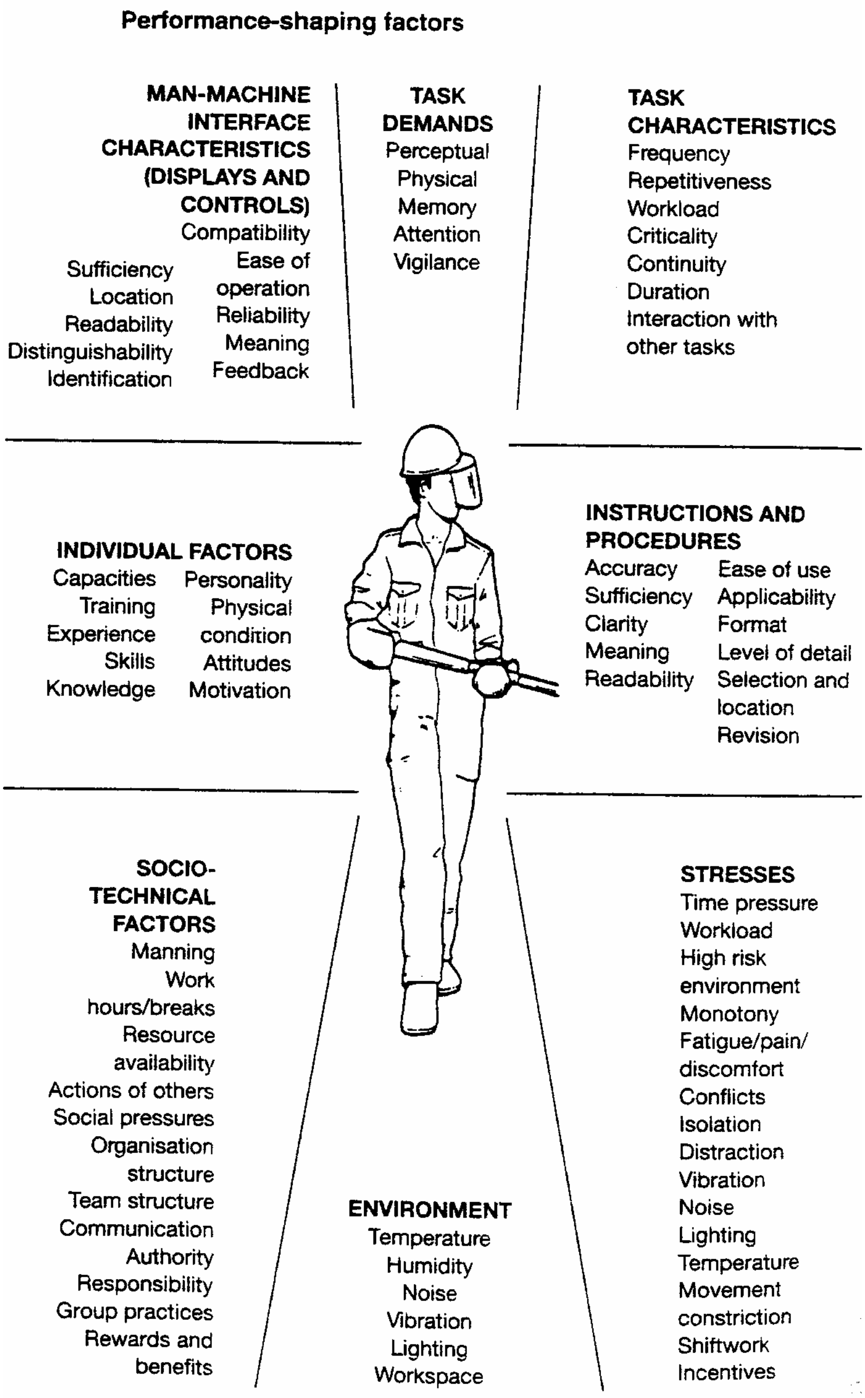


Figure 9: Performance-shaping factors (Source: Stranks, 1997: 422).

These factors mainly consist of eight areas which are:

- man-machine interface characteristics,
- task demands,
- task characteristics,
- individual factors,
- instructions and procedures,
- socio-technical factors,
- environment, and
- stresses (Stranks, 1997).

Man-machine interface, task characteristics, instructions and procedures, social-technical factors and environment are somewhat external factors. The rest are more or less the personal factors. They consist of attitudes, perception, memory, experiences, skills, knowledge, motivation, physical condition, personality and attention. In fact, the accident causation models mentioned in chapter 2.1 have pointed out almost the same causes.

2.4.2 The cognitive revolution: Attribution Theory

The essence of the cognitive approach to behaviour is that individuals are involved in understanding and interpreting their environment as essential antecedents to action.

Hodgetts (1991) explains that attribution theory provides explanations of how individuals observe behaviour and then attribute causes to it. It is developed to explain how people are judged differently depending on the meaning that people attribute to a given behaviour. Basically, the theory suggests that when people observe an individual's behaviour, people attempt to determine whether it was internally or externally caused. Internally caused behaviours are those that are believed to be under the personal control of the individual. Externally caused behaviour results from outside factors; that is, the person is forced into the behaviour by the situation (Robbins & Coulter, 2002)

The determination, however, depends on three factors as:

- distinctiveness – refers to whether an individual displays a behaviour in many situations or whether it is particular to one situation,

- consensus – if everyone who's faced with a situation responds in the same way, the behaviour shows consensus, and
- consistency – it corresponds to the person who responds the same way over time. The more consistent the behaviour, the more the observer is inclined to attribute it to internal causes (Robbins & Coulter, 2002).

In fact, this is the basic theory contributed to the establishment of motivation and learning theory (Glendon & McKenna, 1995).

2.4.3 Attitudes and consistency – Cognitive dissonance theory

Research shows that people seek consistency among their attitudes and between their attitudes and behaviour. This means that individuals try to reconcile differing attitudes and align their attitudes and behaviour so they appear rational and consistent. When there is an inconsistency, individuals will take steps to make it consistent either by altering the attitudes or the behaviour or by developing a rationalization for the inconsistency (Robbins & Coulter, 2002).

Cognitive dissonance theory explains the relationship between attitude and behaviour. Cognitive dissonance is any incompatibility or inconsistency between attitudes or between behaviours and attitudes. The theory argues that any form of inconsistency is uncomfortable and that individuals will try to reduce the dissonance and, thus, the discomfort. In other words, individuals seek stability with a minimum of dissonance (Robbins & Coulter, 2002).

2.4.4 Attitudes influencing behaviour and behaviour influencing attitude vice versa

Some researchers argue that if someone's attitude about something is known, then their behaviour in respect of that same thing can be predicted with a reasonable degree of certainty. In other words, people's behaviour can be changed by modifying their attitude. Therefore, it is frequently assumed that if people's attitudes towards a particular aspect of workplace health and safety, for example, using personal protective equipment (PPE), can be changed, then their behaviour wearing PPE can be changed (Glendon & McKenna, 1995). There is an attitude influencing behaviour link.

However, other researchers argue that the link can be reversed. Through the legislation in health and safety fields, for example, wearing a safety seat belt in a car, an attempt is being to change the behaviour directly; then, attitudes will change accordingly (Glendon & McKenna, 1995).

More versatile theory is proposed with the adoption of an extra factor called the prime causal agent, which is shown in figure 10. This theory addresses mutual influences between attitudes and behaviour. The prime causal agent such as safety campaign is trying to strengthen both the attitude and behaviour change (Glendon & McKenna, 1995).

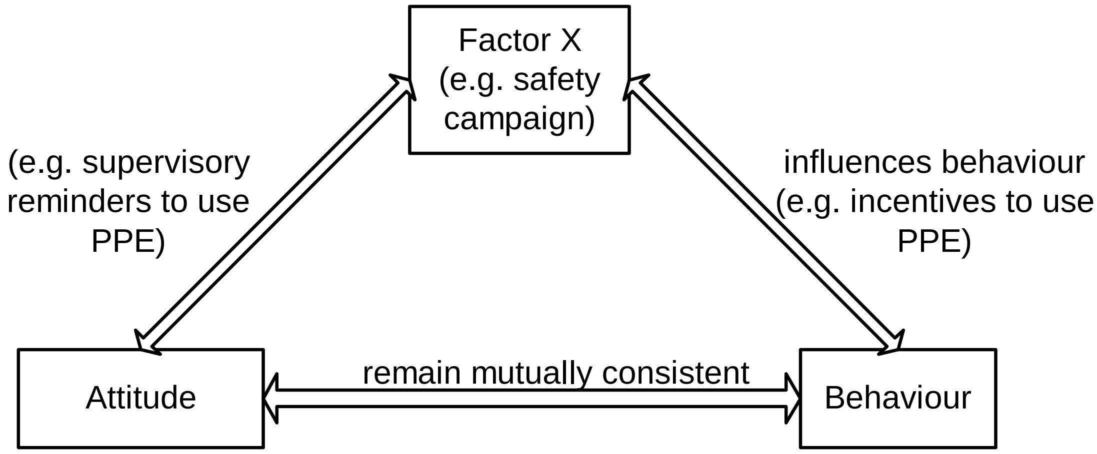


Figure 10: A third factor influencing attitudes and behaviour (Source: Glendon & McKenna, 1995: 81)

2.4.5 Theory of reasoned action

Theory of reasoned action is an extension of theory depicted in figure 11. This theory states that two major predictors of behaviour are:

- attitudes towards the behaviour, and
- subjective social norms (Petal, 2002).

Subject social norms are a combination of a person's beliefs regarding other people's views of a behaviour and the person's willingness to conform to those views (FHI, 2002). Figure 11 presents the theory which illustrates under what conditions people may use or not to use PPE.

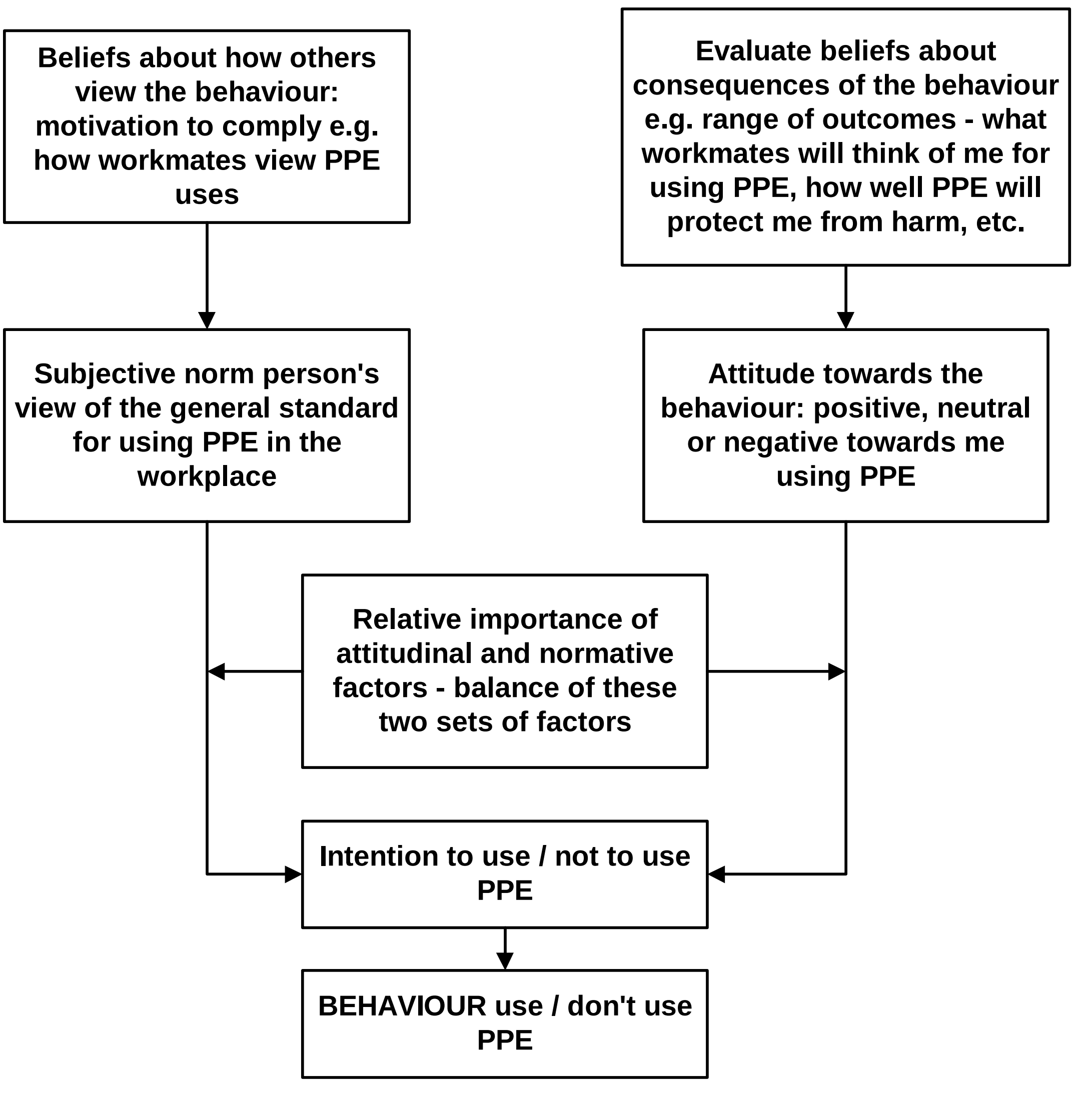


Figure 11: The theory of reasoned action (Source: Glendon & McKenna, 1995: 83).

CAST (2002) further elaborates that the theory of reasoned action aims:

- to focus on translation of beliefs about behaviour and perceptions regarding threat to self into behaviour change,
- to incorporate social and interactional aspects of human behaviour,
- to emphasis on personal attitudes, subjective norms, their relative importance and intentions,
- behaviour always the direct result of intention, and
- not to address dynamic nature of behaviour and neglects relapse.

FHI (2002) states that exploring behaviours using the theory of reasoned action finds its supporters including smoking, drinking, signing up for treatment programs, using contraceptives, dieting and wearing seatbelts or safety helmets areas. However, it has a major drawback. USF (1999) points out that one of the greatest limitations is with people who have little or feel they have little power over their behaviours and attitudes. Lounsbury (1998) mentions that the shortcomings of the model include:

- inability to explain irrational decisions,
- intentions and behaviours are only moderately related, and
- prior experience is not taken into account.

Further comment given by Glendon & McKenna (1995) is that it is not easy to predict or change behaviour even all the above conditions are satisfied. One example shows that workers may be more likely to use PPE in response to pressure from social norms such as colleagues expecting them to behave safe – rather than because they have a positive attitude to using PPE. Other factors may serve to promote the continued use of PPE are a desire to obey and the formation of a particular safety habit.

2.4.6 Health Belief Model

In views of the limitations from the theory of reasoned action, the most widely used model of behaviour change is the health belief model (HBM) (Becker & Rosenstock, 1987). It has been used as basis of many campaigns seeking to change people's behaviour to a healthier way of living. This theory has evolved from the theory of reasoned action by the addition of an individual control component which is influenced by the person's evaluation of factors likely to inhibit or facilitate their performance of the behaviour (Glendon & McKenna, 1995). Figure 12 shows the theory.

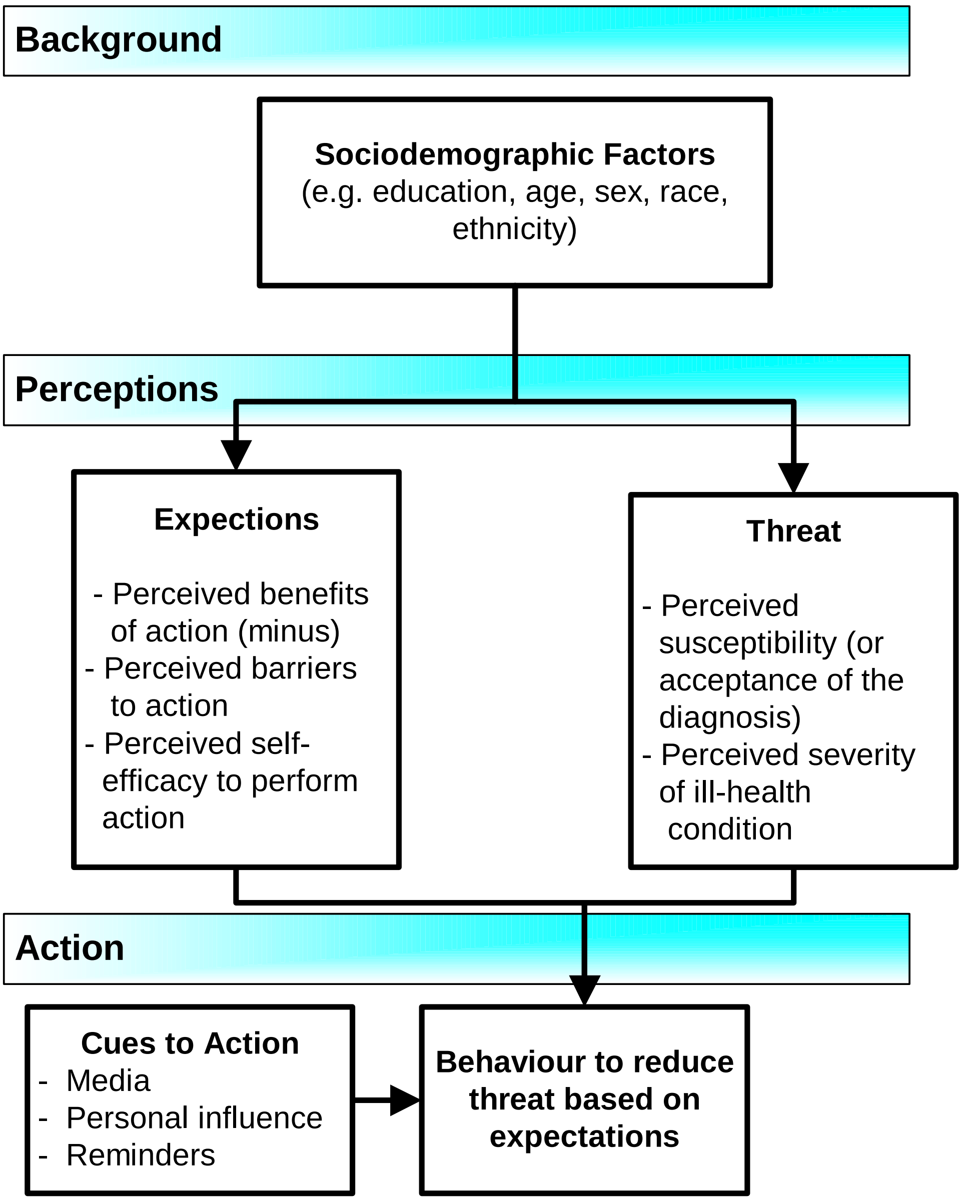


Figure 12: Health Belief Model (Source: FHI, 2002: 4)

However, the theory still has some limitations stated by FHI (2002). They are

- most HBM-based research has incorporated only selected components of the HBM, thereby not testing the usefulness of the model as a whole,
- as a psychological model, it does not take into consideration other factors, such as environmental or economic factors which may influence behaviours, and
- the model does not incorporate the influence of social norms and peer influences on people's decisions regarding their behaviours.

2.4.7 Essential information to predict behaviour

The theories discussed from chapter 2.4.1 to 2.4.6 provide information how to predict behaviour. Obviously, the attribution theory explains individuals always seek stability with a minimum of dissonance with their attitudes, opinions, belief, knowledge and behaviours. Attitude can have an influence to behaviour and vice versa. In the presence of some external factors or prime causal agent such as safety campaign, both attitude and behaviour can be reinforced.

Besides attitudes, subjective social norms, perceptions, intentions and other environmental or economic factors also determine one's behaviour. Thus, behaviour can be predictable provided that these essential elements must be known before hand. In fact, this is almost impossible as most of them are hardly to measure. They are subject to conditions and vary from place to place and person to person.

2.4.7.1 Learning and Training are the common ways

Back to the safety problem, the normal systematic way of permanently changing unsafe behaviour is through learning as discussed in chapter 2.2.4. Glendon & McKenna (1995) supplement that to secure long-term positive changes in safety practices, it is necessary to change both behaviour and attitudes. In most of the studies, links between learning and training emerge strongly. Stranks (1997) points out the difference between learning and training. Learning goes on all the time where people are continually learning from each other and through their own experiences. Training is simply a way to help people to learn.

McAfee and Winn (1989) report findings from a number of studies which examined the effectiveness of positive reinforcement and feedback. They found that all revealed some success in improving safety or reducing accidents.

Cohen et al. (1979) summarizes the requirements for success of safety training which are:

- positive approaches that stress the learning of safe behaviours – not the avoidance of unsafe acts,
- suitable conditions for practice that ensure their resistance to stress, and
- to include the means for evaluating training effectiveness.

2.5 Safety Training Program starts in HKUST

As reviewed in chapter 1.6, the recommendations given in the recent typical local incidents and accidents are quite straight forward without mentioning how to alter the safety behaviour. The recommendations are to provide adequate safety information, management of the storage of hazardous substances, sufficient PPEs, detailed laboratory safety manual or handbook, supervision and monitoring. Until recently, staff from the Safety & Environmental Protection Office (1997) in the Hong Kong University of Science and Technology (HKUST) have proposed a wide range of attitudes towards safety in laboratory. They comment that it is unlikely that a safety culture can be established over night. Given sufficient effort, it will evolve over time.

From spring 1997, every HKUST student who uses the laboratory should receive a new safety training tailored to his or her specific laboratory environment (HKUST, 1997a). It provides an evidence that specific safety training or learning activities should be given to every laboratory users – students. Is this possible to change the behaviour? Learning, mentioned in chapter 2.2.4, requires some kinds of reinforcement to sustain the behaviour and it needs some kinds of feedback mechanism. What are the reinforcement and feedback mechanism in the training offered by HKUST?

2.6 Research Results in Safety in some Vocational Education Provider

Rayburn (1990) proposes the need of effective safety program to alter student safety behaviour. The mentioned programs include safety regulations and standards, personnel orientation and training, role of medical and health factors and accident reduction and emergency planning. There are some researches conducted in similar areas.

2.6.1 Study at Texas Agricultural Mechanics Laboratories

The purpose of the study is to fulfil a need of data regarding types and frequencies of accidents that occur in Texas Agricultural Mechanics Laboratory. Its aim is to find the relationships between accidents, safety attitudes and perceptions of teachers, and safety attitudes and perceptions of students. The target population was all Texas Agricultural Science and Technology programs for the 1992-1993 academic year and all students enrolled in secondary agricultural mechanics courses during the same period. The estimated number was around 21,000 students. Questionnaires for teacher and student were sent and data were analysed using SPSS®. SPSS® is a comprehensive tool for managing, analyzing and displaying data. Descriptive statistics such as measures central tendency, correlation coefficients and frequencies were used to achieve the objectives of the study. The magnitude of relationships was interpreted using Davis' conventions at 0.05 level of significant (Lawver & Fraze, 1994a).

Eight factors were identified which were student negative safety attitude, student positive safety attitude, inconvenient safety practices, teacher safety conscious, teacher careless, condition of laboratory, parent safety conscious and parent careless. The analysis by point-biserial correlation revealed, in general, students who had more positive safety attitudes were less likely to report they had been injured or involved in serious accidents. Also, students who perceived their teacher to be safety conscious were less likely to report injury. Conversely, those who had injured perceived their teacher to be careless. Multiple regression was further employed to discover the amount of variance explained by the factors in combination. Three factors were identified which were injured in the agricultural mechanics laboratory, involved in a serious accident at school and involved in any serious accident. The findings were

- good, healthy student safety attitudes were associated with less incidence of injury,

- teacher carelessness was associated with more incidence of injury, and
- parent carelessness was associated with more serious accidents (Lawver & Fraze, 1994b).

The authors finally conclude that there is a need to promote a positive safety attitude for students to reduce accidents. Laboratory safety manual is important but safety attitude is another key factor. The safety attitude of students in agricultural mechanic laboratory is affected by teacher carelessness and parent carelessness that are nothing to do with safety laboratory manual. As Harding (1998) argues in chapter 2.3.1.2 that personal beliefs and values determine the way they perceive situations and are closely related to the cultural and social influences to which they have been exposed. Adding them together gives the ultimate value position and drives their behaviour. However, this conclusion is true in Texas Agricultural Mechanics Laboratories, but is this conclusion valid in an eastern culture like Hong Kong?

2.6.2 Laboratory Safety in Ohio Vocational Education

A study was conducted to investigate the utilization of accepted safety practices, the availability of safety materials and equipment, the prevalence of accidents and the extent to which schools had been engaged in litigation resulting from student injury. Questionnaires were sent to all principals of comprehensive high schools with agricultural education programs in Ohio. Data were collected and analysed by SPSS®. The findings were, according to school administrators, vocational teachers used many of safety practises espoused in the literature on laboratory safety and vocational teachers instructed pupils in how to properly use equipment and demonstrated proper use of equipment. However, there remained room for improvement on other teacher safety practices. The non-existence of several safety materials and/or equipments in many vocational laboratories was discouraging (Gliem & Miller, 1993a). Results also showed that safety was important to administrators. It should be an integral part of instructional program in vocational education. Teachers should be aware of the expectations that administrators had regarding safety in vocational education (Gliem & Miller, 1993b).

Clearly, this paper reveals that the laboratory safety manual is important as teachers adopt what the literature says. Inadequate safety materials or equipments have an influence to laboratory safety that has been mentioned by the accident in HKUST. This confirms that laboratory safety manual is important to reduce accident rate. However, support from school administrators is also important as well. This paper has just provided the facts but how significant are these factors?

2.6.3 An Example to Verify the Validity of the Findings in Two Studies

Having reviewed the two studies, there are four important issues that bring out:

- student safety attitudes are important,
- situational factors influences the student safety attitudes,
- laboratory safety manual is useful, and
- supports from management are crucial to laboratory safety.

Davidson is the assistant principal for instruction at Madison County High School. In order to improve the safety in chemistry laboratory, she compiled a new list of safety rules as well as presented a chemistry laboratory safety contract to students and parents in the fall of 1992. The chemistry teachers there took the first few days of the term to explain the rules and walk the students through the laboratory. This purpose was to let the students to have a clear understanding what the safety practice was. After getting approval from the principal, each student and parent had to sign and return a signed safety contract to be placed in their file and the students also had to pass a safety quiz. A climate of personal responsibility was then established. Students realized that how they conducted themselves in the laboratory was important. Chemistry teachers new to her school often scheduled their students' orientation and safety tour of the laboratory where a veteran teacher was present (Davidson, 1999).

This example illustrates how important is the support from the principal or management. The safety of student should be addressed but also including their parents. Updating the safety instruction or manual should be done periodically but the consistency in enforcement of the safety rules are also essential.

In fact, these four important factors exactly acknowledge the concept in changing one's behaviour. The safety behaviour, in our concern in vocational education providers, has been included in the theory of reasoned action discussed in chapter 2.4.5. They fall in the sub-elements of the model which are:

- attitudes towards the behaviour
- subjective social norms influenced by the teachers (management) and their parents.

2.7 How to measure the effectiveness of a safety training or learning

Recall Cohen et al.'s summarization (1979) about the requirements for success of safety training in chapter 2.4.7.1 that training should include the means for evaluating training effectiveness. The safety behaviour is aimed to be improved in vocational education. Based on the cognitive dissonance theory and attitude behaviour mutually influencing link in chapter 2.4.3 and 2.4.4, either attitude or behaviour can be used to measure the effectiveness of changing behaviour.

2.7.1 Measuring behaviour is the best way to safety training or learning

Westwood (1992) points out that knowing someone's attitude does not always help us predict what that person will do which depends on situational and dispositional variables. Attitude is not absolutely equivalent to behaviour. HKUST (1995) emphasizes that safety is essential to protect one's life. Being safe should have nothing to deal with situational variables. People should take care of themselves no matter in home, in school or at work. Measuring attitude as an indicator to safety behaviour is not so appropriate. Thus, measuring behaviour is the most direct way as suggested by Glendon & McKenna (1995).

2.7.2 Personality is better to reflect one's behaviour subject to less situational factors

Among those factors associated with behaviour, personality is somewhat independent with situational variable as reviewed in chapter 2.2. The target and the situation have an influence on perception. Motivation depends on the stimulus and the outcome.

Personality is relatively in-born. Greenberg & Baron (1995) describes that it is the unique and relatively stable pattern of behaviour, thoughts and emotions shown by individuals. George & Jones (1996) argue that personality is relatively easy to measure. Indeed, Glendon & McKenna (1995) mention that a number of personality factors have been found to be associated with the likelihood of attitude change. It is an in-direct indicator of attitude, too.

2.7.3 Locus of control is the best and feasible indicator to measure safe behaviour in personality

There are five personality traits which have proved to be the most powerful in explaining individual behaviour as mentioned in chapter 2.2.3. They are:

- locus of control,
- machievellianism,
- self-esteem,
- self-monitoring, and
- risk-taking (Robbins & Coulter, 2002).

Most factors, except locus of control, describe how people behave themselves more intrinsically. They take responsibility of their own acts. However, locus of control (LOC) deals with their thinking and people react towards external influences. LOC involves an individual's perceptions regarding control over events in the future. LOC constructs is directly related to one's coping abilities and efforts (Ganellen & Blaney, 1984). Hoffman, et al. (2000) points out that people, in general, act on or are acted upon by their environment depends on their general expectancies as to whether their own actions will produce predictable results. LOC is one of the most consistently researched variables in the social sciences (Lefcourt, 1992; Rotter, 1990). LOC captures people's general expectancies about the causes of rewards and punishments (Rotter, 1966). Thus, LOC can explain or predict why people behave safe or unsafe in some circumstances. LOC has been found to influence the likelihood of an individual's participation in various activities including being injured (Wishart, 1997). Gates (1997) mentions that LOC is a way to measure one's personality. Rinehart (1995) suggests that the construct of LOC may have a significant impact on an individual's perception of reality.

2.8 Locus of Control

2.8.1 The Evolution of Locus of Control – Rotter's LOC

Locus of control is a psychological construct which originated in Social Learning Theory, a theory attempts to integrate concepts from both behavioural and cognitive schools of learning theory (Rinehart, 1995). According to Rotter (1975: 16),

> *" … interest in this variable developed because of the persistent observation that increments and decrements in expectancies following reinforcement appeared to vary systematically depending on the nature of the situation and also a consistent characteristic of the particular person who was being reinforced"*.

Two types of individuals are identified. Steers & Black (1994) mention that people with an internal locus of control tend to attribute their successes and failures to their own abilities and efforts. Hence, a student would give himself credit for passing an examination; likewise, he would accept blame for failing. In the contrast, people with an external locus of control tend to attribute things that happen to them as being caused by someone or something else. They give themselves neither credit not blame. Hence, passing an examination may be dismissed by saying it is "too easy" whereas failing may be excused by convincing oneself that the examination is "unfair".

Rincover (1996) cites the classification of LOC:

- those who take personal responsibility for their behaviours and resulting consequences and generally believe that they are in control of there are said to have an internal locus of control and are called "internalizers", whereas
- those who generally believe that the events of life essentially happen to them without their control and feel victim to fate or luck are side to have an external locus of control and are termed "externalizers".

Internalizers are believed to have higher levels of inquisitiveness, more developed problem-solving abilities and a greater resistance to the influences and control of others than those who do not have an internal locus of control (Agarwal & Misra, 1986; Lefcourt, 1982). Hoffman et al. (2000) cite that those with an internal LOC generally expect that their actions will produce predictable outcomes while those with external LOC expect that outcomes are due to external variables.

Rotter (1966) perceives Locus of Control as an unidimensional construct which is made up of 29 item, forced choice scale to measure individual LOC. Rotter (1975) devises the scale as a “broad gauge” instrument to allow theoretical comparisons of groups, not to act as an instrument for individual prediction and, when used appropriately, the scale is found to yield consistent, valid and reliable results.

2.8.2 Some Journal Papers on Safety Topic using Locus of Control

2.8.2.1 Accident Prone

John Vavrik (1998), holding a Doctorate Degree, is ICBC’s (Insurance Corporation of British Columbia) manager of human factors research, has published a paper on “Accident Prone”. He has discussed that those who have an external locus of control feel that they have little power over events, attributing their own behaviour to external forces. Believing in an external locus of control increases crash risk, presumably because people who hold this view devote less time to anticipating risk or taking precautions. In their minds, at least, they cannot control hazards anyway.

2.8.2.2 The Role of Individual Differences in Accident Involvement

Sweeney (1988) has presented a paper called the “The Role of Individual Differences in Accident Involvement” on the Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting. Sweeney cites that many research studies have focused on identifying how individual differences are linked to accident involvement. Results have indicated that such factors as external locus of control, anti-authority, delinquency, and low emotional stability are predictive of accident involvement.

2.8.2.3 Traffic Accidents, Job Stress, and Supervisor Support

Sherry et al. (1996) has conducted a survey on the “Traffic Accidents, Job Stress, and Supervisor Support”. The role personality variables have been considered as a contributing factor to the involvement in accidents. These data have been described by Hansen (1989). Variables such as distractibility, irritability, locus of control, and risk taking have been found in various studies to be related to accident involvement. The scale of the survey consists of 5 items which are designed to determine the individual's belief that accidents and injuries are under the control of the individual and not just due to chance. Cronbach's alpha, a figure to indicate the reliability, for this particular sample was found to be 0.67.

2.8.2.4 The relationships among burnout, accident locus of control and accidental risk behaviour of factory workers

Koywiwattrakul (1998) has made a research to examine the relationships among burnout, accident locus of control and accidental risk behaviour of factory workers, including predictions of accidental risk behaviour from burnout and accident locus of control. Four hundred and thirteen workers who worked in petrochemical factories in Rayong province were administered questionnaires which consisted of burnout, accident locus of control and accidental risk behaviour inventory. The Pearson product moment coefficient correlation and multiple regression were employed to analyze the data. Four hypotheses were tested and the result were as follows:

- accident locus of control was negatively related to factory workers' burnout at 0.01 level of significance.
- accident locus of control was negatively related to factory workers' accidental risk behaviour at 0.01 level of significance.
- burnout was positively related to factory workers' accidental risk behaviour at 0.01 level of significance.
- burnout and accident locus of control could predict accidental risk behaviour of factory workers at 0.01 level of significance.

This paper provides evidence to adopt locus of control as a study of safety.

2.8.3 Levenson's Locus of Control

Wedge (1999) cites that the locus of control proposed by Rotter are very useful instruments, but there is some debate about the validity of what the Internal-External scale measures. Shackleton and Fletcher (1984) argue that the I-E scale has been shown to assess a number of different control aspects under just the one scale. It is entirely possible that an individual be very Internal in view of their own immediate circumstances, but highly External in their perceptions of the world and its politics. In light of such, other scales have been developed to measure further dimensions of control reinforcement loci.

Levenson (1973) investigates an individual's perception of the power of others (P), Internality (I), and the power of chance factors (C). She does this from the view of locus being a relatively fixed trait like characteristic of personality, making reference only to therapeutic changes to locus, rather than simply experience based changes. She reasons that while people may believe the world is an ordered environment, they can still be classed as External. The powerful others (P) shows a person belief in the orderliness of the world, but also their perception of being without power themselves (Levenson, 1973). The scale maintains Rotter's (1966) concept of internality (I) but distinguishes between external orientation in two different categories of in terms of P and C. The definitions given by Levenson (1974) are:

- P is characteristic of those who believe the world is ordered by powerful others are in control, and
- C is indicative of those who believe the world is unordered and things happen due to chance or luck.

Based on this conceptualization of the Locus of Control construct, Levenson devises a scale (the I-P-C scale) to measure Locus of Control as a multidimensional construct (MLOC) rather than one-dimensional. Her scale consists of three separate and distinct dimensions:

- internality (I),
- belief in powerful others (P), and
- believe in chance, luck or fate (C) (Rinehart, 1995).

Rinehart (1995) comments that Levenson's idea of two separate and distinct types of external individuals has some interesting implications from a behaviour perspective. In general, externally oriented individuals perceive themselves as out of control of the outcomes of their behaviour and behave accordingly, expect behavioural patterns may vary based on the belief in either power others or chance. Individuals who perceive outcomes to be controlled by powerful others are more likely to address those "others" in an effort to achieve desired outcomes and to perceive themselves as having more control over the situation than if they believe that outcomes are solely governed by fate, luck or chance.

2.8.4 Multidimensionality of "locus of control"

Levenson has found evidence to support the multidimensional LOC as discussed in chapter 2.8.3. Based on this concept, Wallston et al. (1978) has developed the "Multidimensional Health Locus of Control" (MHLC) scales which measure significant locations as Internal, Powerful Others and Chance. This scale has been chosen to use more situation-specific, health-related locus of control measures in their investigations by most health-related researchers.

The MHLC Scale consists of two alternative forms (A and B). Each of them contains 18 items. Each form, in turn, contains three six-item Likert scales which, in "normal healthy" populations are uncorrelated, or only slightly correlated, with one another (Wallston and Wallston, 1981). The Internal Health Locus of Control (IHLC) dimension assesses the degree to which one believes one's health status is influenced by one's own behaviour. People who score high on the IHLC are said to have a sense of responsibility for their own health (Wallston and Wallston, 1982). Power Others Health Locus of Control (PHLC) measures the belief that powerful other people (one's family, friends or health-care providers) control one's health. Lastly, the Chance Health Locus of Control (CHLC) assesses perceived non-control of health, or the belief that fate, luck, or chance determines one's health status. (Wallston, 1989)

2.8.5 Using MHLC as a basis to measure safety locus of control

The World Health Organization (WHO) defines

> *"Health is a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity"* (Source: Feitshans, 2000: 1)

whereas, safety is a

> *"State in which the risk of harm (to persons) or damage is limited to an acceptable level. Freedom from those conditions that can cause death, injury, or occupational illness, or damage to or loss of equipment or property, or damage to the environment"* (Source: Cigital Labs, 2002: 1).

Thus, health and safety seem to have a close relationship. Individual's safety can influence health and health can have an effect on safety. They cannot be separated when occupational safety and health is concerned. Safety and health has always been discussed at the same time.

The area to be focused is to explore the safety & health course offered by an accredited Vocational Education Provider in changing the safety locus of control of the Vocational Education students. The MHLC scale proposed by Wallston et. al. serves the basis to investigate the change in the safety locus of control. The questionnaires in MHLC will be modified to suit the need in the investigation of safety rather than health.

3 Research Methodology

A research methodology defines what the activity of research is, how to proceed, how to measure progress and what constitutes success (MIT AI Lab, 1998). The aim of research methodology is to obtain valid, reliable and reproducible information (Leary, 2001). There are a number of methods used in social science. Three possible methodological approaches are:

- ethnographic research,
- action research (Leary, 2001), and
- survey research methods (IC, 1997).

3.1 Various methodological approaches

3.1.1 Ethnographic research

Ethnographic research essentially involves descriptive data collection as the basis of interpretation. Ethnography is a relevant method for evaluating school life, hospital life since these contexts are essentially cultural entities (Burns, 2000). Ethnographers (sometimes called fieldworker) often live among the people they are studying, or at least spend a considerable amount of time with them. While there, ethnographers seek to gain what is called an “emic” perspective or the “native’s points of view” without imposing their own conceptual frameworks. Through the participant observation method, ethnographers record detailed fieldnotes, conduct interviews based on open-ended questions and gather whatever site documents might be available in the setting as data (Hall, 1999).

3.1.2 Action research

Action research is the application of fact-finding to practical problem-solving in a social situation with a view to improving the quality of action within it, involving the collaboration and cooperation of researchers, practitioners and laymen. Action research is a total process in which a ‘problem situation’ is diagnosed, remedial action planned and implemented and its effects monitored, if the improvements are to get underway. It is both an approach to problem-solving and a problem-solving process (Burns, 2000).

The focus in action-research is on a specific problem in a defined context, and not on obtaining scientific knowledge that can be generalized. There are four basic characteristics of action-research.

- Action-research is situational – diagnosing a problem in a specific context and attempting to solve it in that context.
- It is collaborative, with teams of researchers and practitioners working together.
- It is participatory as team members take part directly in implementing the research.
- It is self-evaluative – modifications are continuously evaluated within the ongoing situation to improve practice (Burns, 2000).

Figure 13 shows the Lewin's model of action research. Indeed, the action research is a cyclic process that recycles again and again until it ends to a particular spiral of action and research and switches to a quite different issue or problem.

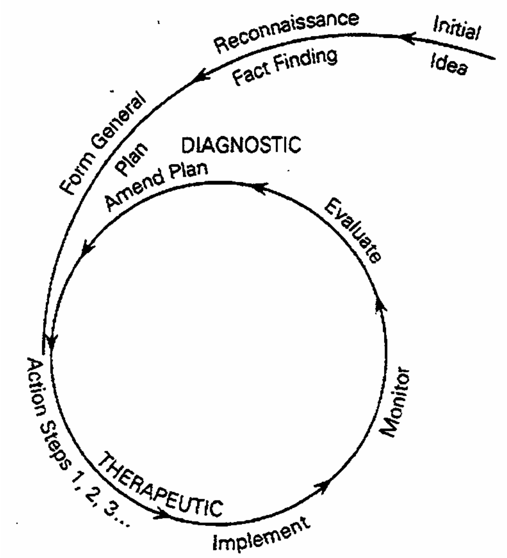


Figure 13: Lewin's cyclic model (Source: Burns, 2000: 445)

3.1.3 Survey Research Methods

Survey research method is commonly used where behaviours, beliefs and observations of specific groups are identified, reported and interpreted (IC, 1997). Survey design has two stages:

- research definition stage (I), and
- research design/plan stage (II) (Hetherington, 1997) where figure 14 shows the model.

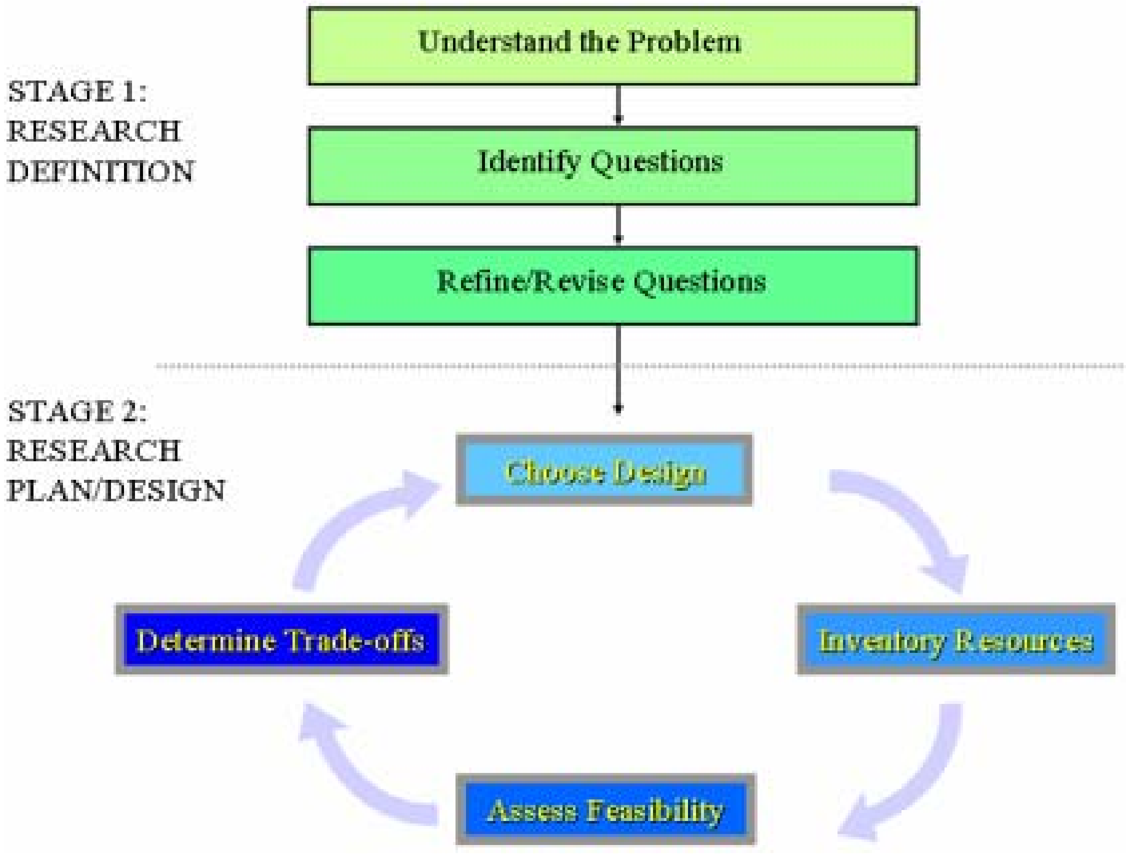


Figure 14: Research Planning Model (Source: Hetherington, 1997: Lecture 10, p3).

Hetherington (1997) mentions there are two approaches. Self-administered surveys subject responds to printed questions, for example, group or mail surveys while other-administered surveys subject responds to questions directly posed by researcher, for example, interview and phone survey.

The advantages of self-administered surveys over other-administered surveys are to:

- be cost effective and less time consuming,
- require less training of staff to conduct surveys,
- ask questions with long, complex or visual response categories,
- ask batteries of similar questions, and
- obtain answers where respondent does not share (Hetherington, 1997).

However, Hetherington (1997) warns that self-administered surveys should require:

- careful questionnaire design,
- no open response questions included, and
- good reading and writing skills by respondents.

3.1.4 Choice of Methodologies Approaches

Back to the chosen area of interest: to explore the effect of the Safety & Health Course offered by an Accredited Vocational Education Provider in changing the Safety Locus of Control of the Vocational Education Students, there is an area of concern – changing the safety locus of control. Does the introduction of Safety & Health Course change the safety locus of control? Various causes or factors will be explored. It is specific and does involve a cyclic process to redefine the problem; therefore, ethnographic research and action research are not adopted.

Indeed, owing to the relatively large population size of 200 students, limited time and resources inherited in this study, only Survey Research Method can be conducted where self-administered survey by means of questionnaire is adopted. Other approach such as interview requires more time, resources and supports which are out of the constraints of the study. Hence, survey-questionnaire research method is selected.

3.2 Target Population Background

This study is to focus on the introduction of safety and health course in changing the safety locus of control of student based on the concept of the MHLC scale proposed by Wallston et al. (1978).

3.2.1 Target Population

The target population is all students taking the introduction of safety and health course in the accredited vocational education provider. Currently, only some of the year-one students of the Department of Applied Science take this course. The course is one-unit weighting, meaning that students should attend a two-hour lecture a week. It divides into two parts:

- safety issues, and
- public health issue.

These year-one students come from various full-time courses which are:

- Higher Diploma in Biotechnology,
- Higher Diploma in Environmental Technology,
- Higher Diploma in Food Science and Technology,

- Higher Diploma in Safety and Health,
- Higher Diploma in Analytical Science and Technology, and
- Higher Diploma in Health Services Management.

The total target population is around 200. There are two mass lecture sessions offered to them per week. Mass lecture 1 is scheduled on 11:30 to 1:30 every Wednesday for students enrolling in

- Higher Diploma in Safety and Health and
- Higher Diploma in Health Services Management.

Mass lecture 2 is scheduled on 2:30 to 5:30 every Wednesday for the rest of the students. In addition, there are tests and examination to assess students' performance.

3.2.2 Academic Background of the target population

All the students mentioned in chapter 3.2.1 have completed at least their secondary level. The minimum entry requirements to these courses are:

- 5 subjects at Grade E or above in Hong Kong Certificate of Education (HKCEE) including English Language (syllabus B), and
- pass in one or two specified Science subject or equivalent.

Five passes in HKCEE is deemed to be equivalent to the completion of secondary school and academically further proceed to next higher level of study. A pass in the English Language (syllabus B) is deemed to acceptable achievement in reading and writing fluently in English.

3.3 Tools used and timing to conduct survey

As mentioned in chapter 3.1.5, the research method is by survey-questionnaire as the limited time and resources are imposed. Restate the chosen area of interest is to explore whether there is any change in safety locus of control before and after taking the introduction to safety and health modules. Two questionnaires are needed to conduct at the time before taking the module and after taking the module.

However, the module is one-year course. It starts on 25 September, 2002 and ends on 5 May, 2003. It is impossible to take the second survey after 5 May, 2002 because of the time span for this research. According to the teaching plan of this module, the first two lectures are to focus on the laboratory safety which is the major risk to students as revealed by the accidents in chapter 1.5 & 1.6. In order to strike the balance, the first questionnaire is taken on the first lecture on 25 September, 2002 and the second questionnaire is taken on the third lecture on 9 October, 2002 where they have acquired the safety knowledge on laboratory topic.

4 Questionnaire Instrument Design

The questionnaire design is modified based the concept of MHLC scale proposed by Wallston et al. as mentioned in chapter 2.8.4. The MHLC scale consists of two Forms, namely form A and form B. Each of these two "equivalent" forms contains three 6-item subscales: internality; powerful others externality; and chance externality. Wallston (1998) points out that in the past 20+ years, forms A/B have been used in over a thousand studies and have been cited in the literature hundreds of times. MHLC is designed to be used with people who function at an eighth grade reading level who are about 13 years old.

Wallston (1998) mentions forms A & B were designed to be "equivalent" forms; therefore, it's pretty much of a toss-up as to which one choose. As in research concerned where subjects' safety locus of control beliefs change as a function of some experimental intervention – an introduction to safety and health course, form A is used in pretest and form B is used in protest. The reason why there are two equivalent forms is to have fair and unbiased results obtained during the two surveys conducted.

Back to the chosen area of interest, the MHLC scales will be modified to measure the safety locus of control and is termed as Multidimensional Safety Locus of Control (MSLC).

4.1 Topics covered in the modified questionnaire based MHLC

The topics cover in the questionnaires that are modified and based on Wallston's MHLC scale - Multidimensional Safety Locus of Control (MSLC) scales and some student's background information. Thus, the covered topics are:

- Internal Safety Locus of Control (ISLC) which consists of six questions same as Wallston's MHLC,
- External Power other Safety Locus of Control (PSLC) which consists of six questions same as Wallston's MHLC,
- Chance Safety Locus of Control (CSLC) which consists of six questions same as Wallston's MHLC, and
- Several student's personal background items.

The inclusion of student's personal background items is to investigate if there is any relationship among these items and various components in MSLC that is the second objective of this study as mentioned in chapter 1.8.

4.2 Human Research Ethics

Researcher should beware of research ethics. In Hong Kong, the personal privacy is protected by Personal Data (Privacy) Ordinance (Cap. 486).

> *The Ordinance covers any data relating directly or indirectly to a living individual (data subject), from which it is practicable to ascertain the identity of the individual and which are in a form in which access or processing is practicable. It applies to any person (data user) that controls the collection, holding, processing or use of personal data* (Source: PCO, 2001: 1).

UWS HREC (2002) states that the principles of ethical conduct cover:

- integrity, respect for persons, beneficence and justice,
- consent,
- research merit and safety, and
- ethical review and conduct of research.

Thus, in designing the questionnaire, the above points should be taken into consideration and avoided.

4.3 Conduct of Research

To follow the ethnical conduct, no personal particular information should be collected including the student address, telephone number, course number and age. All respondents are assured that their responses are to be anonymous and therefore, confidential. Students have the freedom either to answer or refuse to fill in the questionnaire. This questionnaire does not constitute a part of their Safety and Health Course Assessment. Detailed information will not be disclosed. Any queries about the questionnaire, students have the right to contact the researcher with detailed contact phone number provided. Consent from the Head of Department should be received before the survey is conducted.

The topic of the study is to focus the change in safety locus of control where pre-test and protest survey-questionnaires have to be conducted subject to the intervention of the attending of the safety and health course. Particular student must be identified for the study of before-and-after effect. In order to follow the Personal Data (Privacy) Ordinance, students are required to fill in only the leading seven digits of their student number. The remaining two digits are left blank. For example, if the student number is 021234567, only 0212345xx will be shown in the questionnaire. Of course, some of the questionnaires may be invalid because of the overlapping of the leading seven digits. For details about the questionnaire, please refer to the appendix.

4.4 Question Design

The questions are divided into three sections for Form A and two sections for form B. Since all the target population has the ability to read and understand materials in English, no Chinese translation of questions is required.

4.4.1 Form A Question Design

Form A contains three sections which are:

- Section A - Personal particular,
- Section B - Personal background information, and
- Section C - Safety beliefs.

All questions except in section A are composed of 5-choice Likert type questions ranging from strongly disagree, disagree, neutral, agree to strongly agree.

4.4.1.1 Form A - Personal particular

Students are required to fill their gender and their leading six digits of their student number. The rest digits of student numbers are left blank to avoid collecting personal privacy information. The filled six-digit student number helps to sort out questionnaire and study the before-and-after effect of a particular student subject to the intervention – attending the introduction of safety and health course. Of course, this act can cause some collected questionnaire to be invalid due to the overlapping the leading seven digits for some students, but the chance is expected to be small.

4.4.1.2 Form A - Personal background information

The reason to include this section is to study if there is any association among:

- personal educational level belief,
- personal age belief,
- safety knowledge belief,
- belief to Government safety promotion effort, and
- personal accident experience

with the internal, powerful others and chance safety locus of control. This serves to meet the second objective of the study.

4.4.1.3 Form A - Safety Beliefs

4.4.1.3.1 Original Form A Questions proposed by Wallston

As mentioned in chapter 4.1, the questions in this section are modified and based on MHLC proposed by Wallston et al. (1978). The original questions proposed by Wallston are shown in the table 3.

Question No	Question Statement
1	If I get sick, it is my own behavior which determines how soon I get well again.
2	No matter what I do, if I am going to get sick, I will get sick.
3	Having regular contact with my physician is the best way for me to avoid illness.
4	Most things that affect my health happen to me by accident.
5	Whenever I don't feel well, I should consult a medically trained professional.
6	I am in control of my health.
7	My family has a lot to do with my becoming sick or staying healthy.
8	When I get sick, I am to blame.
9	Luck plays a big part in determining how soon I will recover from an illness.
10	Health professionals control my health.
11	My good health is largely a matter of good fortune.
12	The main thing which affects my health is what I myself do.
13	If I take care of myself, I can avoid illness.
14	Whenever I recover from an illness, it's usually because other people (for example, doctors, nurses, family, and friends) have been taking good care of me.
15	No matter what I do, I 'm likely to get sick.
16	If it's meant to be, I will stay healthy.
17	If I take the right actions, I can stay healthy.
18	Regarding my health, I can only do what my doctor tells me to do.

Table 3: MHLC Scale Form A (Source: Wallston, 1998a: 1)

In fact, according to Wallston (1998), these 18 questions can be grouped into three subscales to measure internal, powerful others and chance health locus of control. Table 4 summarizes the classification.

Subscale	Items or Question No.
Internal	1, 6, 8, 12, 13, 17
Chance	2, 4, 9, 11, 15, 16
Powerful Others	3, 5, 7, 10, 14, 18

Table 4: Questions classification according to the sub-scale (Source: Wallston, 1998a: 1)

4.4.1.3.2 MSLC Form A Questions measuring safety locus of control

However, the above questions cannot be directly adopted to investigate the safety locus of control of vocational education students. Chapter 2.8.5 has explained that safety and health has a direct relationship. Indeed, the questions in table 3 can be modified to investigate the safety locus of control. Table 5 lists out the modified version for Form A questions.

No.	Statement
1.	If I get injured, it is my own behaviour which determines how often the same injury occurs to me again.
2.	No matter what I do, if I am going to get injured, I will get injured.
3.	Having regular contact with my safety expert is the best way to avoid injury.
4.	Most things that affect my safety happen to me by unpredictable events.
5.	Whenever I feel in dangerous situation or unsafe (at work or in school), I should consult a trained safety professional.
6.	I am in control of my safety.
7.	My family has a lot to do with my becoming injured or staying safe.
8.	When I get injured, I am to blame.
9.	Luck plays a big part in determining how often injury occurs to me.
10.	Safety professionals control my safety.
11.	Being safe is largely a matter of good fortune.
12.	The main thing which affects my safety is what I myself do.
13.	If I take care of myself, I can avoid injured.
14.	Whenever I remain safe from an accident, it's usually because other people (for example, teachers, family, and friends) have been taking good care of me.
15.	No matter what I do, I'm likely to get injured.
16.	If this is the way it is, I will stay safe.
17.	If I take the right actions, I can stay safe.
18.	Regarding my safety, I only do what my teacher tells me.

Table 5: Modified Form A MSLC questions measuring multidimensional safety locus of control.

4.4.1.3.3 Modification Principle in MSLC Form A Questions

The objective of questions in MHLC proposed by Wallston et al. (1978) is to measure mainly the health belief of concerning participants. Thus, the keywords such as sick, medically trained professional, healthy are used to describe the health status of concerning participants. In modification to measure the safety issue, these keywords are replaced by the corresponding keywords: get injured, trained safety professional and safety to measure safety locus of control of concerning participants.

4.4.1.3.4 Examples illustrating the modification principle

The original question 1 in MHLC scale "If I get sick, it is my own behaviour which determines how soon I get well again" is replaced by "If I get injured, it is my own behaviour which determines how often the same injury occurs to me again" in modified Multidimensional Safety Locus of Control (MSLC). The keyword "get sick" is replaced by "get injured".

Similarly, the original question 6 in MHLC scale "I am in control of my health" is replaced by "I am in control of my safety". The keyword "health" is replaced by "safety".

4.4.1.3.5 MSLC Form A Questions commented by other expertises

The modified form A has been reviewed and commented by the following personnel who are:

- Dr. S. F. Wu, lecturer of Department of Applied Science, who teaches the area of safety and health, has more than nine-year living aboard,
- Dr. Flora Lau, lecturer of Department of Applied Science and graduated from Chinese University of Hong Kong, holding a Doctor of Philosophy in Physics, who teaches the area of safety and health.
- Mr. Derek Pang, lecturer of Department of Applied Science and holding a Master of Science, who teaches the area of food science and has more than eight-year living aboard.

They believe the questions can be well-understood by most of the students. Thank for their contributions. For details about the MSLC Form A questions, please refer to the appendix.

4.4.2 Form B Question Design

Form B contains two sections which are:

- Section A - Personal particular, and
- Section B - Safety beliefs.

All questions except in section A are composed of five-choice Likert type questions ranging from strongly disagree, disagree, neutral, agree to strongly agree. Personal background information has been skipped because students have filled in Form A.

4.4.2.1 Form B - Personal particular

Similar to form A, students are required to fill their gender and their leading six digits of their student number. The rest digits of student numbers are left blank to avoid to collect personal privacy information. This serves for the identification of particular students for comparing before-and-after effect subject to the intervention – attending the introduction of safety and health module.

4.4.2.2 Form B - Safety Beliefs

4.4.2.2.1 Original Form A Questions proposed by Wallston

The original questions of form B proposed by Wallston are shown in the table 6.

Question No	Question Statement
1	If I become sick, I have the power to make myself well again.
2	Often I feel that no matter what I do, if I am going to get sick, I will get sick.
3	If I see an excellent doctor regularly, I am less likely to have health problems.
4	It seems that my health is greatly influenced by accidental happenings.
5	I can only maintain my health by consulting health professionals.
6	I am directly responsible for my health.
7	Other people play a big part in whether I stay healthy or become sick.
8	Whatever goes wrong with my health is my own fault.
9	When I am sick, I just have to let nature run its course.
10	Health professionals keep me healthy.
11	When I stay healthy, I'm just plain lucky.
12	My physical well-being depends on how well I take care of myself.
13	When I feel ill, I know it is because I have not been taking care of myself properly.
14	The type of care I receive from other people is what is responsible for how well I recover from an illness.
15	Even when I take care of myself, it's easy to get sick.
16	When I become ill, it's a matter of fate.
17	I can pretty much stay healthy by taking good care of myself.
18	Following doctor's orders to the letter is the best way for me to stay healthy.

Table 6: MHLC Scale Form B (Source: Wallston, 1998b: 1).

Similarly, according to Wallston (1998), these 18 questions can be grouped into three subscales to measure internal, powerful others and chance health locus of control. Table 7 summarizes the classification.

Subscale	Items or Question No.
Internal	1, 6, 8, 12, 13, 17
Chance	2, 4, 9, 11, 15, 16
Powerful Others	3, 5, 7, 10, 14, 18

Table 7: Questions classification according to the sub-scale (Source: Wallston, 1998a: 1).

4.4.2.2.2 MSLC Form B Questions measuring safety locus of control

Same as Form A, the above questions cannot be directly adopted to investigate the safety locus of control of vocational education students. Table 8 lists out the modified version for Form B questions.

No.	Statement
1.	If I get injured, I have the power to prevent myself the same injury occurring to me again.
2.	Often I fell that no matter what I do, if I am going to get injured, I will get injured.
3.	If I see an excellent safety professional regularly, I am less likely to have safety problems.
4.	It seems that my safety is greatly influenced by unpredictable happenings.
5.	I can only maintain my safety by consulting safety professionals.
6.	I am directly responsible for my safety.
7.	Other people play an important part in whether I stay safe or get injured.
8.	Whenever I get injured even a minor one, it is my own fault.
9.	Whenever I get injured, I hardly control of its happening.
10.	Safety professionals keep me safe.
11.	When I stay safe, I'm just lucky.
12.	My safety well-being depends on how well I take care of myself.
13.	When I feel in unsafe situation, I know it is because I have not been taking care of myself.
14.	The type of care I receive from other people is what is responsible for how well I remain safe from an accident.
15.	Even when I take care of myself, it's easy to get injured.
16.	When I get injured, it's a matter of fate.
17.	I can pretty much stay safe by taking good care of myself.
18.	Following teacher's instructions is the best way for me to stay free from accidents.

Table 8: Modified Form B questions measuring safety locus of control.

4.4.2.2.3 Modification Principle in MSLC Form B Questions

The modification principles are the same as in chapter 4.4.1.3.3. Thus, the keywords such as sick, medically trained professional, healthy are used to describe the health status of concerning participants. In modification to measure the safety issue, these keywords are replaced by the corresponding keywords: get injured, trained safety professional and safety to measure safety locus of control of concerning participants.

4.4.2.2.4 Examples illustrating the modification principle and Questionnaire commented by other expertises

The original question 1 in form B of MHLC scale "If I get sick, I have the power to make myself well again" is replaced by "If I get injured, I have the power to prevent myself from the same injury occurring to me again" in modified Multidimensional Safety Locus of Control (MSLC). The keyword "get sick" is replaced by "get injured".

Similarly, the original question 6 in form B of MHLC scale "I am directly responsible for my health" is replaced by "I am directly responsible for my safety". The keyword "health" is replaced by "safety".

Similar to chapter 4.4.1.3.5, the modified form B has been reviewed and commented by the citied expertises. They believe the questions can be well-understood by most of the students. Thank for their contributions.

5 Survey-Questionnaire conducted and Data Collection

The questionnaires were conducted as the schedule mentioned in chapter 3.2. MSLC Form A was distributed to target students before attending the first lecture on Wednesday 25 September by the subject lecturer but not the author. Two weeks later, after the students had completed attending 2-lecture about laboratory safety, MSLC form B was distributed again by the subject lecturer. Consent to conduct the questionnaire had been given by Head of Department. Total number of target students should be around 200. Table 9 summarizes the number of questionnaires collected.

Items	MSLC Form A	MSLC Form B
Number of Questionnaires collected	164	124
Percentage per total number of target students	82%	62%

Table 9: Number of Questionnaires collected during the two surveys.

The return rate for Form A was found to be higher than Form B. The reasons why the return rate for Form B was lower were due to the two reasons.

- Form A questionnaires were distributed at the start of first lecture. Students had enough time to fill in the questionnaires.
- Form B questionnaires were distributed at the end of third lecture. Students were hurry to leave; therefore, some of them refused to fill in.

Despite of the above reasons, the sample size or return rate was statistically sufficient large.

5.1 Preliminary scanning of the collected questionnaires

Leary (2001) mentions the aim of research is to obtain valid, reliable and reproducible information. Preliminary scanning of the collected questionnaires increases both the validity and reliability. It was found among those questionnaires collected, some have missing data such as:

- leading seven digits of student number leaving blank,
- choices in some of questions leaving blank, and

- multiple selection of choices in some questions.

Table 10 summarizes the valid questionnaires after preliminary scanning.

Items	MSLC Form A	MSLC Form B
Total number before scanning	164	124
Invalid student number	2	2
Invalid choices of questions	21	9
Remaining Valid questions	141	113
Valid questions by percentage	70.5%	56.5%

Table 10: Valid questionnaires after preliminary scanning.

5.2 Further investigation of remaining questionnaires

Restate the topic of the research is to focus the change in safety locus of control where pre-test and protest survey-questionnaires have to be conducted subject to the intervention of the attending of the safety and health module. The data before and after the intervention must be collected and matched. This is called paired data. Therefore, two different equivalent forms were designed. Without any one of the paired data can have no meaning to study the before-and-after the intervention effect.

According to table 10, it seems that 113 paired-questionnaires could be collected. However, it was impossible due to the following reasons.

- Some of students did not attend both lectures.
- Only the leading seven digits filled in the questionnaires could not provide the adequate information to identify the particular students. Different students could have the same leading seven digits student number.

The remaining questionnaires for MSLC Form A and B after preliminary scanning were further subject to sorting according the student number. Duplicate student number questionnaires either in Form A or B were discarded. Unpaired questionnaires were removed. Then, the final valid questionnaires ready for data analysis was summarized in table 11.

Items	MSLC Form A	MSLC Form B
Total number before scanning	164	124
Remaining Valid questions after scanning	141	113
Invalid number either duplicate student number or unpaired	61	33
Valid number ready for data analysis	80	80
Valid questionnaires by percentage over the total 200 target population	40%	40%

Table 11: Number of valid questionnaires ready for data analysis.

5.3 Comments about the valid questionnaires collected

The two equivalent Multidimensional Safety Locus of Control (MSLC) questionnaires Form A and B were modified based on MHLC scale proposed by Wallston et al. (1978). Two surveys were conducted. 82% and 62% percentage of target population involved. Participants had the freedom to choose to answer. After the first preliminary data scanning and further investigation of individual questionnaires, only about 80 questionnaires was found to be valid which constituted about 40% of the total target population. Although about half of crude questionnaires were lost, still, the remaining valid questionnaires were statistically large enough to undergo further data analysis.

6 Data Analysis and hypothesis testing

Leary (2001) states that the aim of research is to obtain valid, reliable and reproducible information. Validity and reliability are most important. In this research, Multidimensional Safety Locus of Control (MSLC) which consists of three factors:

- internal,
- powerful others, and
- chance.

These factors were in form of six questions a group to measure the safety locus of control of the participants. The classification of questions is shown in table 4 and 7. This MSLC scale was modified based on MHLC proposed by Wallston at el. (1978). Wallston (1998) points out that in the past 20+ years, MHLC forms A/B have been used in over a thousand studies and have been cited in the literature hundreds of times. This provides evidences that MHLC forms A/B are valid and reliable to measure health locus of control, but is the MSLC scale scientifically valid and reliable?

6.1 Some Terms' Definitions

In order to have a clear understanding in the steps of data analysis, the following terms mentioned should be well-understood (BDT, 2001).

- Correlation - it is defined if there is a relationship between two variables, the value that represents the change in distance between them from moment to moment.
- Validity – it is the measurement of what is supposed to be measured. It is the extent of unbiasedness of a measure or set of indicators.
- Reliability – it is the measure of relationship between the actual score and the observed score. The closer the observed score is the actual score, the higher the reliability.
- Cronbach's Alpha – it measures how well a set of items (or variables) measures a single one-dimensional latent construct. However, when data have a multidimensional structure, Cronbach's Alpha will usually be low.

6.2 Validity of MSLC Scale

The two Forms A and B should be equivalent. They both consist of three factors as discussed in chapter 5 and table 4 and 7. To ensure the validity of the two MSLC scales, factor analysis is employed to verify how many factors the questionnaires contain.

Reyment and Joreskog (1993: 71) state:

> *Factor analysis is a generic term that we use to describe a number of methods designed to analyze interrelationships within a set of variables or objects [resulting in] the construction of a few hypothetical variables (or objects), called factors, that are supposed to contain the essential information in a larger set of observed variables or objects .... that reduces the overall complexity of the data by taking advantage of inherent interdependencies [and so] a small number of factors will usually account for approximately the same amount of information as do the much larger set of original observations.*

Cureton and D'Agostino (1983) describe factor analysis as a collection of procedures for analyzing the relations among a set of random variables observed or counted or measured for each individual of a group. The purpose is to account for the intercorrelations among n variables, by postulating a set of common factors, considerably fewer in number than the number, n, of these variables. Bryman and Cramer (1990) broadly define factor analysis as a number of related statistical techniques which help to determine the characteristics which go together. This exactly matches with the aim to verify these 18 questions of MSLC scale represent three major factors. This validity construct has to do with factor analysis (Stapleton, 1997).

6.3 Factor Analysis of MSLC scales

Exploratory factor analysis (EFA) is used that attempts to discover the nature of constructs influencing a set of responses (DeCoster, 2001). It is done by showing the intercorrelations among the variables without having prior specifications of what these factors might be (Stapleton, 1997). It seeks to uncover the underlying structure of a relatively large set of variables. The researcher’s a priori assumption is that any indicator may be associated with any factor. It is the most common form of factor analysis (Garson, 2002).

Some common uses of EFA are to:

- identify the nature of constructs underlying responses in a specific content area,

- determine what sets of items “hang together” in a questionnaire,
- demonstrate the dimensionality of a measurement scale, and
- determine what features are most important when classifying a group of items (DeCoster, 2001).

Point number 3 best matches with the aim using EFA to explain the dimensionality of MSLC scale. The common factor model is used to describe the dimensionality which is shown in figure 15.

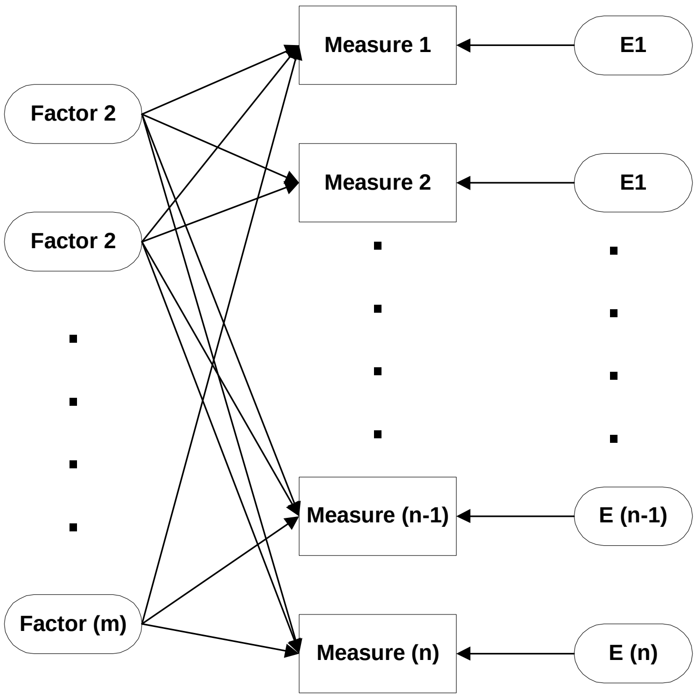


Figure 15: The Common Factor (DeCoster, 2001: 1).

The Common Factor Model illustrated has contained m factors, n measures of each observed response and n residuals or unique factors. Any correlation between a pair of the observed variables can be explained in terms of their relationships with the latent variables. Cureton and D'Agostino's (1983: 3) make the definition:

> *"The factors are random variables that cannot be observed or counted or measured directly, but which are presumed to exist in the population and hence in the experimental sample .... they are sometimes termed latent variables".*

The number of factors or latent variables of MSLC may have three same as MHLC scale. In the factor analysis, DeCoster (2001) mentions that the common factor model should use the maximum likelihood extraction method.

6.3.1 Procedures performing factor analysis

ACITS (1995) cites the procedures to conduct the factor analysis. The flowchart is depicted in figure 16.

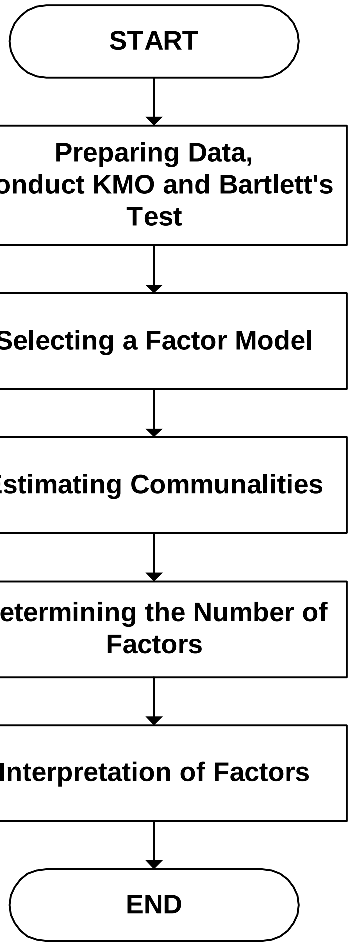


Figure 16: Flowchart showing the procedures to perform factor analysis.

6.3.1.1 Preparing Data, Conducting KMO and Bartlett's Test

ACITS (1995) mentions that several important questions should be considered by a researcher before preparing input data for a factor analysis.

First what variables should be included in the analysis? Factor analysis is designed to explain why certain variables are correlated. Common factor analysis is concerned only with that portion of total variance shared by the variables included in the model (ACITS, 1995).

Second, how many variables should be included? Factors are unobserved latent variables that can be inferred from a set of observed variables. Therefore, factors cannot emerge unless there are a sufficient number of observed variables that vary along the latent continuum (ACITS, 1995).

Third, is the number of observations sufficient to provide reliable estimations of the correlations between the variables? Correlation coefficients tend to be unstable and greatly influenced by the presence of outliers if the sample size is not large. It is generally unwise to conduct a factor analysis on a sample of fewer than 50 observations (ACITS, 1995).

Fourth, is correlation a valid measure of association among the variables to be analyzed? The correlation coefficient is being used as a measure of conceptual similarity of the variables. If strong curvilinear relationships are present among variables, for example, the correlation coefficient is not an appropriate measure. In such cases, the results of a factor analysis based on correlation coefficients will be invalid.

Once the data has been entered, is the strength of the relationship among variables large enough? Is it feasible to proceed a factor analysis for the data? The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy should be conducted. KMO measure is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial coefficients (Krus, 2002). UNC (2000) points out that KMO measure should be greater than 0.5 for a satisfactory factor analysis to proceed. Another indicator of the strength of the relationship among variables is Bartlett's test of sphericity. The obtained figure should be less than 0.05 for a significant sample.

6.3.1.2 Selecting a Factor Model

When the input data have been prepared for the analysis, it is necessary to decide a factoring technique, that is, a method of extracting factors. As mentioned in chapter 6.3, common factor model should be used in the analysis of MLSC scale.

6.3.1.3 Estimating Communalities

The next step for Factor Analysis is to estimate communalities according to the flowchart in figure 16. Garson (2002) describes the communality is the squared multiple correlation for the variable using the factors as predictors. The communality measures the percent of variance explained by all the factors jointly and may be interpreted as the reliability of the indicator. ACITS (1995) points out that the communality estimate for a variable is the estimate of proportion of the variable that is both error free and shared with other variables. Since the concept of common variance is hypothetical, what proportion of the variance is common and what proportion is unique among variables are never known. Thus, estimates of communalities need to be supplied for a factor analysis.

6.3.1.4 Determining the Number of Factors

ACITS (1995) mentions that determining the optimal of factors to be extracted is not a straightforward task since the decision is ultimately subjective. There are several criteria for the number of factors to be extracted, but these are just empirical guidelines rather than an exact quantitative solution.

6.3.1.4.1 Kaiser criterion

The Kaiser rule is to drop all components with eigenvalues under 1.0 and retains components with eigenvalues greater than 1 to be factors. The eigenvalue for a given factor measures the variance in all the variables which is accounted for by that factor (Garson, 2002).

6.3.1.4.2 Scree plot

The Cattell scree test plots the components as the X axis and the corresponding eigenvalues as the Y axis. As one moves to the right towards later components, the eigenvalues drop. When the drop ceases and the curve makes an elbow towards less steep decline, Cattell's scree test says to drop all further components after one starting the elbow (Garson, 2002).

6.3.1.4.3 Choice of Kaiser Criterion or Scree plot

Field (2000) comments that the Kaiser's rule may not be accurate when the communalities after extraction are not greater than 0.7 or when the sample size exceeds 250 and the average communality is not greater than 0.6. This implies that as stated in chapter 6.3.1.3, these indicators may not so reliable. The scree plot may be used as an estimation of the number of factors extracted.

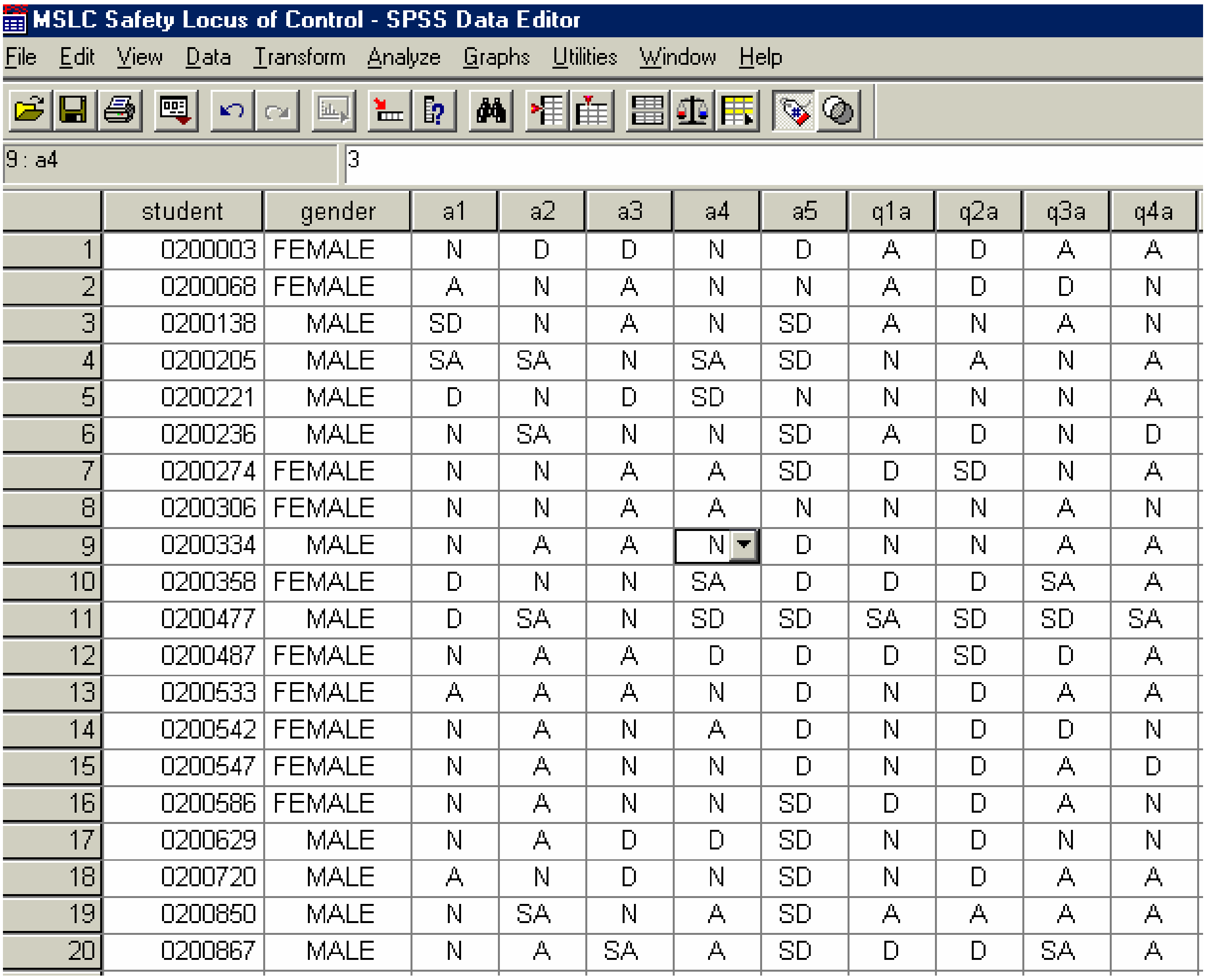
6.3.1.5 Interpretation of Factors

Once the number of factors has been fixed, the next logical step is to determine the method of rotation. The fundamental theorem of factor analysis is invariant within rotations. Rotating the reference axes of the factor solution is to simply the factor structure and to achieve a more meaningful and interpretable solution. The simplest case of rotation is an orthogonal rotation. Varimax with Kaiser Normalization rotation method is commonly used. A factor loading or factor structure matrix is then obtained. The meaning of the rotated factors is inferred from the variables significantly loaded on their factors. A decision needs to be made regarding what constitutes a significant loading. A rule of thumb frequently used is that factor loadings greater than 0.30 absolute value are considered to be significant (ACITS, 1995).

6.3.2 Data Entry into SPSS®

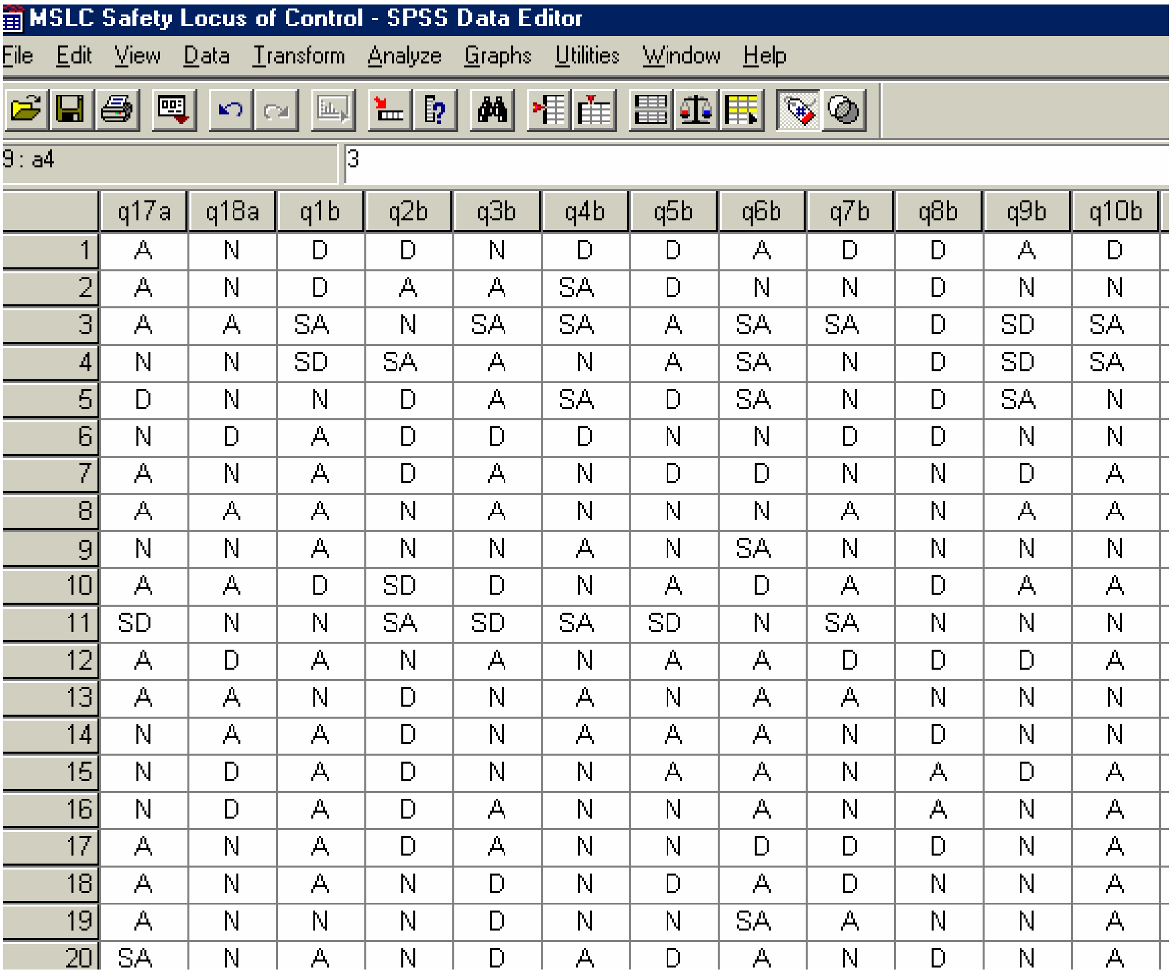
The factor analysis of the MSLC scale was conducted in SPSS®. ACITS (2001) explains that SPSS® is a software package used for conducting statistical analyses, manipulating data and generating tables and graphs that such as regression models, analysis of variance, factor analysis and reliability test.

The 80 sorted matched-pair questionnaires in chapter 5.2 were then keyed into the SPSS®. Figure 17 & 18 show the snapshots of the data keyed in SPSS®.



	student	gender	a1	a2	a3	a4	a5	q1a	q2a	q3a	q4a
1	0200003	FEMALE	N	D	D	N	D	A	D	A	A
2	0200068	FEMALE	A	N	A	N	N	A	D	D	N
3	0200138	MALE	SD	N	A	N	SD	A	N	A	N
4	0200205	MALE	SA	SA	N	SA	SD	N	A	N	A
5	0200221	MALE	D	N	D	SD	N	N	N	N	A
6	0200236	MALE	N	SA	N	N	SD	A	D	N	D
7	0200274	FEMALE	N	N	A	A	SD	D	SD	N	A
8	0200306	FEMALE	N	N	A	A	N	N	N	A	N
9	0200334	MALE	N	A	A	N	D	N	N	A	A
10	0200358	FEMALE	D	N	N	SA	D	D	D	SA	A
11	0200477	MALE	D	SA	N	SD	SD	SA	SD	SD	SA
12	0200487	FEMALE	N	A	A	D	D	D	SD	D	A
13	0200533	FEMALE	A	A	A	N	D	N	D	A	A
14	0200542	FEMALE	N	A	N	A	D	N	D	D	N
15	0200547	FEMALE	N	A	N	N	D	N	D	A	D
16	0200586	FEMALE	N	A	N	N	SD	D	D	A	N
17	0200629	MALE	N	A	D	D	SD	N	D	N	N
18	0200720	MALE	A	N	D	N	SD	N	D	A	A
19	0200850	MALE	N	SA	N	A	SD	A	A	A	A
20	0200867	MALE	N	A	SA	A	SD	D	D	SA	A

Figure 17: A snapshot of the data in SPSS®.



	q17a	q18a	q1b	q2b	q3b	q4b	q5b	q6b	q7b	q8b	q9b	q10b
1	A	N	D	D	N	D	D	A	D	D	A	D
2	A	N	D	A	A	SA	D	N	N	D	N	N
3	A	A	SA	N	SA	SA	A	SA	SA	D	SD	SA
4	N	N	SD	SA	A	N	A	SA	N	D	SD	SA
5	D	N	N	D	A	SA	D	SA	N	D	SA	N
6	N	D	A	D	D	D	N	N	D	D	N	N
7	A	N	A	D	A	N	D	D	N	N	D	A
8	A	A	A	N	A	N	N	N	A	N	A	A
9	N	N	A	N	N	A	N	SA	N	N	N	N
10	A	A	D	SD	D	N	A	D	A	D	A	A
11	SD	N	N	SA	SD	SA	SD	N	SA	N	N	N
12	A	D	A	N	A	N	A	A	D	D	D	A
13	A	A	N	D	N	A	N	A	A	N	N	N
14	N	A	A	D	N	A	A	A	N	D	N	N
15	N	D	A	D	N	N	A	A	N	A	D	A
16	N	D	A	D	A	N	N	A	N	A	N	A
17	A	N	A	D	A	N	N	D	D	D	N	A
18	A	N	A	N	D	N	D	A	D	N	N	A
19	A	N	N	N	D	N	N	SA	A	N	N	A
20	SA	N	A	N	D	A	D	A	N	D	N	A

Figure 18: Another snapshot of the data in SPSS®.

The 7 leading-digit of the student number item was labelled as "student" where the five personal background information questions were labelled from a1 to a5 shown in the figure 17. The 18 questions in MSLC form A were labelled from q1a to q18a shown in the figure 17. The other 18 questions in MSLC form B were labelled from q1b to q18b shown in figure 18. The 36 Likert-type questions in form A q1a to q18a and in from B a1b to q18b have values ranging from 1 (SD – Strongly Disagree) to 5 (SA – Strongly Agree).

6.3.3 MSLC Form A – Selection of Factor Model and Finding Communalities

As mentioned in chapter 6.3, Common Factor Model and Maximum Likelihood Extraction Methods were used. Q1a to q18a were included to first undergo KMO and Bartlett's test to ensure that samples were adequate and significant for a satisfactory factor analysis to proceed. Table 12 shows the result.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.799
Bartlett's Test of Sphericity	Approx. Chi-Square	257.446
	Df	153
	Sig.	.000

Table 12: Table showing the results of KMO and Bartlett's Test in Form A from SPSS®.

As stated in chapter 6.3.1.1, the KMO in table 12 is greater than 0.5 and the significant level of Bartlett's test of sphericity is less than 0.05, table 12 confirms that the samples were significant to further undergo factor analysis.

The communalities for Form A q1a to q18a were then calculated and shown in table 13.

	Initial	Extraction
Q1A	1.000	.217
Q2A	1.000	.331
Q3A	1.000	.370
Q4A	1.000	.360
Q5A	1.000	.468
Q6A	1.000	.342
Q7A	1.000	.338
Q8A	1.000	.154
Q9A	1.000	.259
Q10A	1.000	.411
Q11A	1.000	.169
Q12A	1.000	.472
Q13A	1.000	.570
Q14A	1.000	.383
Q15A	1.000	.355
Q16A	1.000	.338
Q17A	1.000	.672
Q18A	1.000	.454

Table 13: Communalities Result run from SPSS® for Form A.

As stated in chapter 6.3.1.4.3, the communalities after extraction are not greater than 0.7, therefore, Scree plot was performed. Figure 19 shows the result.

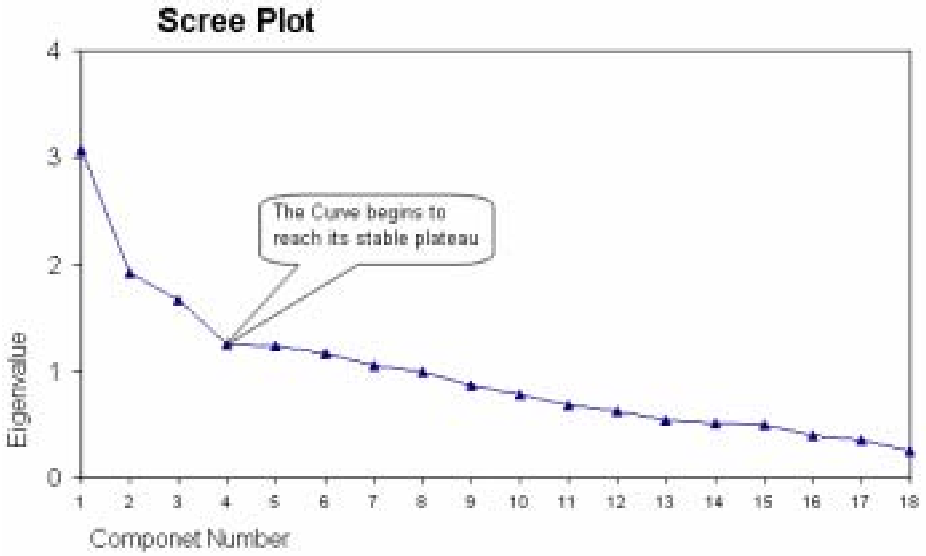


Figure 19: Scree Plot run from SPSS® for MLSC Form A.

From the Scree Plot, it shows a distinct break at factor number 4. Thus, it appears that a three-factor model should be sufficient for the MSLC Form A questionnaire.

6.3.4 Interpretation of Factors & Validity in MSLC Form A

Once the number of factors has been fixed, the next logical step is to determine the method of rotation as stated in chapter 6.3.1.5. Factor loadings lower than 0.30 absolute value are considered to be insignificant. The rotated factor matrix using Varimax-rotation gave the result illustrated in the table 14.

	Factor		
	1	2	3
Q17A	.752	.329	
Q13A	.591		-.308
Q6A	.417		
Q8A	.396		
Q1A	.356		
Q12A	.321	-.309	
Q5A		.590	
Q3A		.410	
Q7A		.424	
Q10A		.489	
Q14A		.421	.338
Q18A		.407	.385
Q15A	-.461		.585
Q4A			.415
Q16A		.408	.409
Q2A	-.396		.389
Q9A	-.331		.350
Q11A			.345

Table 14: Rotated Factor Matrix for MSLC Form A - Extraction Method: Maximum Likelihood. Rotation Method: Varimax with Kaiser Normalization.

Questions with relatively larger magnitude are classified according to their belonging Factor column. Clearly, the following points are summarized.

- Factor 1 consists of question component no. 17, 13, 6, 8, 1 and 12 from Form A.
- Factor 2 consists of question component no. 5, 3, 7, 10, 14 and 18 from Form A.
- Factor 3 consists of question component no. 15, 4, 16, 2, 9 and 11 from Form A.

The components of these factors exactly match with the items found in the table 4 in chapter 4.4.1.3.1. Thus, factor 1 is then called the internal health locus of control in MHLC scale or the internal safety locus of control in MSLC scale. Factor 2 is then called the powerful others health locus of control in MHLC scale or the powerful others safety of locus in MSLC scale. Factor 3 is then called chance health locus of control in MHLC scale or the chance safety locus of control in MSLC scale. Thus, the MSLC scale is validated having three distinct factors.

6.3.5 MSLC Form B – Selection of Factor Model and Finding Communalities

Similarly to chapter 6.3.3, common factor model and Maximum Likelihood Extraction Methods were used. Q1b to q18b were included to first undergo KMO and Bartlett's test to ensure that samples were adequate and significant for a satisfactory factor analysis to proceed. Table 15 shows the result.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.774
Bartlett's Test of Sphericity	Approx. Chi-Square	309.158
	Df	153
	Sig.	.000

Table 15: Table showing the results of KMO and Bartlett's Test in Form B from SPSS®.

As stated in chapter 6.3.1.1, the KMO in table 15 is greater than 0.5 and the significant level of Bartlett's test of sphericity is less than 0.05, table 15 confirms that the samples were significant to further undergo factor analysis. The communalities for Form B q1b to q18b were then calculated and shown in table 16.

	Initial	Extraction
Q1B	1.000	.479
Q2B	1.000	.370
Q3B	1.000	.573
Q4B	1.000	.520
Q5B	1.000	.643
Q6B	1.000	.384
Q7B	1.000	.537
Q8B	1.000	.349
Q9B	1.000	.444
Q10B	1.000	.662
Q11B	1.000	.370
Q12B	1.000	.584
Q13B	1.000	.157
Q14B	1.000	.506
Q15B	1.000	.523
Q16B	1.000	.461
Q17B	1.000	.491
Q18B	1.000	.469

Table 16: Communalities Result run from SPSS® for Form B.

Since the communalities after extraction are not greater than 0.7 Scree plot was performed. Figure 18 shows the result.

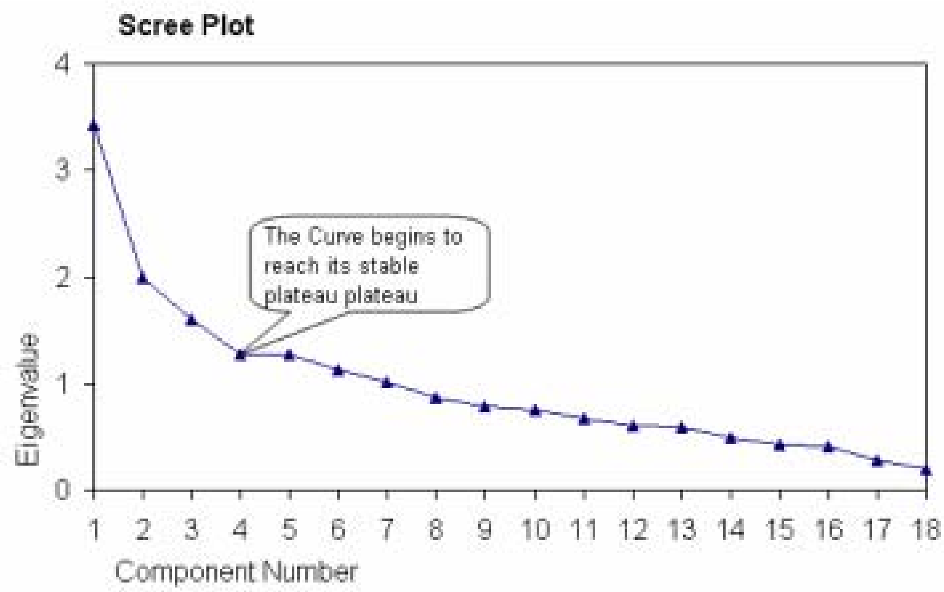


Figure 20: Scree Plot run from SPSS® for MLSC Form B.

From the Scree Plot, it shows a distinct break at factor number 4. Thus, it appears that a three-factor model should be sufficient for the MSLC Form B questionnaire.

6.3.6 Interpretation of Factors & Validity of MSLC Form B

Similar to the chapter 6.3.4, the rotated factor matrix using Varimax-rotation gave the result illustrated in the table 17. Factor loadings lower than 0.30 absolute value are considered to be insignificant.

	Factor		
	1	2	3
Q17B	.712		-.356
Q1B	.521		
Q12B	.519	.493	
Q8B	.489		-.312
Q6B	.389	.	
Q13B	.347		
Q2B		.687	
Q4B		.475	
Q9B	-.367	.465.	
Q11B		.415	
Q15B		.398	
Q16B		.357	
Q10B			.848
Q18B	-.536		.756
Q14B	.340	.528	.685
Q7B		.654.	.760
Q5B			.511
Q3B	.-378		.444

Table 17: Rotated Factor Matrix for MSLC Form B - Extraction Method: Maximum Likelihood. Rotation Method: Varimax with Kaiser Normalization.

Questions with relatively larger magnitude are classified according to their belonging Factor column. The following points are summarized.

- Factor 1 consists of question component no. in the order of 17, 1, 12, 8, 6 and 13 from Form B.
- Factor 2 consists of question component no. in the order of 2, 4, 9, 11, 15 and 16 from Form B.
- Factor 3 consists of question component no. in the order of 10, 18, 14, 7, 5 and 3 from Form B.

The components of these factors exactly match with the items found in the table 7 in chapter 4.4.2.2.1. Thus, factor 1 is then called the internal health locus of control in MHLC scale or the internal safety locus of control in MSLC scale. Factor 2 is then called the chance health locus of control in MHLC scale or the chance safety of locus in MSLC scale. Factor 3 is then called powerful others health locus of control in MHLC scale or the powerful others safety locus of control in MSLC scale. Thus, the MSLC scale for Form B is validated having three distinct factors.

6.4 Reliability of MSLC Scale

The MSLC scale had been validated having three factors in each of the two equivalent Forms A/B. However, are these six factors reliable predictor components in MSLC scale model? Santos (1999) emphasizes that reliability tests are especially important when derivative variables are intended to be used for subsequently predictive analyses. Reliability is the correlation between the observed variable and the true score when the variable is an inexact or imprecise indicator of the true score (Cohen & Cohen, 1983). Inexact measures may come from random inattentiveness, guessing, differential perception, recording errors, etc on the part of the observers (Yaffee, 2000).

Cronbach’s alpha is to measure how well a set of items or variables measures a single unidimensional latent construct. It is a coefficient of reliability or consistency (UCLA-ATS, 2002). It measures the extent to which subject’s response to any one item on an instrument is a good indicator of his/her performance on other items on the instrument (UNB, 2002).

6.4.1 Procedures to perform reliability test in SPSS®

Figure 21 shows the flowchart to perform reliability test in SPSS®.

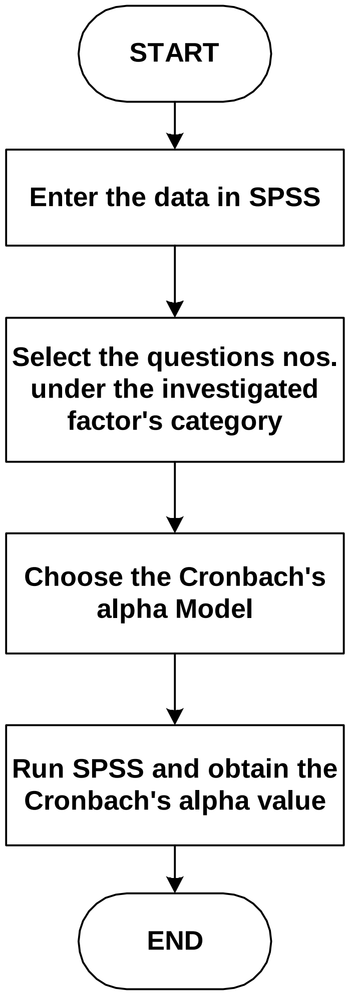


Figure 21: Flowchart illustrating the steps to perform reliability test.

6.4.1.1 Snapshots in performing reliability test for Form's A Internal Safety Locus of Control (ISLC)

The question no. 17, 13, 6, 8, 1 and 12 from Form A under the ISLC scale were selected as shown in figure 22. The result run from SPSS® is shown in table 16.

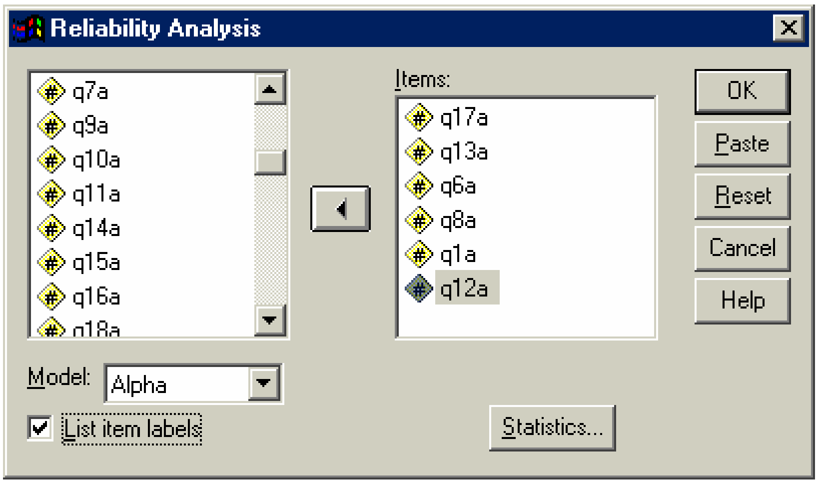


Figure 22: Figure showing the selected questions under the ISLC Form A.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

  1.     Q17A
  2.     Q13A
  3.     Q6A
  4.     Q8A
  5.     Q1A
  6.     Q12A

Reliability Coefficients

N of Cases =     80.0                    N of Items =  6

Alpha =    .7499
```

Table 18: The reliability test for Form A ISLC.

6.4.1.2 Verifying the reliability of Form A ISLC

Santos (1999) mentions that Cronbach's alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted. The higher the score, the more reliable the generated scale is. Nunnaly (1978) has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature.

From table 18, there are 80 cases which correspond to the 80-paired questionnaires. Cronbach's alpha for Form A Internal Safety Locus of Control (ISLC) was found to be 0.7499. Thus, the reliability of factor ISLC was verified.

6.4.2 Cronbach's alpha for other factors

Following the similar steps in chapter 6.4.1.1, the other Cronbach's alphas were found as shown in table 19.

Factor or subscale	Form A	Form B
Internal Safety Locus of Control (ISLC)	0.7499	0.7381
Chance Safety Locus of Control (CSLC)	0.6962	0.7236
Powerful Others Safety Locus of Control (PSLC)	0.8001	0.8523

Table 19: Results showing Cronbach's alpha for all factors in Form A/B.

6.4.3 All the factors in Form A and B are reliable

Refer to table 19, all the Cronbach's alphas were found to be greater or roughly equal to 0.7. Hence, the three factors in each instrumental question were verified and reliable to represent a single unidimensional latent construct.

6.5 Hypothesis Testing

Restate the aim of this study is to evaluate the effectiveness of the Safety & Health Course offered by an Accredited Vocational Education Provider by means of measuring the Safety Locus of Control of the Vocational Education Students. The Safety Locus of Control had been verified to consist of three factors:

- internal safety locus of control (ISLC),
- chance safety locus of control (CSLC) and
- powerful others safety locus of control (PSLC).

Before the investigation, hypothesis must be stated firstly. A hypothesis is a tentative explanation that accounts for a set of facts and can be tested by further investigation (Beltz et al., 2002). It is a scientific method to systematically investigate observations and solve problems. Figure 23 shows the concept.

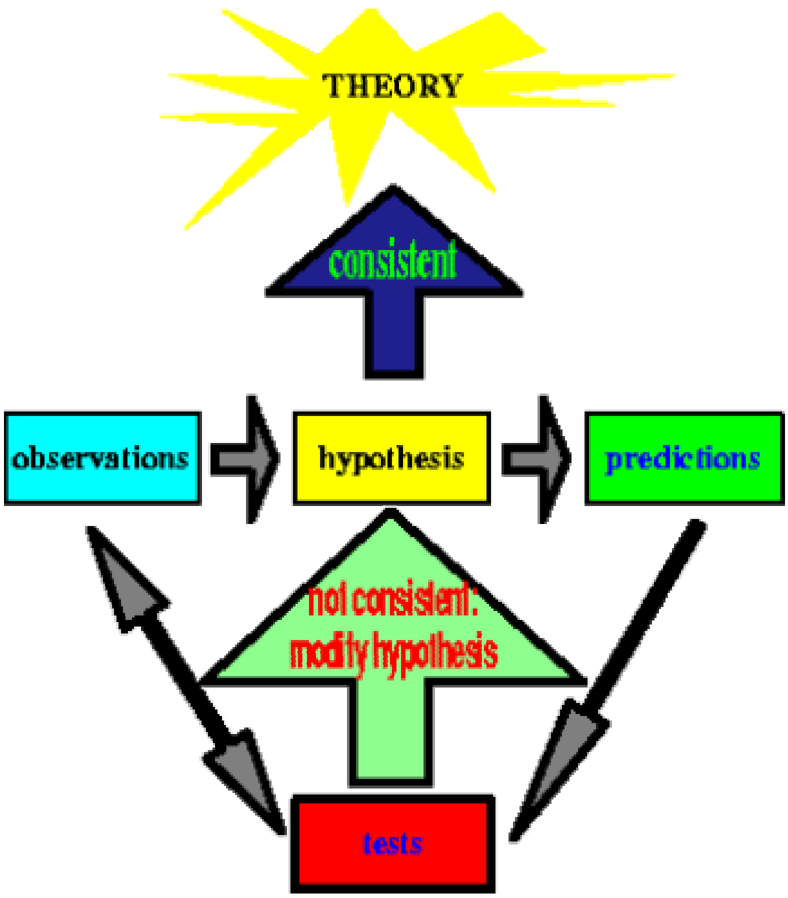


Figure 23: Concept illustrating the steps in scientific methods (Source: Beltz et al., 2002:1).

The scientific method has 5 steps which consist of:

- stating the problem,
- making observations,
- forming a hypothesis,
- doing the experiment, and
- drawing a conclusion.

6.5.1 Formulating hypotheses

Recall what have been discussed in chapter 1.8, the mentioned hypotheses are tested to justify the objectives set in this study. Based on the assumptions of the modified safety locus of control, these three null hypotheses are established and re-stated:

- $H1_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the internal safety locus of control of the vocational education students
- $H2_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the chance safety locus of control of the vocational education students
- $H3_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the powerful others safety locus of control of the vocational education students

On the other hand, the alternative hypotheses have effect on the corresponding safety locus of control.

6.5.2 Hypothesis Testing

Stockburger (1996) describes hypothesis tests are procedures for making rational decisions about the reality of effects. The two questionnaires Form A & B collected were to study the so called pre-test and post-test responses attributed to the change caused by taking the safety & health course. These two questionnaires having before-and-after responses are called paired-samples (BBN, 1997). Paired t-test is the statistical test used to compare means on the same or related subject over time or in differing circumstances (TexaSoft, 2001). There are three separate paired t-tests required to test for the respective three hypotheses formulated in chapter 6.5.1.

6.5.3 Steps to perform paired t-test

Factor analysis in chapter 6.3.4 & 6.3.6 verifies that each safety locus of control factor is made up of six Likert-type scale questions ranging from value 1 to 5. Wallston (1978) comments the score on each subscale is the sum of the values circled for each item on the subscale. Thus, the value of individual factor is then equal to the summing up all these questions' scores having value from 6 (lowest) to 30 (highest). The steps to perform paired t-test are shown in figure 24.

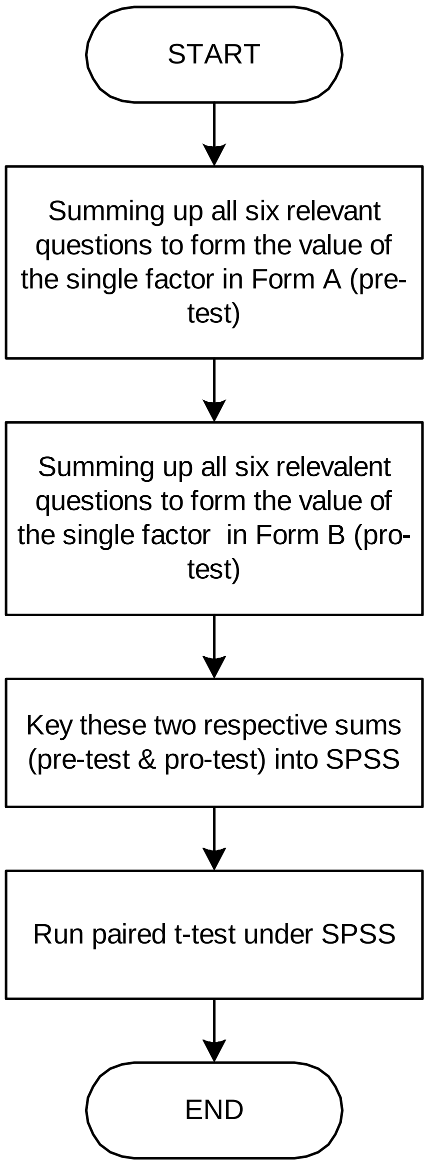


Figure 24: Flowchart showing the steps in paired t- test.

6.5.4 Snapshot running the paired t-test in SPSS® for comparing three safety locus of control instruments

The sum-up values for internal safety locus of control for Form A & B are then termed as “sumia” and “sumib” respectively. The terms “sumca” and “sumcb” are the chance safety locus of control variables for Form A and B respectively. The terms “sumpa” and “sumpc” are called the powerful others safety locus of control for Form A and B respectively. Figure 25 shows the snapshot for running paired t-test.

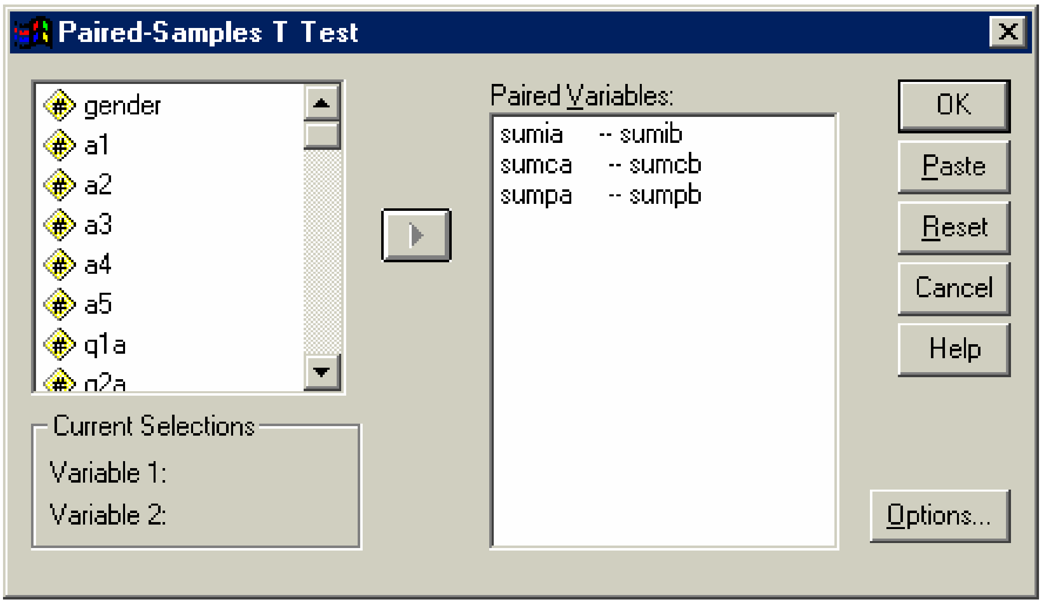


Figure 25: Snapshot running paired t-test for internal safety locus of control.

6.5.5 Paired t-test results for three safety locus of control dimensions

Paired t-tests were run in SPSS®. Results from SPSS® are shown in table 20 and 21.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	SUMIA	20.2625	80	2.5445	.2845
	SUMIB	20.3875	80	2.5318	.2831
Pair 2	SUMCA	18.0250	80	2.1227	.2373
	SUMCB	17.2000	80	2.5378	.2837
Pair 3	SUMPA	19.6500	80	2.9170	.3261
	SUMPB	19.2500	80	2.9421	.3289

Table 20: Descriptive Statistics for three safety locus of control scales.

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	SUMIA - SUMIB	-.1250	2.9638	.3314	-.6846	.6346	-.377	79	.707
Pair 2	SUMCA - SUMCB	.8250	2.9112	.3255	.1771	1.4729	2.535	79	.013
Pair 3	SUMPA - SUMPB	.7000	3.0877	.3452	.0129	1.3871	2.028	79	.046

Table 21: Paired t-tests results for three safety locus of control dimensions.

6.5.6 Results Analysis - Descriptive statistics results

6.5.6.1 Internal Safety Locus of Control

The mean internal safety locus of control score before attending the safety & health module was found to be 20.2625 which is about 67.5% of full score with a standard deviation of 0.2845. After attending two lectures, the value was found to increase to 20.3875 which is 70.0% with a standard deviation of 0.2831. Both standard deviation's figures reveal the individual score is quite consistent. Not extreme values were present. The internal safety locus of control is somehow increased.

6.5.6.2 Chance Safety Locus of Control

The mean chance safety of control score before the two lectures was calculated to be 18.025 which accounts for 60.0% of the maximum score with a standard deviation of 0.2373. After the two lectures, the score dropped to 17.2 (57.3% of maximum score) with a standard deviation of 0.2837. Again, standard deviation's figures confirmed that individual score is quite consistent.

6.5.6.3 Powerful Others Safety Locus of Control

The mean powerful others safety of control score before was found to be 19.65 which accounts for 65.5% of the maximum score with a standard deviation of 0.3261. The mean score after decreased to 19.25 (64.2% of maximum score) with a standard deviation of 0.3289. Again, standard deviation's figures confirmed that individual score is quite consistent.

6.5.7 Results Analysis - Paired t-test results

Although the means in chapter 6.5.6 are changed, it is not sufficient to say that the changes really take place in the view of scientific justification. A significance test should be performed to determine. HyperStat (2002) mentions that, traditionally, experimenters have used either the .05 level (sometimes called the 5% level) or the .01 level (1% level), although the choice of levels is largely subjective. The lower the significance level, the more the data must diverge from the null hypothesis to be significant. Therefore, the .01 level is more conservative than the 0.05 level.

This level of significance also marks the size of the rejection region. If the calculated value falls into the rejection region, the null hypothesis should be rejected and the effect found in a sample is said to be statistically significant. If the null hypothesis is not rejected, then the effect is not significant (HyperStat, 2002). Garson (2002) points out that most social scientists often use the .05 level as a cut-off if there is 5% or less chance that a relationship is just due to chance, they conclude the relationship is real. In this study, 0.05 level of significance is adopted.

6.5.7.1 Internal Safety Locus of Control

Restate the null hypothesis

> $H1_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the internal safety locus of control of the vocational education students

The paired t-test t-value for internal safety locus of control was calculated to be -0.377 while the mean was -0.125 from the table 21. Although it shows that there is an increase of this scale due to the pre-test value being smaller than pro-test value, it cannot be concluded that there is a significant change based on 0.05 level of significance. The calculated t-value was found within the 95% confidence interval but not the rejection region. Therefore, null hypothesis should not be rejected.

6.5.7.2 Chance Safety Locus of Control

Restate the null hypothesis

> $H2_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the chance safety locus of control of the vocational education students

The paired t-test t-value for chance safety locus of control was found to be 2.535 while the mean was 0.825. There is a drop in this scale and it is confirmed to be statistically significant as the value falls within the rejection region. There is an evidence to say that the null hypothesis should be rejected based on 0.05 level of significance. Attending the safety and health course offered by an accredited vocational education provider changes the chance safety locus of control of students.

6.5.7.3 Powerful others Safety Locus of Control

Restate the null hypothesis

> $H3_0$: Attending the safety & health course offered by an accredited vocational education provider has no effect on the powerful others safety locus of control of the vocational education students

The paired t-test t-value for powerful others safety locus of control was found to be 2.028 while the mean was 0.7. There is a drop in this scale and it is confirmed to be statistically significant as the value falls within the rejection region. There is an evidence to say that the null hypothesis should be rejected based on 0.05 level of significance. Attending the safety and health course offered by an accredited vocational education provider changes the powerful others safety locus of control of students.

6.6 Further analysis on what influencing the three safety locus of control scales

As seen from chapter 6.5.7, students who attending two lectures safety & health course have significantly change on their chance and powerful others safety locus of control while their internal safety locus of control has not significantly changed. It is reasonable to say that safety & health course has a significant influence. But what are the underlying elements that determine their safety locus of control?

In this chapter, the students' beliefs such as

- personal feeling on their educational background,
- personal feeling on their age,
- personal feeling on their safety knowledge,
- personal feeling on government's contribution to safety and health and
- personal accident experience

are investigated to see if they have any contributions to three dimensions safety locus of control. In fact, these beliefs have been questioned in section B of Form A. Please refer to appendix for details. Are there any correlations among them?

6.6.1 Correlation Analysis

In the social and natural sciences, researchers seek to understand and explain the nature of causal relations between phenomena. The phenomena are operationalized into measured relationships that are observed or tested. Yaffee (2000) describes correlations serve as empirical indications of possible relationships between variables.

Correlations are relationships between two or more variables or sets of variables (Cohen and Cohen, 1983). They have three fundamental dimensions: significance, direction, and magnitude. These dimensions will be addressed throughout.

6.6.2 Steps to perform correlation analysis

Figure 26 shows the flowchart to perform correlation analysis. The questions on the five students' beliefs were labelled as "a1" to "a5" respectively.

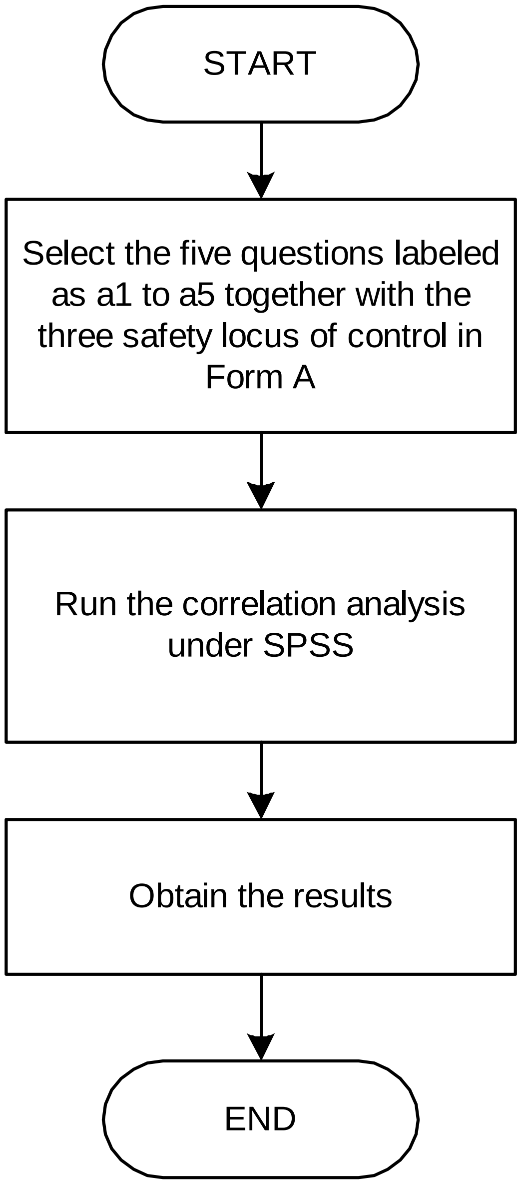


Figure 26: Flowchart showing the steps in correlation analysis.

6.6.3 Snapshot running correlation analysis in SPSS®

Figure 27 shows the snapshot running the correlation analysis in SPSS® after the seven items had been selected using Pearson's correlation coefficient. Pearson's Correlation Coefficient is to measures the strength of the linear relationship between two variables (User, 2001).

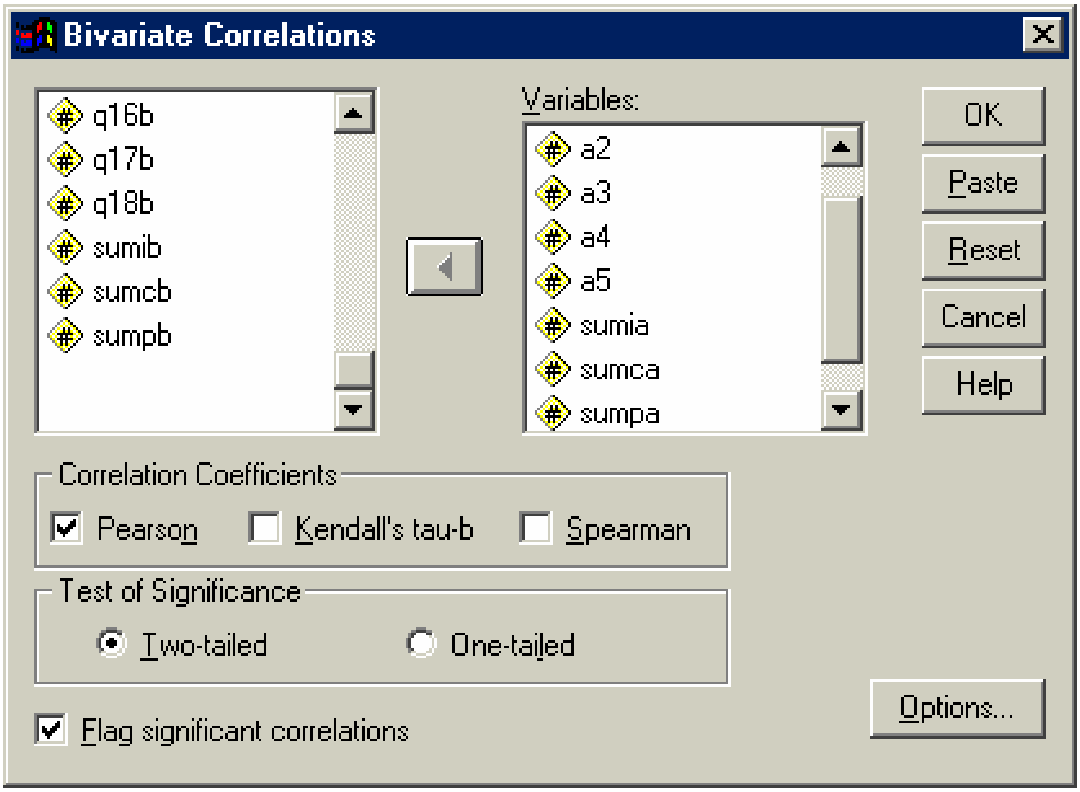


Figure 27: Snapshot running the correlation analysis in SPSS®.

6.6.4 Correlation Analysis Printout Result from SPSS®

Table 22 shows the printout from SPSS®. Recall that the five questions are

- A1: I am well-educated.
- A2: I am young.
- A3: I have received a good safety knowledge during my past school life.
- A4: I think our Government has shown efforts to promote safety and health.
- A5: I have suffered a serious accident.

		A1	A2	A3	A4	A5	SUMIA	SUMCA	SUMPA
A1	Pearson Correlation	1.000	.090	.201	.249*	.034	.250*	.236*	.200
	Sig. (2-tailed)	.	.428	.074	.026	.764	.026	.035	.075
	N	80	80	80	80	80	80	80	80
A2	Pearson Correlation	.090	1.000	-.035	-.172	-.243*	.028	-.146	-.045
	Sig. (2-tailed)	.428	.	.756	.128	.030	.809	.196	.693
	N	80	80	80	80	80	80	80	80
A3	Pearson Correlation	.201	-.035	1.000	.133	.040	-.243*	.069	.035
	Sig. (2-tailed)	.074	.756	.	.238	.724	.030	.541	.757
	N	80	80	80	80	80	80	80	80
A4	Pearson Correlation	.249*	-.172	.133	1.000	-.004	.052	.012	.131
	Sig. (2-tailed)	.026	.128	.238	.	.975	.646	.913	.246
	N	80	80	80	80	80	80	80	80
A5	Pearson Correlation	.034	-.243*	.040	-.004	1.000	-.082	-.085	-.351**
	Sig. (2-tailed)	.764	.030	.724	.975	.	.468	.451	.001
	N	80	80	80	80	80	80	80	80
SUMIA	Pearson Correlation	.250*	.028	-.243*	.052	-.082	1.000	-.226*	.238*
	Sig. (2-tailed)	.026	.809	.030	.646	.468	.	.044	.034
	N	80	80	80	80	80	80	80	80
SUMCA	Pearson Correlation	.236*	-.146	.069	.012	-.085	-.226*	1.000	.214
	Sig. (2-tailed)	.035	.196	.541	.913	.451	.044	.	.057
	N	80	80	80	80	80	80	80	80
SUMPA	Pearson Correlation	.200	-.045	.035	.131	-.351**	.238*	.214	1.000
	Sig. (2-tailed)	.075	.693	.757	.246	.001	.034	.057	.
	N	80	80	80	80	80	80	80	80

Table 22: Correlation Analysis Printout from SPSS®.

The value with '*" indicates that it is significant at 0.05 level (2-tailed) while the value with '**' represents that it is significant at 0.01 level (2-tailed). The value of Pearson's Coefficient ranges from -1 to +1. The closer it is to -1 or +1, the stronger the relationship between the variables. The closer the value is to 0.0000, the weaker it is. A value of 0 means that the variables have no effect on each other. A value greater than 0.4 or less than -0.4 is considered strong (Shambaugh, 2002).

It was found from table 22 that the following items were proved to be significantly correlated at 0.05 level.

- Internal Safety Locus of Control positively correlates with questions educational background (A1) and safety knowledge (A3).
- Chance Safety Locus of Control negatively correlates with question educational background (A1).
- Powerful others Locus of Control negatively correlates with question accident experience (A5).

All of these figures are less than 0.4. None of them exhibits strong correlation relationship, but they have relationship that is significant at 0.05 level. Educational background, safety knowledge and past accident experience do contribute to the three dimensional safety locus of controls.

7 Discussion of Findings

Owing to the time and resources limitation, two 3-hour lectures in safety and health courses about laboratory safety had been offered to all first-year vocational educations enrolled in 8 higher diploma courses in the Department of Applied Science. Two forms A/B modified from multidimensional healthy locus of control proposed by Wallston were answered by 164 students in form A and 124 students in form B respectively. 80 valid questionnaires were collected. Validity and reliability tests were performed to support that these questionnaires contained three significant dimensional factors:

- internal safety locus of control,
- chance safety locus of control, and
- powerful others safety locus of control.

Paired t-test was conducted to investigate if there were any significant changes in the captioned dimensions. It was found that both the chance and powerful others safety locus of control were found to improved with a significant drop in their scores. However, the internal safety locus of control did not show significant change.

The mean score of the three dimensions ranged from 17.2 to 20.4. A very similar experiment citied by MHHE (2001) using three multidimensional health locus of control conducted having the same scale indicates that

- a score of 23 to 30 on any subscale means people have a strong inclination toward that particular subscale,
- a score of 15 to 22 means people are moderate on that particular subscale, and
- a score of 6 to 14 means people are low on that particular subscale.

Thus, this may serves as an indication that all the three dimensions safety locus of controls of all vocational education students have a moderate inclination or equal weighting.

Moreover, results supported that there were significant relationships among:

- Internal Safety Locus of Control with students' belief on their academic standing and safety knowledge,
- Chance Safety Locus of Control correlates with student's belief on their academic standing, and
- Powerful others Safety Locus of Control with students' experience on accident.

7.1 Some explanations of Locus of Control

As defined by Rotter (1975: 48),

> *"internal versus external control refers to the degree to which persons expect that a reinforcement or an outcome of their behaviour is contingent on their own characteristics versus the degree to which persons expect that reinforcement or outcome is a function of chance, luck or fate, is under the control of powerful others or is simply unpredictable".*

Note that reinforcement, consequence and expectation are the major factors influencing one's locus of control (LOC). Locus of control, a personality construct that assesses how people attribute their success or failure outcomes, has been theorized to be a moderator of change. Examining differences in LOC effect across program characteristics can help set the stage for a more in depth understanding of how change occurs as a result of these programs (Hans, 2000). Since LOC involves an individual's perceptions regarding control events in the future, it logically follows that LOC construct is directly related to one's coping abilities and efforts (Ganellen & Blaney, 1984).

Individuals who are highly internal in orientation will tend to perceive themselves as in control of their own destiny. That is, they will be more likely to believe that there is a definite relationship between their own actions and the outcomes of those actions. On the other hand, individuals who are highly external are more likely to perceive their destiny as mostly beyond their control and thus tend to assume a rather weak relationship between their behaviour and a given outcome (Rinehart at el., 1995). According to Levenson (1983), those who believe that powerful others are in control will behave and think differently than those who feel the world is unordered and unpredictable. When in general, externally oriented individuals perceive themselves as out of control of the outcomes of their behaviour and behave accordingly, expected behavioural patterns may vary based on the belief in either powerful others or chance. Individuals who perceive outcomes to be controlled by powerful others are more likely to address those "others" in an effort to achieve desired outcomes and to perceive themselves as having more control over the situation than if they believe that outcomes are solely governed by fate, luck or chance (Rinehart at el., 1995).

7.2 Interpretation of Findings

The results in chapter 6 confirm that the safety locus of control correlates significantly with the individual's belief in their educational standing, safety knowledge and past accident experience. These beliefs provide the measure how much learning they have received in the past. As reviewed in chapter 2, learning is a relatively permanent change in behaviour as a result of experience. In the operant conditioning approach in learning, individuals learn to behave in certain ways based on the consequences of those actions. It increases the probability of desired behaviour or belief through the antecedents, behaviours and consequences of behaviour relationships.

The higher their educational standing they believe, the more learning they have. Hence, their educational standing and degree of their safety knowledge change their views on the locus of control about safety internally. They start to understand accident can be controlled and happened solely due to their behaviours, but not the external factors.

Moreover, in the similar explanation, their beliefs in their educational standing also determine the chance safety locus of control. The higher their educational standing they believe, the lesser they believe the occurrence of accidents is solely based on chance. However, safety knowledge was found to have no significant relationship. The author suspects that the chance safety locus of control is mostly attributed by external factors. Specific safety knowledge can have only slightly or insignificant influence on the overall belief on the individual's safety contributed by chance.

The more the accident experience students have, the lower the powerful others locus of control they have. Revisit the definition made by Rotter in chapter 6.1. Reinforcement and outcome affect the LOC. Rotter (1975) suggests that general locus of control beliefs come from specific experiences and past reinforcement history. When students have some experiences on accidents, their degree of injury and the review or report of the cause to accidents provide some insights that accidents are not caused by other people. In most occasions, it is caused by their unsafe act. The more accidents they have, the more insights come to their mind and start to realize the unsafe acts. Thus, the powerful others safety locus of control drops.

The provision of specific safety & health courses, though it was only 6-hour lecture, was proved to change both the chance and powerful others safety locus of control significantly. In fact, it is not surprising to see these results. As stated in chapter 2, learning can change individual's behaviour, hence, perception, attitude and belief. Since there is an assessment in the safety & health course, this provides a reinforcement which is a typical element in learning theory, to direct the desirable outcome. General locus of control beliefs come from specific experiences and past reinforcement history (Rotter, 1975). Reinforcement theory (Skinner, 1938) argues that what controls behaviour are reinforcers. The assessment in the safety & health course in the term-end becomes a reinforcer. A reinforcer is a consequence that immediately follows a response and either removes a negative stimulus or adds a positive stimulus. Thus, students understand the occurrence of laboratory accident is not due to chance or other people. It is caused by incorrect procedures, unsafe condition or unsafe act. Once they realize these concepts, their mind towards chance and powerful others safety locus of control will be changed accordingly.

However, the internal safety locus did not show the corresponding effect. This cannot say that there is no relationship between them but the relationship is not statistically significant. As stated in chapter 2.3.1.3, personality may change in terms of years but not within several days. Locus of control is one of components in personality and internal safety locus of control is even attributed internally. This may take a long time to accumulate. Such two 3-hour lectures may not have sufficient time for them to build up and the result may show insignificant. Nevertheless, the result did show there is an increase in this measure but it is not statistically significant.

8 Comments and Conclusion

This research attempts to explore the effect of the Safety & Health Course offered by an Accredited Vocational Education Provider in changing the Safety Locus of Control of the Vocational Education Students. As reviewed in chapter 2, the underlying cause to most accidents is the unsafe behaviour. The well-known accidents such as:

- Three Mile Island accident in USA,
- Chernobyl disaster in the former Soviet Union,
- King's Cross Underground fire in London, and
- The Exxon Valdez accident in Alaska,

all revealed that there lacked a 'good' safety culture. Unsafe behaviour is the character of being a 'poor' safety culture (Pidgeon, 2001).

Similar tragedy also happened in tertiary education in Hong Kong. A PhD student was killed by the inhalation of hazardous chemical gas in the Hong Kong University of Science and Technology. Other serious laboratory accidents are also found in other tertiary institutes as reviewed in chapter 1.6. In this study, the aim is to evaluate the effectiveness of the safety & health course by means of measuring the safety locus of control scales of vocational education students. The objectives of this study are:

- to find out what are the three safety locus of control scales of the students before and after attending the safety and health course provided by an vocational education provider,
- to investigate what influences the three safety locus of control scales, and
- to study how to utilize these three safety locus of control scales to improve the safety situation in vocational education institutes.

Behaviour greatly depends on five major factors which are attitudes, perception, personality, learning and motivation and these factors are highly inter-related. However, personality is relatively easy to measure (George & Jones, 1996). It is better to reflect one's behaviour which is subject to less situational factors.

There are five personality traits described by Robbins & Coulter (2002) which consist of locus of control, machievellianism, self-esteem, self-monitoring and risk-taking. Among all, locus of control deals with people thinking and people reacting towards external influences. LOC involves an individual's perceptions regarding control over events in the future which can serve as an indicator to predict one's behaviour. It is about an individual's beliefs and attitudes regarding control over personal successes and failures. They are vitally important concepts to consider when studying one's actions and performances, person's locus of control (LOC) manifests great influence in directing and motivating behaviour (Zeitgeist, 1998). Learning is the general step in permanently changing one's behaviour. Learning or training is the normal practise or the first step offered in tackling safety problem.

Three dimensional safety locus of controls were constructed based the multidimensional health locus of control proposed by Wallston (1978). Two equivalent forms namely Form A and Form B were created to investigate the safety locus of control before and after attending two lectures whose content covers laboratory safety. These three dimensional safety locus of control are:

- internal safety locus of control,
- chance safety locus of control, and
- powerful others safety locus of control.

These three dimensions of scales were proved to be valid and reliable as confirmed by the factor and reliability analysis in SPSS®. 80 sets of valid questionnaires were collected. For details about these two questionnaires, please refer to the appendix attached.

Results showed that the mean score of the three dimensions before and after attending two lectures safety & health course ranged from 17.2 to 20.4 which are shown in table 20. This addresses the first objective of the study. All these three scales are moderate and there is a room for improvement.

The results from Correlation Analysis obtained show that these three dimensions correlate significantly with the students' beliefs in their educational standings, safety knowledge and past accident experiences. This explains what influences the three safety locus of control scales which is the second objective of the study. According to table 22 in chapter 6.6.4, the introduction of two safety and health lectures did show significant change in chance and powerful others safety locus of control but internal safety locus of control showed only insignificant improvement.

Rotter (1966) suggests that internality is more positive orientation than externality. Greenberg & Baron (1993) point out Internals tend to be more successful in their careers than Externals. They further comment that locus of control, like other personality characteristics or dimensions, is definitely open to change. When individuals find themselves in situations where good performance is both recognized and rewarded, even those initially holding beliefs in external locus of control tend to shift towards a more internal orientation. This explains why there is a change in both chance and powerful others safety locus of control. The writer argues that internal safety locus of control is attributed more internally and needs more time to accumulate. 6-hour of lectures may not be sufficient to change the internal safety locus of control.

8.1 Using Safety Locus of Control as a measure of Unsafe Behaviour

Safety locus of control has been proved to be easy indicator to predict their unsafe behaviours. Vavrik (1998) illustrates this concept to predict road accidents in his journal called "Accident Prone". Forcier at el. (2001) describe a safety conscious employee is one who has an internal locus of control in matters related to workplace safety and avoids engaging in high-risk sensation-seeking activities. Jones & Wuebker (1993) use similar scale of safety locus of control to study accidents among 283 hospital workers. They report that employees with more internal safety attitudes were significantly less likely to experience occupational accidents and were less likely to have severe and costly accidents compared to employees with more external attitudes. Thus, they conclude strongly that

> *"construct of safety locus of control can be assessed and used to predict behaviour"* (Jones & Wuebker, 1993: 160).

This can be extended to safety in vocational education to utilize these three safety locus of control as a measure of the students' unsafe behaviour. This addresses the last objective of this study. Subsequent training or safety and health courses should be offered to rectify the unsafe behaviour. Safety locus of control can also evaluate the effectiveness of safety training or course offered to students as argued in chapter 2.4.7.1, safety training should include the means for evaluating training effectiveness (Cohen et al., 1979).

9 Recommendations

- Supports from the management are crucial to laboratory safety. These include financial support, adequate laboratory equipments, competent teachers in the area of laboratory safety and effective laboratory safety manual where the top management should realize these factors and put into practise by integrating them in its safety policy.
- Subsequent training or courses such as the introduction of safety and health should be offered to improve their safety locus of control of the vocational education students. Hence, in return, their unsafe behaviour can be rectified. Their safety or life in vocational institute can be guaranteed. This can be done by fusing laboratory safety into each laboratory-based course syllabus. Or, there should be a laboratory safety orientation like the safety training program in HKUST mentioned in chapter 2.5. If time is allowed, a formal course like the introduction of safety and health course in the accredited vocational education provider should be offered to each student.
- Learning requires some kind of reinforcement to sustain the behaviour so that permanent change takes place. Thus, some reinforcements such as quiz, test or rewarding system should be incorporated in any safety training or safety and health course to make the behavioural change more effectively. A safety and health course is better than safety training because course has an efficient reinforcement – examination that requires student to get a pass and acknowledges their effort. Safety course or training planner should carefully design these reinforcements to sustain the safety behaviour of students.
- Further investigation should be made how efficient the safety and health course will change the safety locus of control of the vocational students. Will the internal safety locus of control be improved significantly after attending a full-year safety and health course? By launching the safety of locus questionnaire survey, it can provide one way how to measure the efficiency of any safety and health course or safety training program.
- Using safety locus of control questionnaire survey as a measure of unsafe behaviour can be extended to other industries, such as catering and construction

industries. Hence, the effectiveness of any training in these industries such as mandatory basic safety training in construction industry can be evaluated by means of safety locus of control scales. Nowadays, most approved safety training providers in Hong Kong lacks of a common performance indicator to compare how effectiveness of the training they offer. Thus, the safety locus of control measure can serve as a basis for the training program to have a continuous improvement. This measurement should be encouraged in most approved safety training providers in Hong Kong by the Government.

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11 Appendix – MSLC Form A

Questionnaire: Safety & Health Course changes the Safety Locus of Control (Form A)

Please read this carefully before attempting to answer the following questions.

- ***This is not a compulsory exercise! It is not a part of your Safety and Health Assessment. You have the right to refuse to fill in.***
- The purpose of this questionnaire is to help to investigate the safety locus of control of students after taking the Safety and Health Course offered by Department of Applied Science.
- Detailed data in this questionnaire are strictly not disclosed.
- Any queries about this questionaries, please feel free to contact Mr. K. L. Yam for further information at 2595-8258 during office hours.

Instructions:

- The questionnaire consists of three sections.
- Each item below is a statement about your safety condition with which you may agree or disagree.
- Beside each statement, there is a scale which ranges from

Strongly Disagree	**SD**	Disagree	**D**	Neutral	**N**	Agree	**A**	Strongly Agree	**SA**

- Please place a tick on space provided and make sure you answer **EVERY ITEM.**
- This is a measure of your personal beliefs; obviously, there is no right or wrong answers.

Section A – Personal Details

Student Number: (For example, if your student no. is 021234567, fill in 0212345××.

							×	×

Gender:	Male		Female	

Section B - Personal Background Information

No.	Statement	SD	D	N	A	SA
1.	I am well-educated.					
2.	I am young.					
3.	I have received a good safety knowledge during my past school life.					
4.	I think our Government has shown efforts to promote safety and health.					
5.	I have suffered a serious accident.					

Section C - Safety Beliefs

No.	Statement	SD	D	N	A	SA
1.	If I get injured, it is my own behaviour which determines how often the same injury occurs to me again.					
2.	No matter what I do, if I am going to get injured, I will get injured.					
3.	Having regular contact with my safety expert is the best way to avoid injury.					
4.	Most things that affect my safety happen to me by unpredictable events.					
5.	Whenever I feel in dangerous situation or unsafe (at work or in school), I should consult a trained safety professional.					
6.	I am in control of my safety.					
7.	My family has a lot to do with my becoming injured or staying safe.					
8.	When I get injured, I am to blame.					
9.	Luck plays a big part in determining how often injury occurs to me.					
10.	Safety professionals control my safety.					
11.	Being safe is largely a matter of good fortune.					
12.	The main thing which affects my safety is what I myself do.					
13.	If I take care of myself, I can avoid injured.					
14.	Whenever I remain safe from an accident, it’s usually because other people (for example, teachers, family, and friends) have been taking good care of me.					
15.	No matter what I do, I’m likely to get injured.					
16.	If this is the way it is, I will stay safe.					
17.	If I take the right actions, I can stay safe.					
18.	Regarding my safety, I only do what my teacher tells me.					

12 Appendix – MSLC Form B

Questionnaire: Safety & Health Course changes the Safety Locus of Control (Form B)

Please read this carefully before attempting to answer the following questions.

- ***This is not a compulsory exercise! It is not a part of your Safety and Health Assessment. You have the right to refuse to fill in.***
- The purpose of this questionnaire is to help to investigate the safety locus of control of students after taking the Safety and Health Course offered by Department of Applied Science.
- Detailed data in this questionnaire are strictly not disclosed.
- Any queries about this questionaries, please feel free to contact Mr. K. L. Yam for further information at 2595-8258 during office hours.

Instructions:

- The questionnaire consists of three sections.
- Each item below is a statement about your safety condition with which you may agree or disagree.
- Beside each statement, there is a scale which ranges from
-

Strongly Disagree	**SD**	Disagree	**D**	Neutral	**N**	Agree	**A**	Strongly Agree	**SA**

- Please place a tick on space provided and make sure you answer **EVERY ITEM.**
- This is a measure of your personal beliefs; obviously, there is no right or wrong answers.

Section A – Personal Details

Student Number: (For example, if your student no. is 021234567, fill in 0212345××.

							×	×

Gender:	Male		Female	

Section B - Safety Beliefs (Form B)

No.	Statement	SD	D	N	A	SA
1.	If I get injured, I have the power to prevent myself from the same injury occurring to me again.					
2.	Often I fell that no matter what I do, if I am going to get injured, I will get injured.					
3.	If I see an excellent safety professional regularly, I am less likely to have safety problems.					
4.	It seems that my safety is greatly influenced by unpredictable happenings.					
5.	I can only maintain my safety by consulting safety professionals.					
6.	I am directly responsible for my safety.					
7.	Other people play an important part in whether I stay safe or get injured.					
8.	Whenever I get injured even a minor one, it is my own fault.					
9.	Whenever I get injured, I cannot take control of its happening.					
10.	Safety professionals keep me safe.					
11.	When I stay safe, I’m just lucky.					
12.	My safety well-being depends on how well I take care of myself.					
13.	When I feel in unsafe situation, I know it is because I have not been taking care of myself properly.					
14.	The type of care given by other people is responsible for how well I stay safe from an accident.					
15.	Even when I take care of myself, it’s easy to get injured.					
16.	When I get injured, it’s a matter of fate.					
17.	I can pretty much stay safe by taking good care of myself.					
18.	Following teacher’s instructions is the best way for me to stay safe from accidents.					