Perceptions and Attitudes of Pupils Toward Technology

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Abstract

Students' technological concepts and attitudes have been researched for just over three decades. The chapter addresses several viewpoints concerning the construct of attitudes toward technology, such as definitions of attitude, and fundamental reasons for measuring students' attitudes. The main part of the chapter presents the Pupils' Attitudes Toward Technology-Netherlands (PATT-NL) instrument and the PATT-USA instrument associated with the classical PATT studies, as well as the PATT Short Questionnaire (PATT-SQ) as a recent adaptation of PATT-USA. It also focuses on new instruments, such as the Attitudinal Technology Profile (ATP) questionnaire that were developed based on regional and contextual factors. The latter part of the chapter provides general research findings from the PATT studies on students' attitudes toward technology, as well as examples of recent multidimensional versus unidimensional studies.

Keywords

Technology education • Attitudes • Concepts • Behavior • Attitude measurement

Contents

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M.J. de Vries (ed.), *Handbook of Technology Education*, Springer International Handbooks of Education, DOI 10.1007/978-3-319-44687-5_43

Introduction

The chapter addresses several viewpoints concerning the construct of attitudes toward technology, such as definitions of attitude, and fundamental reasons for measuring students' attitudes. The main part of the chapter presents the Pupils' Attitudes Toward Technology-Netherlands (PATT-NL) instrument and the PATT-USA instrument associated with the classical PATT studies, as well as the PATT Short Questionnaire (PATT-SQ) as a recent adaptation of PATT-USA. It also focuses on new instruments, such as the Attitudinal Technology Profile (ATP) questionnaire that were developed based on regional and contextual factors. The latter part of the chapter provides general research findings from just over three decades of PATT studies on students' attitudes toward technology, as well as examples of recent multidimensional versus unidimensional studies.

In the next section, reasons why researchers are interested in measuring students' attitudes toward technology will be considered.

Rationale for Ascertaining Pupils' Attitudes Toward Technology

Researchers regard studying students' attitudes toward technology as important for the following reasons:

- The development of attitudes is part of pragmatic education where the student as an individual is the focal point, within a social context. The role of the teacher is one of facilitator or group leader (De Klerk Wolters 1989a; Hill 1997).
- The development of students' technological concepts and attitudes is part of the aims of technology education (De Vries 2000, 2005).
- Students' attitudes have a major impact on career choices, courses of study, and subject fields in school (Ardies et al. 2013; De Klerk Wolters 1989a; Gaotlhobogwe 2015; Mammes 2004; Rohaan et al. 2010; Volk and Yip 1999).
- Students' attitudes toward technology play a significant role in alleviating anticipated shortages for technology within the labor market (Ardies et al. 2015b).
- Students' attitudes toward technology may be used to predict their achievement (Volk et al. 2003).

- Knowledge of students' attitudes toward technology enables curriculum developers, course designers, and teachers to better assist students in learning technology (De Klerk Wolters 1989a; Dunlap and Dugger 1991; Prime 1991; Yu et al. 2012).
- An understanding of students' technological literacy and attitudes toward technology is a prerequisite for effective technology teaching (Ardies et al. 2013; Bame 1991; Bame et al. 1993; De Klerk Wolters 1989a; Jeffrey 1995).
- Students' attitudes toward technology could inform teacher education (De Klerk Wolters 1989a).

In order to measure attitudes, a clear understanding of the concept is necessary; therefore, definitions of the concept will be discussed in the next section.

Definitions of Attitude

Attitude is a broad concept with different definitions and interpretations. A controversy has long existed in literature regarding the dimensionality of attitudes, with various models comprising one to three dimensions (Ankiewicz et al. 2001; Ardies et al. 2013). The traditional approach is that attitudes have an integrated three-dimensional nature, consisting of cognitive, affective, and behavioral components (Breckler 1984; Fishbein and Ajzen 1973; Ostrom 1969). This approach forms part of the consistent theories as one category of three attitude theories, namely, functional, formational, and consistent theories. Attitude theories and their components are not exclusive but complement one another (Metsärinne and Kallio 2015).

The cognitive component of attitudes includes a person's ideas or opinions that express the relationship between situational and attitudinal objects (Gagné 1977). Statements that reflect a person's perception and knowledge of the attitudinal object are part of the cognitive component (Corsini and Ozaki 1984). The affective component refers to a person's "feeling" or emotion concerning an attitudinal object (Heaven 1982). The behavioral component includes a person's predisposition or readiness for action, as well as his or her actions concerning the "behavioral object" (Ankiewicz et al. 2001; Gagné 1977). For Bagozzi and Burnkrant (1979), attitude is primarily the interplay of affect and cognition, with the behavioral tendency as a secondary consequence (Ankiewicz et al. 2001; Van Rensburg et al. 1999).

According to the traditional approach, an attitude toward a concept such as technology thus is the person's collection of beliefs about it (cognitive component) and associated episodes linked with emotional reactions (affective component). The stimulation of these reactions results in decisions to engage in behavior (behavioral component), such as choosing to take a technology course, to read about technological matters, or to adopt a technology-related hobby (Ankiewicz et al. 2001; White 1988). Researchers in technology education often acknowledge, either implicitly or explicitly, the traditional approach to attitudes (De Klerk Wolters 1988, 1989a; Metsärinne and Kallio 2015; Rohaan et al. 2010; Tseng et al. 2013; Volk and Yip 1999).

Measuring Attitudes

The construct of attitude toward technology is multidimensional and may include enthusiasm/enjoyment or its antagonist, boredom, interest in the subject, students' career aspirations and future intentions, the perceived difficulty of technology, and one's beliefs regarding the consequences of technology (Ardies et al. 2015b). Attitude consists of a large number of sub-constructs, all contributing in varying proportions toward an individual's attitude. Hence, producing a unitary score on attitude is of no use. Care needs to be taken when separate constructs are combined to form one scale, with justification that these constructs are closely related (Ardies et al. 2013).

Attitudes have commonly been measured in PATT studies using questionnaires consisting of Likert scale items, which are ordinal scales used to determine students' levels of agreement or disagreement. Concepts have been measured using three-point scales, usually treated as dichotomous scales (Jeffrey 1993, 1995). Items were derived from an underlying theoretical framework, views of experts, and/or free-response answers generated by students, which is the major justification for their validity. Such open responses were then reduced to a set of usable and reliable items, piloted, and further refined by statistical analyses to eliminate those that fail to discriminate (Ardies et al. 2013; Rennie and Jarvis 1995a).

Based on the aforementioned sections, various instruments have been developed to measure attitudes. These will subsequently be discussed.

Pupils' Attitudes Toward Technology (PATT) Instruments for Ascertaining Students' Attitudes Toward Technology

The Contribution of the Pupils' Attitudes Toward Technology (PATT) Foundation and Its Studies to Instruments for Ascertaining Students' Attitudes

Before the 1980s, research related to students' attitudes toward technology was unusual (Yu et al. 2012). In the 1980s, several countries introduced technology education as a successor to some form of craft or technical education, and it began to develop its own distinct research area. Studies into students' attitudes toward and concepts of technology mostly contained information on students' ideas when entering technology education (Kőycű and De Vries 2016).

The most noted study of students' attitudes toward technology has probably been the work pioneered by Prof Jan Raat and Marc de Vries as part of "Project Physics and Technology" in the Department of Physics Education at Eindhoven University of Technology in the Netherlands in 1984 (De Vries 1988; Volk and Yip 1999). The first part of the research was done among students of ages 13–14 in secondary

general education regarding their attitudes as well as how they conceptualized technology.

The PATT instrument used in the Netherlands, referred to as PATT-NL, was the first instrument specifically designed for this purpose. Results in the Netherlands were so significant that an international extension of the research was the logical next step (Ardies et al. 2013). In 1986, ten countries participated in pilot studies with the aim to increase the reliability and validity of the PATT-NL instrument. In 1987, 12 countries from across the world (e.g., Australia, India, Kenya, Mexico, Nigeria, and also European countries like Belgium, France, Italy, Poland, and the UK) started using the PATT-NL in survey studies with the aim to ascertain and describe the attitudes of students toward technology (De Klerk Wolters 1989a, c; Dugger 1988).

Initially PATT studies aimed to investigate secondary school students' attitudes and the concepts they had of technology (De Klerk Wolters 1988). PATT was a means of generating theoretical knowledge with practical implications for the development and assessment of technology education and was not aimed primarily at curriculum content (De Klerk Wolters 1989a), although it valued the link between research and curriculum development (Raat 1988).

The subsequent development of related international surveys led to workshops and the annual PATT conference, which has brought scholars involved in technology education together for over 25 years to provide a discussion platform for PATT-related issues (Jones et al. 2013; Kőycű and De Vries 2016; Volk and Yip 1999).

PATT studies as well as the PATT Foundation have played an international leadership role in the field of technology education. It has been instrumental in determining the research agenda and establishing an international research fraternity in technology education. It has also become an international discussion forum for all aspects of technology education, like curriculum development, research, teacher education, assessment, and pedagogical issues in primary and secondary schools. It brings scholars together to offer opportunities for an exchange of ideas and information to contribute toward the development of technology education (Jones et al. 2013; Mottier et al. 1991).

PATT conferences, because of their frequency, are the most productive source of research papers in the field of technology education (Williams 2016). The number of classical PATT studies focusing on students' views of technology at these conferences has declined over time in favor of technological literacy, which is still the most common category of papers presented (Volk and Yip 1999; Williams 2013, 2016).

Classical PATT studies generally made use of the following five instruments:

- An attitude questionnaire
- A concept questionnaire
- Qualitative methods like essays with the topic "*What do you think technology is*?" (age group 13–15), drawings (age group 10–12), and open-ended questions (age group 16–18) to get more information on students' attitudes and concepts
- The Technology Attitude Scale (TAS)
- The Teacher Attitude Questionnaire (De Klerk Wolters 1988, 1989a)

The PATT-Netherlands Instrument (PATT-NL)

PATT-NL was the result of an extensive development process that involved rigorous theoretical frameworks, student interviews, and expert opinions to draft the Likert-type items, as well as written responses to validate the results of early pilot studies. Large-scale survey studies in the Netherlands and international pilot studies in more than a dozen other countries resulted in two questionnaires to measure high school students' affective and cognitive perceptions about technology (De Klerk Wolters 1988, 1989a; Luckay and Collier-Reed 2014; Raat and De Vries 1986, 1987; Rennie and Jarvis 1995a).

PATT-NL consisted of the **attitude questionnaire** (De Klerk Wolters 1988; Rennie and Jarvis 1995a; Rohaan et al. 2010; Van Rensburg et al. 1999) and the **concept questionnaire** (Bame and Dugger 1989; Becker and Maunsaiyat 2002; De Klerk Wolters 1989a, b; De Vries 1992; Jeffrey 1993; Rennie and Jarvis 1995a; Rohaan et al. 2010; Van Rensburg et al. 1999) measuring the affective and the cognitive components of attitudes, respectively.

One of the aims of technology education is the formation of a positive concept of technology; therefore, students' concepts have always been an important element in PATT studies (De Vries 2005). Most of the work on students' concepts has been in relation to student perceptions of technology, using the PATT concept questionnaire (De Klerk Wolters 1988, 1989a; Raat and De Vries 1986) which was undertaken in 22 countries spread over Europe, Asia, America, Australia, and Africa (Bame et al. 1993; Jones 1997; Mawson 2010; Rennie and Jarvis 1995b; Solomonidou and Tassios 2007). In its early form, PATT-NL also included an **essay (qualitative) section.** This read *Technology can mean different things to different people. When you read the word 'technology' what comes into your mind?* to ascertain students' cognitive views of technology (Luckay and Collier-Reed 2014).

PATT-NL was subsequently adapted for use in other parts of the world, for example, the USA and South Africa. These adaptations will be briefly discussed in the next section.

The PATT-USA Instrument (PATT-USA)

The original PATT-NL was translated and modified by Bame et al. (1993) for use in the USA (Bame and Dugger 1989; Boser et al. 1998; De Klerk Wolters 1988, 1989a; Householder and Bolin 1993; Volk and Yip 1999; Zuga 1997).

PATT-USA was a one-page instrument consisting of four parts. The first was a short written description of technology, then 11 questions to gather demographic data and information about the technological climate of students' homes, 58 statements (items 12–69) with a five-point Likert-type scale to assess students' attitudes toward technology, and 31 statements (items 70–100) with a three-point Likert-type scale to assess students' concept of technology. The PATT-NL essay question was replaced with a brief statement of what the students thought technology was (Bame and Dugger 1989; Boser et al. 1998; De Klerk Wolters 1988, 1989a).

After adjusting the instrument to the specific regional context, the PATT-USA has been used in countries around the world including Botswana, Kenya, India, South Africa, Nigeria, and Mexico (Ankiewicz et al. 2001; Ardies et al. 2013; Becker and Maunsaiyat 2002; Chikasanda et al. 2013; De Klerk Wolters 1989a; Kapiyo and Otieno 1986; Meide 1997; Rajput 1988; Van Rensburg et al. 1999; Volk and Yip 1999). The language of the instrument often had to be changed, and context-specific items had to be adapted, for example, the technological toys children were exposed to (Ardies et al. 2013; Bame et al. 1993; Volk and Yip 1999). As noted by Bame et al. (1993), the international PATT studies used similar instruments, but the scales used and conditions under which the instrument was administered were different (Volk and Yip 1999).

The PATT-USA was applied in South Africa with less success than in the USA and in some other developing countries in Africa (Gaotlhobogwe 2012; Gaotlhobogwe et al. 2011; Van Rensburg et al. 1999). In Asia, Volk and Yip (1999) revised PATT-USA to develop the PATT-Hong Kong (PATT-HK). Drawing on the PATT series of instruments, Yu et al. developed an instrument suitable for junior high school students in Taiwan (in Ardies et al. 2015b). This is important as the Asian region had been neglected – the PATT studies of over 20 countries, on which the instrument was based, largely focused on countries from Europe, North America, and Africa, the sole exception being India (Bame et al. 1993; Volk and Yip 1999).

The application of PATT-USA in South Africa, as an example of a developing context, as well as the development of new instruments based on regional and contextual factors, such as the Attitudinal Technology Profile (ATP) questionnaire, will be discussed in the next section.

The Application of PATT-USA in South Africa

Van Rensburg et al. (1999) analyzed the data collected with the PATT-USA attitude questionnaire (affective component) among 1,010 students in South Africa. Contrary to the PATT-USA findings, it was found that South African girls had more positive attitudes toward technology than boys did. Girls also viewed boys as more competent at or knowledgeable in technology than boys viewed themselves. Based on the low explained variance (24.4%) and the Cronbach alpha (0.66), Van Rensburg et al. (1999) concluded however, that the PATT-USA attitude questionnaire in this instance had not yielded valid and reliable results. The researchers attributed these differences to problems concerning the questionnaire design and its application in developing countries. They pointed out that the understanding of concepts and terminology due to language barriers, frame of reference, culture, and how items were formulated influenced the empirical research (Solomonidou and Tassios 2007; Van Rensburg et al. 1999).

The affective-related items (12–69) in PATT-USA were formulated using prescriptive or evaluative propositions (Van Rensburg et al. 1999). Its revisions departed from the original PATT-NL, and in the overwhelming majority of attitude measures, the items were formulated as prescriptive or evaluative propositions.

In resolving the contextual and formulation problems experienced with the PATT-USA, Van Rensburg et al. (1999) designed the **Attitudinal Technology Profile (ATP) questionnaire** to be used in the lower secondary school (ages 13–14). In Part A of this instrument, students were familiarized with the construct of technological product, in order to avoid misconceptions. In Part B, 24 items were included on a five-point Likert-type scale to assess students' attitudinal technology profile (Ankiewicz et al. 2001).

The ATP questionnaire avoided demanding any high-level language proficiency. The items were designed and formulated as descriptive propositions linked to the affective components of the content of technology and attitude. By using descriptive propositions, it was also possible to integrate the affective component of attitude to some extent with the behavioral component (only students' readiness for action). PATT-USA did not address the behavioral component of attitude. In the ATP questionnaire, students had to respond to gender-neutral descriptive items. The responses of the boys on all items were then compared with the responses of the girls on all items in order to determine whether any gender-related differences existed (Ankiewicz et al. 2001; Van Rensburg et al. 1999).

The ATP questionnaire was piloted in two so-called township schools among 481 students. Only four factors or subscales were identified, in contrast to the six factors identified with PATT-USA. The 24 affective-related items, based on descriptive propositions, yielded more valid and reliable results than the 58 affective-related items of PATT-USA, which were based on evaluative/prescriptive propositions, had done. The explained variance (35.5%) and the Cronbach alpha (0.78) were higher, compared to 24.4% and 0.66 for PATT-USA previously used in South Africa (Ankiewicz et al. 2001).

Several researchers stated that PATT-NL and PATT-USA were useful, but often too long to administer in a study combining instruments. If measuring attitude and technological literacy in the same students, time limitation became an issue (Ardies et al. 2013; Volk and Yip 1999). The problem of length was partly addressed, at least for the attitude questionnaire, by the shorter PATT-SQ version.

The Reconstruction of PATT-USA into the PATT Short Questionnaire (PATT-SQ)

The attitude questionnaire (affective component) of the PATT-USA instrument as developed in the 1990s was recently reconstructed and revalidated by Ardies et al. (2013). This resulted in the shorter PATT-SQ instrument with six sub-factors (career aspirations, interest in technology, tediousness, positive perception of effects of technology, perception of difficulty, and perception of technology as a subject for boys or for boys and girls) and 24 items of attitude toward technology (Ardies et al. 2013).

PATT studies of students' attitudes toward technology often focus on the effects of a single determinant or predictive characteristic (e.g., gender) on one aspect of attitude (e.g., interest in technology) as a unidimensional concept. The total effect

can then not be ascertained adequately as attitude is a multidimensional concept. In contrast to most earlier research, Yu et al. (2012) and Ardies et al. (2013, 2015b) embarked on multidimensional (multivariate, multilevel) studies, which will be discussed next.

Multidimensional (Multivariate, Multilevel) Versus Unidimensional Studies

By drawing on the PATT series of instruments, Yu et al. (2005, in Yu et al. 2012) developed the Attitudes Toward Technology Scale for junior high school students in Taiwan to enable Taiwanese scholars of technology education to design and implement research consistent with international norms. By comparing the five attitude factors based on dimensions of the affective domain to the six PATT-NL factors, they proposed five factors, namely, technology interest, identification, perplexity, curriculum, and career (Yu et al. 2012). The technology acceptance model (TAM) explains relationships among users' attitudes, motivations, and use by focusing on the usefulness and ease of use of technology. The correlations among the five factors, namely, technology interest, identification, perplexity, curriculum, and career (Yu et al. 2012) themselves, the effect of the factors on the attitudes of junior high school students in Taiwan, and the identification of the factor with the strongest influence on their attitudes were studied through path analyses of effects via multiple regression analyses. Contrary to the expectation of significant other correlations, this study confirmed only the correlation of intention to pursue a career in technology with identification with technology and with experience of technology curricula (Yu et al. 2012).

Ardies et al. (2015b) developed a matrix in which the five different dimensions of attitude as described by De Vries (1988) were set up as rows. The predictive characteristics found in literature (i.e., gender, age, toys, and parents) were set up as columns. The studies, presented in the cells of the matrix, drew on technology (T), science (S), or the broader domain of STEM. The PATT-SQ instrument was used in a large-scale multivariate (i.e., a statistical model that allows analyses of multiple dependent variables in one analysis), multilevel (i.e., the first level is the student level and the second level is the teacher level) investigation of 12–14-year-old students in Flanders (grade 1 and 2 of secondary education). The aim was to determine the effect of all predictive characteristics or determinants (Ardies et al. 2015a) on all aspects of students' attitudes. The results confirmed previous fragmented studies in related disciplines like science education (Ardies et al. 2015b).

Ardies et al. (2015a) also performed a longitudinal investigation with PATT-SQ of 12–14-year-old students in Flanders, exploring the evolution of their interest in technology and the determining characteristics for differences in the attitudes of boys and girls, respectively, over time. The results indicated that boys' and girls' interest in technology evolved differently and that the initial differences between them diminished over time.

A summary of the general research findings regarding students' attitudes toward and concepts of technology, in particular in the PATT studies, is given in the next section.

Summary of General Research Findings on Students' Attitudes Toward and Concepts of Technology

The general findings of research studies, in particular the international PATT, indicated that while students had positive attitudes toward technology, they generally had a limited concept of technology. Students often perceived technology as a recent phenomenon and as artifacts or products (e.g., domestic appliances and computers) and did not recognize it as a process (Bame et al. 1993; Cajas 2002; De Klerk Wolters 1989b; De Vries 1988; De Vries and Tamir 1997; Jones 1997; Rennie and Jarvis 1995b; Rohaan et al. 2010; Solomonidou and Tassios 2007).

Students' attitudes toward technology may be attributed to various determinants or predictive characteristics (Ankiewicz et al. 2001; Becker and Maunsaiyat 2002; Van Rensburg et al. 1999) such as context, gender, students' age, the technological nature of the family's professions, and the technological toys and facilities at home (Ardies et al. 2015a).

Context is an important determinant or predictive characteristic that influences students' attitudes. Educational research is far from easy because of the importance of context (Ardies et al. 2015b). The contextual problems experienced with PATT-USA in a developing country have already been alluded to. Gaotlhobogwe (2012) also found that in a developing context, a lack of resources (i.e., the availability of materials, tools, and other equipment) in schools may influence secondary school students' attitudes and perceptions toward technology to such an extent that they did not choose the subject technology.

The age of students as a determinant has an influence on how students perceive technology and their attitudes toward it (Bame 1991; De Vries 1988). De Klerk Wolters (1989b) found that a student aged 10 already had a clear perception or concept of technology as a base for developing attitudes toward technology.

Another important determinant is gender. Findings from studies examining gender issues generally indicated that boys had more positive attitudes toward technology than girls did (Ardies et al. 2015a; Bame et al. 1993; De Klerk Wolters 1989b; De Vries 1988; Mawson 2010; Rennie 1988; Rohaan et al. 2010). Exceptions to these findings were noted by Balogun (1988) in Nigeria and Prime (1991) in Trinidad and Tobago, where no significant gender differences with regard to attitudes and concepts were found. However, on the African continent, attitudes seemed less clear-cut (Meide 1997). Gaotlhobogwe et al. (2011) reported that girls' attitudes toward technology were generally less positive than boys'. In South Africa as another example of a developing context, Van Rensburg et al. (1999) found, on the contrary, that boys were less interested in technology than girls. Furthermore, girls were found to possess more positive attitudes toward technology than boys

(Ankiewicz et al. 2001). In Asia, the PATT-HK results paralleled many of the broad characteristics found in the PATT-USA data on other developed countries (Volk and Yip 1999).

Gender differences are also related to age (Ardies et al. 2015a; Lou et al. 2011; Mawson 2010; Rasinen et al. 2009; Salminen-Karlsson 2007). Gender differences have been found to exist at the age of 10 already and do not disappear on the attitude scales over time (De Klerk Wolters 1989b, c). Recently Ardies et al. (2015a) found the contrary regarding the interest scale, where the gender differences diminished over time. There was an increase in the perceived utility of technology for boys between the ages of 10 and 14 years old, resulting in differences between boys and girls from the age of 14 (Ardies et al. 2015b).

The presence of technological toys has a stimulating effect on students' attitudes, and gender differences may correlate with the presence of and actually playing with technological toys (Ardies et al. 2015b; Bame et al. 1993; Volk and Yip 1999). Rasinen et al. (2009) and Salminen-Karlsson (2007) point out that stereotypical ideas, for example, that technology is a male profession, are stimulated from primary school age by giving students gender-specific toys (Ardies et al. 2015b; Volk and Yip 1999).

Factors such as parents' level of training and/or occupation, their interest in technology, and technology education at primary school level have a positive effect on the attitudes of both boys and girls (Doornekamp 1991). Parents in a profession related to technology have a positive influence on several aspects of attitude toward technology (Ardies et al. 2015b; Bame et al. 1993; Becker and Maunsaiyat 2002).

Students' perceptions of technology and technology education influence what knowledge and skills they operationalize in a technological task and hence affect their technological capability. Students with a broad concept of technology are more likely to undertake technological activities in a holistic fashion, i.e., displaying links between the various stages in the process. A narrow concept of technology constrains students' technological practice and limits their potential for learning technological concepts and processes (Jones 1997). Students associating technology only with computers and modern appliances have less positive attitudes toward technology. Unfortunately, but not fully accidentally, these tend to be mostly girls (Jarvis and Rennie 1996; Rohaan et al. 2010). It has also been found that students' understanding of the concepts of technology increases with age (Bame et al. 1993; Becker and Maunsaiyat 2002; Mawson 2010).

From the PATT studies, it can be concluded that students' concepts of technology are strongly related to their attitudes toward technology. Concept appears to influence affect and not the other way around. This result indicates that a correct and comprehensive concept corresponds with a positive attitude toward technology (De Klerk Wolters 1989b; Rohaan et al. 2010).

Studies of students' attitudes toward technology often focus on the effects of a single determinant or predictive characteristic (e.g., gender) on one aspect of attitude (e.g., interest in technology) as a unidimensional concept. The total effect can then not be ascertained adequately as attitude is a multidimensional concept.

Conclusion

PATT studies were a pioneering initiative in ascertaining students' attitudes toward and perceptions or concepts of technology in the mid-1980s. These were pivotal in setting the broader research agenda for the field of technology education and played a major role in establishing and unifying the international research fraternity in technology education by providing frequent opportunities to share broader research findings.

Based on contextual factors such as language and age, the PATT-NL was adapted for several countries like the USA, Hong Kong, and Taiwan. Subsequently new instruments, such as the ATP, were also developed.

It has been found that students generally have a positive attitude toward technology but a limited concept of technology. Students often perceive technology as a recent phenomenon and as artifacts or products and do not recognize it as a process. Their attitudes toward technology may be attributed to various determinants or predictive characteristics such as gender, technological nature of family's professions, existence of technological toys, and facilities at home.

Research has evolved to a stage now where researchers are interested in small- to medium-scale multidimensional (multivariate, multilevel) studies to determine the effect of all characteristics or determinants on all aspects of students' attitudes as opposed to the effects of a characteristic on a specific aspect of attitude only. More such effect studies will be crucial for deepening our understanding of students' perceptions of and attitudes toward technology.

Acknowledgment I would like to express my sincere gratitude toward my former colleague and Master's student, Dr. Susan van Rensburg, and colleague, Prof Chris Myburgh all working together enthusiastically and committedly on this theme toward the end of the previous century. Also to my research assistant, Ben Low who assisted me in collating and meticulously organizing the applicable sources over a short period.

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