ASSESSING FORM FOUR STUDENTS' ATTITUDE TOWARDS SCIENCE IN NORTH EAST DISTRICT OF PENANG.

CHIN SOOK FUI

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ASSESSING FORM FOUR STUDENTS' ATTITUDE TOWARDS SCIENCE IN NORTH EAST DISTRICT OF PENANG.

by

CHIN SOOK FUI

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LIST OF ABBREVIATIONS

Abbreviation	Meaning	Page*
AERA	American Educational Research Association	33
APA	American Psychological Association	33
ATA	Attitude towards Arts	12
ATS	Attitude towards Science	1
ATSS	Attitude towards Science Scale	62
DIF	Differential Item Functioning	7
ITC	International Test Commission	33
MNSQ	Mean Square	77
NCME	National Council on Measurement in Education	33
PCA	Principal Component Analysis	93
SPSS	Statistical Package of Social Science	22
ZSTD	Standardized as a z-score	77

*The abbreviation is first used.

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MENAKSIR SIKAP TERHADAP SAINS BAGI PELAJAR TINGKATAN EMPAT DI TIMUR LAUT PULAU PINANG.

ABSTRAK

Tujuan kajian ini adalah mengadaptasi dan mengesahkan instrumen sikap terhadap sains (STS), menaksir STS pelajar, dan juga mengkaji kesan kedudukan aliran ke atas STS pelajar. Seramai 749 pelajar Tingkatan Empat dari lapan buah sekolah menengah di Pulau Pinang, Malaysia telah dilibatkan dalam kajian ini. Satu instrumen STS, iaitu Ujian Sikap terhadap Sains (USTS) telah diadaptasikan daripada "Test of Science-Related Attitude, TOSRA" (Fraser, 1981) dan Attitude towards Science Measure, ATSM (Kind, Jones, & Barmby, 2007) atas pertimbangan kesesuaian, kerangka teori, dan ciri-ciri psikometrik. Ia mengandungi lapan konstruk STS: (1) Konsep kendiri dalam sains; (2) Implikasi sosial dalam sains; (3)Kenormalan ahli sains; (4)Sikap terhadap inkuiri saintifik, (5) Penerimaan sikap saintifik; (6) Minat dalam sains pada masa lapang; (7) Minat dalam kerjaya sains dan penyertaan dalam sains pada masa hadapan; dan (8) Keseronokan dalam pembelajaran sains. Setiap konstruk mengandungi lima item dengan skala Likert. STST telah diterjemahkan daripada bahasa Inggeris kepada bahasa Melayu berdasarkan garis panduan terjemahan Hambleton dan Patsula (1999). Dengan menggunakan analisis Rasch, hasil keputusan menunjukkan bahawa STST menunjukkan ciri-ciri psikometrik yang memuaskan. Selain itu, keberbezaan item fungsi (DIF) antara responden lelaki dan perempuan telah diperiksa. Enam item (15%) daripada 40 item menunjukkan sifat DIF. Di samping itu, keputusan kajian menunjukkan bahawa terdapat kesan kedudukan aliran ke atas STS bagi pelajar-

pelajar aliran sains, tetapi tidak mempunyai kesan terhadap pelajar-pelajar aliran sastera. Keputusan kajian ini menyumbangkan implikasi penting dalam menghasilkan satu instrumen STS untuk kegunaan pada masa hadapan. Ia juga dapat meningkatkan kesedaran para pendidik tentang kesan kedudukan aliran ke atas STS pelajar, terutamanya pelajar aliran sains. Tambahan pula, kerangka teori STS dalam kajian ini berpotensi memantapkan pengetahuan tentang STS dan membekalkan kerangka bagi kajian yang berkaitan dengan STS pada masa hadapan.

ASSESSING FORM FOUR STUDENTS' ATTITUDE TOWARDS SCIENCE IN NORTH EAST DISTRICT OF PENANG.

ABSTRACT

This study aimed to adapt and validate an ATS measure, assess students' ATS, and investigate the effect of track position on students' ATS. A total of 749 Form Four students from eight secondary schools in the state of Penang, Malaysia were involved in this study. An ATS measure, namely Attitude towards Science Scale (ATSS) was adapted from Test of Science-Related Attitude, TOSRA (Fraser, 1981) and Attitude towards Science Measure, ATSM (Kind, Jones, & Barmby, 2007) upon considerations of appropriateness, theoretical framework, and psychometric properties. It consists of eight distinct ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson. Each construct consists of five items with five point Likert scale. ATSS was translated from English language to Malay language by following test adaptation guidelines by Hambleton and Patsula (1999). By using Rasch analyses, results showed that ATSS demonstrated sufficient evidences of psychometric properties. Besides, DIF was examined to determine items that function differently between male and female respondents. Six items (15%) out of 40 items showed DIF. In addition, findings showed that there is effect of track position on science stream students' ATS but not for arts stream students. Besides, there are strong correlations among the eight ATS constructs, supporting the relevancy and accuracy of the

framework. The findings of this study bear significant implication to provide a valid and reliable ATS measure for future implementation. It also can serve to remind stakeholders to pay more attention on the effect of track position on students' ATS, especially for science stream students. Furthermore, the ATS framework in this study has the potential to serve to advance the knowledge of ATS and provide a framework for ATS research in the future.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Science education is an important area in education. As in National Research Council (1996) as cited by (Chin, Shieh, & Tuan, 2005), aims of science education is to help students master essential science concepts, learn the nature of science, understand the contribution of science and technology to their lives, and willing to learn science either in or out of school. Furthermore, science education is the cornerstone of scientific careers. According to Maltese and Tai (2010), public has the great attention on science education. In United States, science education is one of the areas of national interest (Kumar & Sherwood, 2007). In Malaysia, science education plays an important role in the technological development. This can be seen clearly through the National Science Education Philosophy of Malaysia, "Science education in Malaysia nurtures a Science and Technology Culture" (Minister of Education, 2002, p. v).

One major concern in science education is attitude towards science (ATS). It is identified as a cornerstone and substantive feature of work in science education in many countries (Osborne, Simon, & Collins, 2003; Zhang & Campbell, 2010). For examples, United Kingdom (Francis & Greer, 1999; Kind, Jones, & Barmby, 2008; Reiss, 2010), United States of America (George, 2000; 2003; Zhang & Campbell, 2010), Nigeria (Oluwatelure & Oloruntegbe, 2009), Australia (Hassan, 2008), and South Africa (Pell & Manganye, 2007). It is because ATS is a paramount factor in determining students' science achievement (Ahmad, Rohandi, & Azman, 2010a; Osborne, Simon, & Collin, 2003; Simpson & Oliver 1990; Zhang & Campbell,

2010). According to Simpson and Oliver (1990), a positive ATS leads to a positive commitment to science and it will affect lifelong interest and learning in science. There is also a correlation between ATS and future access to science experiences (Ahmad Nurulazam, Samsudin, Rohandi, & Azman, 2010b; Simpson & Oliver, 1990).

As ATS has positive correlation with science achievement, it becomes paramount that valid and reliable instruments are available for revealing students' ATS (Zhang & Campbell, 2010). Although many instruments are existing but the quantity of the instrument does not reflect the interpretation of scores obtained through these instruments (Kind, Jones, & Barmby, 2007; Zhang & Campbell, 2010). Problems and weakness with existing ATS measures have been identified. There are two serious limitations: (a) the concept of attitude is not well defined and (b) the ATS measures often have poor psychometric quality (Garner, 1996; Munby, 1997; Francis & Greer, 1999; Kind, Jones, & Barmby, 2007; Osborne et al., 2003; Reid, 2006). While studying students' ATS provides valuable information about what students think and feel about science, it is very important to establish a valid and reliable ATS measure. However, develop a new instrument is very time consuming compared with adapts an existing instrument. It is supported by (Blalock, Lichtenstein, Owen, Pruski, Marshall, & Toepperwein, 2009) that:

"*Rather than continuing to create new instruments, those that show the most promise should be validated further; replication studies should be done to estimate the generalizability of findings, and, when appropriate, instruments should be refined and improved."*(p. 972)

Therefore, this study aimed to adapt and validate existing instruments that are appropriate to the purpose of this study. It becomes more paramount especially

nowadays students' ATS and the number of students studying in science are decreasing in many countries, including Malaysia, the country where this research took place (George, 2000; Hassan, 2008; Kamisah, Zanaton, & Lilia, 2007; Welch, 2010; Wood, 2004; Zanaton, Lilia, & Kamisah, 2006).

On the other hand, although many studies have been done to investigate the factors that contribute to the decreasing of students' ATS, little consideration has been given to the relationship between tracking and students' ATS (Ahmad Nurulazam, Rohandi, & Azman, 2010a; Chen & Howard, 2010; George, 2000; Hassan, 2008; Kamisah, Zanaton, & Lilia, 2007; Ong & Ruthven, 2009). Tracking or streaming is an educational stratification that separating, grouping, sorting students into courses, groups, classes or schools according to achievement and ability (Callahan, 2005; Houtte & Steven, 2009; LeTendre, Hofer, & Shimizu, 2003; Lynch & Baker, 2005; Yonezawa, Wells, & Serna, 2002). In Malaysia, tracking is a common and informal educational practice and its implication is varying across schools (Prihadi, Hairul, & Hazri, 2009). Form Four students (Grade 10 in United States; age 16 or 17) are tracked based on their academic achievement in a public examination, namely Lower Secondary Assessment (PMR) (Education in Malaysia, 2010; Sharifah, et al., 2007). On the other words, only cognitive aspect is concerned but non-cognitive aspect or affective aspect such as ATS is overlooked. While affective aspects play little role or none at all in tracking, learning objectives involve attitudes (Hopkins, 1998). It means that students' ATS should be taken into account to achieve learning objectives in science education. In line with the decreasing of students' ATS and number of students studying in science, it is very important to examine the effect of track position on students' ATS.

Hence, this study aimed to adapt and validate an ATS measure, assess students' ATS, and investigate the effect of track position on students' ATS.

1.2 Problem Statements

The main research problem in this study is that ATS measure which meets the psychometric properties is insufficient. ATS has been recognized as the cornerstone of science learning (Osborne, Simon, & Collins, 2003; Scherz & Oren, 2006; Zhang & Campbell, 2010). As ATS has a positive correlation with science achievement, it becomes paramount that valid and reliable instruments to be available for revealing students' ATS (Ahmad Nurulazam, Samsudin, Rohandi, & Azman, 2010b; Simpson & Oliver, 1990). Many ways were identified to help students develop more positive ATS including the development of ATS measures (Zhang & Campbell, 2010). Although there are several existing ATS measures, they are developed for different purpose rather than for exploring the ATS constructs (Blalock, et al., 2009). There are two serious limitations: (a) the concept of attitude is not well articulated and (b) the ATS measures often have poor psychometric quality (Gardner, 1996; Munby, 1997; Francis & Greer, 1999; Kind, Jones, & Barmby, 2007; Reid, 2006).

For (a) the concept of attitude is not well articulated, there has been a lack of clarity over the last few decades about "attitude" and "ATS" itself (Kind, Jones & Barmby, 2007; Osborne et al., 2003). When ATS is not defined clearly, what is actually being measured is ambiguous. Disparate items may be put together in an attitude scale. This will affect the construct validity, the degree to which tests are able to measure these constructs accurately (Gay, Mills, & Airasian, 2009). Furthermore, this leads to inconsistency between ATS measures and making

comparison between studies impossible (Bennett, 2001; Kind, Jones, & Barmby, 2007).

For the second limitation, (b) the ATS measures often have poor psychometric quality, the key concepts in psychometrics are validity and reliability. For example, to demonstrate good psychometric quality, an instrument needs to be not only statistically internally consistent but also having unidimensionality (Kind, Jones, & Barmby, 2007). In many ATS related studies, there is a misconception that internal consistency implies unidimensionality (Garner, 1995; Kind, Jones & Barmby, 2007). Theoretically, all items in a unidimensional scale measure the same construct, so they will be internally consistent. However, internally consistent scale does not represent unidimensionality, as it may consist of more than one factor (Kind, Jones, & Barmby, 2007).

While an ATS instrument with poor psychometric properties yields invalid information, it is very important to ensure the psychometric properties of the instrument to reveal valuable information on students' ATS. Especially, students' ATS and also the number of students studying in science are decreasing.

Malaysia, the country where this research took place, is facing the increasing demands of science-related human power. Like other Association of Southeast Asion Nations (ASEAN) countries, ATS studies have been focused since few decades ago. However, many studies reported that students' ATS is decreasing. Moreover, the number of students studying in science is decreasing also (George, 2000; Hassan, 2008; Kamisah, Zanaton, & Lilia, 2007; Welch, 2010; Wood, 2004; Zanaton, & Lilia, 2007). Kamisah, Zanaton, and Lilia reported that the marginalization of science among students is a serious problem in Malaysia especially in upper secondary schools. Meanwhile, Zanaton and Lilia denoted that the decrease of students'

involvement in science at secondary schools and universities is a worrying phenomenon. Razila (1998) reported that there is misconception that science-related career will not contribute to good income. Furthermore, Subahan (1997) and Ruhizan (1999) revealed that students perceived science subject as a tough subject. The decreasing of students' ATS and the number of students studying in science is not only endangering the future of science education, but also the future of a country itself. Science education nurtures future scientist and science-related professionals (Hassan, 2008; Osborne, Simon, & Collins, 2003). Hence, if the number of students studying in science and students' ATS are decreasing seriously, there will be a serious shortage of science-related human power. In turn, this will cause negative effects on country's innovation economy (Hassan, 2008). While the decreasing of students' ATS and the number of students studying in science are problematic, establishing a valid and reliable ATS measure in Malaysia context enables researchers/educators to pinpoint the attributes that contribute to these two critical problems.

On the other hand, despite the importance of ATS on students' science achievement, it is neglected in the common educational practice in Malaysia, namely tracking or streaming (Prihadi, Hairul, & Hazri, 2009). It is one of the known effective methods in delivering education and was once popular in English-speaking countries as a standard practice in educational systems (Hallam & Ireson, 2003; Lynch & Baker, 2005). In theory, tracking can enhance teaching and learning process (Callahan, 2005). In Malaysia, all Form Three students (Grade 9 in United States; age 15 or 16) are assigned by schools to either science stream or arts stream based on their previous academic result (Education in Malaysia, 2010; Sharifah et al., 2007). They are given little choice and limited authority in tracking (Sharifah, et al., 2007).

This shows that as a part of affective domain, students' ATS plays little role or none at all in tracking. Nevertheless, since few decades ago, Piaget (1976) had clarified that cognitive and affective aspects are distinct but they are not separable and not reducible. Furthermore, Hopkins (1998) pointed out that learning objectives involve attitude. To achieve learning objectives in science education, ATS should be taken into account. Furthermore, ATS is an important factor that is related to students' science achievement (Ahmad Nurulazam, Rohandi, & Azman, 2010a; Osborne, Simon, & Collins, 2003; Simpson & Oliver 1990; Zhang & Campbell, 2010). Therefore, it is important to have a valid and reliable ATS measure to investigate the effect of tracking on students' ATS.

In line with the problems, it is very important to adapt and validate an ATS measure, assess students' ATS, and investigate the effect of track position on students' ATS.

1.3 Research Objectives

The main research objective of this study is to establish a valid and reliable ATS measure in terms of psychometric propertiest to reveal students' ATS.

Specifically, the research objectives are:

a) To adapt and validate an ATS instrument in terms of content validity, construct validity, and Differential Item Functioning (DIF)s.

b) To investigate the differences of ATS between science stream students who are assigned to track and who choose own track with respect to the eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to

scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson.

c) To investigate the differences of ATS between arts stream students who are assigned to track and who choose own track with respect to the eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson.

d) To investigate the correlations among the eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson.

1.4 Research Questions

To achieve the research objectives in this study, there are several research questions need to be answered:

(a) Is the ATS measure used in this study is valid and reliable in terms of :

  (i) Content validity?

  (ii) Construct validity?

(b) Is there any DIF item exists between male students and female students in the adapted ATS measure?

(c) Is there any significant differences of ATS between science stream students who are assigned to track and who choose own track with respect to the eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3)

Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson?

(d) Is there any significant differences of ATS between arts stream students who are assigned to track and students who choose own track with respect to the eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson?

(e) Is there any correlation among the eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson?

1.5 Significance of the Study

The findings of this study would bear significant implication to provide a valid and reliable ATS measure in terms of psychometric properties for future implementation. ATS has been recognized as the cornerstone of science learning (Osborne, Simon, & Collins, 2003; Scherz & Oren, 2006; Zhang & Campbell, 2010). As ATS has positive correlation with science achievement, it becomes paramount that valid and reliable instruments are available for revealing students' ATS (Ahmad Nurulazam, Samsudin, Rohandi, & Azman, 2010b; Simpson & Oliver, 1990). While an instrument with poor psychometric properties will produce invalid information, it is very important to ensure the psychometric properties of the instrument. A valid

and reliable ATS measure provides valuable information about what actually students think and feel about science (Cothran & Ennis, 1998).

From the perspective of schools, the instrument of this study might be used as a diagnostic assessment reference to assess students' ATS. It has the potential to be used as a formal test that must be taken by every Form Three students before they are assigned into either science stream or art stream. Furthermore, educators might use the instrument to make changes or improvements in teaching and learning process. Science teachers could use this instrument to investigate the level of ATS of students in their classes. If they found that students' ATS is low, they could take remedial actions as such implement activity that can increase students' ATS.

Moreover, the instrument might also bear significant implication to students. They might be able to use the instrument as a self-check test before they make decision in stream selection or course selection. Through the instrument, students might be able to gain more detailed information about what is actually their thinking and feeling about science. Accordingly, this could guide them to choose stream/course correctly.

On the other hand, this study would bear significant implication to solve the decreasing number of students studying in science and also the decreasing of students' ATS. Studying students' ATS might pinpoint attributes that contribute to the decreasing of students' ATS. Students' attitude provides valuable information about what students think and feel about science (Subramaniam & Silverman, 2000). This information could be used to make curricular changes (Cothran & Ennis, 1998). In turn, contribute to the elevation of students' ATS and increase the number of students studying in science. While science education nurtures future scientist and science-related professionals, elevation of students' ATS and increasing of the

number of students studying in science might contribute to the technological development of the nation. Positive ATS drives students into the field of science and give them the motivation to fulfill their ambitions. Our educational system needs to cultivate positive ATS and promote scientific inquiry to produce individuals who are able to contribute to our country's innovation economy (Hassan, 2008).

Moreover, the findings of this study could enhance the awareness of public and educators about the importance of affective aspects, especially ATS. While ATS is not new in science education, it is not focused as much as cognitive aspects (Reid, 2006). As supported by Oliver and Venville (2011) that affective aspects received much less attention than the cognitive aspects. Naturally, science teachers focus on students' cognitive aspects while teaching and ignore the affective aspects (Tegtmeier, 2009). However, affective aspects are as important as cognitive aspects. Since few decades ago, Piaget (1976) had clarified that cognitive and affective aspects are distinct but they are not separable and not reducible. Furthermore, Hopkins (1998) pointed out that learning objectives involve attitude. Thus, concerning ATS in tracking could achieve learning objectives in science education. Moreover, ATS is an important factor of science courses selection, concerning it might minimize the placement error in tracking (Farenga & Joyce, 1998; Forgasz, 2010). Consequently, this might elevate students' ATS and the number of students studying in science. Hence, it is important to ensure that affective aspects especially ATS is taken into account in tracking.

1.6 Limitations of the Study

There are some limitations in this study. First, although the adapted ATS measure in this study has the potential to be used in determining students' stream in

future, predictive validity of the measure will not be determined in this study. To examine the predictive validity, criterion measure is collected at some later time after a test is administrated (Pang & Lajium, 2008). In the other words, it is very time consuming to determine the predictive validity. Moreover, purpose of the adapted ATS measure in this study is to assess students' ATS but not for determining stream selection. Nevertheless it has the potential to be used as a test for stream selection in tracking, this is something that can be address in future studies. Hence, due to the time constraint and purpose of this study, researcher had decided not to demonstrate the predictive validity of the adapted ATS measure.

Another limitation in this study is that students' ATS is concerned but not attitude towards arts (ATA) although both science stream students and arts stream students are involved. This is because the main focus of this study is science education but not arts education. One assumption is made in which students' ATS is inversely proportional to his/her level of ATA. In the other words, if a student has a high level of ATS, he/she will have low level of ATA.

On the other hand, although tracking consists of four structural dimensions, only electivity dimension is concerned in this study. It is due to the appropriateness of electivity to best describe the practice of tracking in Malaysia. Furthermore, electivity dimension is the only dimension that involving students' affective aspect, it is the degree to which students are assigned to tracks (based on cognitive aspect) or choose their own track (based on affective aspect) (Gamoran, Nystrand, Berends, & LePore, 1995). Thus, to emphasize the importance of affective aspect in tracking and to match the objectives of this study, only the electivity dimension is focused. In addition, there are other factors that contribute to the variation of tracking, such as parental involvement, peer pressure and environment. However, concern of this

study is the effect of track position on students' ATS. Hence, other factors that contribute to the variation of tracking are beyond the scope of this study.

Besides, the number of students involved in this study is limited. Since both science stream students and arts stream students were involved, this study can only be carried out in secondary schools which are having of both streams. Furthermore, in Malaysia, students are tracked into different streams after they completed their study at lower secondary school. Thus, only upper secondary schools students but not lower secondary schools students can be involved. Hence, only limited respondents in a school were involved in this study.

Furthermore, the honesty of respondents is another limitation in this study. All data was collected based respondents' response. It is very hard to determine and judge that whether respondents answer the test questions honestly and accurately or not. Researcher can only reduce the possibility of dishonesty of respondents by telling them that result of the test will not be evaluated as a part of their academic performance in school.

On the other hand, another limitation is the duration of test. In order not to affect teaching and learning process in school, duration of test could not be too long. Meanwhile, excessive time could make respondents feel boring. Thus, number of items/questions must be well organized and planned according to time.

Meanwhile, it is not easy to get permission from school principals to carry out data collection in school. This is because some school principles do not wish any disturbances in the teaching and learning process at school. Thus, data collection was restricted to permitted schools only.

Moreover, due to the limited financial support, this research cannot be carried out in all the states in Malaysia. It was carried out in one of the states in Malaysia,

which is Penang. The ATS level among students in different states in Malaysia cannot be compared. Hence, ability to generalize the findings in this research in other states in Malaysia is limited.

1.7 Definition of Terms

Attitude – It is the tendency of thinking, feelings, and action that a person has about an object, based on his or her belief and preferences about that object that can be positive or negative (Kind, Jones, & Barmby, 2007; Oluwatelure & Oloruntegbe, 2010; Salta & Tzougraki, 2004; Sax, 1997).

Attitude towards Science (ATS) – It is the tendency of thinking, feelings, and action that a person has about science, based on his or her belief and preference about science that can be positive or negative, which consists of eight ATS constructs: (1) Self-concept in science; (2) Social implications of science; (3) Normality of scientists; (4) Attitude to scientific inquiry; (5) Adoption to scientific attitudes; (6) Leisure interest in science; (7) Career interest and future participation in science; and (8) Enjoyment of science lesson (Fraser, 1981; Kind, Jones, & Barmby, 2007; Oluwatelure & Oloruntegbe, 2010; Salta & Tzougraki, 2004; Sax, 1997).

Validation – It refers to the process in assessing the degree to which an instrument is valid and reliable in term of psychometric properties.

Content Validity – It refers to the degree to which a test measures the content domains that it is designed to measure. It is very important to determine content validity especially for a test which is adapted from a source of language to a target language. To ensure the test content of an adapted test is congruent with the testing purpose, proper test adaptation guidelines such as Hambleton and Patsula Guidelines (1999) should be referred.

Construct Validity – It refers to the degree to which a test is able to measure the theoretical constructs accurately. It can be determined by using Rasch analyses, including unidimensionality (fit statistics and point-biserial correlations), person-item reliability and separation, rating scale diagnostics, and Differential Item Functioning (DIF).

Differential Item Functioning (DIF) – It occurs when two or more subgroups have different probability of giving a certain response on a test item.

Tracking – It refers to the educational practice that places students into different curricular tracks that vary across school in term of track position: assigned to track or choose own track.

Track position – It refers to students' position in tracking, either they choose their own track or they are assigned to track. It is an indicator to measure the electivity dimension, which is the degree of students choose or are assigned to tracks. This measure relies on students' perception of electivity (Gamoran & Berends, 1987; Gamoran, 1992; Sorensen, 1970; Rosenbaum, 1976). Generally, Malaysian students are grouped based on their previous academic achievement. However, schools may vary in the ways of grouping students. In most of the schools, students are assigned by schools to a particular track. Meanwhile, in some schools, students are allowed to choose their own track, especially for good academic students. This differences leads to different track position among students.

Assigned to track – It refers to students' perception of their track position. Regardless of science stream or arts stream, if a student is not studying in his/her preferred stream, he/she can be categorized as student who is assigned to track.

Choose Own Track – It refers to students' perception of their track position. Regardless of science stream or arts stream, if a student is studying in his/her preferred stream, he/she can be categorized as students who choose own track

Form Four Students - Form Four students (Grade 9 in United States; age 16 - 17) are defined as secondary school students who are already completed their lower secondary education (Form 1 – 3; Grade 6 – 8 in United States; age 13 - 15) and studying in Form Four class in any secondary schools in Malaysia.

Science Stream Students - Science stream students are defined as any upper secondary school students (Grade 9 – 12 in United States; age 16 - 18) and study science subjects such as chemistry, physics, biology and/or additional mathematics.

Arts Stream Students – Arts stream students are defined as any upper secondary school students (Grade 9 – 12 in United States; age 16 - 18) and study arts subjects such as compound sciences, history, geography, language, accountancy and/or commerce.

1.8 Conclusion

This chapter had discussed the background, objectives, questions, significant and limitations of the study. Also, definitions of terms involved. The next chapter will discuss the related theories and literature review of previous studies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, attitude and attitude towards science (ATS) were defined clearly, followed by brief description of psychometric properties of existing ATS measures and ATS related previous studies. On the other hand, validity, content validity (test adaptation), construct validity (Rasch Model), and DIF were explained. In addition, tracking and track position were defined clearly, followed by previous related studies. Lastly, this chapter is ended with theoretical framework and framework of the study.

2.2 Attitude towards Science (ATS)

2.2.1 Defining Attitude towards Science (ATS)

Attitude is a very complex and unique concept which integrates multiple properties and has different domains (Zhang & Campbell, 2010). Definition of attitude itself has been one of the problems in many ATS related studies (Francis & Greer, 1999; Kind, Jones, & Barmby, 2007; Osborne, Simon, & Collins, 2003). In general, the definition of attitude is based on three components: cognitive, affective, and behavioral (e.g., Francis & Greer, 1999; Kind, Jones, & Barmby, 2008; Reid, 2006; Subramaniam & Silverman, 2000; Walker, 2006). Reid (2006) had described these three domains in more details:

(a) Cognitive is the knowledge about objects, beliefs, and ideas.

(b) Affective is the feeling about objects, such as like or dislike.

(c) Behavioral is the tendency to take action towards objects.

These three components are closely linked together (Kind, Jones, & Barmby, 2007). For example, a person has the knowledge about science (cognitive), he/she has feeling about science (affective). This feeling triggers him/her to take some actions regarding science (behavioral). As supported by Subramaniam and Silverman (2000), feeling towards an attitude object impacts behavior. If a person likes science, this feeling will trigger him/her to do something that is related with science, such as carry out experiment (behavior).

However, some researchers have argued that these three components should be assessed independently and attitude should be viewed as the basis for evaluative judgments (Ajzen, 2001; Crano & Prislin, 2006). When a person has the attitude towards something, he/she judges it with his/her feelings, such as good or bad, happy or unhappy. The one he/she judges is often called the attitude object (Crano & Prislin, 2006). On the other word, when he/she is asked about his/her attitude towards an object, he/she is actually asked to judge the object. Yet it is very hard to separate affective and cognitive component (George, 2000; Kind, Jones, & Barmby, 2007). This is because affective component is always linked to cognitive component which is the belief that a person holds (Klopfer, 1971). Hence, Kind, Jones, and Barmby (2007) had defined attitude as "the feelings that a person has about an object, based on his/her beliefs about the object" (p. 873). According to Sax (1997), attitude is a preference for groups, institutions or objects. It is a tendency to think, feel or act towards objects in people surrounding, that can be positive or negative (Oluwatelure & Oloruntegbe, 2010; Salta & Tzougraki, 2004). Following the various definitions of attitude, in this study, attitude is defined as: "the tendency of thinking, feelings, and actions that a person has about an object, based on his/her belief and preference about the object that can be positive or negative".

Based on different views of attitude, many definitions of attitude towards science (ATS) emerged. In science education, ATS could refer to science as a subject (George, 2003). Klopfer had made an early notable contribution towards ATS elaboration in the year of 1971. He had categorized a set of affective behaviours in science education which consists of six subcategories (H.1. to H.6.):

H.1 The manifestation of favourable ATS and scientist.

H.2 The acceptance of scientific enquiry as a way of thought.

H.3 The adoption of scientific attitudes.

H.4 The enjoyment of science learning experiences.

H.5 The development of interests in science and science-related activities.

H.6 The development of an interest in pursuing a career in science or science-related work.

As pointed out by Klopfer (1971) that although this classification does not pretend to be a complete taxonomy of the affective domain as it concerns students' learning in science, it would be the most desirable to have such taxonomy. One decade later, Fraser (1981) had developed a Test of Science-Related Attitude (TOSRA) based on Klopfer's Classification. According to Fraser (1981), students' ATS can be measured by using TOSRA, which consists of seven constructs, as shown in Table 2.1.

Table 2.1.

Constructs of TOSRA based on Klopfer's Classification.

Scale Name	Klopfer's Classification (1971)
Social Implications of Science (S) Normality of Scientist (N)	H.1: Manifestation of favorable attitude towards science and scientists.
Attitude to Scientific Inquiry (I)	H.2: Acceptance of scientific inquiry as a way of thought.
Adoption of Scientific Attitude (A)	H.3: Adoption of "scientific attitude".

Table 2.1.

Continued.

Scale Name	Klopfer's Classification (1971)
Enjoyment of Science Lessons (E)	H.4: Enjoyment of science learning experiences.
Leisure Interest in Science (L)	H.5: Development of interest in science and science-related activities.
Career Interest in Science (C)	H.6: Development of interest in pursuing a career in science.

In the following few decades, many researchers had contributed to the extended elaboration of ATS. Garner (1975, as cited in George, 2000) defined ATS as a learned predisposition to judge particular objects, people, actions, situations or propositions involved in science learning. On the other hand, Coll, Dalgety, and Salter (2002) defined ATS as to do with what we think of science, such as boring, difficult, and fun. Furthermore, Osborne, Simon, and Collins (2003) had proposed some dimensions of ATS such as the perception of the science teacher; anxiety toward science; the value of science; self-esteem at science; motivation towards science, enjoyment of science; attitudes of peers and friends towards science; attitudes of parents towards science; the nature of the classroom environment; achievement in science; and fear of failure on course.

On the other hand, Kind, Jones, and Barmby (2007) had defined ATS as a way of mapping students' cognitive and emotional opinions about various dimensions of science. They pointed out that ATS can be measured based on seven constructs: (1) Learning science in school, (2) Practical work in science, (3) Science outside of school, (4) importance of science, (5) Self-concept in science, (6) Future participation in science, and (7) Combined interest in science. The first three constructs aimed to measure pupil's ATS learning activities in three different contexts: inside the classroom, practical, and outside the classroom. The fourth

construct aimed to measure pupils' belief in value of science in a wider social context. The fifth construct aimed to measure pupil's self-concept based on beliefs about one's own ability to master school science. In turn, this will form pupil's ATS. The sixth construct is future participation, which is students' attitude towards getting more involved with science in the future career. The last construct is the combination of (1) learning science in school, (3) science outside of school, and (6) future participation in science.

Table 2.2.

ATS Framework by Kind, Jones, and Barmby (2007).

Construct	Scope
(1) Learning science in school.	ATS learning activities inside the classroom.
(2) Practical work in science.	ATS learning activities inside the practical classroom.
(3) Science outside of school.	ATS learning activities outside the classroom.
(4) Importance of science.	Belief in value of science in a wider social context
(5) Self-concept in science.	Individual's perception and beliefs about one's own ability, or how someone perceives themselves in mastering school science.
(6) Future participation in science.	Attitude towards involving more with science in the future career.
(7) Combined interest in science.	Combination of (1) learning science in school, (3) science outside of school, and (6) future participation in science.

In the context of this research, ATS is defined as: "the tendency of thinking, feelings, and action that a person has about science, based on his or her belief and preference about science that can be positive or negative, which consists of eight ATS constructs: (1) Self-concept in science, (2) Social implications of science, (3) Normality of scientists, (4) Attitude to scientific inquiry, (5) Adoption to scientific attitudes, (6) Leisure interest in science, (7) Career interest and future participation in science, and (8) Enjoyment of science lesson.

2.2.2 Psychometric Properties of Existing ATS Measures

Many ATS measures were developed in the past few decades. However, the number of instruments does not reflect the interpretation of scores obtained through these instruments (Kind, Jones & Barmby, 2007; Zhang & Campbell, 2010). There are some problems and weaknesses have been identified. One serious problem is the insufficient of psychometric quality (Francis & Greer, 1999; Garner, 1996; Kind, Jones, & Barmby, 2007; Munby, 1997; Osborne et al., 2003; Reid, 2006).

It is very important to ensure the psychometric properties of ATS measure in order to provide valid and reliable information. Blalock et al. (2009) stated that more studies should be carried out to provide more reliability and validity evidences of existing ATS measures. Meanwhile, Kind, Jones, and Barmby (2007) had proposed several psychometric guidelines that should be of concern when formulating an ATS measure:

(a) Clear descriptions of constructs which are going to be measured.

(b) Clear justification that ATS constructs are closely related.

(c) Demonstrate reliability by confirming the internal consistency of the construct and unidimensionality.

(d) Demonstrate validity with the use of psychometric techniques.

A good instrument needs to be internally consistent and unidimensional. In many studies, internal consistency often implies unidimensional. However, while unidimensional scales will be internally consistent, internally consistent scale does not imply unidimensionality. It is because consistent scale might be consisting of several clusters of items, in which each cluster measures a distinct factor. As long as all items have high correlation with other items, a high Cronbach alpha will still be obtained (Garner, 1995; Kind, Jones, & Barmby, 2007; Osborne et al., 2007).

Another psychometric issue for ATS measures is the use of negative item. Negative item is defined as item that is phrased in the opposite semantic direction of the positive item (Barnette, 2000). It is common that negative items are used in ATS measure. This is because the reliability of ATS measure can be well assured as more responses can be obtained from the respondents (Reid, 2006). However, previous studies showed that negative items can lead to psychometric problem. Schriesheim and Hill (1981) reported that the use of negative item can impair the response accuracy. This is supported by Marsch (1996), and Fletcher and Hattie (2005) that negative items affect the item response inconsistency of a measure. Furthermore, in the study carried out by Chamberlain and Cummings (1984), it was found that the score reliability of test with positive items only is higher than test with both positive and negative items. Another study by Pilotte and Gable (1999) also showed that the use of both positive and negative items will affect the reliability of an affective instrument. On the other hand, Brown and Maydeau-Olivares (2011) reported that negative items can be confusing for respondents. This is supported by Fletcher and Hattie (2005) that negative items can be difficult for respondents to understand and interpret. Hence, to ensure the psychometric properties of an ATS measure, the use of negative items is not encouraged and should be avoided.

2.2.3 Previous ATS related Studies

2.2.3.1 In Foreign Countries

George (2006) had examined the effect of attitudes about science and attitudes utility of science on science learning in schools. Cross-domain analysis was used to examine the changes in ATS and attitudes about the utility of science over the middle school and high school years. The findings of the study showed that