Rethinking Measures of Attitude Toward Technology in Technology Education

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ABSTRACT

Technology curriculums encompass an interdisciplinary approach that integrates science, engineering, the arts, and mathematics, along with a design-oriented learning process. Given the rapid advancement of technology and the challenging environment, technology education has the potential to enhance students' positive outlook on technology. The objectives of this study are to gather existing student attitude scales for technology education, analyse the cognitive, affective, behavioural, and environmental components of these scales, and describe the measurement format and its application. This study referenced established research procedures and instructions, used keywords to research and examine the literature, and collected literature on relevant scales. Afterwards, a coding framework was developed based on the theoretical structure of this study for the research content analysis. Last, descriptive data and critical analysis information were reported. The results of this study can offer a comprehensive component structure for the development of attitude scales in technology education. Furthermore, they will contribute to a more comprehensive understanding of how research in technology education investigates students' attitudes.

Key Words: attitude, perception, attitude toward technology

1. INTRODUCTION

In the early 1980s, Jan Raat and Marc de Vries et al. (1985) conducted an international study on attitudes toward technology called Pupils' Attitude Toward Technology (PATT), which marked the beginning of studies in this field. The PATT study focuses on measuring individuals' cognitive, affective, and behavioural attitudes toward technology, which includes personal interest, role pattern, consequence, difficulty, curriculum, and career categories (Ankiewicz, 2019a). The development of the PATT scale and its study of pupils' attitudes toward technology have widely influenced research on technology education, instruction, and curriculum design, leading curriculum designers to plan technology education programs that meet students' interests and needs. Since then, many scholars have continued to research attitudes towards technology in different countries based on the PATT scale (Ardies et al., 2013; Bame et al., 1993; Becker & Maunsaiyat, 2002; Svenningsson et al., 2021; Van Rensburg et al., 1999; Voke et al., 2003).

In addition to the discussion of the affective component, some studies on PATT have also focused on the cognitive and behavioural components. However, based on Bandura's (1986; 1997) social cognitive theory, studies of learner attitudes also need to explore environmental component effects to be more comprehensive. Therefore, the purpose of this study is twofold: (1) to collect scales on student attitude in the current technology education and analyse the cognitive, affective, behavioural, and environmental components of these scales. (2) to analyse the measurement and application of these attitude scales as a reference for developing a more comprehensive technology attitude scale in the future.

2. THEORETICAL FRAMEWORK

In the model in which technology is manifested, as seen in Mitcham (1994), the formation of technological attitudes mainly results from knowledge, volition, activities (methodology), and objects (ontology) (Fig. 1). Based on Mitcham's (1994:160) philosophical framework of technology, Ankiewicz (2019b) proposed the concept of superposition, meaning that cognition affects emotion and both of them form behaviour (Fig. 2). Essentially, these three attitudes are not independent of each other but rather interact and influence each other. This theoretical perspective has also been widely applied in studies using the PATT scale, which shows how PATT studies have examined students' cognitive, affective, and behavioural attitudes toward technology.

However, Ankiewicz (2019b) highlighted in his research that the mainstream PATT-NL instrument and its derivatives (i.e., PATT-USA and PATT-SQ) have mainly been focusing on the cognitive and/or affective component of attitudes, neglecting the behavioural component. Besides, students' attitudes towards technology are not only dynamically changed by their learning experience but also by the stimulus and influence of environmental factors during the learning process. The social cognitive theory emphasises the interaction of individual, behaviour, and environment (Bandura, 1986; Bandura, 1997). Du et al. (2022) built on Bandura's (2008) model of learner agency to re-emphasise the importance of the environment for problem-based and topic-based team learning (Fig. 3). Therefore, environmental factors should also be a component of PATT research, but it is worth examining whether they have been mentioned in relevant studies.

Figure 1.
Model in which technology is manifested (Mitcham 1994:160)

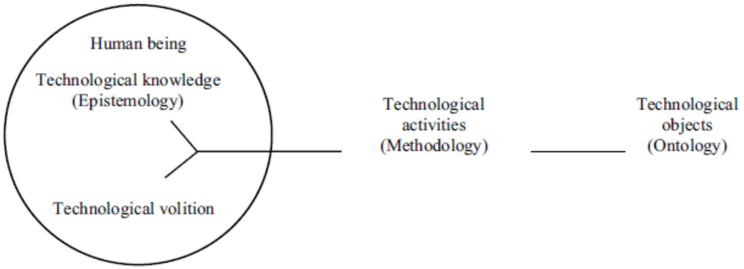


Figure 2.
A superposition of the traditional approach to attitudes and Mitcham's philosophical framework of technology (Ankiewicz, 2019b)

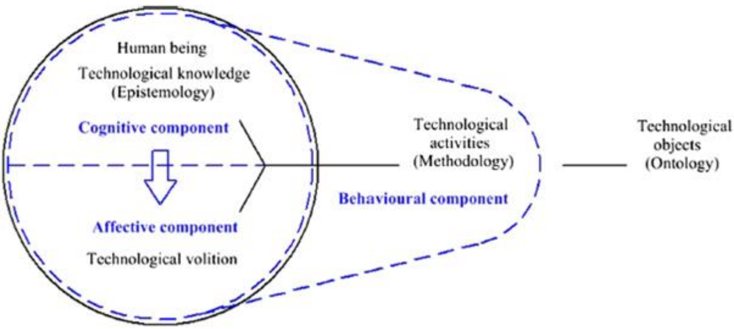
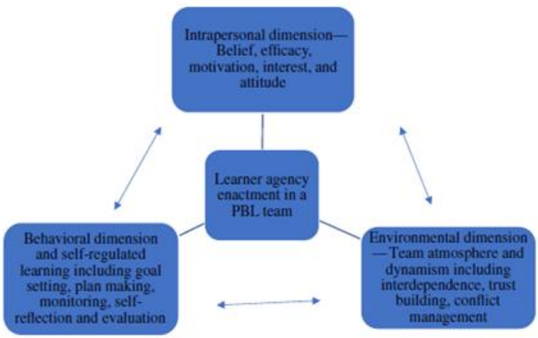


Figure 3.
A model of learner agency in a problem- and project-based learning (PBL) team consisting of three interrelated dimensions (Bandura, 2008)



Based on the above theoretical foundations, this study collected scales on students' attitudes in technology education based on four components: a person's beliefs (the cognitive component), emotional reactions (the affective component), the behavioural component, and the environmental component. On this basis, this study examines how these four components have been explored in PATT measuring scales, and how these technology attitude scales have been assessed and applied.

3. METHODS

To conduct a systematic content analysis, this study follows the research procedures and guidelines (Gao et al., 2020) by conducting literature research and review based on relevant keywords, collecting literature on relevant scales, and developing a coding framework for content analysis based on the theoretical framework of this study (Mitcham, 1994; Bandura, 2008). Finally, descriptive data and key analysis information are reported to provide useful reference results for educational researchers.

The rationale behind the selection of journals underwent a three-stage reflection process. Firstly, a horizontal perspective was considered, taking into account the influence of STEM education trends. It was anticipated that PATT-related research might publish in significant journals within the fields of technology, engineering, and STEM, i.e., International Journal of Technology and Design Education Design (IJTDE), Journal of Engineering Education, and International Journal of STEM Education. Therefore, a search was conducted for article titles and abstracts in these three journals by using keywords (i.e., attitude, belief, efficacy, motivation, interest, and perception). This search obtained 123, 39, and 71 potentially articles over the past decade. Next, content analysis was used on the titles and abstracts of these articles. It was found that PATT-related research was predominantly present in IJTDE, while other journals primarily focused on discussing students' attitudes without adopting PATT measuring scales. Subsequently, a vertical perspective was considered, recognizing that PATT research could also be found in journals within other technology-related journals. Based on the references from IJTDE articles, it was inferred that Technology Education: An International Journal (TEAIJ) and the Journal of Technology Education (JTE) were important journals for the publication of PATT-related research. Therefore, IJTDE, TEAIJ, and JTE were chosen as the journals for systematic content analysis. This outlined process contributes to the validity and reliability of the rationale for this article.

Due to the initial keyword searches mentioned in previous paragraph resulted in overlapping articles. In the final selection of journals, we focused solely on the keywords "attitude" and "perception." The following procedure has been used to conduct this study. First, this study searched for articles with the keywords "attitude" and "perception" from the IJTDE, TEAIJ, and JTE, from which 82, 20, and 7 articles were obtained, respectively, adding up to a total of 108 relevant articles.

Next, the articles were screened by the type of target population, the type of technology attitude, and the type of technology curriculum. The analysis was done by discussion among the authors on the article selection criteria. One of the authors searched the articles in the journal database and used an Excel sheet to organise the results, including: the article title, abstract, and DOI, and then preliminarily categorised the articles by types of research subjects (i.e., student and teacher), types of technological attitudes (i.e., technology attitude, engineering attitude, and STEM attitude), and types of curriculums (i.e., is it a technological curriculum). The outcome was then checked by another author before the final articles were selected for analysis. The research subjects of technology curriculum studies may include both students and teachers; this study, nevertheless, focuses on K-12 students as the target population and only discusses studies on technology curricula and attitudes towards technology, excluding those on engineering attitudes and STEM attitudes. Therefore, three specific criteria were applied. Articles were included if they addressed (a) students as the sample population, (b) K-12 educational settings, and (c) technology curricula. Notably, articles focusing on "attitude" were only considered if they utilized a "PATT measuring scales" for assessment, rather than merely discussing students' attitudes. Finally, a total of 23 articles were selected for data analysis (Appendix A).

Finally, two authors conducted a content analysis together, including: the year of publication, components of technological attitudes, formats of measurement, and comparative analysis of applications. In the coding process, three codes have been configured, with the first code being for the journal, and the second and third codes for the article label. The code number for IJTDE is 1 and there are 17 articles, leading to a code representation of 101-117. The code number for TEAIJ is 2 and there are 2 articles, and therefore the representation is 201-202. JTE is referred to by the code number 3 and there are 4 articles, resulting in 301-304.

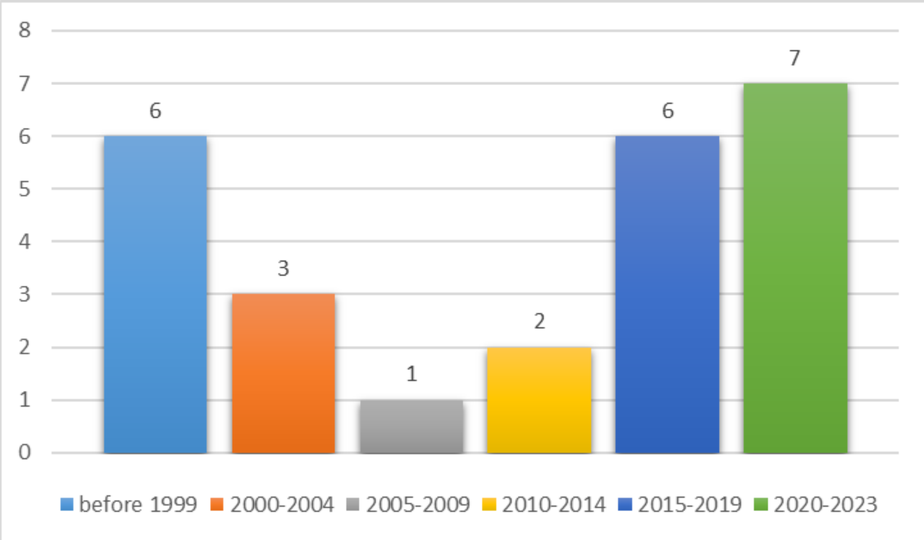
4. RESULTS

4.1. Year of publication

This study's analysis is divided into four sections: First, the distribution of the year of publication of the articles on attitudes towards technology. Second, the components of the articles on attitudes towards technology. Third, the format of measurement in the articles on attitudes towards technology. Fourth, the application of technology attitude scales.

In terms of the distribution of the year of publication of the articles on attitudes towards technology, there were six articles before 1999, three articles from 2000 to 2004, one article from 2005 to 2009, two from 2010 to 2014, six from 2015 to 2019, and seven from 2020 to 2023 (Fig. 4). There is a clear trend of increase in articles on technological attitudes after 2015, mainly concentrated in IJTDE, with 10 articles in all (coded as 108-117 respectively).

Figure 4.
Distribution of articles on attitudes towards technology by year of publication



4.2. Components of technology attitude scales

This study integrates Mitcham's (1994) philosophical framework of technology and Bandura's (2008) model of learner agency theory to classify the components of technology attitude articles into cognitive, affective, behavioural, and environmental types for analysis purposes (Table 1). There are nine articles for the cognitive type, 23 articles for the affective type, eight articles for the behavioural type, and four articles for the environmental type. On the whole, the articles are still mainly concentrated on the study of the affective type, and a few studies have focused on an ongoing basis on cognitive and behavioural discussions, but there is a lack of attention to the environmental type. In articles exploring environmental issues, only climate in the home is discussed. Therefore, it is clear that the development of this part of the scale can be further strengthened.

Table 1.
Components of articles on attitudes towards technology

Components	Articles	Total
Cognitive	101, 103, 106, 112, 113, 201, 301, 302, 303	9
Affective	101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 201, 202, 301, 302, 303, 304	23
Behavioural	101, 103, 105, 108, 109, 112, 116, 304	8
Environmental	105, 301, 302, 303	4

4.3. Format of measurement of technology attitude scales

The format of the measurement of technology attitude scales (Table 2) comprises questionnaires and interviews. All 23 articles analysed used questionnaires and tended to use the Likert scale. Most of the articles used the 5-point Likert scale, while a few used the 4-point Likert scale and the 6-point Likert scale (e.g., 201 and 112). Only two of the analysed articles also used interviews as a means of explanation to supplement the quantitative data of the questionnaires; and both used structured individual interviews (i.e., 103, 110).

Table 2.
Format of measurement of technology attitude articles

Main formats	Articles	Total
Questionnaire	101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 201, 202, 301, 302, 303, 304	23
Interviews	103, 110	2

4.4. Application of technology attitude scales

The application of technology attitude scales can be divided into two types: a survey on the current status of students' attitudes towards technology curriculum and a survey on the change in students' attitudes towards technology when participating in technology curriculum (Table 3). There are 19 articles in the former and four articles in the latter. It can be seen from the data that most of the studies still focus on investigating the current status of students' attitudes towards technology, while a few studies try to examine changes in attitudes. For example, some compare the change in students' attitudes towards technology before and after taking technology curriculum (i.e., 111, 114, 115, 301).

Table 3.
Application of attitude towards technology scales

Means of application	Times of application	Articles	Total
Survey on students' attitude towards technology in technology curriculum	Once	101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 112, 113, 116, 117, 201, 202, 302, 303, 304	19
Survey on changes in students' attitude towards technology before and after participating in technology curriculum	Twice (and more)	111, 114, 115, 301	4

5. DISCUSSION AND SUGGESTION

In planning the attitude scale for technology education, it can be observed that the relevant research has been mainly focused on discussing the affective component, and more exploration is needed regarding the cognitive, behavioural, and environmental components. This aligns with Ankiewicz's (2019b) assertion regarding the neglect of the behavioural component. Furthermore, our study has also revealed a relative scarcity of research focusing on the cognitive and environmental components. Therefore, it is suggested that future PATT research should provide a broader category structure that enables a more complete understanding of the cognitive, behavioural, and environmental aspects of students' attitudes toward technology in technology education curriculum.

In addition, the attitude scales developed in related research studies mainly use the Likert scale of questionnaires, which are mostly designed to discuss positive perceptions. A few studies have developed attitude scale tools or qualitative observations based on the design process of technology activities, for example, Doornekamp (1991) provides students with open-ended items for them to respond about their design skills in cases of design problems, and Hendley et al. (1996) and Svenningsson et al. (2018) adopted qualitative interviews to assess and gain a deeper understanding of students' perceptions of participation in the technology curriculum. These studies not only discuss whether students develop positive perceptions of technology during the curriculum but also find that students are prone to negative emotions during the design process or do not understand the learning objectives that affect their attitudes toward technology.

Furthermore, most studies have focused on the current status of students' attitudes toward technology in a single subject or the overall technology curriculum, and only a few studies have examined changes in students' attitudes toward technology before and after technology design (e.g., Boeve-de Pauw et al., 2022; Volk & Yip, 1996). Therefore, it is still difficult to know the real reasons for the rise and fall in students' attitudes due to the lack of research on students' attitudes towards technology and perceptions during the technology design learning process.

From the results of the above data analysis, this study has concluded that there are three difficulties in the application of the current student technology attitude scale. First, technology attitude scales have mostly been used to investigate students' affective attitudes toward technology curriculum but there is a lack of observation on the cognitive and behavioural attitudes toward technology (e.g., educational interests and career intentions), and even less observation on the environmental effects (e.g., teamwork and teacher attention). Second, the assessment approach shows a lack of research on negative perceptions. In these cases, it is easy for educational researchers to assess educational outcomes through only the overall average results of positive student attitudes, but not from students' negative perceptions of technology to improve teaching strategies. Third, technology attitude scales show a lack of awareness to investigate students' attitudes and perceptions in the technological design learning process. Although some studies have repeatedly used the scale for before and after technological design, it is difficult for them to truly observe students' positive or negative feelings in the design of the curriculum and help teachers identify the more difficult or uninteresting stages of the curriculum for improvement.

In summary, few studies have attempted to examine students' attitudes toward technology from the perspective of the design process, that is, attitudes towards technology as an environmentally influenced and dynamic form of inquiry. From the perspective of career development theories, it is often the feelings and learning experiences that students have during their participation in technology curriculum for K-12 education that shapes their perceptions of self-identity, interdisciplinary education, and career intentions (Hammack et al., 2015; Mohd Shahali et al., 2017).

6. REFERENCES

Ankiewicz, P. (2019a). Perceptions and attitudes of pupils towards technology: In search of a rigorous theoretical framework. *International Journal of Technology and Design Education*, *29*(1), 37-56. https://doi.org/10.1007/s10798-017-9434-z

Ankiewicz, P. (2019b). Alignment of the traditional approach to perceptions and attitudes with Mitcham's philosophical framework of technology. *Int J Technol Des Educ, 29*, 329–340 https://doi.org/10.1007/s10798-018-9443-6

Ardies, J., De Maeyer, S., & Gijbels, D. (2013). Reconstructing the Pupils Attitude Towards Technology-survey. *Design and Technology Education, 18*(1), 8-19. https://files.eric.ed.gov/fulltext/EJ1007134.pdf

Bame, E., Dugger, W., De Vries, M., & McBee, J. (1993). Pupils' attitudes toward technology: PATT-USA. *Journal of Technology Studies, 19*(1), 40-48. https://www.jstor.org/stable/43603608

Bandura, A. (1986). *Social foundation of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A. (2008). Toward an agentic theory of the self. In H. W. Marsh, R. G. Craven, & D. M. McInerney (Eds.), *Self-processes, learning, and enabling human potential: Dynamic new approaches* (pp. 15–49). Information Age Publishing.

Becker, K. H., & Maunsaiyat, S. (2002). Thai students' attitudes and concepts of technology. *Journal of Technology Education*, *13*(2), 6-20. https://files.eric.ed.gov/fulltext/EJ646589.pdf

Boeve-de Pauw, J., Ardies, J., Hens, K. et al. (2022). Short and long term impact of a high-tech STEM intervention on pupils' attitudes towards technology. *International Journal of Technology and Design Education, 32*, 825–843. https://doi.org/10.1007/s10798-020-09627-5

Doornekamp, B.G. (1991). Gender differences in the acquisition of technical knowledge, skills and attitudes in Dutch primary education: the need for technology education. *International Journal of Technology and Design Education, 2,* 37–47. https://doi.org/10.1007/BF00275230

Du, X., Lundberg, A., Ayari, M. A., Naji, K. K., & Hawari, A. (2022). Examining engineering students' perceptions of learner agency enactment in problem- and project- based learning using Q methodology. *Journal of Engineering Education, 111*(1), 111-136. https://doi.org/10.1002/jee.20430

Gao, X., Li, P., Shen, J., & Sun, H. (2020). Reviewing assessment of student learning in interdisciplinary STEM education. *International Journal of STEM Education, 7*(1), 1-14. https://doi.org/10.1186/s40594-020-00225-4

Hammack, R., Ivey, T. A., Utley, J., & High, K. A. (2015). Effect of an engineering camp on student's perceptions of engineering and technology. *Journal of Pre-College Engineering Education Research, 5*(2), 1-12. https://doi.org/10.7771/2157-9288.1102

Hendley, D., Stables, A., Parkinson, J. et al. (1996). Pupils' attitudes to technology in key stage 3 of the national curriculum: A study of pupils in South Wales. *International Journal of Technology and Design Education, 6*, 15–29. https://doi.org/10.1007/BF00571070

Mitcham, C. (1994). *Thinking through Technology*. Chicago: The University of Chicago Press.

Mohd Shahali, E. H., Halim, L., Rasul, M. S., Osman, K., & Zulkifeli, M. A. (2017). STEM learning through engineering design: impact on middle secondary students' interest towards STEM. Eurasia *Journal of Mathematics, Science and Technology Education, 13*(5), 1189-1211. https://doi.org/10.12973/eurasia.2017.00667a

Svenningsson, J., Höst, G., Hultén, M., & Hallström, J. (2021). Students' attitudes toward technology: exploring the relationship among affective, cognitive and behavioral components of the attitude construct. *International Journal of Technology and Design Education,32*, 1531–1551. https://doi.org/10.1007/s10798-021-09657-7

Svenningsson, J., Hultén, M. & Hallström, J. (2018). Understanding attitude measurement: exploring meaning and use of the PATT short questionnaire. *International Journal of Technology and Design Education, 28*, 67–83. https://doi.org/10.1007/s10798-016-9392-x

Raat, J.H., & de Vries, M. (1985). *What do 13-Year old pupils think about technology? The conception of and the attitude towards technology of 13-year old girls and boys*. Eindhoven University of

Technology, Netherlands. (ERIC Document Reproduction Service No. ED 262998). https://eric.ed.gov/?id=ED262998

Van Rensburg, S., Ankiewicz, P., & Myburgh, C. (1999). Assessing South Africa learners' attitudes towards technology by using the PATT (Pupils' Attitudes Towards Technology) questionnaire. *International Journal of Technology and Design Education*, *9*(2), 137-151. https://doi.org/10.1023/A:1008848031430

Voke, K. S., Yip, W. M., & Lo, T. K. (2003). Hong Kong pupils' attitudes toward technology: The impact of design and technology programs. *Journal of Technology Education*, *15*(1), 48-63. https://vtechworks.lib.vt.edu/bitstream/handle/10919/8309/volk.pdf?sequence=1

Volk, K.S., Yip, W.M. (1999). Gender and Technology in Hong Kong: A Study of Pupils' Attitudes Toward Technology. *International Journal of Technology and Design Education, 9*, 57–71. https://doi.org/10.1023/A:1008894006039

7. APPENDIX A:

7.1. List of reviewed articles

Coding Label	Articles
101	Doornekamp, B.G. Gender differences in the acquisition of technical knowledge, skills and attitudes in Dutch primary education: the need for technology education. *Int J Technol Des Educ* 2, 37–47 (1991). https://doi.org/10.1007/BF00275230
102	Householder, D.L., Bolin, B. Technology: Its influence in the secondary school upon achievement in academic subjects and upon students' attitude toward technology. *Int J Technol Des Educ* 3, 5–18 (1993). https://doi.org/10.1007/BF00454392
103	Hendley, D., Stables, A., Parkinson, J. *et al.* Pupils' attitudes to technology in key stage 3 of the national curriculum: A study of pupils in South Wales. *Int J Technol Des Educ* 6, 15–29 (1996). https://doi.org/10.1007/BF00571070
104	van Rensburg, S., Ankiewicz, P. & Myburgh, C. Assessing South Africa Learners' Attitudes Towards Technology by Using the PATT (Pupils' Attitudes Towards Technology) Questionnaire. *International Journal of Technology and Design Education* 9, 137–151 (1999). https://doi.org/10.1023/A:1008848031430
105	Volk, K.S., Yip, W.M. Gender and Technology in Hong Kong: A Study of Pupils' Attitudes Toward Technology. *International Journal of Technology and Design Education* 9, 57–71 (1999). https://doi.org/10.1023/A:1008894006039
106	Ankiewicz, P., van Rensburg, S. & Myburgh, C. Assessing the Attitudinal Technology Profile of South African Learners: A Pilot Study. International Journal of Technology and Design Education 11, 93–109 (2001). https://doi.org/10.1023/A:1011210013642
107	Yu, KC., Lin, KY., Han, FN. et al. A model of junior high school students' attitudes toward technology. Int J Technol Des Educ 22, 423–436 (2012). https://doi.org/10.1007/s10798-011-9154-8
108	Ardies, J., De Maeyer, S., Gijbels, D. *et al.* Students attitudes towards technology. *Int J Technol Des Educ* 25, 43–65 (2015). https://doi.org/10.1007/s10798-014-9268-x
109	Metsärinne, M., Kallio, M. How are students' attitudes related to learning outcomes?. Int J Technol Des Educ 26, 353–371 (2016). https://doi.org/10.1007/s10798-015-9317-0

110	Svenningsson, J., Hultén, M. & Hallström, J. Understanding attitude measurement: exploring meaning and use of the PATT short questionnaire. *Int J Technol Des Educ* 28, 67–83 (2018). https://doi.org/10.1007/s10798-016-9392-x
111	Boeve-de Pauw, J., Ardies, J., Hens, K. *et al.* Short and long term impact of a high-tech STEM intervention on pupils' attitudes towards technology. *Int J Technol Des Educ* 32, 825–843 (2022). https://doi.org/10.1007/s10798-020-09627-5
112	Xu, M., Williams, J.P. & Gu, J. An initial development and validation of a Chinese technology teachers' attitudes towards technology (TTATT) scale. *Int J Technol Des Educ* 30, 937–950 (2020). https://doi.org/10.1007/s10798-019-09551-3
113	Candela, P.P., Gumbo, M.T. & Mapotse, T.A. Adaptation of the Attitude Behavioural Scale section of a PATT instrument for the Omani context. *Int J Technol Des Educ* 32, 1605–1627 (2022). https://doi.org/10.1007/s10798-021-09665-7
114	Miranda, C., Goñi, J., Pickenpack, A. *et al.* The ethical implications of collecting data in educational settings: discussion on the technology and engineering attitude scale (TEAS) and its psychometric validation for assessing a pre-engineering design program. *Int J Technol Des Educ* 32, 1495–1513 (2022). https://doi.org/10.1007/s10798-021-09653-x
115	del Olmo-Muñoz, J., Cózar-Gutiérrez, R. & González-Calero, J.A. Promoting second graders' attitudes towards technology through computational thinking instruction. Int J Technol Des Educ 32, 2019–2037 (2022). https://doi.org/10.1007/s10798-021-09679-1
116	Svenningsson, J., Höst, G., Hultén, M. *et al.* Students' attitudes toward technology: exploring the relationship among affective, cognitive and behavioral components of the attitude construct. *Int J Technol Des Educ* 32, 1531–1551 (2022). https://doi.org/10.1007/s10798-021-09657-7
117	Purković, D., Kovačević, S. & Luttenberger, L.R. Attitudes of Croatian Pupils on the relationship of Environmental Issues and Sustainable Development with Technology and Engineering. *Int J Technol Des Educ* (2022). https://doi.org/10.1007/s10798-022-09779-6
201	CHE-MING, Yau; CHENG-CHENG, Ong. Pupils' views towards design and technology in Singapore. Design and Technology Education: an International Journal, [S.l.], v. 10, n. 3, may 2008. ISSN 1360-1431. Available at: <https://ojs.lboro.ac.uk/DATE/article/view/Journal_10.3_RES3>. Date accessed: 19 may 2023.
202	ARDIES, Jan; DE MAEYER, Sven; GIJBELS, David. Reconstructing the Pupils Attitude Towards Technology-survey. Design and Technology Education: an International Journal, [S.l.], v. 18, n. 1, mar. 2013. ISSN 1360-1431. Available at: <https://ojs.lboro.ac.uk/DATE/article/view/1796>. Date accessed: 04 may 2023.
301	Boser, R. A., & Daugherty, M. K. (1998). Students' attitudes toward technology in selected technology education programs. *Journal of Technology Education, 10*(1), 4-19. https://vtechworks.lib.vt.edu/bitstream/handle/10919/8203/boser.pdf?sequence=1
302	Becker, K. H., & Maunsaiyat, S. (2002). Thai Students' Attitudes and Concepts of Technology. *Journal of Technology education, 13*(2), 6-20. https://files.eric.ed.gov/fulltext/EJ646589.pdf
203	Volk, K. S., Yip, W. M., & Lo, T. K. (2003). Hong Kong pupils' attitudes toward technology: The impact of design and technology programs. *Journal of Technology education, 15*(1), 48-63. https://vtechworks.lib.vt.edu/bitstream/handle/10919/8309/volk.pdf?sequence=1
304	Autio, O. A. (2016). Changes in attitudes toward craft and technology during the last 20 years. Journal of Technology Education. *Journal of Technology education, 28*(1), 53-70. https://helda.helsinki.fi/bitstream/handle/10138/178732/Autio.pdf?sequence=1