Students' attitudes toward technology: exploring the relationship among affective, cognitive and behavioral components of the attitude construct

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Abstract

When studying attitudes toward technology education, the affective attitudinal component has primarily been the focus. This study focuses on how the affective, cognitive and behavioral attitudinal components of technology education can be incorporated using a two-step survey: the traditional PATT-questionnaire (PATT-SQSE) and the recently developed Mitcham Score questionnaire. The aim of this study is to explore the relationship among the cognitive, affective and potential behavioural components of students' attitudes toward technology in a Swedish context, using the PATT-SQ-SE instrument including the Mitcham score open items. Results of the analyses show that relationships among the attitudinal components are observable. The results also imply that relationships among the attitudinal components are different for girls than boys. A key factor for the participating students' attitudinal relations was interest (affective component) in technology education. An individual interest in technology education was related to both the cognitive component and behavioral intention. Another key relationship, for girls, was that the cognitive component had a strong relationship with behavioral intention, which was not the case for boys. Based on the observed relations between the cognitive, affective and behavioural components we have identified two key implications for educational practice: Girls should learn a broader conception of technology in technology education, if we want them to pursue technology-related careers to a higher degree; Students' interest in technology should be stimulated through engaging tasks in technology education.

Keywords Technology education · Attitudes · Attitude measurement · PATT · Mitcham score

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Introduction

Researchers studying students' knowledge and willingness to pursue a career by study-ing a subject area in school, such as technology, have often used students' attitudes as a proxy for determining that willingness. Investigating students' attitudes–for example, what influences attitudes or what is the nature of affective, cognitive and behavioral components of attitudes (Fishbein and Ajzen 1975)—is therefore important in educa-tional research in general, and technology education research in particular. As early as the 1980s, the first technology attitude instrument was developed in the Netherlands—PATT, Pupils' Attitudes Toward Technology (Raat and de Vries 1986). In recent years, however, the theoretical foundation for the study of attitudes toward technology has been increasingly discussed and problematized; there is still a lack of knowledge about how the relationships among the three attitude components should be described and measured. The inclusion of the behavioral component in the attitude model, for instance, was questioned and considered to not be a part of attitude, rather as a compo-nent succeeding attitude (van Aalderen-Smeets et al. 2012). Furthermore, Ankiewicz (2019a) pointed out that in PATT studies the affective and cognitive components were primarily considered, whereas the behavioral component was downplayed, and Sven-ningsson et al. (2018) highlighted gender skewness in the questionnaire items.

The attitude construct of the PATT short questionnaire (PATT-SQ, Ardies et al. 2013), which is used in this article in its latest version adapted to a Swedish context and renamed PATT-SQ-SE (Svenningsson et al. 2018), needs further exploration as there is still relatively limited understanding about the attitude construct. In particular, it is not clear which parts, if any, of the PATT-SQ-SE are related to the three atti-tude components. As mentioned, the PATT Likert items have traditionally been seen as related primarily to the affective component, but also to some extent the cognitive attitude components, through a separate questionnaire, although this remains largely unexplored (Ankiewicz 2019a). The PATT questionnaire has commonly been used to find factors influencing the affective component of attitudes (e.g. Ardies et al. 2015).

Furthermore, an additional open item instrument has been proposed: the Mitcham Score, designed to measure aspects of the cognitive component based on Mitcham's (1994) four dimensions of technology: knowledge, volition, activity and object (Sven-ningsson 2020). Adding the Mitcham Score measure to an attitude survey based on the PATT instrument can potentially strengthen the cognitive parts of the survey. There seems to be the potential to analyze and problematize the attitude construct of the PATT-SQ more thoroughly using the Mitcham score, particularly the relationships among the cognitive and affective components as well as aspects–if any–of the behav-ioral component.

The aim of this study is thus to explore the relationships among the cognitive, affec-tive and potential behavioral components of students' attitudes toward technology in a Swedish context, employing the PATT-SQ-SE instrument including the Mitcham score open items. The research question for this study is as follows:

- What are the relationships, if any, among the affective, cognitive and behavioral components of students' attitudes toward technology and how does this relationship relate to gender?

Theoretical framework

An attitude is an evaluation of a psychological object, represented in dimensions such as good versus bad, pleasant versus unpleasant, or likable versus dislikeable (Ajzen 2001). In the traditional notion of attitude, it is usually divided into three different components that make up the attitude: affective, cognitive and behavioral components (Breckler 1984; Eagly and Chaiken 1993; Fishbein and Ajzen 1975). Attitudes toward, for example, technology are based on a person's beliefs about that topic and those beliefs—cognitive and/or affective—can have an influence on their behavior (Fishbein and Ajzen 1975). The cognitive component has to do with the role of cognition in a person's attitude toward a psychological object, such as beliefs and thoughts about technology. The affective component, on the other hand, is made up of a person's positive or negative emotions toward technology, for example, as in the above-mentioned dimension pleasant versus unpleasant. A special case of the affective dimension is interest, which is understood analytically as an emotional schema but in reality also includes cognitive dimensions. This also means that interest can be changed and developed over time as new knowledge is acquired, thus enabling a shift from situational to individual interest (Hidi and Renninger 2006; Reeve et al. 2015).

One of the most influential theories about the relationship between general attitude and behavior is the theory of planned behavior (TPB) (Ajzen and Fishbein 1980). According to this theory, attitude consists of a cognitive component and an affective component. The cognitive and affective components of attitudes partly determine behavioral intention, which is the immediate motivational factor for behavior itself. Behavioral intention is thus viewed as a direct outcome of these two dimensions of attitude.

Some studies have used attitudinal questionnaires to link them more closely with theory of attitudes. Abd-El-Khalick et al. (2015) adapted the theory of reasoned action approach (by Fishbein and Ajzen 2010). That led to an instrument (similar to PATT) to survey students´ attitudes toward science (Summers and Abd-El-Khalick 2018). In technology education, Autio et al. (2019) used the PATT questionnaire as a basis for a questionnaire to study the affective, cognitive and behavioral components of attitudes by reinterpreting items as affective, cognitive and behavioral dimensions. In a recent study, Ankiewicz (2019b) superimposed the traditional attitude framework onto Mitcham's four dimensions of technology, on which the Mitcham score is based (see Fig. 1). This is a novel way of breaking down attitudes along the same lines as the technology dimensions, which are both based on the same view of humans in relation to external activities/behavior (Mitcham 1994). This study aims to test the usefulness of this model, in order to examine the relationships among the attitude components.

Methods

The study design uses statistical analysis of survey data on students' attitudes in responding to the research questions. In the following sections we describe the questionnaires, recruitment of respondents and methods for data analysis.
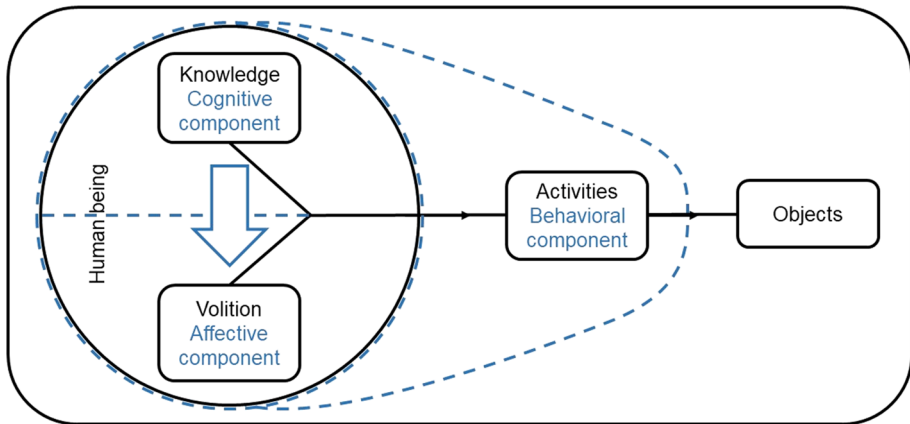
Fig. 1 Superimposition of the traditional approach to attitudes (in blue) upon Mitcham's philosophical framework of technology (in black), adapted from Ankiewicz (2019b, p. 337). (Color figure online)

Survey

A two-part survey instrument was constructed to combine the Mitcham Score (Svenningsson. 2020) with the PATT-SQ-SE (Svenningsson et al. 2018).

The Mitcham score questionnaire was used to gain information about the participants, i.e. students' beliefs and thoughts about technology. It consists of two open-ended questions: (1). "Describe what you consider to be technology?" and (2) "If you were to describe the school subject of technology, for anyone who has not studied it at school themselves, how would you describe it?"

The PATT-SQ-SE consists of 26 items which students respond to by choosing how well they agree with each statement using a 5-point Likert scale (ranging from "disagree completely-1" to "agree completely-5"). The items are grouped into six categories (Ardies et al. 2013): (1) Career (4 items)—Respondents' career aspirations in technology; (2) Gender (6 items)—Perceived gender patterns in technology; (3) Importance (4 items)—Consequences and importance of technology; (4) Interest (4 items)—Interest in technology education; (5) Difficulties (4 items)—Perceived difficulties in the technology subject; (6) Boredom (4 items)—Perceived boredom with technology.

Drawing on the superimposition of the traditional approach to attitudes onto Mitcham's philosophical framework (see Fig. 1), we question the appropriateness of three of the categories in PATT-SQ to measure the affective component of attitudes; 'Importance' of technology; perceived 'Difficulties' in the technology subject and 'Gender'. These three have been considered as affective components of attitudes (e.g. Ankiewicz 2019a); we argue that these categories have problems in relation to theory about attitudes (cf. researched items in Summers and Abd-El-Khalick 2018, p. 186). The items in these three categories are not formulated as indicating an individual's positive or negative feelings toward technology. Instead, the items are formulated as general beliefs or assumptions about technology, with an emphasis at a general rather than an individual level. Therefore we decided not to use them. Items in the Importance category seem to survey the students' general beliefs about technology; thereby they are more closely linked to the cognitive component. In the Difficulties category, items are also formulated to indicate general beliefs about technology,

for example, as something you have to be smart to study. The third category that we believe does not fit the model as an affective component is the Gender category. The study by Svenningsson et al. (2018), shows that students generally favor their own sex regarding performance in technology. Meaning that girls generally believe that girls are more suitable for technology and the opposite for boys, thus also indicating perception of gender performance may be a cognitive type of category.

Following Svenningsson et al.'s (2018) recommendations, PATT-SQ-SE is a revised version of the original PATT-SQ (Ardies et al. 2013), see Appendix for a complete list of the items. Items in the 'interest in technology education' category are considered to measure a student's well-developed individual interest (Svenningsson et al. 2018) within the four-phase model of interest (Hidi and Renninger 2006). For items in the Gender category, the traditional gender-specific items (see e.g. Ardies et al. 2013) are complemented with inverted statements (e.g. an original statement formulated as *"boys are able to…"* would be complemented with a statement formulated as "*girls are able to…"*) to avoid gender bias in the results.

In addition, the survey included items related to background information. Open-ended items were used for school and school year of each participant.

Participants and data collection

30 schools were invited to participate in the study, of which six schools agreed to participate. However, one of the schools did not provide complete data, and was therefore excluded from the study. At each school a teacher distributed the survey digitally in class to all students in school years 7 and 9 (aged 12–13 and 14–15, respectively) who agreed to participate. According to the ethical regulations of the Swedish Research Council (2017; cf. Olsson and Gericke 2017) the data were collected during ordinary teaching hours (not necessarily during technology class) in the fall of 2016. All responding pupils agreed to participate in the study after being informed about the research and that they could withdraw from the study at any time prior to publication of findings. In total 485 pupils (Table 1) responded to the survey. Responses from two of those students were excluded from analysis as they consistently chose the first response option for all items in the survey. Background information consisted of gender (boy/girl/no answer), school and school year.

Data analysis

To test the relationships among the affective, cognitive and behavioral components, traditional attitude theory (see above) was employed to identify survey items that could operationalize each of the components. From this, the career category was considered to be an indication of the behavior component of attitude in the form of behavioral intent, as a high

Table 1 Participating students' background variables (n = 483)	Variable	Category	N Valid respondents	% Respondents
	Grade	7 (age 13)	272	56.3
		9 (age 15)	211	43.7
	Gender	Female	243	50.3
		Male	240	49.7

score for this category indicates an intention to choose a technological career. The interest and boredom categories were both considered to be indicators of the affective component of attitude. Students' conception of technology (the Mitcham Score) was considered to be an indicator of the cognitive component of attitude.

Students' responses to the Mitcham questionnaire were analyzed as described in Svenningsson (2020) by discerning whether their written answers included each of Mitcham's (1994) manifestations of technology: objects, activities, knowledge and volition. Students' written answers to the two open-ended questions, presented above, were coded as 0 or 1 point for each of the four dimensions of technology. The dimensions are handled as dichotomies: objects are considered either to have been mentioned in the student description or not. Thus, each student attained a Mitcham score ranging from 0 to 4, with a higher score indicating a more extensive understanding of technology.

Three of the authors categorized responses. Reproducibility of the categorization method (interrater reliability) was assessed by calculating Krippendorff's alpha for each of the four categories by the three raters on a random sample of 34 (7.2%) student descriptions of technology and technology education. Krippendorff's alpha was calculated using IBM Statistical Package for the Social Science (SPSS) with a macro by Hayes and Krippendorff (2007). Typical guidelines suggest that alpha values should be above 0.667 to be considered robust (Krippendorff 2004). However, as interrater reliability calculations are known to be sensitive to rare categories, a low alpha value does not necessarily correspond to a low agreement among raters (Viera and Garrett 2005). Considering previous findings that indicate some Mitcham categories are rare (Svenningsson 2020), and that the three raters (authors 1, 3 and 4) are well acquainted with Mitcham's philosophical framework, agreement expressed as a percentage of identical categorizations can also serve as a good benchmark (McHugh 2012).

PATT-SQ-SE responses were analyzed by calculating mean values for the items within each of the six attitude categories. The Boredom category's item scoring were inverted before the analysis, meaning that; if a student "agree completely" to "I think machines are boring" the score will be calculated as 1(one). Thereby, a low mean score equals that a student is more bored with technology than a student with a high mean score. Internal reliability was assessed by calculating Cronbach's alpha (α) for each category. A typical guideline suggests that Cronbach α-value > 0.70 is acceptable (Lovelace and Brickman 2013). Participants' tendencies to respond differently to items in the Gender category depending on whether they were formulated as female or male specific were investigated by calculating the difference between them. A value of 0 indicates that a participant does not systematically view either girls or boys as more capable.

The relationships among the measures of attitude components were analyzed in two steps. Firstly, a detailed analysis of the PATT-SQ-SE results was performed by stratifying them with respect to level of technology conception. Three student groups of roughly equal size with progressively broader technology views were created by separating the participants into Low Mitcham score (score 0 and 1; 31.4% of students), Medium Mitcham score (score 2; 39.4% of students), and High Mitcham score (score 3 and 4; 29,3% of students) categories. Differences among groups in the attitudes measured by PATT-SQ-SE were investigated by one-way analysis of variance (ANOVA), with Tukey HSD *post-hoc* tests to test multiple comparisons after any significant ANOVA results. Initial analysis indicated that many attitude categories in the PATT-SQ-SE results violated the assumption of homogeneity of variance (Moder 2007). This was revealed to be an effect of the gender variable, indicating that the distribution of attitude patterns across different levels of technology conceptions differs between girls and boys. In other words, gender may be a moderating

variable (cf. Elias et al. 2012) for the relationship between technology conception and attitude. To account for this, separate ANOVAs were performed for boys and girls.

Secondly, the structure of the relationships among different attitude components was investigated using multinomial logistic regression (Field 2009). This method reveals how variables (predictor variables) affect the likelihood that persons belong to different groups (dependent variable). The effect size is typically reported in the form of odds ratios (Field 2009) but it should be noted that this value cannot be directly interpreted as relative probabilities (Niu 2020). Here, the statistical modelling was based on the attitude model in Fig. 1 and is used to explore how the behavioral attitude component is affected by other attitude components and background variables. Thus, the dependent variable was behavioral intention, which we operationalized as membership in groups that differ in the value for the career category in PATT-SQ-SE. Three groups were constructed by assigning respondents with career category values in the lower third (i.e. mean value 1–2.33) to "Low" behavioral intention, the middle third (i.e. 2.34–3.66) to "Medium" and the upper third (i.e. 3.67–5) to "High". The high career ambition group was used as the reference group in the multinomial logistic regression. The affective attitude component was included in the analysis by entering the attitude categories 'interest in technology education', and 'boredom in technology' as continuous predictor variables. In addition, the discrete predictor variables (and the corresponding reference categories) Gender (girl) and school year (7th grade), were used. Arguably, the object of the participants' attitudes toward technology differs between persons with different technology conceptions. Therefore, the cognitive attitude component was accounted for by conducting a separate analysis for each of the three Mitcham score groupings described previously.

Results

A total of 483 responses from students at 5 different schools (Table 1) were analyzed. The following results will be presented separately for the PATT-SQ-SE instrument and the Mitcham score instrument. Then the results will be analyzed in terms of the relationships among affective, behavioral and cognitive components of attitude.

PATT-SQ-SE

Table 2 presents Cronbach's α-values for the PATT-SQ-SE scales. Items on Gender structured beliefs are presented as separate scales (Gender M and Gender F) for items formulated as male and female specific, respectively. Analysis of reliability shows that all scales except the perceived difficulties in technology are above the recommended Cronbach α-value > 0.70.

Mean values (1–5) for the PATT-SQ-SE categories are presented in Table 2 for all participants as well as separately for girls and boys. In the gender beliefs category, the mean difference between the male specific (i.e. "boys are able to…") and the female specific (i.e. "girls are able to…") formulations indicates a tendency among students to believe that boys are more capable in technology. The gender category mean represents the mean from each respondent's "Gender M mean (1–5)"—"Gender F mean (1–5) $= -4$ to $+4$". However, the gender bias tends to follow the gender of the respondent. Thus, the negative mean for girls indicates that they tend to see themselves as, for instance, more capable to do practical things than boys, and vice versa.

Table 2 Results from the PATT-SQ-SE instrument, including the reliability of category scales with example item, and scale means

	Category	Cronbach's α	N items	Scale mean	Std. deviation	Girl/Boy mean	Example item
Behavioral intent	Career aspirations in technology	.89	4	3.18	.97	2.83/3.52	I would enjoy a job in technology
Affective components	Interest in technology education	.78	4	3.26	.97	3.00/3.52	If there was a school club about technology I would certainly join it
	Boredom in technology	.70	4	3.55	.84	3.37/3.73[a]	A technological hobby is boring
	Perceived difficulty in technology	.66	4	2.79	.81	2.68/2.89[b]	To study technology you have to be talented
	Perceived importance of technology	.73	4	4.05	.73	4.05/4.05	Technology is very important in life
	Gender structured beliefs (M)	.87	3	2.48	1.20	2.04/2.92	Boys know more about technology than girls
	Gender structured beliefs (F)	.82	3	2.17	.99	2.30/2.04	Girls know more about technology than boys
	Gender difference (Gender M–Gender F)/6	–	6	.31	3.83	–.26/.88	

[a] Low mean score indicates that technology is perceived as boring

[b] Low mean score indicates that technology is perceived as less difficult

Table 3 Distribution of the students' descriptions within Mitcham's different aspects of technology. Krippendorff's alpha inter-rater reliability for authors 1, 3 and 4 and percentage agreement among all three authors

	Total N descriptions including	Percentage	Alpha	Observed total agreement
No definition	84	17.8	.798	.94
Objects	362	74.9	.845	.94
Activities	294	60.9	.756	.82
Knowledge	183	37.9	.843	.91
Volition	20	4.1	.320	.94

Table 4 Distribution of the different aspects of Mitcham's typology in the students' Mitcham Score

Mitcham score	Object	Knowledge	Activities	Volition	N students in each score	Percent of students in each score
0	–	–	–	–	84	17.8
1	47	3	13	0	63	13.6
2	177	52	144	2	187	39.4
3	131	121	130	11	131	27.8
4	7	7	7	7	7	1.5
Total	362	183	294	20	472	100

Mitcham score

The Mitcham score (ranging between 0 and 4 points) indicates how broad each description of technology is, where a higher score indicates a broader conception of technology since it includes a larger fraction of the four aspects (objects, activities, knowledge and volition). Responses to the two open-ended survey questions were analyzed according to the Mitcham Score method as a measure of how broad students' conceptions of technology are (Svenningsson 2020). A total of 472 (of 483) respondents provided written answers to one of or both open-ended questions. Table 3 presents inter-rater reliability (Krippendorff's alpha) for the analysis of aspects in respondents' descriptions of technology.

Table 4 shows the distribution of technological aspects across students' Mitcham scores. The aspects of Mitcham's model that were most common in students' descriptions are objects (74.9%) and activities (60.9%), followed by knowledge (37.9%). The volitional aspect was rarely included in any responses.

The most frequent Mitcham Score value is 2, wherein respondents' descriptions include two aspects of technology (most commonly combining Activities and Objects). Many of the 84 respondents who scored 0 points describe other phenomena that are also designated by the Swedish word [*teknik*] in the sense of skills/technique, for example "when I practice soccer". Others describe technology only by using the word technology (e.g. "technology is technology") or by stating their emotions toward technology (e.g. "it's fun").

Relationship between PATT-SQ and the Mitcham Score

A deepened view of students' attitudes was pursued by exploring how behavioral and affective components of attitude (PATT-SQ) relate to aspects of the cognitive component in terms of technology conceptions (the Mitcham Score). In Table 5, mean values for the different attitude scales of the PATT-SQ-SE questionnaire are presented for Low, Medium and High Mitcham score groups, respectively. Values are presented separately for boys and girls.

As shown in Table 5, the mean scores are lower in the Low Mitcham score group for both girls and boys. The High Mitcham score group has the highest mean value for all scales for girls, while the same is true for boys for all scales apart from Career aspirations and Perceived importance.

The relationships among the cognitive component and other attitude components were further examined by analyzing differences among the three Mitcham score groups with respect to the PATT-SQ-SE scales using one-way ANOVA. The analysis was conducted separately for girls and boys, with results presented in Table 6.

The significant differences in Table 6 range from small (> 0.01) to medium (> 0.06) effect sizes. The Tukey HSD test indicates that differences in girls' mean scores for career aspirations (medium effect size; $\eta^2 = 0.06$) are significant between low ($M = 2.35$, $SD = 0.85$) and medium ($M = 2.91$, $SD = 0.97$) Mitcham scores, as well as between low and high ($M = 3.00$, $SD = 1.03$) Mitcham Scores. Another significant difference was found between girls' mean scores in the interest in technology education category (effect size, η^2 0.04) between low ($M = 2.68$, $SD = 0.81$) and medium ($M = 3.09$, $SD = 0.97$) Mitcham scores, as well as between low and high ($M = 3.13$, $SD = 0.78$) Mitcham Scores. Thus, girls with medium and high Mitcham scores had higher career aspirations and were more interested in technology education compared to girls with low Mitcham scores.

For boys, the Tukey HSD test indicates differences in mean score in the interest in technology education category (small effect size, $\eta^2 = 0.05$) between low ($M = 3.29$, $SD = 0.97$) and medium ($M = 3.67$, $SD = 1.05$) Mitcham scores, as well as between low and high ($M = 3.78$, $SD = 0.83$) Mitcham Scores. The test also indicates significant differences in mean scores of perceived importance of technology (small effect size, $\eta^2 = 0.05$) between low ($M = 3.86$, $SD = 0.79$) and medium ($M = 4.20$, $SD = 0.73$) Mitcham scores, and between low and high ($M = 4.19$, $SD = 0.55$) Mitcham Scores. A significant difference was also found for perceived difficulty (small effect size, $\eta^2 = 0.03$) between low ($M = 3.07$, $SD = 0.87$) and medium ($M = 2.78$, $SD = 0.85$) Mitcham scores as well as between low and high ($M = 2.72$, $SD = 0.72$) Mitcham Scores. Thus, boys with medium and high Mitcham Scores were more interested in technology education while perceiving technology to be more important and less difficult than students with a low Mitcham score.

Relationships among behavioral, affective and cognitive components of students' attitudes.

Table 7 shows the results of a multinomial regression analysis. The analysis investigated to what extent respondents' career intentions (behavioral attitude component) are affected by their interest and boredom with technology (affective attitude component), gender and age, and whether these interactions depend on their technology conception (cognitive attitude component).

Gender was found to be a significant factor for career intention among those with a narrow technology conception (i.e. Mitcham Score 0–1). In this group, girls were

Table 5 Attitude scale mean scores for three student groups that differ in Mitcham Scores (low 0–1, med 2, high 3–4). Bold indicates the highest score for each column and 95% confidence intervals are provided with lower (LL) and upper limits (UL) in square brackets

		Career aspirations		Interest		Boredom		Difficulty		Importance		Gender	
		Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy
Low	Mean	2.35	3.43	2.68	3.29	3.31	3.41	2.73	3.07	3.87	3.86	−.27	1.10
	N	50	97	50	97	50	97	50	97	50	97	50	97
	SD	.85	1.03	.81	.98	.84	.79	.74	.87	.79	.79	1.09	1.31
	95% CI [LL, UL]	[2.11, 2.59]	[3.22, 3.64]	[2.45, 2.91]	[3.09, 3.48]	[3.07, 3.55]	[3.25, 3.57]	[2.52, 2.94]	[2.90, 3.25]	[3.64, 4.09]	[3.70, 4.02]	[−.58, .04]	[.83, 1.36]
Med	Mean	2.91	**3.65**	3.09	3.67	**3.41**	3.93	2.76	2.78	4.10	**4.20**	−.30	.81
	N	94	93	94	93	94	93	94	93	94	93	94	93
	SD	.97	1.08	.97	1.05	.85	.84	.77	.85	.70	.73	1.00	1.31
	95% CI [LL, UL]	[2.71, 3.11]	[3.43, 3.87]	[2.87, 3.29]	[3.45, 3.88]	[3.24, 3.59]	[3.76, 4.10]	[2.60, 2.91]	[2.60, 2.95]	[3.96, 4.24]	[4.05, 4.35]	[−.50, .09]	[.54, 1.08]
High	Mean	**3.00**	3.51	**3.13**	**3.78**	**3.41**	**4.04**	**2.56**	**2.72**	**4.12**	4.19	**−.20**	**.67**
	N	92	46	92	46	92	46	92	46	92	46	92	46
	SD	1.03	.96	.78	.83	.80	.44	.75	.72	.70	.55	.88	1.21
	95% CI [LL, UL]	[2.79, 3.22]	[3.23, 3.80]	[2.96, 3.29]	[3.54, 4.03]	[3.25, 3.58]	[3.91, 4.18]	[2.41, 2.72]	[2.50, 2.93]	[3.99, 4.25]	[4.01, 4.37]	[−.39, −.02]	[.31, 1.03]

Table 6 Results from ANOVA that compare scores for PATT-SQ-SE scales of attitude toward technology for the three Mitcham score groups (low, med, high). Separate analyses were conducted for girls and boys. Effect sizes are provided as eta squared (η^2) values

		df	SS		MS		F		p		η^2	
			Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy
Career aspirations	Between groups	2	14.95	2.33	7.47	1.16	7.91	1.09	.00	.34	.06	–
	Within groups	233	220.23	249.36	.95	1.07						
	Total	235	235.18	251.68								
Interest	Between groups	2	6.88	10.44	3.44	5.22	4.74	5.43	.01	.01	.04	.05
	Within groups	233	169.00	224.00	.73	.96						
	Total	235	175.87	234.43								
Boredom	Between groups	2	.40	18.34	.20	9.17	.295	15.91	.75	.00[1]	–	–
	Within groups	233	159.98	134.25	.69	.58						
	Total	235	160.39	152.59								
Perceived difficulty	Between groups	2	1.92	5.87	.96	2.94	1.68	4.19	.19	.02	–	.03
	Within groups	233	133.18	163.41	.57	.70						
	Total	235	135.10	169.27								
Perceived importance	Between groups	2	2.36	6.45	1.18	3.23	2.44	6.00	.09	.00	–	.05
	Within groups	233	112.74	125.37	.48	.54						
	Total	235	115.10	131.82								

Table 6 (continued)

		df	SS		MS		F		p		η^2	
			Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy
Gender difference	Between groups	2	.44	6.93	.22	3.47	.23	2.08	.80	.13	–	–
	Within groups	233	223.36	388.98	.96	1.67						
	Total	235	223.80	395.92								

[1] Violates the homogeneity of variance assumption

Table 7 Multinomial logistic regression analysis of Career intention based on affective component of attitude, gender and age. Separate analyses for Low, Medium and High Mitcham Scores. Bold indicates significant Odds Ratio

	Career 1–2.33 vs. Career 3.67–5				Career 2.34–3.66 vs. Career 3.67–5			
	B (SE)	Lower	95% CI for Odds Ratio		B (SE)	Lower	95% CI for Odds Ratio	
			Odds Ratio	Upper			Odds Ratio	Upper
Low Mitcham score (0–1)								
Intercept	11.20 (2.29)***				5.29 (1.61)***			
Interest in technology education	−3.47 (.59)***	.01	**.03**	.1	−1.73 (.41)***	.08	**.18**	.40
Boredom in technology	−.57 (.50)	.21	.56	1.50	−.25 (.39)	.66	1.29	2.50
I am a girl	4.48 (1.03)***	11.72	**88.42**	667.15	2.39 (.81)**	2.42	**10.95**	53.81
I am in the 7th grade	−1.88 (.82)*	.02	**.15**	.76	−.31 (.49)	.28	.73	1.91
Medium Mitcham score (2)								
Intercept	10.99 (1.82)***				8.01 (1.47)***			
Interest in technology education	−1.61 (.35)***	.10	**.20**	.39	−.77 (.27)**	.28	**.46**	.78
Boredom in technology	−1.73 (.41)***	.08	**.18**	.40	−1.18 (.33)***	.16	**.31**	.58
I am a girl	1.10 (.58)	0.95	2.95	9.12	.79 (.42)	.97	2.21	5.03
I am in the 7th grade	−.62 (.59)	.17	.54	1.71	−1.00 (.45)*	.17	**.41**	.99
High Mitcham score (3–4)								
Intercept	16.00 (2.94)***				9.36 (2.22)***			
Interest in technology education	−1.78 (.49)***	.07	**.17**	.44	−.76 (.39)	.22	.47	1.00
Boredom in technology	−2.48 (.64)***	.02	**.08**	.29	−1.60 (.47)***	.08	**.20**	.51
I am a girl	−1.06 (.76)	.08	.35	1.54	.34 (.50)	.53	1.41	3.76
I am in the 7th grade	−1.35 (.64)*	.07	**.26**	0.91	−.57 (.50)	.21	.58	1.52

*p<.05, **p<.01, ***p<.001

significantly more likely than boys to be in the career intention 1–2.33 group than in the 3.67–5 group. The odds for girls in the low Mitcham Score group belonging in the career group 1–2.33 rather than in the career group 3.67–5 was increased by a factor of 88.42 compared to boys if other variables were kept constant. One interpretation of that large odds is that there are very few girls that have a low Mitcham Score who intend to pursue a career in technology. For the girls with medium and high Mitcham Scores there is no significant increased odds of belonging to either of the career groups.

The measures of the affective attitude component were also found to be factors of relevance for the behavioral intention attitude component. A significant relationship between career and boredom in technology was found among the students with medium and high Mitcham Scores, with a greater relationship between career groups 2.34–3.66 and 3.67–5. For students who are more bored with technology the odds increased (factor of 0.31 respectively 0.20) of being in the lower career group. Having an interest in technology education decreased the odds of being in career group 1–2.33 by a factor of 0.03 for low Mitcham Score students, 0.20 for medium Mitcham Score students and 0.17 for high Mitcham Score students. Interest was a significant factor for all three levels of technology conceptions (i.e. groups of Mitcham Score), meaning that an interest in technology has an overall positive association with students' intention to pursue a career in technology, independently of technology conception.

Being younger (i.e. in school year 7 rather than 9) decreases the odds of being in the career group 1–2.33 versus the career group 3.67–5 with a factor of 0.15 for low Mitcham Score students. The same effect of age is also present among students with a medium Mitcham Score, where being younger decreases the odds of being in career group 2.34–3.66 rather than in career group 3.67–5 by a factor of 0.41. The corresponding effect was also seen for the high Mitcham Score group, where being younger decreases the odds of being in the career group 1–2.33 versus the career group 3.67–5 with a factor of 0.26.

Summary of results

At a first glance, in Table 5, a pattern appears between Mitcham Score and the PATT-SQ score, indicating that a high Mitcham Score equals a higher score on the PATT-SQ score and that there is a clearer relation for girls than for boys. Girls in general scored a lower score in all researched PATT scale means (Career, Interest & Boredom). The results of the Mitcham Score imply an opposite pattern: girls in general have a broader view of technology than boys. The relationships among the two scores (Mitcham Score & PATT-SQ) through ANOVA (Table. 6), however, reveals that this is not a significant relation for all PATT-SQ scores. For girls, the significant relationships occur for Career intention ($\eta2=0.06$) and Interest in technology education ($\eta2=0.04$). For boys, a significant relationship occurs for Interest in technology education ($\eta2=0.05$).

From the performed multinomial regression analysis (Table. 7) we can observe how our two affective components (Interest in technology education & Boredom) relate to behavioral intention (Career) sorted by the Cognitive level component (Mitcham Score). The results imply that students who are bored with technology more likely belong to a lower career group when their Mitcham Score is medium or high. Similarly, higher interest in technology decreases the probability of belonging to one of the lower career groups, independent of the students' Mitcham Score. Finally, being a girl with a low Mitcham Score increases the odds of being in one of the lower career groups, although this relationship is eliminated for girls with medium or high Mitcham Scores. There are, however, no significant differences between
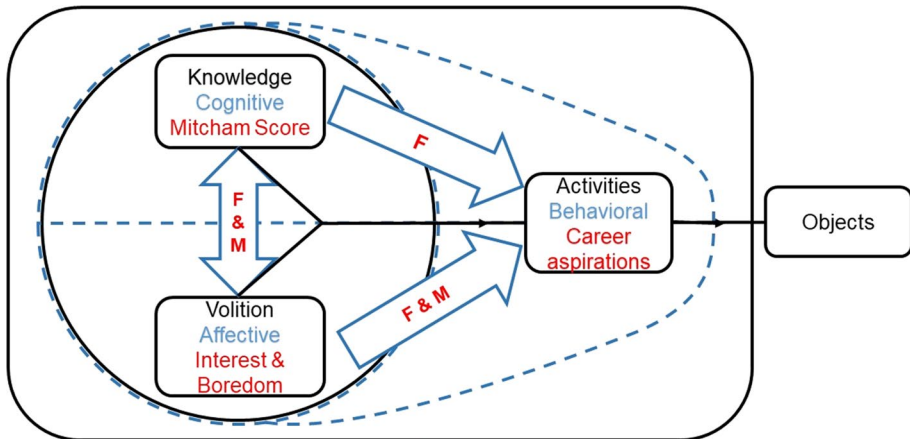
Fig. 2 Empirically based model of attitudinal profile in technology; attitude components in blue, Mitcham's philosophical framework of technology in black, and the corresponding instrument categories from this study in red. F = Females, M = Males. (Color figure online)

girls and boys in career intention when they have a broad view of technology, that is, a high Mitcham score.

Discussion

The aim of this study was to explore the relationships among the cognitive, affective and potential behavioral components of students' attitudes toward technology in a Swedish context. In doing so, we presented the PATT-SQ-SE instrument and Mitcham Score open items in a questionnaire. We let the attitude components 'behavioral intention' correspond with 'career aspirations' and the affective component with boredom and interest in technology, while the cognitive attitude component corresponded with the Mitcham Score.

To visualize the results from the study, the superimposition by Ankiewicz (2019b) of the traditional approach to attitudes upon Mitcham's philosophical framework of technology (Fig. 1) has been used to create a new empirically-based model (Fig. 2). The model presents the relationships among the affective, cognitive and behavioral attitudinal components for girls and boys. The age factor has been excluded in this model.

Relationships among the affective, cognitive and behavioral components of attitudes

The model can be discussed from a theoretical and empirical point of view, and this is done separately below.

Theoretical relations

Based on Ankiewicz's (2019b) model the directions for relations are described as: the cognitive component affects the affective component, and the two components further affect

the behavioral component. On the other hand, Azjen and Fishbein (1980) explains TPB as the cognitive and affective components together partly determine the behavioral intention. Hence, we have used a two-way directed arrow between the cognitive and affective components to visualize this connection. Even though a change in, for example, interest from situational to individual interest is observable when knowledge is developed, an individual interest often leads to a will to learn more (Hidi and Renninger 2006). As the items in the interest category measure individual interest (Svenningsson et al. 2018) we cannot discard a mutual relationship between affect and cognition.

Empirical relations

Even though theory suggests directional relationships among the attitude components, our analysis does not allow us to discern their different directions. Hence, based on the data analyzed in this study we can only say whether relationships among attitude components exist or not. The results from both the ANOVA and the regression analysis indicate that the affective component 'interest' is an important factor for both boys and girls, which is positively related to both the cognitive component (e.g. Reeve et al. 2015) and the behavioral component. The other affective component, boredom, is positively related to behavioral intention if their cognitive component, in terms of their technology conception, is well developed.

The results suggest that the cognitive component is another important factor to consider in relation to girls' behavioral intent, given that a broad view of technology eliminated gender differences in career aspirations in the data. This becomes particularly interesting as 79% of the girls in this study describe technology in a broad way (Mitcham Score 2–4). The remaining 21% (Mitcham Score 0–1) of the girls, however, were less likely to consider a career in technology compared to boys with a low Mitcham Score.

However, for boys we were unable to discern a direct relationship between the cognitive and behavioral attitude components, as illustrated by the similar values for career intention across the three groups based on Mitcham Score in Table. 5. Despite these results, both affective components measured positively related to both career intentions and Mitcham Score. Even though a direct relationship is missing, there is possibly an indirect relationship between cognition and behavioral intention for boys that cannot be dismissed.

Conclusions and implications

The reinterpretation of the items in PATT-SQ according to theory about attitudes (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975) and interest (Hidi and Renninger 2006; Reeve et al. 2015), which are inspired by similar studies (Autio et al. 2019; Summers and Abd-El-Khalick 2018), enabled us to construct a new model (Fig. 2) of students' attitudes toward technology, adapted from Ankiewicz (2019b).

The behavioral component has been considered weak in PATT-studies (Ankiewicz 2019a). Autio et al. (2019) incorporated behavior by interpreting items that survey a student's readiness for action. In this study, we used a similar approach, and the theoretical concept of behavioral intention was used and items in the career category were reinterpreted as such an intention (cf. Summers and Abd-El-Khalick 2018 p. 186). For the affective component, the boredom and interest categories were used. This is in line with similar studies which undertake a theoretical examination of the items (e.g. Autio et al. 2019;

Summers and Abd-El-Khalick 2018). In this study the Mitcham Score was used to serve as an indication of cognitive level in relation to technology.

This study indicates that there is a potential for the use of PATT-SQ in combination with a strengthened cognitive component (the Mitcham Score). By reinterpreting the career category as an indication of behavioral intent it enables us to study relationships among affective, cognitive and behavioral aspects of the attitude toward technology construct. The analysis of the items in the survey enables a more theoretically based discussion of attitudes toward technology. By adapting Ankiewicz's (2019b) model the results can be explained and visualized in a distinct fashion (cf. Autio et al., 2019 p. 102). The model can be used in PATT-studies for further testing of the model in other contexts than the Swedish one. The items of Importance, Gender and Difficulty categories in the PATT-questionnaire were not used in this study, for reasons discussed in the paper. If they could be successfully incorporated in the model, will have to be studied more thoroughly in the future.

Educational implications

Based on the correlations observed between the cognitive, affective and behavioral components we have identified two key implications for educational practice.

Girls should meet a broad conception of technology in technology education Although students' descriptions of technology only constitute a part of a student's cognitive level, they still seem to make up an important factor related with both affection and behavior for girls. For girls the ability to describe technology in a broad way (the Mitcham Score) is positively related with career aspirations. If we want to increase the number of girls (ages 13–15) considering technology-related careers, something which is generally considered a central issue in technology education (e.g. Sultan et al. 2019), it will be important for technology education to enable students to see a broad variety of what technology can be. The broadness of technology may not directly affect the road toward a career in technology. However, we believe that a broader view of technology increases the chance to see oneself as a part of our technological world or being technological, especially if one is a girl. The results also show that students with a broad view of technology are less bored and more likely to pursue a career in technology (cf. Dusek 2006).

Students' interest in technology should be stimulated through engaging tasks in technology education Interest is a key factor for both boys and girls, positively related to both the cognitive component (first key implication) and the behavioral component. Interest may not be an educational objective, but it can lead to students' learning more (Hidi and Renninger 2006) and that students become more willing to pursue a career in technology.

Appendix

Items surveyed in PATT-SQ-SE.

Career (Behavioral intention)

17. I will probably choose a job in technology.
    39. I would enjoy a job in technology.
    45. I would like a career in technology later on.
    63. Working in technology would be interesting.

Interest (Affective)

32. I would rather not have technology lessons at school
    27. Technology lessons are important.
    34. If there was a school club about technology I would certainly join it.
    46. *I am not interested in technology* (not analyzed in "interest in technology education")
    50. There should be more education about technology.
    52. *I enjoy repairing things at home* (not analyzed in "interest in technology education")

Boredom (Affective)

33. I do not understand why anyone would want a job in technology
    57. Most jobs in technology are boring.
    58. I think machines are boring
    64. A technological hobby is boring.

Gender

30 M. Boys are able to do practical things better than girls.
    41 M. Boys know more about technology than girls.
    47 M. Boys are more capable of doing technological jobs than girls.
    30F. Girls are able to do practical things better than boys (added opposite item).
    41F. Girls know more about technology than boys (added opposite item).
    47F. Girls are more capable of doing technological jobs than boys (added opposite item).

Importance

20. Technology makes everything work better.
    25. Technology is very important in life.
    31. Everyone needs technology.
    27. Technology lessons are important.

Difficulties

21. You have to be smart to study technology.
    26. Technology is only for smart people.
    43. To study technology you have to be talented.
    49. You can study technology only when you are good at both mathematics and science.

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