Reconstructing the Pupils Attitude Towards Technology-Survey

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Abstract

In knowledge based economies technological literacy is gaining interest. Technological literacy correlates with the attitude towards technology, therefore, when measuring technological literacy as an outcome of education, one should take the attitude towards technology into account. This requires a valid, reliable instrument that should be as concise as possible, in order to use it in correlation with other instruments. We therefore reconstructed the Pupils' Attitude Towards Technology (PATT) instrument. We validated and piloted this and used it in a large study.. This resulted in an instrument with six subscales and 24 items of attitude towards technology that is easy to use and evaluate. The six items are: Career Aspirations, Interest in Technology, Tediousness of Technology, Positive Perception of Effects of Technology, Perception of Difficulty and Perception of Technology as a Subject for Boys or for Boys and Girls.

Introduction

In western countries technology, defined as any modification of the natural world done to fulfill human needs or desires, is gaining interest as a subject in the school curricula. Different nations are investing in the development of teaching programmes, research, and the establishing of platforms for the promotion of technology. The American National Assessment Governing Board ,for example, is making a framework for Technology and Engineering Literacy in 2014 (National Assessment Governing Board, 2011); in the Netherlands a platform for Beta-science is established aiming to achieve a structural increase of 15 per cent more pupils and students in scientific and technical education (Stichting Platform Bèta Techniek). Although industries and policy makers think technology education is far more relevant these days than it was ever before, the public opinion about studying technology and technical jobs is not very positive (Johansson, 2009). The Organisation for Economic Cooperation and Development (OECD) reports on student interest in Science and Technology Studies (OECD, 2008) states that, although absolute numbers of S&T students have raised, the relative share of S&T students among the overall student population has increased. The report shows that encouraging interest in S&T studies requires action to improve the image and knowledge of S&T careers. A report ordered by the department of education of the Flemish ministry (2006) points this out as follows: the image of technological studies and professions is rather low, which seems to be in contrast with the enthusiasm young people have for new technologies.

The image is strengthened by some prejudices like: 'the working conditions in industrial environments are not interesting, boring, they are hard and dirty labour, moderate payment, bad working hours.' More general people think science and technology are hard and boring to study. Technology is also often associated with danger. These are widely spread ideas about technology and the public opinion. How interested young people really are in technology and how this interest evolves during their school career has not yet been examined in the Flemish context. To be able to do this on a large scale we need an instrument to measure pupils' attitude towards technology with a manageable number of questions. In this paper we will clarify the revalidation of such a survey instrument. First a theoretical base will be described, followed by the methodology used in the research. Finally results of the study will be written down in a concluding chapter.

Theoretical base

Attitudes towards technology

It could be assumed that if students have a tendency to act positively toward a subject, for example technology, they will have more interest in that subject (Krathwohl, Bloom, & Bertram, 1964). Thus students exhibiting a positive attitude towards technology would be more likely to attain technological literacy through technology education (Bame, Dugger, de Vries & McBee, 1993). Therefore, a good interpretation of students' attitude toward technology is important. Attitude is a broad concept with different interpretations and definitions. For this research we use the concept 'attitude' as defined by Eagly and Chaiken (Eagly & Chaiken, 1993) "Attitudes are psychological tendencies that are expressed by evaluating a particular entity with some degree of (dis)favour", which is commonly regarded as the most conventional definition (Albarracin, Zanna, Johnson, & Kumkala, 2005). This is in line with the view of The Committee on Assessing Technological Literacy from the National Academies on attitudes (Garmire & Pearson, 2006). Attitude towards technology is explicitly conceptualized not to contain a cognitive dimension. What a person knows about a –technological - subject can however be correlated with his attitude towards that subject. Hereby a person's attitude can provide a context for interpreting the results of an assessment on technological knowledge as an outcome variable for educational effectiveness.

How do we measure attitudes?

A review study on attitudes towards science (Osborne, Simon, & Collins, 2003) notes that such attitudes – towards science – do not consist of a single unitary construct, but rather of a large number of sub-constructs all contributing in varying proportions towards an individual's attitudes towards science (e.g. anxiety; value; motivation; enjoyment; achievement; fear of failure…). Hence, producing a unitary score on attitude is useless. The best that can be done is to ensure that the components are valid and reliable measures of the constructs they purport to measure and look for the significance of each of these aspects. A good instrument needs to be internally consistent and unidimensional (Gardner, 1995). Internal consistency is often expressed with Cronbach's alpha. Commonly, attitudes have been measured through the use of questionnaires that consist of Likert-scale items where students are asked to respond to a number of statements. Despite the fact that these scales have been widely used and extensively tried in the domain of science education (Osborne et al, 2003) only few instruments have been made for measuring attitude in the domain of technology as defined above.

The PATT instrument

A number of instruments have been made for measuring an attitude in the field of technology (Garmire & Pearson, 2006). Considering the fact that we investigate students of age of 12 to 14, one instrument can be retained: the Pupils' Attitudes Towards Technology instrument (PATT) (Bame et al, 1993), consisting 58 statements on a five-point Likert scale. Since 1984 researchers have been assessing students' attitudes toward technology by using the PATT instrument. This instrument was first conducted in the Netherlands and is the first instrument specifically made for this purpose. Results in the Netherlands were so striking that an international extension of the research was the logical next step. In 1987 twelve countries decided to start using the PATT instrument or a part of it. A work conference was put together in the Netherlands to initiate the collaboration (Raat, Coenen-van den Bergh, de Klerk Wolters, & de Vries, 1988). Participants came from all over the world (e.g. India, Nigeria, Mexico, Australia but also West-European countries like France, UK and Belgium). In this report, due to the fact that not all participating researchers had the opportunity or knowledge to use statistical programmes (e.g. SPSS), the suggestion is made to create a shorter instrument. The idea was to investigate the possibilities of using a 'subset of scales' with maximum 5 items for each scale. Such an instrument yields many advantages (easier to apply, less time consuming, teachers can use it in the classroom). But the major objection of the participants was that a high reliability is required. Ever since there has been no reported research concerning a possible reduction of the PATT.

Research questions

In the West-European and, more specifically, in the Flemish context research in the field of technological literacy is rare but necessary, as is indicated by the Flemish ministry of education. It is important to be able to measure attitude towards technology. The absence of a concise but powerful instrument to measure this leads us to the following research questions:

- Is the PATT instrument suitable for the Flemish context?
- Can we adapt and reduce the PATT instrument and still retain validity and reliability?

Methodology

Principal components of the test

In order to be able to answer these questions we needed an instrument that was validated in the Flemish context. The most recent PATT survey contains questions (1-11) about demography of the pupil. Items 12-69 are the affective components of attitudes towards technology and items 70-100 are about the concepts of technology. An open-ended question at the end asks for a description of technology.

We will focus on the items concerning attitude towards technology. These 58 questions about attitude are dividable in five scales. 'Technology is difficult' and 'Consequences of Technology' contain five items each. 'Technology as an activity for Both Boys and Girls' and 'Attitude Towards Technology' each contain eight questions. 'General interest in Technology' contains sixteen questions (Bame et al, 1993). This results in a total of 42 questions which are withdrawn from the original 58.

The validation of the instrument contains different steps. First there is the translation. The PATT-USA test items 12-69 had to be translated into Dutch. Because the original PATT questionnaire developed by de Vries (1988) was in Dutch, a good translation was available.

The second step was the pilot study (n=251). An explorative factor analysis (EFA) was conducted on the data of this study. Although we had a clear idea of the different subscales it was interesting to see how all 58 items corresponded. The scales composed by Bame (1993) contained only 42 of the 58 items. Therefore we chose to analyse these results with an EFA with oblique rotation because this allowed us to undertake a data driven exploration taking into account the fact that latent variables might correlate and could contain some unexplained variance. In a scree plot we looked at the 'elbow point' (Pallant 2001). In interpreting the factor analyses we did not take loadings of items between -.30 and .30 into account.

Based on the outcome of this EFA and substantive arguments, factors were defined and tested on their reliability. Cronbach's alpha on each factor and the remaining impact of each item was taken into account to assure reliable scales with a reasonable number of items. To define a reliable scale Cronbach's alpha of .70 and higher are acceptable.

In the third step the remaining items from the pilot study were used in the main study on a larger group of students (n=3039). Allowing us to confirm our first analysis, this time a confirmative factor analysis (CFA) was used to confirm the measurement model. Goodness of fit indices helped us find the most appropriate model. In the analysis the Comparative fit-index (CFI) and Root-Mean-Square-Error-of-Approximation (RMSEA) will was taken into account. For the CFI a score >.95 indicates a good modelfit (Hu & Bentler, 1999) for RMSEA the maximum score is .05 for a good modelfit between .05 and .08 is still acceptable (Hoyle, 1995).

Different models were compared with a Chi² test on the -2 LogLikelyhood differences and Akaike's Information Criteria (AIC) to determine the best fitting model. The test not only showed the Chi² score for each model but the model' significance (p<.05).

Data collection

The pilot study was conducted with 251 pupils (111 Girls, 137 Boys , 3 missing) from first grade of secondary education (12-14 years old) divided over first and second year in five different schools – both rural and non-rural environment and public and non-public schools. All had to achieve the same national goals for technology but had different curricula. Each school however had at least two hours of technology a week.

In the main phase the slimmed version of the PATT test was conducted in 17 schools with a total number of 3039 pupils. Students from the first and second year of secondary education were represented. Students had different curricula (e.g. Latin, economy, social sciences, electricity,...). This survey allowed us to confirm previous findings from the pilot and framed a fitting model for this instrument.

Results

In our pilot study we used all 58 items (items 12-69) from the original questionnaire. An Explorative Factor analysis (EFA) was applied. We also performed a scree test and plotted the parallel analysis (fig.1). The parallel analysis suggests a solution with five factors and the scree plot shows an elbow point between the fifth and the sixth factor. Therefore an EFA with oblique rotation was applied with a fixed number of five factors. The cumulative explaining variance of the five factors was a satisfying 43% (table 1).

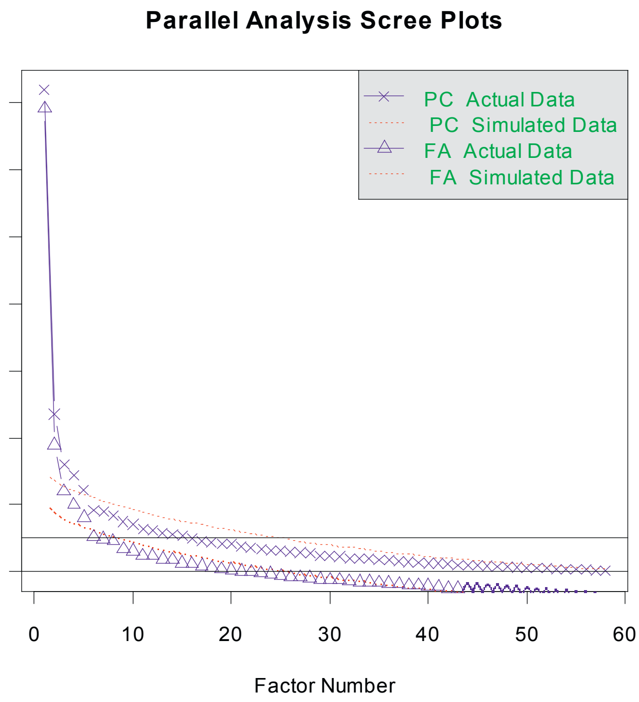

Fig. 1:
screeplot Parallel factor analysis with 58 items

	Factor 1	Factor 2	Factor 3	Factor ‘	Factor 5
Eigenvalue	9.41	4.70	3.90	4.12	2.67
Proportion explained variance	0.16	0.08	0.07	0.07	0.05
Cumulative explained variance	0.16	0.24	0.31	0.38	0.43

Table 1: eigenvalues, explained variance per factor and cumulative explained variance of the five factors after oblique rotation.

Analysing the standardized factor loading for each we learn that the results show great resemblance with the factors as defined by de Vries (1988). Table 2 shows all the items for the different factors in our data.

Factor	Description	High score indicates	Items
1	Interest in technology	more interest	12, 16, 17, 18, 23, 27, 28, 32, 34, 39, 45, 46, 50, 51, 52, 57,58, 62, 63, 69
2	Attitude towards technology	more positive attitude	22, 28, 29, 33, 40, 46, 51, 57, 58, 60, 64, 65, 68
3	Technology as an activity for both girls and boys	technology is for both genders	13, 19, 24, 30, 35, 41, 47, 53
4	Consequences of technology	more positive consequences	14, 20, 25, 27, 31, 38, 42, 56, 60, 66
5	Technology is difficult	technology is more difficult	26, 43, 44, 49, 61, 67

Table2: items with a loading >.30 in the different factors

According to the number of items in the first factor ‘interest’ (20) and the theoretical background of the test one can wonder whether this really is an unidimensional construct or whether it is an artefact of conducting an EFA on the total number of 58 items. To test this new hypothesis we conduct a new EFA with only the items of the factor ‘interest’.

Results of the screeplot of the analysis (fig. 2) and the parallel test confirm the first analysis, leading to the conclusion that these 20 items measure general interest.

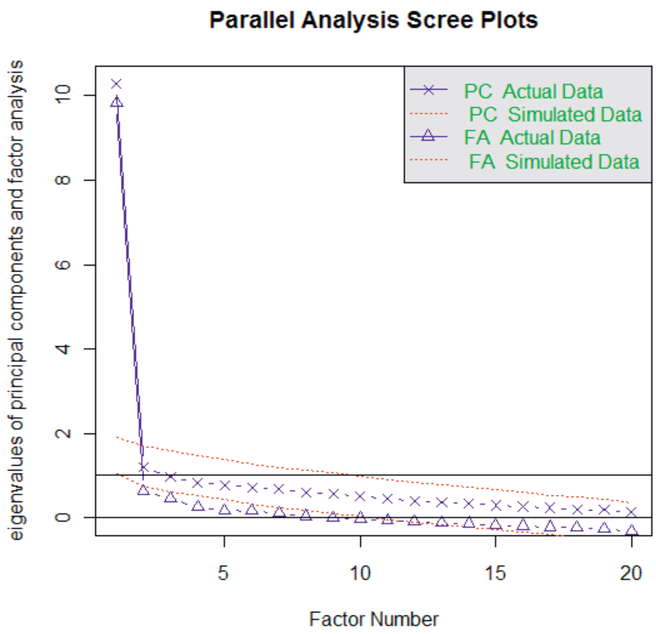

Fig.2: Scree plot Parallel factor analysis with 20 items from factor 1 'General interest'

Although the scree plot showed a unidimensional scale, the eigenvalues of the first two factors were above 1 and content analyses indicate that there were two sub factors, which will most likely be highly correlated. Thus a factor analysis with two factors and oblique rotation was conducted. From the results we derived two clearly different factors. Because of the clear distinction in content (see factor description below) the first sub factor of 'general interest' was defined as 'technological career aspirations' and the second as 'interest in technology'.

With a total of six factors we started analysing the internal consistence of each factor. And if possible items were dropped either to raise reliability or to make an equal reliable factor with less items. Results for each factor are explained below.

Technological career aspirations

Seven items form the factor technological career aspirations. A reliability analysis on all items learns us that the factor reliability for all items is .91. When eliminating less consistent items one by one we become a reliability for these four items of .92, which is considered as excellent. The remaining items are 17, 39, 45 & 63.

Interest in technology

The number of items with a loading above .30 was nine. These items have a Cronbach's alpha of .87. Dropping item per item we can bring the number of items back to five with an alpha of .84. Eliminating more items would decrease the reliability too much. These five items are: 32, 42, 46, 50 & 52.

Attitude towards technology

The original attitude scale consists of eight items (Bame Dugger, 1993). The EFA results in a nine item factor (α=.83). Exploring the specific content of these questions and a new reliability analysis of a shorter list of items delivers us a factor with an absolute minimum of four questions for this factor, with a reliability quasi equal to the scale with nine items and still defined as 'good' (α=.81). The remaining four items are: 33, 57, 58 & 64.

Technology is for both, Boys and Girls

Eight items compose the scale 'technology is for both'. An equally good reliability (α=.80) can be obtained with only half the number of items. Therefore we will only retain the four following items: 24, 30, 41 & 47.

Consequences of technology

Compared to the original scale of five items we derived a double number of items. Reliability remains above .70 when excluding 6 items step by step to finalize the diminishing at four items. (α =.72) The remaining items are: 20, 25, 27 & 31.

Technology is difficult

The original scale provided an answer to whether pupils thought technology was difficult based on five questions. In our analysis the factor contains six items. Because of the low Cronbach's alpha (.60) the data are analysed again based on the content of the items and the theoretical frame made by Bame et al (1993). Items 15 and 21 are included. The reliability of the scale containing eight items (15, 21, 26, 43, 44, 49, 61, 67) is .65. A further analysis learns that this reliability can't be made higher than this. However, excluding four items doesn't effect the reliability a lot. The following four items remained with an alpha score of .64: 21, 26, 43, & 49.

Conclusions of the pilot study

The original factor 'General Interest' (Bame, et al, 1993) containing 18 items was slimmed to two factors, career aspirations and interest in technology, with four and five items in each scale respectively and alpha's above .80, which are considered to be good.

The factor 'Attitude' contained in his original version eight items with a variety of questions about prosperity, environment, the need of mathematics, etc. The slimmed version with only four questions defines attitude as 'the degree in which someone finds technology boring or not' and all of the items are negatively stated. Therefore it could be appropriate to change the title of the factor in 'tediousness'.

The factor 'Technology as an activity for both boys and girls' was perfectly slimmed to only four questions of the original eight with a good reliability (.80)

For the factor 'Consequences of Technology' one of the four remaining items was not in the original factor. Nevertheless our analysis showed a bigger internal consistency of the items (α_{new} =.72; $\alpha_{original}$ =.67).

For the factor 'Technology is Difficult' the results are not as straightforward as for the other factors. A reliability score between .60 and .70 is questionable but we retain this factor with four items to maintain a questionnaire including six different aspects of attitude towards technology.

With a total number of 25 items divided over six factors this analysis of the first pilot study results in a questionnaire with sufficient reliability and less than half the number of items of the original PATT questionnaire.

Main run

We used a CFA to examine the dimensionality of the questionnaire in more detail. This CFA explored the different models for the six factors until a good fitting model was found in line with theoretical evidence for this model. The different steps will be subscribed below, starting with an overview of the data in table 3. This displays the model number, the comparative fit index (CFI), the Root Means Square Error of Approximation (RMSEA), Akaike's Information Criteria (AIC), Chi², and the p-value for significant improvement with the previous model.

Model	CFI	RMSEA	AIC	Chi²	df	P -2LL test
1	.928	.050	190904	2007	260	
2	.939	.046	190639	1740	259	<.001
3	.951	.043	184456	1402	236	

Table 3: The fit indices for the different models

Model 1

The first model includes all factors as defined after the first pilot study. The factor 'structure' is shown in figure 3. The fit indices for this model don't reach the critical values (CFI>.95; RMSEA<.50). Therefore we used the function modification indices to inspire us for any improvements on the model. This resulted in the suggestion to implement item 27 '*Technology lessons are important'* as a factor loading for 'interest'. Because both internal consistencies for the factors 'interest' and 'consequences' will improve we implement this item in the factor 'interest'. This results in a second model.

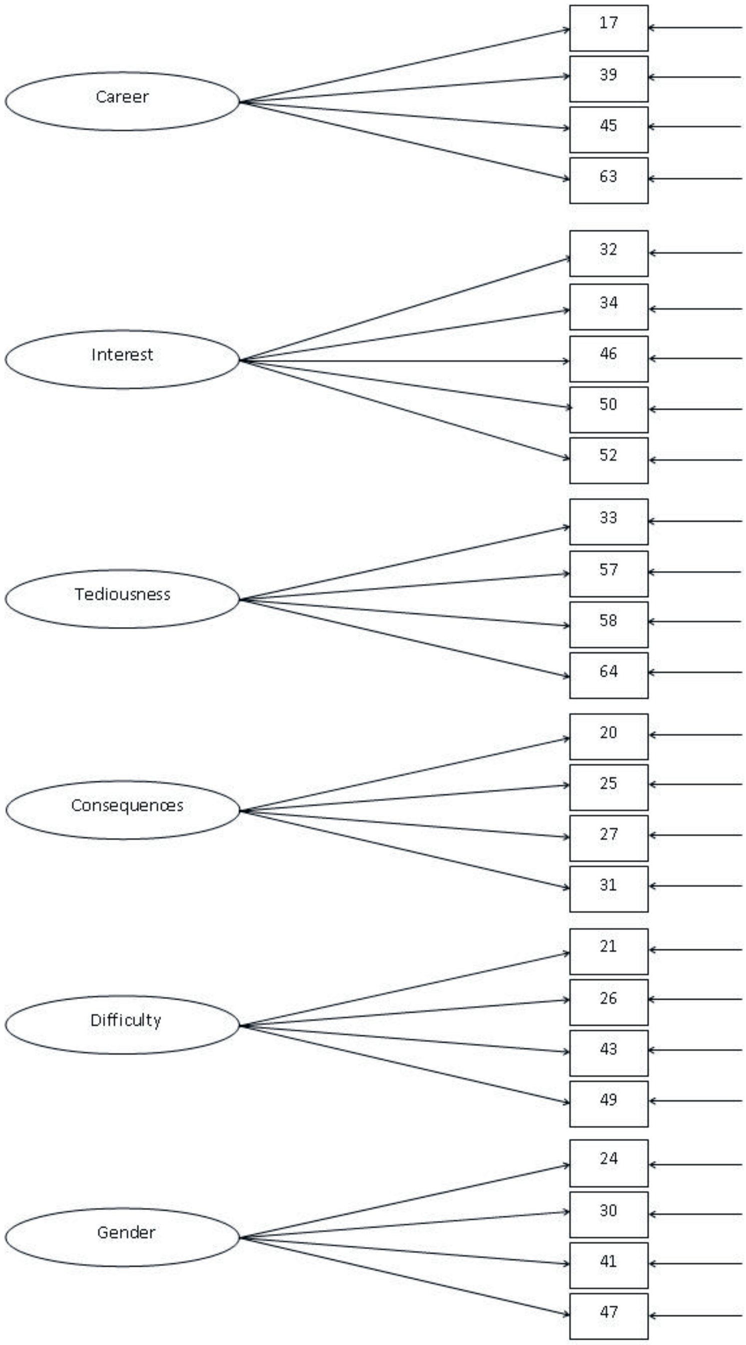

Figure 3: Model 1

Model 2

As shown in table 3, the second model containing the cross loading of item 27, significantly improves the fit. The RMSEA has dropped under .05, which is considered to be good but the CFI still is under .95, which indicates the model can improve some more. Modification indices suggest that a loading for item 24 should be added for 'consequences of technology'. However this seems not to have any kind of logical reason. Therefore we think it might be a better idea to drop the item. The internal consistence of the factor 'gender' would increase from α=.74 to α=.82 without item 24 for the second pilot group. This leads to a third model to analyse.

Model 3

Based on the first and second model but without item 24. Goodness of fit indices show now an acceptable CFI and RMSEA and also Akaike's Information Criteria is a lot lower than in model 2 , which indicates a better model. All fit indices taken into account we conclude this is the best model.

Conclusion

With our research we follow the opinion of Osborne, Simon, and Collins (2003), that a scale for attitude towards a subject actually consists of a number of subscales. And the best that can be done is to ensure that the sub-factors, which form the concept of attitude, are valid and reliable measures of the constructs they purport to measure and look for the significance of each of these aspects. We found six of these so-called sub-factors in the PATT questionnaire. All of these six sub-factors are highly in accordance with the original scales made by Bame, Dugger and de Vries (1988), although all of them contain less items. Five of the factors have at least an acceptable internal consistence (>.70) and only one of them, 'Difficulty' has a dubious internal consistence. Overall, the questionnaire seems to be useful as an instrument for measuring different aspects of attitudes towards technology.

Discussion

To future researchers who would like to work with the PATT-survey we suggest to randomize questions in order to avoid the bias due to the fact that questions on similar topics are influenced by each other when appearing together. Factors that are measured by less than four items can be improved by adding more items we dropped after our first pilot study.

It might be worth investigating if the variance explained by these factors is equal for sub-groups in the population like boys and girls, or whether the items are linguistic or gender dependent.

Future research could point out what the correlations are between the factors in the attitude questionnaire and aspects of technological literacy, or what the effect of education could be on attitude towards technology. This cohort could be followed through their educational career to investigate the evolution of attitude towards technology.

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