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Swedish Technology Teachers' Attitudes to their Subject and its Teaching

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Background:

From previous research among science teachers it is known that teachers' attitudes to their subjects affect important aspects of their teaching, including their confidence and the amount of time they spend teaching the subject. In contrast, less is known about technology teachers' attitudes.

Purpose:

Therefore, the aim of this study is to investigate Swedish technology teachers' attitudes toward their subject, and how these attitudes may be related to background variables.

Sample:

Technology teachers in Swedish compulsory schools (n=1153) responded to a questionnaire about teachers' attitudes, experiences, and background.

Methods:

Exploratory factor analysis was used to investigate attitude dimensions of the questionnaire. Groupings of teachers based on attitudes were identified through cluster analysis, and multinomial logistic regression was performed to investigate the role of teachers' background variables as predictors for cluster belonging.

Results:

Four attitudinal dimensions were identified in the questionnaire, corresponding to distinct components of attitudes. Three teacher clusters were identified among the respondents characterized by positive, negative, and mixed attitudes toward the subject of technology and its teaching, respectively. The most influential predictors of cluster membership were to be qualified for teaching technology, having participated in in-service-training, teaching at a school with a proper overall teaching plan for the subject of technology and teaching at a school with a defined number of teaching hours for the subject.

Conclusions:

The results suggest that efforts to increase technology teachers' qualifications and establishing a fixed number of teaching hours and an overall teaching plan for the subject of technology may yield more positive attitudes among teachers toward technology teaching. In turn, this could improve the status of the subject as well as students' learning.

Keywords: attitudes; technology education; technology teachers

Introduction

Teachers' attitudes play a central part in managing science and technology teaching, with all its complexities, both inside and outside the classroom. From research in science education it is known that teachers' attitudes to their subjects affect their teaching in several areas (Osborne, Simon, and Collins 2003; van Aalderen-Smeets and Walma van der Molen 2013). Less positive attitudes are found among teachers with, for example, lower self-efficacy and confidence. Negative attitudes are also associated with less time spent on teaching the subject and discussing it in the classroom. Such teachers also tend to prefer standardized methods and top-down instructions. Furthermore, science teachers with less positive attitudes seem to be poorer at encouraging the students' own attitudes toward science (Holroyd and Harlen 1996; van Aalderen-Smeets and Walma van der Molen 2013).

Attitude can be defined as 'a psychological tendency to evaluate an object in terms of favorable or unfavorable attribute dimensions such as good/bad or positive/negative' (van Aalderen-Smeets, Walma van der Molen, and Asma 2012, 161). Attitudes are often separated into three parts: cognition, affect, and behavior. This division informs a theoretical framework for primary teachers' attitudes toward science in general and the teaching of science, developed by van Aalderen-Smeets, Walma van der Molen, and Asma (2012). In this framework, attitudes consist of three components: Cognitive beliefs, which concerns the relevance of teaching science and the perceived difficulty of teaching science; Affective states, including positive and negative feelings such as enjoyment and anxiety of teaching science; and Perceived control, concerning feelings of difficulties in teaching science related to internal and external factors such as self-efficacy and context dependency (van Aalderen-Smeets, Walma van der Molen, and Asma 2012; van Aalderen-Smeets and Walma van der Molen 2013; cf. Rohaan, Taconis, and Jochems 2012). In the present study, this attitude

model will be applied to technology education to understand and analyse technology teachers' attitudes to their subject.

Previous research on how technology teachers view their subject has focused on the implementation of the technology curriculum (e.g. Jones and Carr 1992; Jones, Harlow, and Cowie 2004). Other studies have investigated teachers' concept of and attitudes toward technology (e.g. De Vries 1991). The perceived importance of the technology subject, which can be considered to be an aspect of cognitive belief, has been examined in New Zealand in a study by Almutairi (2009), indicating that technology teachers themselves find the subject of technology to be important. However, technology is considered to be a low status subject by headmasters and teachers in other subjects according to Swedish studies (Nordlander 2011; Skolinspektionen 2014). A study by the Swedish National Agency for Education (Skolverket 2013) indicated that a vast majority (97 %) of teachers in general, including technology teachers, consider themselves to have good enough subject knowledge, which can be considered to be an aspect of perceived control. A lack of confidence in technology teaching may nevertheless be a problem, related to the affective state component of teachers' attitudes. Holroyd and Harlen (1996) point out that a lack of confidence and understanding influence how teachers teach: 'Teachers may compensate for doing less of a low-confidence aspect by doing more of a higher-confidence aspect; in practice this can mean [...] spending more time on construction work in technology and less on design' (Holroyd and Harlen 1996, 334).

Despite the established importance of teachers' attitudes in relation to teaching, the literature review above indicates that teachers' attitudes is still a rather unexplored area in technology education. The present study will therefore focus on teachers' views of and attitudes to technology teaching in response to this identified need for more research.

Aim

The aim of this study is to investigate Swedish technology teachers' attitudes toward their subject, and how these attitudes may be related to background variables. The aim is addressed by responding to the following research questions:

- (1) What are Swedish technology teachers' attitudes to the subject of technology and its teaching?
- (2) What are the possible explanations for their different attitudes?

Methods

Educational context, Participants and Data Collection

Technology is a mandatory, standalone subject in the Swedish compulsory school but shares teaching time with chemistry, physics, and biology, which means that the amount of teaching hours in technology varies among schools. The current technology curriculum was introduced in 2011 and its core content includes three areas: Technological solutions, Working methods for developing technological solutions, and Technology, man, society and environment. Specific core content is defined for grades 1-3, 4-6, and 7-9. For example, the area Technological solutions contains common materials and mechanisms with a focus on everyday life (1-3); electrical circuits and simple technological systems (4-6); and basic electronics, control systems, manufacturing and properties of materials (7-9) (Skolverket, 2011). Technology education thus mainly focuses on technological literacy and includes both practical and theoretical components. According to a report from the Swedish Schools Inspectorate (Skolinspektionen, 2014), however, teachers generally devote too much time to designing and constructing with their students, and too little time to reflection and consideration of contextual aspects of technology.

The target population for this study was Swedish teachers who teach technology at levels ranging from preschool class (6 years old) to ninth grade (16 years old), which included approximately 16 000 teachers (Skolverket, 2016). An invitation to participate in a web-based inquiry was sent to 4 000 teachers, of which 1 367 completed the questionnaire. Of these, 214 individuals were excluded since they had not taught technology, giving a total number of 1 153 participants (79.5% female and 20.5% male) from 234 of 290 Swedish municipalities. Teachers from school levels across the Swedish compulsory school (from preschool class to ninth grade) participated, but most responding teachers taught grades 4-6, that is students 10 to 12 years old. The distribution of respondents does not reflect where most technology education is carried out, however, because it is actually decided by the schools themselves and most common is to have the lion's share of technology in grades 7-9.

Approximately half of the participants (51.3%) confirmed that they were qualified to teach technology according to the current rules at the time of data collection in 2012. To be qualified to teach technology, teacher training in technology was required.

Data were collected by the survey company Demoskop in April 2012 through a web-based questionnaire. The questionnaire was constructed by CETIS (Centre for School Technology Education), a center commissioned by the government to develop technology education in Sweden, in collaboration with 'Teknikföretagen', a Swedish industrial employers' organization that represents 3 600 technology companies. The latter has as one of its commitments to bring more young people in Sweden to study technology in tertiary education, which is why it has an interest in technology education in compulsory school. Aspects of the results with respect to the situation for compulsory school technology education was published in a report (Teknikföretagen 2012). The questionnaire were developed by CETIS during three iterations of enquiry between 1998 and 2009.

The questionnaire consisted of teacher background questions, school context questions and attitude items. The full questionnaire consisted of 21 closed items and one open item. Some closed items contained one or more follow-up questions, yielding a maximum of 46 questionnaire items in total. The present study uses 32 closed questionnaire items. For 10 of these, participants responded by selecting among a number of defined options (e.g. yes/no, male/female), while 22 required respondents to rate their agreement to a statement on a Likert-type scale ranging from 1 to 6. The scale represented opposites, where 1 corresponded to a disagreement with the statement (e.g. 'Do not agree at all') and 6 corresponded to agreement (e.g. 'Totally agree').

Data Analysis

Analytical overview

Responding to the research questions prompted us to employ a quantitative approach wherein statistical methods were applied in three steps. First, exploratory factor analysis was used to examine the underlying structure of teachers' responses to the attitude items. This step involved revealing relations between items and forming corresponding factors that reflect aspects of underlying attitudes in the items. Second, cluster analysis was employed to identify groupings of teachers based on their attitudes. This method discerns clusters of teachers that have similar patterns of attitudes, as revealed by the scores on the factors identified in the factor analysis. Third, relations between teachers' attitudes and their backgrounds and teaching contexts were explored through multinomial logistic regression, wherein cluster membership was predicted based on teachers' responses to background variables. SPSS 22 was used to analyse the study data.

Factor Analysis

Exploratory factor analysis was conducted with 17 questionnaire items that were related to teachers' attitudes (Fig 1). The decision to use factor analysis was supported by the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) =0.83 (Beavers et al. 2013) and Bartlett's test of Sphericity ($p<.001$), which indicated that factor analysis was appropriate for the data (Dziuban and Shirkey 1974). Correlations were found to be larger than 0.30, further supporting factor analysis (Tabachnick and Fidell 2014). Factor analysis was conducted through Principal Component Analysis (PCA) of the correlation matrix and Oblimin rotation.

1. How satisfied are you overall with the way technology education is managed in your school?									
Very dissatisfied	1	2	3	4	5	6	Very satisfied	Don't know	
Here are some statements about the subject of technology, how well does this agree with your opinion?									
Doesn't agree at all	1	2	3	4	5	6	Completely agree	Don't know	
2. It is a good thing that technology is compulsory throughout school									
3. Technology is an important subject									
4. The management of my school wants to develop the subject of technology									
5. The subject of technology will have increased importance in the future									
6. Knowledge of technology is generally important for the students and their future									
How important are the following factors for how you teach technology?									
No importance at all	1	2	3	4	5	6	Very important	Don't know	
7. My own interest/knowledge of various technology fields									
8. The core content of the curriculum									
9. At my school there are well-established work fields in technology									
How well do the following statements agree with your opinion?									
Doesn't agree at all	1	2	3	4	5	6	Completely agree	Don't know	
10. At my school, we have plenty of good teaching material for technology education									
11. It can be difficult to have enough time to teach technology									
12. I think the curriculum core content is a good starting point for teaching									
13. The knowledge requirements are clear									
14. I have the necessary training to conduct good technology education									
15. I feel confident in teaching technology									
16. I get sufficient time for developing my teaching									
17. I am passionate about the subject of technology									

Figure 1. Statements from the inquiry, as used in the factor analysis.

One construct ('It can be difficult to get enough time to teach technology') was removed after the first round of analysis since it showed loadings of less than 0.4 and a low communality (Pett, Lackey, and Sullivan 2003). The remaining 16 constructs were kept since they showed high communalities.

The number of factors to retain was decided based on multiple methods, as recommended in the literature (Henson and Roberts 2006; O'Connor 2000). All methods used - the Eigenvalue > 1 rule, Screeplot analysis, Parallel analysis and Velicer's minimum average partial (MAP) test - supported a four-factor solution as the most appropriate.

Factors were interpreted based on the Oblimin rotation, since the Component Correlation Matrix showed correlations between factors 1 and 3 (0.328), and 1 and 4 (-0.307) (Pett, Lackey, and Sullivan 2003). The Pattern matrix and Structure matrix are shown in Table 1.

Cluster analysis

Cluster analysis using teachers' factor scores as data was conducted in two steps. An initial hierarchical cluster analysis was performed to find out the most appropriate number of clusters, followed by a K-mean cluster analysis to find the cluster solution (Clatworthy et al. 2005; Hair et al. 2010; Mooi and Sarstedt 2011).

Hierarchical clustering. A selection of different types of hierarchical methods and similarity measures indicated similar solutions containing two, three or five clusters of approximately equal sizes, providing a validation of stability (Mooi and Sarstedt 2011).

Ward's method was employed to further investigate the appropriate number of clusters, using the Squared Euclidean distance, as recommended (Hair et al. 2010). Inspection of the agglomeration schedule (Fig. 2) (Clatworthy et al. 2005) indicated a large

Table 1. Structure Matrix, Pattern Matrix and communalities.

	Structure coefficients				Pattern coefficients				Communalities
	Component 1	Component 2	Component 3	Component 4	Component 1	Component 2	Component 3	Component 4	h ²
Technology is an important subject	0.89	0.19	0.326	-0.354	0.856	0.013	0.018	-0.083	0.8
It is a good thing that technology is compulsory throughout school	0.839	0.189	0.33	-0.374	0.789	0.011	0.035	-0.119	0.72
Knowledge of technology is generally important for the students and their future	0.839	0.152	0.351	-0.342	0.794	-0.027	0.073	-0.084	0.716
The subject of technology will have increased importance in the future	0.811	0.199	0.256	-0.189	0.825	0.072	-0.009	0.079	0.666
At my school, we have plenty of good teaching material for technology education	0.148	0.78	0.189	-0.225	-0.004	0.77	0.004	-0.04	0.61
How satisfied are you overall with the way technology education is managed in your school?	0.137	0.734	0.202	-0.284	-0.033	0.707	0.019	-0.119	0.552
At my school there are well-established work fields in technology	0.099	0.73	0.128	-0.115	-0.011	0.75	-0.023	0.055	0.537
I get sufficient time for developing my teaching	0.142	0.616	0.211	<u>-0.464</u>	-0.067	0.541	0.013	-0.352	0.49
The management of my school wants to develop the subject of technology	0.375	0.58	0.248	-0.079	0.305	0.549	0.07	0.166	0.437
I think the curriculum core content is a good starting point for teaching	0.272	0.166	0.902	-0.239	-0.023	-0.038	0.919	0.002	0.816
The knowledge requirements are clear	0.257	0.212	0.8	-0.215	-0.007	0.037	0.798	0.015	0.641
The core content of the curriculum	0.267	0.149	0.771	-0.228	0.015	-0.032	0.769	-0.016	0.595
I feel confident in teaching technology	0.28	0.35	0.319	-0.889	-0.025	0.138	0.059	-0.848	0.814
I have the necessary training to conduct good technology education	0.198	0.326	0.312	-0.855	-0.109	0.126	0.085	-0.835	0.76
I am passionate about the subject of technology	<u>0.525</u>	0.235	0.316	-0.793	0.304	0.01	0.02	-0.692	0.717
My own interest/knowledge concerning various technology fields	0.369	0.03	0.188	-0.537	0.24	-0.131	0	-0.495	0.35

Major loading for each item is in bold. Numbers in bold also indicate where the items were placed. Double loadings are underlined (cut-off 0,4).

Figure 2. Plot of similarity measure coefficient and number of clusters.

jump between two and one clusters, a fairly big jump between three and two, and minor jumps between further clusters. The large jump between two and one clusters is not a dependable indicator, since the combination of the final two large clusters is expected to yield this behavior (Mooi and Sarstedt 2011).

Cluster analyses with forced solutions of three, four and five clusters were created and compared. The three-cluster solution was the most appropriate given that it resulted in interpretable clusters and that the other solutions contained unbalanced cluster sizes.

K-mean cluster analysis. The K-mean cluster analysis was performed with the final three-cluster solution from the hierarchical clustering analysis (Table 2) as initial cluster centres. Final cluster centres, and the number of cases, are presented in Tables 3 and 4, respectively. Only slight differences between the initial (Table 2) and final (Table 3) cluster centres were found.

K-mean clustering was conducted on a subset of the data produced by splitting the dataset into randomized halves (Table 5). The final cluster centroids of the randomized half

and the complete dataset were very similar, indicating stability (Clatworthy et al. 2005; Mooi and Sarstedt 2011) and validity of the clusters. The analysis of variance was statistically significant at the $p < .01$ level (Table 6), further supporting differences between clusters for each of the four factors.

Table 2. Initial cluster centres for K-mean clustering for the whole dataset, based on the final cluster centres from hierarchical clustering.

Initial Cluster Centres			
	Cluster		
	1	2	3
Factor 1 mean	4.38	5.64	5.39
Factor 2 mean	2.50	3.52	2.74
Factor 3 mean	3.91	5.08	4.98
Factor 4 mean	2.83	5.10	3.77

Table 3. Final cluster centres from K-mean clustering for the whole dataset.

Final Cluster Centres				
	Cluster			
	1	2	3	Total mean
Factor 1 mean	4.24	5.64	5.48	5.21
Factor 2 mean	2.36	3.74	2.73	3.00
Factor 3 mean	3.79	5.15	4.96	4.72
Factor 4 mean	2.90	5.18	3.79	4.07

Table 4. Number of cases in each cluster in the final cluster solution.

	Number of cases		%
Cluster	1	296	26 %
	2	419	37 %
	3	423	37 %
Valid		1138	
Missing		15	

Multinomial Logistic Regression

Multinomial logistic regression (Field 2009) was conducted with cluster membership as the dependent variable using ‘the Positive’ cluster as the reference (see Results section).

Teachers’ responses to questionnaire items regarding their backgrounds, school conditions, and perceived influences on their technology teaching were used as predictors in the analysis (Table 7). The predictors included categorical as well as continuous variables.

Table 5. Final cluster centres of half the dataset.

Final Cluster Centres				
	Cluster			Total mean
	1	2	3	
Factor 1 mean	4.24	5.57	5.50	5.21
Factor 2 mean	2.50	3.85	2.59	3.00
Factor 3 mean	3.76	5.13	4.97	4.72
Factor 4 mean	2.82	5.10	3.84	4.07

Table 6. ANOVA of final cluster solution.

ANOVA						
	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Factor 1 mean	193.4	2	.426	1135	453.6	.000
Factor 2 mean	189.0	2	.587	1135	322.1	.000
Factor 3 mean	179.6	2	.593	1135	302.8	.000
Factor 4 mean	476.2	2	.479	1135	994.6	.000

Table 7. Variables used as predictors in Multinomial Logistic Regression.

Continuous Variables		Categorical Variables
<i>Variables of teaching methods and materials</i>	<i>Variables of the teachers' backgrounds</i>	<i>Variables of the school context</i>
The methodology of the educational material has a large impact on my technology teaching.	Are you, according to the new rules, qualified to teach technology?	Is there an overall planning, based on the new curriculum Lgr 11, for the subject of technology in your school?
Other teaching methods, such as contests, have a large impact on my technology teaching.	Have you participated in some kind of in-service-training in technology?	How is technology generally taught in your school today?
My colleagues have a large impact on my technology teaching.	Are you teaching ages 6-9?	Does the subject of technology have a fixed number of teaching hours in your school?
The questions from the students have a large impact on my technology teaching.	Are you teaching ages 10-12?	
The possibilities for inspiration and excursions in the nearby area have a large impact on my technology teaching.	Are you teaching ages 13-15?	
	What year did you graduate?	
	Are you a man or a woman?	

Factor 1 - Technology education is important

- Technology is an important subject
- It is a good thing that technology is compulsory throughout school
- Knowledge of technology is generally important for the students and their future
- The subject of technology will have increased importance in the future

Factor 2 – Conditions are favorable for technology education

- At my school, we have plenty of good teaching material for technology education
- How satisfied are you overall with the way technology education is managed in your school?
- At my school there are well-established work fields in technology
- I get sufficient time for developing my teaching
- The management of my school wants to develop the subject of technology

Factor 3 – Curriculum is in focus for technology education

- I think the curriculum core content is a good starting point for teaching
- The knowledge requirements are clear
- The core content of the curriculum (is important on how I achieve technology education)

Factor 4 – Confidence, interest and knowledge of the teacher is high

- I feel confident in teaching technology
- I have the necessary training to conduct good technology education
- I am passionate about the subject of technology
- My own interest/knowledge of various technology fields (is important on how I achieve technology education)

Figure 3. The four factors.

Results

Factor Analysis

Exploratory factor analysis revealed that the underlying structure of the teachers' responses to the attitude items is best described by a four-factor model (Table 1) (Figure 3), explaining 63.9% of the variance (Table 8). Each of the factors was interpreted by considering the included items. Thus, the first factor was distinguished by the importance of technology and the subject of technology, and will therefore be referred to as 'Technology education is important' in the following. The second factor was characterized by positive statements about how the teachers feel about the provisions and support for the subject in their school, and will be called 'Conditions are favorable for technology education'. All of the items in the third factor were about the curriculum, and this factor was therefore named 'Curriculum is in focus for technology education'. The last factor was named 'Confidence, interest and knowledge of the teacher is high' since the items were about the teachers' own experience of, and comfort in, technology teaching. Cronbach's Alpha values were greater than 0.70 for all factors, indicating that the instrument has adequate reliability for measuring the four attitude dimensions inherent in the identified factors (e.g. Field 2009).

Table 8. Names of the factors, variance explained, Reliability, Mean and Standard Deviation.

Component/Factor	Item	% of variance explained	Reliability (Cronbach's alpha)	Mean (Range 1-6)	Standard deviation
1. Technology education is important	2, 3, 5, 7	33.1	0.88	5.21	0.88
2. Conditions are favorable for technology education	1, 4, 10, 11, 17	12.7	0.72	3.00	0.97
3. Curriculum is in focus for technology education	9, 13, 14	9.4	0.76	4.72	0.95
4. Confidence, interest and knowledge of the teacher is high	8, 15, 16, 18	8.8	0.80	4.07	1.15

Cluster Analysis

The three identified clusters (Table 3 and Figure 4) were interpreted in terms of the underlying attitude dimensions based on the factor values. In the following, each cluster is characterized and labeled.

‘Positive’ cluster (n=419): This cluster had relatively high values on all the four factors. Teachers in this cluster view technology education as very important (5.48 of 6). They perceive the conditions in their schools to be favorable, although not very good (3.52 of 6). They have a strong focus on the curriculum, and they feel secure in their teaching and their knowledge of the subject.

‘Negative’ cluster (n=296): This cluster had relatively low values on each of the four factors, implying that teachers in this cluster tend to view technology education as less important, and school conditions as less favorable, and tend to focus less on the curriculum than teachers in the positive cluster. In addition, they tend to assess themselves as less secure in the subject (education and interest) than teachers in the positive cluster.

‘Mixed’ cluster (n=423): This cluster displayed factor values that were relatively high on two of the factors (factors 1 and 3) and relatively low on two (factors 2 and 4). Hence, teachers in this cluster find technology education to be important and have a strong focus on the curriculum. They do however, also tend to experience the conditions in their schools as worse compared to teachers in the positive cluster and they feel less educated and secure in their subject.

Figure 4. Cluster means and total means for each of the four factors.

Multinomial logistic regression

The full model, containing all the predictors, was statistically significant. The model classified 58.5 % of the cases correctly. There was a significant relationship between cluster membership and the predictors in the model ($\chi^2 = 402.63$, $df = 40$, $p < 0.001$). Pearson and Deviance tests of Goodness-of-fit indicated a good fit ($p > 0.05$). The results are displayed in Table 9 – Table 11, where significant Odds Ratios are indicated in bold. The results can be described as follows, with the Positive cluster as the reference group:

Variables of the teachers' backgrounds

The result (Table 9) indicates that the variable with the highest contribution in this category was qualification. Teachers qualified in technology were about five times more likely to be in the Positive cluster than in one of the others. Gender did not have a significant effect on the likelihood of being in the Negative cluster, but the odds for a man to be in the Mixed cluster were half as large as for a woman. The only significant result with respect to students' ages was that teachers of students aged 10-12 years were about twice as likely to be in the

Negative cluster as in the Positive, compared to teachers who taught ages 13-15. Teachers who had participated in some kind of in-service-training in technology were less likely to end up in either the Negative cluster (with an odds ratio of 0.28) or the Mixed cluster (with an odds ratio of 0.49). There were no significant differences in cluster-belonging when it came to graduating year, except for teachers who graduated in 1960-1979. They were about twice as likely to end up in the Negative cluster as the Positive, compared to those who graduated in 2000-2011.

Table 9. Results of a Multinomial Logistic Regression with respect to predictor variables related to the teachers' backgrounds.

Predictors (reference category)	The Negative vs. The Positive				The Mixed vs. The Positive			
	B (SE)	95% Confidence Interval for Exp (B)			B (SE)	95% Confidence Interval for Exp (B)		
		Lower	Odds Ratio	Upper		Lower	Odds Ratio	Upper
Intercept	4.90 (0.69)		***		3.37 (0.58)		***	
Variables of the teachers' backgrounds								
Man (Woman)	-0.42 (0.27)	0.39	0.66 (ns)	1.10	-0.69 (0.23)	0.32	0.50**	0.78
Qualified to teach technology (not qualified)	-1.82 (0.22)	0.11	0.16***	0.25	-1.51 (0.18)	0.15	0.22***	0.32
Teaching age 6-9 (Teaching ages 13-15)	0.73 (0.46)	0.84	2.01 (ns)	5.01	0.04 (0.36)	0.52	1.04 (ns)	2.10
Teaching age 10-12 (Teaching ages 13-15)	0.76 (0.38)	1.02	2.14*	4.51	0.06 (0.29)	0.60	1.06 (ns)	1.90
Teaching among several ages (Teaching ages 13-15)	0.39 (0.38)	0.70	1.47 (ns)	3.09	-0.48 (0.29)	0.35	0.62 (ns)	1.09
Has participated in some kind of in-service-training in technology (not participated)	-1.29 (0.26)	0.17	0.28***	0.46	-0.71 (0.23)	0.31	0.49**	0.77
Graduation year 1960-1979 (Graduation year 2000-2011)	0.69 (0.30)	1.10	1.99*	3.60	0.27 (0.26)	0.78	0.31 (ns)	2.20
Graduation year 1980-1989 (Graduation year 2000-2011)	0.24 (0.32)	0.68	1.28 (ns)	2.41	0.18 (0.27)	0.71	1.20 (ns)	2.04
Graduation year 1990-1999 (Graduation year 2000-2011)	0.43 (0.26)	0.92	1.54 (ns)	2.57	0.38 (0.22)	1.46	1.46 (ns)	2.23

Note: 'The Positive' is the reference group *P<0.05, **P<0.01, ***P<0.001.

Variables of the school context

This part of the results is presented in table 10. Teachers in schools without a fixed number of teaching hours for the subject of technology had approximately double the odds of being in the Negative cluster (with an odds ratio of 2.13), or the Mixed cluster (with an odds ratio of

1.84) compared to the teachers in schools with a fixed number of hours. The teachers who did not know if there was a fixed number of teaching hours in their school had an even higher chance (with an odds ratio of 4.21) of being in the Negative cluster. The odds ratio of being in the Mixed cluster was 2.48. Teachers in schools with an overall planning based on the curriculum Lgr 11 (introduced 2011) for the subject were about three times less likely to be in the Negative cluster and about 2.5 times less likely to be in the Mixed cluster. The other school context predictor variables did not contribute significantly to cluster belonging in this model.

Table 10. Results of a Multinomial Logistic Regression with respect to predictor variables related to the school context.

Predictors (reference category)	The Negative vs. The Positive				The Mixed vs. The Positive			
	B (SE)	95% Confidence Interval for Exp (B)			B (SE)	95% Confidence Interval for Exp (B)		
		Lower	Odds Ratio	Upper		Lower	Odds Ratio	Upper
Intercept	4.90 (0.69)		***		3.37 (0.58)		***	
Variables of the school context								
The subject of technology does not have a fixed number of teaching hours in my school (Technology has a fixed number of teaching hours)	0.76 (0.26)	1.29	2.13**	3.51	0.61 (0.21)	1.21	1.84**	2.78
I don't know if the subject of technology has a fixed number of teaching hours in my school (Technology has a fixed number of teaching hours)	1.44 (0.38)	2.02	4.21***	8.78	0.91 (0.33)	1.29	2.48**	4.76
Technology is integrated with other subjects (Technology is a subject in its own right)	0.44 (0.25)	0.95	1.56 (ns)	2.54	0.24 (0.21)	0.85	1.27 (ns)	1.93
Technology teaching is taught in theme-days, at science centres, at museums or other alternatives (Technology is a subject in its own right)	0.51 (0.34)	0.77	1.66 (ns)	3.55	0.09 (0.34)	0.56	1.09 (ns)	2.14
The subject of technology has an overall planning based on the new curriculum Lgr 11 in my school (The subject of technology does not have an overall planning based on the new curriculum Lgr11)	-1.01 (0.22)	0.22	0.34***	0.52	-0.88	0.29	0.42***	0.59

Notes: 'The Positive' is the reference group *P<0.05, **P<0.01, ***P<0.001.

Variables of teaching methods and materials

These variables were assessed using a Likert-type scale with a response range from 1 to 6, and the odds ratios reported in Table 11 indicates the change in odds for each successive step along the corresponding Likert scale. The odds for a teacher to be in the Negative cluster decreased with increasing responses to the two variables *Other teaching methods, like contests, have large impact on my technology teaching* (with an odds ratio of 0.69) and *The possibilities for inspiration and excursions in the nearby area have large impact on my technology teaching* (with an odds ratio of 0.43). Conversely, the odds increased with increasing response values for the two variables *The methodology of the educational material has a large impact on my technology teaching* (with an odds ratio of 1.21) and *My colleagues have a large impact on my technology teaching* (with an odds ratio of 1.29). The probability of classifying a teacher as belonging to both the Negative cluster (with an odds ratio of 0.43) and the Mixed cluster (with an odds ratio of 0.71) increased for increasing values of responses to the variable *The questions from the students have a large impact on my technology teaching*.

Table 11. Results of a Multinomial Logistic Regression with respect to predictor variables related to variables of teaching methods and materials.

Predictors	The Negative vs. The Positive				The Mixed vs. The Positive			
	B (SE)	95% Confidence Interval for Exp (B)			B (SE)	95% Confidence Interval for Exp (B)		
		Lower	Odds Ratio	Upper		Lower	Odds Ratio	Upper
Intercept	4.90 (0.69)		***		3.37 (0.58)		***	
Variables of teaching methods and materials								
The methodology of the educational material has a large impact on my technology teaching	0.19 (0.08)	1.05	1.21*	1.40	0.03 (0.06)	0.91	1.03 (ns)	1.17
Other teaching methods, like contests, have a large impact on my technology teaching	-0.38 (0.98)	0.57	0.69***	0.83	-0.10 (0.08)	0.78	0.91 (ns)	1.07
My colleagues have a large impact on my technology teaching	0.26 (0.09)	1.08	1.29**	4.54	0.13 (0.07)	0.99	1.14 (ns)	1.31
The questions from the students have a large impact on my technology teaching	-0.84 (0.12)	0.34	0.43***	0.54	-0.34 (0.10)	0.59	0.71***	0.86
The possibilities for inspiration and excursions in the nearby area have a large impact on my technology teaching	-0.20 (0.09)	0.68	0.82*	0.98	-0.15 (0.08)	0.74	0.86 (ns)	1.00

Notes: 'The Positive' is the reference group *P<0.05, **P<0.01, ***P<0.001.

Discussion

The results of the analysis reflect the complexity of teaching and education, with no single factor emerging as the most important in relation to teachers' attitudes. The findings indicate a range of different attitudes among the teachers and a number of factors may have an effect on the teachers' attitudes to their subject and its teaching. In the following, the results are discussed in relation to each of the two research questions that guided the study.

What are Swedish technology teachers' attitudes to the subject of technology and its teaching?

The answer to the first research question is informed by the results from the factor analysis and the cluster analysis. Exploratory factor analysis revealed four distinct attitude dimensions with different characteristics among the questionnaire items. Furthermore, the cluster analysis indicated differences between the teachers with respect to the four attitude dimensions. Given that 'cluster analysis will always create clusters, regardless of the actual existence of any structure' (Hair et al. 2010, 482), the validity of the discerned clusters resides in their conceptual meaningfulness. In this regard, the emerging picture of teacher attitudes is comparable to other studies, including a recent report from the Swedish Schools Inspectorate (Skolinspektionen 2014).

We interpret the first factor, 'Technology education is important', to correspond to an attitude dimension related to 'cognitive beliefs' in the theoretical model (van Aalderen-Smeets, Walma van der Molen, and Asma 2012). In general, it appears that the teachers in this study consider technology to be important, not least in the Positive cluster. Headmasters and teachers in general in Sweden have been shown to regard technology as a low status subject (Nordlander 2011; Skolinspektionen 2014), and a low status has also been identified as a weakness of technology education internationally (Jones, Bunting, and de Vries 2013). Nevertheless, the findings resonate with other studies, where the technology teachers

themselves find the subject to be important, despite the fact that the subject generally seems to have a low status (e.g. Almutairi 2009).

The second and the third factor may both be interpreted as aspects of the ‘perceived control’ component in the three-part attitude model employed in this study (van Aalderen-Smeets, Walma van der Molen, and Asma 2012). The relatively low scores on the factor ‘Conditions are favourable for technology education’ indicated that the teachers, in particular those in the Negative and the Mixed clusters, were dissatisfied with the conditions in their school. This finding confirms previous reports from Sweden (Skolinspektionen 2014) and New Zealand, where a lack of equipment (Jones, Harlow, and Cowie 2004) and insufficient funding (Almutairi 2009) are two main areas of experienced difficulties.

When it comes to the other factor related to perceived control, ‘Curriculum is in focus for technology education’, the mean is rather high. This could indicate that the teachers believe that they are well aware of the curriculum and think that they follow it. According to the Swedish Schools Inspectorate (Skolinspektionen 2014), however, teachers follow the curriculum, but technology education is often taught at too low level, for example, primary level to students in lower secondary education.

The fourth factor, ‘Confidence, interest and knowledge of the teacher is high’ can be interpreted as a reflection of the ‘affective states’ attitude dimension (van Aalderen-Smeets, Walma van der Molen, and Asma 2012). This factor displayed the widest variation in the present study, largely because of the attitude gap between the Positive and the Negative clusters. This might indicate that this is the most interesting area for further investigation, given that a lack of confidence in technology teaching is a problem. According to Holroyd and Harlen (1996), a lack of confidence and understanding affects how the teachers teach. They argue that teachers find strategies to deal with their lack of confidence and those strategies probably do not end up in the best learning opportunities for the students. If we put

this argumentation in a Swedish context, it might explain some of the findings in this study. A possible explanation, which should be further examined, is that teachers stay in their comfort zone when they teach, and that may lead to technology teaching at a lower level or with more focus on other subjects (Holroyd and Harlen 1996). It may also lead to teachers doing what they were taught in their own education or in their own in-service training.

Given that the questionnaire has not been validated before, the reported exploratory factor analysis provides initial indications of construct validity. In particular, the factors conform to the attitude model (van Aalderen-Smeets, Walma van der Molen, and Asma 2012) that was used as a theoretical framework for the study. Prior to this, face validity of the instrument had been ascertained by analyzing the individual items in the questionnaire and finding the formulations of the statements to plausibly require assessments based on attitudes toward technology and its teaching to be answered.

What are the possible explanations for their different attitudes?

Possible explanations can be suggested based on the results of the Multinomial Logistic Regression analysis. Several of the tested variables were found to have an effect as predictors for cluster belonging. The predictors with the greatest effect are found among the variables concerned with the teachers' background and those concerned with the school context.

Qualification to teach technology and in-service training were both found to be important predictors for cluster membership. In particular, teachers with qualification to teach technology are very likely to be in the positive cluster. This result may not be surprising given that 'one of the key factors influencing the development of technology education as a school subject is the education and professional development of teachers' (Jones, Bunting, and de Vries 2013, 202). The importance of well-educated technology teachers has been pointed out by many researchers (Hartell, Gumaelius, and Svärðh 2015; Gumaelius, Hartell,

and Svärth 2013; Mattsson 2005). Teachers' pre-service and in-service education is among the background factors that affect technology teachers' teaching (Bjurulf 2008; Jones and Carr 1992). In addition to this, the results from the present study indicate that teachers' attitudes to their subject may also be linked to educational factors such as qualification to teach technology and in-service training. In the present study, it is not possible to test whether professional development actually has a positive effect on the attitudes, or if teachers with positive attitudes for example might be more likely to work toward qualification. However, previous research has associated in-service training with more favorable attitudes toward technology teaching (Jones and Carr 1992, 238). Thus, while the cross-sectional nature of the present study does not account for causal relations, the findings nevertheless support a tentative interpretation of a beneficial effect on attitudes from teacher development initiatives such as in-service training and qualification.

Technology is one of the subjects with the fewest qualified teachers in the Swedish school system (Skolverket 2014), and calls to alleviate the lack of teachers with the desirable qualifications to teach technology have been raised for a long time (Elgström and Riis 1990). The potential connection between professional development and teachers' attitudes further emphasize that the situation may be problematic. Teachers with a positive attitude to the subject of technology are likely to communicate this attitude and the importance of the subject to their students, which could have various positive effects on the students.

Gender issues have garnered much interest in the technology education research literature, in particular with regard to potential links between gender and interest in technology (cf. Svenningsson, Hultén, and Hallström 2015; Ardies, De Maeyer, and Gijbels 2015). However, gender differences regarding teachers have not been investigated to the same extent. The present study found gender to be a predictor for being in the Mixed cluster, with a lower probability of being in this cluster for men than women. Given that the Mixed

cluster is characterized in part by a low confidence in their profession, the findings indicate that the women may be more likely to feel insecure than the men. The reason for this potential difference would be a very interesting issue to follow up. Similar findings have been obtained in Scotland, but in that case it was a more widespread phenomenon because ‘men were more confident than women about almost everything directly to do with science and technology teaching’ (Holroyd and Harlen 1996).

There is a lack of research in the technology education literature regarding the influence of *variables of the school context*. Results from the present study indicate that having a fixed number of teaching hours for technology is a strong predictor for cluster belonging. In particular, teachers who do not know whether or not their school has a fixed number of hours for technology are very likely to be in the Negative cluster. A lack of awareness among teachers regarding the subject’s number of teaching hours might indicate that the subject is not prioritized in that school. Conversely, having an overall plan for the subject is positive, since lacking an overall plan increases the likelihood of being in the Negative cluster.

Limitations

The main limitation of this study is the response rate (34 %), which warrants caution in generalizing the observed attitude distribution to the entire population of Swedish technology teachers. In particular, it is likely that teachers with negative attitudes to the subject of technology were less likely to respond than teachers with positive attitudes. However, the response rate is well within the typical ranges reported in the literature for web-based surveys (e.g. Shih and Fan 2009; Kennedy and Archambault 2012), and should thus be acceptable for the statistical procedures performed and the conclusions regarding predictors. A further limitation was the limited range of different attitude dimensions that can be discerned through

a questionnaire. Although the identified factors represent important attitude dimensions, there may also be other attitude dimensions that were not addressed by the items included in the instrument.

Conclusions and implications

The study has shown that technology teachers' attitudes towards their subject and its teaching as revealed by a questionnaire are structured along dimensions that conform to an established attitude model (van Aalderen-Smeets, Walma van der Molen, and Asma 2012), and that the teachers fall into distinct groups with respect to these attitudes. The results further contribute to technology education research by identifying important variables among teachers' backgrounds, school contexts and teaching methods and materials that may predict attitudes. Hence, these predictors could inform the design of professional development interventions and policies intended to improve technology education while also supporting positive attitudes among teachers. In this regard, the results indicate that efforts to increase the number of qualified technology teachers and providing in-service education may be beneficial for teachers' attitudes. In addition, ensuring a sufficient and formally established number of teaching hours for the technology subject are possible actions that could support positive attitudes among teachers, and, in turn, an improved learning experience among pupils. Future research could delve deeper into these teacher attitudes by performing studies with a qualitative design to get a deeper understanding of personal and other factors influencing teacher attitudes.

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