

Vanessa Kind is Lecturer in Education in the School of Education, Durham University. She teaches on Masters and teacher education courses, undertakes research and doctorate supervision. Vanessa was Principal of Birralee International School, Trondheim, Norway from 2002-2005. Prior to this she was Lecturer in Science Education at the Institute of Education, University of London.

Rob Wallace is an Assistant Headteacher at Framwellgate School Durham. He trained as a geography teacher and teaches the subject to 11-18s. His management roles have included responsibilities for newly-qualified teachers and leading the school's initial teacher education service. Rob has taught in different schools in north-east England.

VANESSA KIND

School of Education, Durham University, UK
E-mail: Vanessa.kind@durham.ac.uk

ROB WALLACE

Framwellgate School Durham, UK
E-mail: rob.wallace@fram.durham.sch.uk

Train, teach; taught? How the content of specific science subject matter knowledge sessions impacts on trainee teachers' classroom practice and children's learning

Abstract

The impact science sessions for trainee science teachers have on 11-14 year olds' learning of science was assessed using questionnaires and a "Video-Interview (trainee)–Interview (pupils)" (V-I-I) technique devised for this study. V-I-I involved: video-recording trainee-taught lessons; and two interviews – with a pupil group to probe learning occurring in the lesson and with the trainee.

Eighty UK-based trainees taking a one-year postgraduate teacher education course completed the questionnaire probing perceptions about university- and school-based training sessions designed to develop science subject matter knowledge (SMK) and pedagogical content knowledge (PCK). Six trainees participated in V-I-I.

Most trainees saw all sessions as SMK-based, regardless of teacher educators' intended purposes. Lesson videos revealed "describing" activities, task completion and good behaviour as main focii. Explanation of key science ideas and use of materials and /ideas from training sessions were largely absent. Trainee interviews revealed contrasts: most perceived a lesson as "successful" when children completed tasks quietly. Other trainees realised their understanding impacted on pupils' learning science concepts. Pupil interviews showed positive attitudes towards science and learning difficult ideas, but little specific learning of topics taught.

INTRODUCTION

The present study contributes to international debate (Abell, 2000) about how best to ensure secondary science teachers are equipped for their role in subject matter knowledge (SMK) and pedagogical content knowledge (PCK). That this is a complex process is undisputed (Abell, 2007) - evidence indicates that good SMK is only one factor influencing teacher effectiveness (Geddis, et al, 1993; Lederman, 1994). Shulman (1986a, b; 1987) identified seven categories of teacher know-

ledge, including PCK and SMK, that contribute to effective teaching. Here we attempt to articulate the impact of five training sessions designed to help trainees develop PCK alongside SMK – so in some respects our paper's title could be regarded as misleading. Nonetheless, that trainees' focus on SMK in the UK system is unsurprising. As the context (see below) indicates, the requirement to teach all aspects of science to 11-14s in UK state secondary schools means that trainee teachers need good all-round SMK, not just knowledge of their specialist science subject.

Our work is localised in collaboration between a university department of education and a state-funded secondary school in delivering postgraduate initial teacher education for science. The collaboration began in 2005 following opening of Science Learning Centre North East (White Rose Consortium Team, 2005: <http://www.sciencelearningcentres.org.uk/> retrieved 14th August 2008) on the school site. The Centre provides excellent facilities for teacher education, being separate from the school itself and specifically designed for teacher professional development. This gave university and school colleagues an opportunity to devise a teacher education programme that includes a combination of “university-based” sessions (using university facilities) taught by academic staff with expertise in specific aspects of science, with a complementary set held at the Science Learning Centre (referred to as “school-based” sessions) led by science teachers from the school. University-based sessions are intended to develop trainees' SMK in a range of science topics typically taught to 11-14s. The school-based sessions focus on PCK related to these topics by selecting experiments often used to teach key concepts or to illustrate specific information.

Thus, the study offers an insight into a collaborative process of developing effective science teacher education. We attempt to reveal the process of knowledge transfer from teacher educator to trainee and then via teaching to school pupils; hence we examine the transition from training, to those being trained and ultimately those being taught. Our research questions are:

1. What uses do trainee science teachers make of sessions designed specifically to develop their SMK and PCK in planning and teaching their lessons?
2. In what ways do these sessions impact on children's learning?

Questionnaire, video-recording and interview data were used to inform the first question, while pupil group interviews were used for the second. Data were collected during 2006/7 and 2007/8.

THE LOCAL AND NATIONAL CONTEXT

The five sessions referred to in this study contribute to a “Postgraduate Certificate in Education” (PGCE), an initial teacher education programme run by the university. In England and Wales successful completion of a PGCE is the major route into state-funded secondary school teaching. The PGCE involves an intensive nine months of full-time study from mid-September – mid-June. The programme combines school-based teaching practice (24 weeks) in two different schools and Higher Education Institution (HEI)-based work (12 weeks). All participants are graduates holding Bachelor's degrees in a subject linked closely to a National Curriculum (DfES, 2004) subject. Trainees' degree subjects dictate their specialisms of chemistry, physics, or biology. All have studied physics, chemistry and biology to the age of 16. About half of trainees have degrees in biology or biology-related subjects, and little or no post-16 education in physics and/or chemistry. As trainees' minimum age is 21 and average around 26, for most, more than five years have elapsed since all sciences were studied. Inevitably, therefore, trainees claim strong understanding and knowledge of science studied to degree level, while their experiences of other sciences are related to the level they are teaching their students. Perhaps consequently, most trainees experience some anxiety about teaching “outside specialism”. The collaborative programme reported here represents an aspect of our attempt to ameliorate this, providing subject knowledge and opportunities to develop pedagogy.

THE TEACHING PROGRAMME

The school and university involved in the programme are situated in north-east England in close proximity (about 5km distant) to each other, enabling trainees to travel easily between the two locations. Teaching sessions, each of 2.5 hours duration, took place in both. Timing was, where possible, organized so for example, university-based biology sessions preceded the “biology experiments” school-based session.

The university-based sessions:

- provide opportunities to develop trainees’ subject matter knowledge (SMK) in a range of topics
- are taught by academic staff and experienced teachers from other schools
- take the format of a “lecture” followed by a circus of experiments with a plenary discussion

Trainees are provided with handouts at each session giving in depth reading material and a summary of the key aspects. The sessions taught in 2006/7 and 2007/8 are listed in Table 1. An illustrative summary comparing the content of a university- and school-based session is provided in Appendix 1.

Table 1. University-based SMK session topics

Area of science	Topics featured in university-based sessions			
Physics	Forces	Waves	The Earth and Beyond	Electricity
Chemistry	Properties of materials	Chemical change	Substances and materials	
Biology	Survival of the genome	Survival of the ecosystem	Survival of the individual	
General	Science investigations	Energy		

The school-based sessions were planned to differ distinctively from those at the university. These:

- take place at Science Learning Centre North East, i.e. outside the university setting
- focus on pedagogy relating to topics taught to 11-14s
- are led by Framwellgate School Durham science teaching staff
- involve trainees working in groups each with a nominated subject “expert”
- conclude by discussing how the activities presented could be adapted to meet different children’s needs for example, gifted and talented and SEN (special educational needs)

Trainees are provided with a booklet describing the content of all sessions, together with reading lists and discussion points. The purpose of this is to encourage advance reading and preparation.

The topics featured in both 2006/7 and 2007/8 were:

- Biology experiments
- Physics experiments
- Chemistry experiments
- Energy
- ICT

All sessions except ICT comprised about five experiments, each making a particular conceptual or informational point clear. The teacher leading each session ensured that introductory tasks and plenary discussions were also addressed, together with ways of adapting materials for use with the full range of pupils’ abilities. Trainees carried out the experiments and discussed informally with

the presenter how to use these to best effect. Working in groups mixed by science degree background meant trainees could support each other by answering questions and resolving misunderstandings. The ICT session aimed to develop electronic whiteboard and power-point skills.

LITERATURE REVIEW

Possessing “good” SMK is widely accepted as key to teacher effectiveness (Geddis, et al, 1993; Lederman et al, 1994). Teacher education programmes reflect this, offering sessions designed to help shore up potential weaknesses. However, teaching is more than possessing good SMK: Shulman (1986a, b; 1987) proposed that teachers “transform” SMK using PCK, a powerful model that has been re-interpreted widely (Carlsen, 1999; Magnusson et al, 1999; Marks, 1990;). During initial teacher education trainees need to take their first steps in transforming SMK to PCK. Thorén, Kellner, Gullberg and Attorps (n.d.) report on a process of developing a teacher education course that attempts integration of SMK and PCK development, suggesting that one approach may be to emphasise the close-knit nature of domains of teacher knowledge to trainees. Whatever strategy is adopted, inevitably trainees’ ability to transform SMK to PCK varies, with consequent variation in their perception of what constitutes a “successful” lesson (Borko, et al, 1987).

A key aspect of the teacher education system used in this study involves training teachers to teach all sciences, requiring good “all-round” SMK. Kind (2008) found that trainees’ sources of SMK are richer when preparing outside specialism lessons: trainees are more likely to consult colleagues and use a wider range of resources than when preparing lessons in their specialist domains. Arzi and White (2004) found that the school science curriculum was the most dominant source of teacher’s knowledge –in England science departments produce “Schemes of Work” (SoWs) detailing lessons for each year group that are widely used by trainees and experienced colleagues.

Working in non-specialist domains proves less challenging for some trainees than others. Kind (2008) identifies “super-confident” trainees who hit on the principle of transforming SMK to PCK very early. This sub-group focus on preparing activities that promote children’s learning rather than on improving their own subject-specific SMK. Other trainees are “working confident”, concentrating on learning SMK for teaching outside specialism, relying on SoWs for activities. These trainees tend to perceive non-specialist teaching as “more successful” in terms of meeting learning objectives, because the need to filter difficult and complex knowledge held in the specialist subject is removed. Sanders, Borko and Lockard (1993) carried out a study of experienced science teachers working within and outside specialist subjects. They report that limitations in SMK and PCK were apparent in non-specialist teaching, while they were more prepared to take risks and talked less when teaching their specialisms. Halim and Meerah (2002) probed the PCK 12 Malaysian trainee science teachers with varied degree backgrounds used for teaching physics concepts, exploring their awareness of possible misconceptions and explanations of science ideas. A majority did not understand the ideas correctly themselves - the authors note this negatively affected trainees’ ability to select appropriate instructional strategies, suggesting that secure SMK may be a pre-requisite for sound PCK. This finding is supported by Ahtee and Johnston (2006a), who attributed trainee primary teachers’ struggles to teach physics topics to SMK weaknesses.

The issue of trainee confidence also bears discussion. Kind (op cit) reports that over-confidence may result in trainees failing to recognise defects in their teaching, and hence students’ poor examination results are surprising. Hence, although trainees may feel confident, this does not necessarily imply competence. Ahtee and Johnston (2006b) argue that confidence should be developed alongside SMK and PCK. They report differences between Finnish and English primary trainees in regard to teaching physics concepts: Finnish trainees expressed apprehension, rating physics teaching negatively, but English students did not, even though no significant differences were found in trainees’ SMK and PCK.

In terms of PCK development, Peterson and Treagust (1995) investigated the stages of science teacher reasoning while planning. They found that trainees rely heavily on their SMK and knowledge of curricula in planning lessons. However, while teaching, trainees claimed to consider a richer variety of factors, including teaching sequence, content, curriculum, pupils' prior knowledge and their explanations for the lesson activities. van Driel, de Jong and Verloop (2002) claim that teaching experiences contributes significantly to chemistry trainees' PCK development. However, trainees also cited a university-based workshop session as a major influence on their thinking.

These studies indicate that trainees' uses and impact on children's learning of the school-based sessions are likely to vary. Factors that we cannot control, such as self-confidence, may play a part, together with their teaching experiences.

METHODOLOGY

The study takes a qualitative, multi-method approach utilising description and interpretation (Merriam, 2002).

To answer research question No. 1

A questionnaire (Appendix 2) comprising closed and open questions probed trainees' views about the school-based sessions and the extent to which these contributed to their SMK and PCK. They also commented on their use any of the materials during their teaching practices.

To answer research questions No. 1 and No. 2

A "Video-Interview-Interview" (V-I-I) technique, involving video recording science lessons, interviewing pupil groups about their learning in the lesson and then interviewing trainees about their preparation for and teaching of the lesson, was devised for this study. The video-recordings gave insight into instructional strategies trainees selected, together with the impact of these on pupils' responses. Semi-structured interviews (LeCompte and Preissle, 1993) with pupils and the trainees provided deeper insights into the process of knowledge transfer. Interview protocols are provided in Appendix 3.

Six trainee-taught lessons (see Sample section below) were video-recorded using a high quality Sony DVCAM camera with a 6-72mm 1:1,6 lens offering 12x enlargement. Recordings were made onto mini-tapes, transferred to CDs then into Atlas.ti (see www.atlasti.com retrieved 15th August 2008) for analysis. Following the lesson, a pupil group participated in video-recorded interview. When the pupil group interview was complete, the trainee teacher was interviewed and a recording made using a hand-held data recorder. Files were transferred to a PC for analysis using Atlas.ti. Permission had been granted to involve children in the research. No child is identified by name.

All lessons were of 1 hour duration. Pupil group interviews varied in length from 20 – 30 minutes. Trainee interviews were of 15 – 25 minutes duration. Participants are referred to by pseudonyms.

The sample

80 trainees participated in the study: 42 in the 2006/7 academic year and 38 from 2007/8. All completed the questionnaire. Basic information about the trainees' subject specialism, age and gender were collected – these are reported in Table 2.

Six trainees (divided 3:3 between 2006/7 and 2007/8) participated in Video-Interview-Interview. Each trainee consented to the video-recording of one lesson, taught to a class in the 11-14 age range. In 2006/7 the three video subjects were on teaching practice at three different schools: one local to the university and two at different schools about 50 km away. In 2007/8 one of the more

distant schools did not take a trainee. Two trainees were teaching at the same school local to the university and the third was placed in the other more distant school.

A group of about six children from each class were interviewed immediately after the conclusion of the video-recorded lesson. Participants were selected at random from the class although they had been warned beforehand in order to ensure that teaching colleagues were aware these pupils would be absent from the first part of the next lesson. The trainee attended these interviews as a non-participant observer. The trainee was then interviewed as described above.

The V-I-I sessions took place in April- May 2007 and April- May 2008 when trainees were near the end of their main teaching practice period of eleven weeks. About three months elapsed between the last school- and university-based sessions and the lessons recorded for the study.

RESULTS

Trainees' backgrounds

Table 2. Trainee science teachers gender and age shown by subject specialism. (Figures in parentheses are percentages throughout)

Subject specialism	Biology		Chemistry		Physics		Totals	
No. of trainees	39 (49)		24 (30)		17 (21)		80 (100%)	
Gender	Male 12	Female 27	Male 10	Female 14	Male 6	Female 2	Male 32 (40)	Female 48 (60)
Age								
21-25	8	21	3	4	4	1	41 (58)	
26-30	2	2	4	5	1	0	14 (20)	
31-35	1	2	2	3	0	0	8 (11)	
36+	1	2	1	2	1	1	8 (11)	

School-based session Question	Biology Experiments	Chemistry Experiments
Most useful school-based session overall	11 physicists	4 physicists
Reasons for choice of most useful session	Clarified my understanding 58 Gave me ideas for activities 19 Good to do experiments 17 (Note that some trainees gave more than one response)	
School-based session helping subject knowledge most	14 (17)	10 (12)
School-based session helping teaching skills most	9 (17)	7 (13)

Table 2 shows trainees' backgrounds. Of the 80 responses, 42 were obtained in 2006/7 and 38 in 2007/8. For reporting purposes, the two cohorts are considered jointly. More than half of the trainees were female. The average age was 26 – a typical trainee is starting teacher education about five years after graduating with work experience gained in science or an alternative field. The subject specialist split shows around 49% of trainees have biology-based backgrounds. Most of these will not have studied physics since the age of 16, on average, about 10 years earlier. The proportion of physics graduates, about 21%, is regarded anecdotally as “quite good” in PGCE recruitment terms – the university recruits consistently from its own physics graduates. These participants are unlikely to have studied biology since the age of 16. About 30% are chemistry specialists – these include graduates with qualifications in geological sciences and some biochemists. A majority have no post-16 physics qualification.

Questionnaire responses

Trainees' responses to the questionnaire are summarised in Table 3.

Table 3 indicates that trainees perceived the “most useful” school-based session on a subject-specialist basis – all biologists and 22/24 chemists indicated the physics experiments session was most useful, while physicists divided between biology and chemistry experiments. In general graduates' ICT skills are of a high standard - this session was not rated as “most useful” by anyone. Four trainees selected energy – these trainees may have had good all-round science knowledge. These data, coupled with open-question responses, indicate that most trainees saw school-based sessions, especially those in subjects other than their specialisms, as opportunities to develop SMK.

About one-fifth of trainees (19% of responses) perceived that the sessions provided teaching activities they could adapt. One commented that this occurred when the session matched his subject specialism:

”[the physics session] this was my specialism so I could concentrate on teaching ideas”
(physicist)

Seventeen noted the social aspects of working together: trainees valued working in a relaxed, non-lecture situation. The high quality facilities at Science Learning Centre North East and the pleasant atmosphere these helped create were noted by several.

Table 3. Questionnaire responses indicating trainees' perceptions about the school-based sessions. Note that totals vary as some trainees gave more than one response or did not answer a question. Figures in brackets are percentages of the total for each question

Physics Experiments	Energy	ICT	Response totals
39 biologists 22 chemists	0 biologists 2 chemists 2 physicists	0	80
			101
43 (52)	10 (12)	0	82
19 (37)	0	10 (19)	52

Fifty trainees (63%) reported using something from the school-based sessions in their teaching practice. Of these, 36 offered examples, including an experiment (17, 46% of 36 responses) or a specific paper- or ICT-based activity (9, 25%). Twenty-six of the remaining 30 non-users of materials gave reasons: 17 had not taught any topic relating to the experiments; five said that using textbooks and asking teachers in their schools was sufficient.

Trainees commented generally on constraints applying to lesson preparation in their teaching practice schools. Of 101 responses, thirty-five noted that schools' facilities for practical work and/ICT were poor. This implies that trainees did not have the skills necessary to adapt experiments or activities to different environments. Thirty-one commented that their schools' "Schemes of Work" (SoWs) were too rigid to allow variation. SoWs are lengthy and often detailed documents devised by school science department staff as teaching plans for each year group. Variation exists in the extent to which trainees are allowed to deviate from these plans by including innovative activities.

Video-Interview-Interview data

For the purposes of this paper, data obtained in 2007/8 from two trainees, named "Kari" and "Kristin", illustrate this aspect of the study.

Kari

Kari is aged 44 and is a physics specialist. She trained originally as a children's nurse, moved into nuclear medicine then obtained a degree in physics. The video-recorded lesson took place in April 2008. The recorded lesson of 60 minutes duration was with a class of 30 13-14 year olds (Year 9 in UK schools). The class was learning about different types of energy. Some aspects of the topic fell within her specialism, while others, including parts of this lesson, did not.

Kari's stated objectives to the class were:

- "State some different types of energy
- Devise an experiment to investigate the potential difference across various metals in a fruit cell
- Analyse the results"

Table 4 analyses Kari's lesson combining information from the video-recording and interviews with a pupil group and Kari. A researcher comment on the content is included. Kari made these additional comments in interview:

About her reasons for selecting the practical experiment:

"I thought the experiment would be fun – and it was in an exam paper.."

About the sources of her subject knowledge and her reasons for including the points she selected:

"I looked at textbooks and the internet... I like to give a lot of information and a sense of culture..."

About the value of the school-based sessions in her preparation:

"The school sessions gave me confidence to have a go at different activities"

Other parts of Kari's interview revealed that she:-

- Believed the lesson was successful as children had behaved well
- Noted children had completed the activities
- Reflected positively on children knowing the facts she had presented

The children's interview indicated they could recall historical facts about electric cells as new learning.

Table 4. Kari: lesson analysis

Instructional Strategy/ Activity	Timing (Mins)	Kari's reason for selection / other comment	Children's views about what they did	Researcher comment
<p>Class entry and register</p> <p>Introductory task</p> <p>Card sort</p> <p>on components of an electrical circuit</p>	<p>0 – 4</p> <p>4 – 12</p>	<p>Revision of their subject knowledge for the national examination in May 2008.</p>	<p>Like doing card sort</p>	<p>This was a positive activity but did not link to the main topic of the lesson</p>
<p>Oral presentation by Kari</p> <p>About forms of energy and history of the battery and cell</p> <p>Difference between cell and battery</p>	<p>12 - 22</p>	<ul style="list-style-type: none"> • Giving information • Introducing cultural awareness of science topics 	<ul style="list-style-type: none"> • Found the information memorable • “Felt clever” knowing the historical details • Had not known this before 	<ul style="list-style-type: none"> • A passive activity • Clear facts presented • Led into topic of the lesson
<p>Practical work</p> <p>Making a fruit cell using different combinations of metal electrodes</p> <p>Measuring voltage generated</p>	<p>22 – 46</p>	<ul style="list-style-type: none"> • This was an exam question last year • Doing the experiment would help prepare them in case this came up again • Idea came from the normal class teacher 	<p>Liked the hands-on approach</p> <p>Did not mention what they learned from this, but liked doing the experiment</p>	<ul style="list-style-type: none"> • The task was open-ended, no clear focus • Discussion about the results was not directed towards energy forms • There was no explicit explanation related to energy
<p>Review of experiment</p>	<p>46– 51</p>	<p>No specific comment made about this</p>	<p>No specific comment made about this</p>	<p>Quick review of results – Kari showed a pre-prepared data table of Standard Electrode Potentials. No link made to the children's results.</p>
<p>Plenary task</p> <p>Card sort on energy transfer</p> <p>Review of different types of energy using symbols and explanations</p>	<p>51 – 60</p>	<ul style="list-style-type: none"> • Took a long time to prepare it – designed herself • Stimulating task 	<p>Like doing card sorts</p>	<ul style="list-style-type: none"> • Not specifically tied into the experiment • No discussion afterwards

Kristin

Kristin is 24 years old. She holds a biochemistry degree from an American university - chemistry is her specialist subject. She has two years work experience gained in a scientific environment. Her 60-minute lesson, recorded in April 2008, was with a group of 9 children aged 13-14 (Year 9) identified as having low ability and/ special educational needs. The lesson was on a physics topic – the difference between mass and weight. A teaching assistant was present throughout the lesson.

Kristin stated these objectives to the class at the start:

“Recognise the difference between mass and weight

- Understand how to draw a line of best fit
- Recognise why we use graphs to display results
- Identify how a graph can be used”

Table 5 analyses her lesson content, trainee interview and pupil group interview with researcher comments. Kristin also made these comments in her interview:

About the sources of her subject knowledge and her reasons for including the points she selected:

“I looked at textbooks and the internet.. The school’s basic plan was the common sense way to teach it...”

About the value of the school-based sessions in her preparation:

“The School sessions were a bunch of different experiments to use in teaching”

About her own performance:

“I thought I could have explained the concepts better...”

Other parts of Kristin’s interview revealed that she:

- Saw lesson as successful as children had learned what she intended in the objectives
- Activities were completed
- Reflected on her ability to explain the key concept in the lesson, the difference between mass and weight.

Besides the points made in Table 5, the pupil group interview showed that children knew the difference between mass and weight: “mass stays the same”.

Comparing Kari and Kristin

Data presented in tables 4 and 5 and supporting information above show differences between Kari and Kristin. Both were teaching in the same school and working outside specialism. They experienced similar support from science staff and worked from the same SoW. However, their teaching and the impact of this on their learners differed.

Kari’s lesson objectives were not connected - consequently her lesson was broken into sections featuring un-related concepts. The most successful part of her lesson, in terms of impact on children’s learning, was her oral presentation. This gave clear facts that children noted and recalled. Although children achieved the objective of “devising” an experiment, no conceptual learning occurred, as an explicit link to energy was not made. The class enjoyed the experiment for social reasons. Kari saw the school-based sessions as “confidence building”, giving her insight into possibilities. She wanted to make lessons “fun” and “culturally varied” and believed this lesson to be successful because the children behaved well and completed their tasks.

Table 5. Kristin: lesson analysis

Instructional Strategy/ Activity	Timing (Mins)	Kristin's reason for selection	Children's views about what they did	Researcher comment
Class entry and register Objectives explained	2 – 4	No specific comment	No comment	Clarity about the topic from outset
Difference between mass and weight identified as key topic for lesson	6 – 8	To identify children's prior knowledge	Some remembered this topic from work done the previous year	This was not new knowledge for all year
Explanation of difference between mass & weight	8 – 12	This was the first time I have had to explain this	No comment	Clear facts were presented
Practical work explained and carried out	12 – 20	Children need visual impression to help them learn	Like finding out for "myself"	This followed the theme of lesson well
Graph explained	20 – 25	Graph they made was poor last time	White board graph was helpful	Kristin did not explain "best fit" line correctly
Writing conclusion	25 – 30	I wanted to show the connection between mass and weight	No comment	A mathematical link was made explicit
Equation $F=ma$ presented	30 – 35	I wanted them to know this	Equation makes it easy to recall	That changing gravity gives different forces was made clear
Video of feather and hammer being dropped on the Moon is shown	35 – 40	This was memorable information I thought they would like	Liked it best	This was not relevant to the topic
Reading data from a graph	40 – 45	Using a graph is an important skill	No comment	Kristin used "Extrapolation" incorrectly
Exam questions	45 – 50	This was revision for the national examination next month	Liked this least	Used a "jigsaw" to get children working together
Closing comments	50 – 60	Final take home points	No comment	Ensured clear message at end

Kristin's lesson objectives connected to the purpose of learning the difference between mass and weight, and representing force on a graph. She used pupils' prior knowledge and their earlier poor performance in graphing skills to help design the lesson, which was broken into many short components. The clarity of her message was apparent throughout – prior to leaving the classroom, she emphasized the key idea for a final time. Kristin focused entirely on what children had to learn. She criticized her own explanation, working out how this could be improved next time. Kristin recognized that the school-based sessions gave pedagogical advice. The pupil interview revealed that the children had understood the key concept.

Questionnaire responses showed that both found the physics experiments session the most useful for subject knowledge. Kristin also indicated this session was most useful for developing her teaching skills, while Kari identified ICT for this.

DISCUSSION

Trainees' uses of school-based sessions

Data presented above indicate that trainees' uses of the school sessions varied. Kari and Kristin illustrate this:

Kari – used sessions as "confidence building" occasions

Kristin – recognised the sessions opportunities for getting ideas on how to teach

The majority of trainees found that school-based sessions clarified their understanding of science topics (Table 3), suggesting they found little difference between these and the university-based sessions. This may be because anxiety related to non-specialist teaching meant that all sessions were automatically viewed as opportunities to learn SMK. Explicit comparison with university-based sessions was not made – this may have alerted trainees to pedagogical implications of the school-based sessions. A second reason may be that trainees believe their teaching skills develop in their schools, rather than through being "taught" themselves. Comments relating to lack of facilities and equipment may mean they feel a need to rely on their immediate surroundings for PCK rather than think creatively about how to adapt material presented in the training environment. Nevertheless, evidence suggests that a majority of trainees used *something* from the school-based sessions at some point in their teaching practices. Even Kari's comment about "confidence-building" is significant, as this indicates that some trainees' emotions were influenced positively.

Impact on children's learning

The children's interviews revealed that impact on learning was maximized when trainees actually teach the specific topic – in contrast, trainees seem to shy away from explaining difficult ideas. For example, Kari's lesson succeeded only in children recalling specific facts: she avoided explaining the difficult idea in the "energy from fruit" experiment. Her perception of "success" related to children's good behaviour and task completion. Kristin was more successful in terms of children's learning –she explained the difficult idea, and related all activities to this central concept. The "failure to explain" pattern was common to the other four V-I-I trainees – in general, explaining science appears as an optional "extra", while "surviving" a lesson without a major disaster occurring is paramount.

Pupil group interviews revealed that children feel they learn when information is presented in a variety of ways within a lesson; when they are aware of "where lessons are going" in terms of what is coming next; and when information is presented clearly and unambiguously ("telling things as they actually are"). In addition, they clutch mentally at whatever they can make sense of –this is not necessarily what the teacher intended.

Seen from trainees' perspectives, their interviews in general revealed that when preparing lessons they looked for activities that children could complete easily, rather than those giving intellectual challenge. They expressed surprise when children commented that they did not mind learning difficult things and gained a sense of achievement from doing so.

Train, teach; taught?

These data demonstrate only partial success in transferring knowledge from teacher educator to trainee: a significant proportion of trainees ignored the material entirely when preparing lessons, for various reasons. Some lacked adaptation skills, so could not use school-based materials in a different environment. A few regarded the HEI and teaching practice parts of the course entirely separately. Uses made of the sessions varied: a majority saw them as additional opportunities to develop SMK, ignoring the PCK aspect. The intended distinction in approach between university- and school-based session types was not perceived. Nevertheless, a majority made use of the sessions in teaching.

Impact on children's learning of material presented in the sessions was difficult to trace. We think this is partly because trainees did not teach for understanding specifically, but focused on activity completion and good behaviour. We found that children are prepared to work on difficult ideas, and show positive attitudes towards science.

These findings concur with some already in the literature. The strongest influence on trainees' use of these sessions seems to be the desire to acquire SMK for teaching, especially in non-specialist subjects. As Arzi and White (2008) report, the school curriculum, and in particular how this is represented in SoWs, is critical to the uses trainees make of the sessions. Where trainees could vary SoWs, greater use of our sessions was found.

Trainees' confidence (Ahtee and Johnston, 2006b; Kind, 2008) also plays a part. Kari, reported above, saw the sessions as "confidence-building" - she had not yet realised the need to transform her SMK for students' benefit. In contrast, Kristin saw beyond her own SMK needs, and worked to transform knowledge with positive results.

PCK development is complex to detect (Abell, 2007). Nonetheless, we see accord with Peterson and Treagust (1995), in that most of these trainees relied heavily on their SMK and the school's curriculum for their preparation. Kristin took pupils' prior knowledge into account.

LIMITATIONS

Naturally the study is bound by limitations: first, in using V-I-I we were restricted to schools that permitted us to video-record lessons, creating a pool of participants smaller than we would have liked. Further, trainees' teaching schedules meant that finding lessons that dealt explicitly with topics featured in the school-based sessions was constraining. At present we have only used pupil group interviews as a means of data collection from children: ideally we wish to extend this to include whole-class questionnaires to add an extra level of reliability.

IMPLICATIONS

For training science teachers

In our context, these data inform our practice. Preparing sessions that meet trainees' expectations for SMK input and presenters' pedagogical intentions is challenging. Emphasising SMK preparation prior to attending school-based sessions and the intended difference between these and the university-based sessions may help trainees realise our intentions and shift their focus. That

trainees' lessons involve describing rather than explaining science and activity completion rather than achieving genuine understanding is perhaps unsurprising. If we want trainees to deliver lessons at higher cognitive levels, we must consider how best to make this explicit; offering opportunities to give explanations, indicating children's thinking more frequently and encouraging reflection on trainees' misconceptions may all contribute.

For investigating the training of science teachers

This study attempts investigation of a complex process – that of transforming SMK into PCK. Abell (2007) notes that researchers have used a variety of methods to elucidate PCK – we claim addition of V-I-I to the collection. This permits analysis of the impact a teacher's instructional strategies and other pedagogic skills on children's learning, as well as encouraging trainees to reflect on their teaching.

The collaboration between a school and a university in devising components of an initial teacher education programme we believe is beneficial. Trainees found the sessions provided informal contact with experienced teachers valuable and inspiring, and clearly a majority were able to make use of some aspect of the information provided. Combining experienced teacher and academic expertise in a constructive way cemented professional relationships and has helped us reflect more deeply on how to help trainee science teachers in the earliest stage of their careers.

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APPENDIX 1

Differences between university- and school-based sessions

University-based sessions on biology

Three 2.5 hour sessions are devoted to biology topics: “survival of the individual”, “survival of the genome” and “survival of the ecosystem”. These sessions provide a conceptual framework to develop an understanding of key ideas in biology. The aim is to provide information underpinning biologists' thinking that is not always made explicit in school textbooks or in school. The sessions take a “systems” approach. For example, the section on “maintenance and change” in “Survival of the individual” introduces:-

Chromosomes and genes; cells; whole organisms; populations and communities; ecosystems

Each session adopts a combination of lecture interspersed with activities. An activity relating to the above list is:

- Look up the definitions of all the systems mentioned above
- What are their main components?
- Which of these systems are most emphasised in the National Curriculum?

Students sit where they please and work with who they wish.

School-based session on biology experiments – focusing on cells

The 2.5 hour session begins with a 20 minute presentation illustrating what children are likely to know about this topic from primary education (ending at age 11). Trainees are introduced to the precise content of the National Curriculum for 11-14s. They are then organised into five pre-planned groups, each comprising a combination of biologists, chemists and physicists. They complete a “circus” of five experiments:

- Using a microscope – making a slide
- Demonstration of cell multiplication
- Making a model of a cell using a range of resources such as card, plastic samples, sponge, etc
- Producing apple juice using enzymes to break down cell walls to release more juice
- Imitating the small intestine

Equipment is provided so trainees can try out the experiments. They find out what makes the experiments “work”, including how long they last, any special “tricks” to use and mistakes to avoid. A plenary discussion is held to draw out aspects such as adapting the tasks for children with different needs and abilities; key scientific ideas taught by the experiments; and additional background information to include so opportunities for learning are maximised.

APPENDIX 2

Questionnaire

1. Please think back to the sessions. Which did you find the most useful at the time? Please explain your choice
2. Which session:
 - a) Contributed most to developing your subject knowledge? Please explain
 - b) Contributed most to developing your teaching skills? Please explain
3. We would like to know how useful the information provided at the sessions has been in your teaching. Have you used any information from the sessions in your lessons? Yes / No
If “yes”, then what have you used?
If “no” then what stopped you using the information?
4. In general, what constraints are you working under when preparing lessons for 11-14s?

(Note: Some wordings are altered slightly for publication purposes)

APPENDIX 3 INTERVIEW PROTOCOLS

Pupil group interview

1. Do you enjoy science?
2. What do you like about it?
3. Did you enjoy the lesson today?
4. What did you enjoy most?
5. What did you enjoy least?
6. What was the lesson about today?
7. What did you learn (that you didn’t know before)?
8. How did you learn it?
9. Did you know anything in the lesson before?
10. What did the teacher do in the lesson to help you learn?
11. What else helps you learn in science?

Follow-up questions were used where needed, e.g. “why do you / what makes you say that?”, “Is this usual?”, “Does everyone agree? Who disagrees? Why?”

Trainee interview

1. What KS3 teaching have you done? (Classes, topics)
2. In which areas was your subject knowledge strongest?
3. In which areas is your subject knowledge weakest?
4. In what ways has your SK improved during the course?
5. What contributed to this improvement? E.g resources, other sources
6. Did the school-based sessions help you in any way? How / why not etc
7. Which of the sessions did you find most / least useful?
8. How did the school-based sessions tie in with your KS3 teaching?

About today's lesson:

9. What do you think you did that helped the children learn?
10. What was/were the learning objectives for today? Do you think these were achieved?
11. Where did you get the activities?
12. What is your evidence that these were effective?

Björn Andersson var Sveriges första professor i ämnesdidaktik. Han är nu professor emeritus vid Göteborgs universitet med inriktning på de naturvetenskapliga ämnenas didaktik.

Maria Svensson arbetar som lärarutbildare vid Institutionen för pedagogik och didaktik vid Göteborgs universitet. Hon är sedan 2005 också anställd som doktorand i teknikdidaktik vid Nationella forskarskolan i naturvetenskapernas och teknikens didaktik, Linköpings universitet.

Ann Zetterqvist arbetar som lärarutbildare och forskare på Institutionen för pedagogik och didaktik vid Göteborgs Universitet.

BJÖRN ANDERSSON

Institutionen för pedagogik och didaktik vid Göteborgs Universitet, Sverige
Bjorn.Andersson@ped.gu.se

MARIA SVENSSON

Institutionen för pedagogik och didaktik vid Göteborgs Universitet, Sverige
Maria.Svensson@ped.gu.se

ANN ZETTERQVIST

Institutionen för pedagogik och didaktik vid Göteborgs Universitet, Sverige
Ann.Zetterqvist@ped.gu.se

Några uppgifter som belyser elevers uppfattningar om vad som är teknik

Abstract

Discussions about technological literacy have resulted in statements about the technological literate citizen who should recognize technology as something that permeates modern society and should be able to differentiate between nature (shaped by evolution) and technology (shaped by humans). Earlier studies show that pupils express rather limited views of technology, often as modern tools (computers) and isolated from human needs. In the light of these results we wondered if Swedish pupils differentiate between technology and nature, what they view as examples of technology and if they recognize technology as an old enterprise. Our study involved 150-200 pupils in school year 7-9 who answered three questions individually in writing. The results indicate that the pupils in our group differentiate between technology and nature but many of them express limited views of what technology is. Common everyday products are regarded as technology by a minority. Furthermore several pupils seemed to regard technology as a recent activity, for example a stone axe was agreed to be technology by less than half the group and about 1/5 of the group agreed that 'technology is something rather new that only has existed a few hundred years'. Some possible implications of these results are discussed.

UTGÅNGSPUNKTER

Teknik ingår i många länders skolundervisning även om läroplanernas uppläggning varierar. I Sverige har vi ämnet teknik med egen kursplan sedan 1994 (Utbildningsdepartementet, 1994). Teknik kan också vara ett temaområde som skall behandlas i många ämnen. Så är det i Finland, där man har mål och centralt innehåll för temaområdet "Människan och teknologin", men också teknikmål i ämnen som bildkonst, fysik, historia och slöjd (Utbildningsstyrelsen, 2004). I provinsen Saskatchewan i Kanada är teknik en av sex 'common essentials', dvs. något som anses så viktigt att

det ska behandlas i alla ämnen från grundskola till gymnasium (Saskatchewan Education, 2001). I England finns det obligatoriska ämnet 'design and technology' (Department of Education and Skills, 2004).

En bidragande orsak till den nu antydda variationen i olika länders teknikundervisning är förmodligen att teknik är ett mycket stort kunskapsområde, vilket ger många valmöjligheter. Skolämnet teknik har inte som t.ex. fysik sin motsvarighet i ett akademiskt ämne, utan i hundratals inriktningar vid tekniska högskolor och otaliga yrken (Layton, 1994). Det finns också historiska skäl till att ämnen ser ut på olika sätt i olika länder.

TEKNISK BILDNING – TECHNOLOGICAL LITERACY

I den debatt om skolans teknikundervisning som förs i engelsktalande länder har begreppet 'technological literacy' en framträdande plats (Garmire & Pearson, 2006; Pearson, 2004; Pearson & Young, 2002). Möjliga svenska begrepp är 'teknisk bildning' eller 'teknisk allmänbildning' (Hagman & Hultén, 2005) men vi använder likväl i fortsättningen den engelska termen.

Diskussioner om 'technological literacy', har lett till ståndpunkten att en 'tekniskt bildad' person skall känna igen teknik i dess många former och vara medveten om att tekniken genomsyrar det moderna samhället. Elever skall kunna skilja mellan naturen och den värld som är gjord av människohänder (ITEA, 2002; National Research Council & National Academy of Engineering, 2002). Vi menar att kunskaper om teknikens väsen är viktiga ur ett medborgarperspektiv. Om elever t.ex. menar att datorer och mobiltelefoner är exempel på teknik, men inte odlade fält och vägar, så är deras möjligheter att resonera om teknikens roll i samhället begränsade.

Tre styrdokument om teknikens väsen – nature of technology

Ett omfattande arbete för att klargöra vad som menas med 'technological literacy' har utförts av International Technology Education Association, ITEA (2002). Från denna utgångspunkt har 20 'standards for technological literacy' tagits fram. Av dessa 20 standards gäller 3 'the nature of technology' som vi översätter med 'teknikens väsen':

Students will develop an understanding of

- the characteristics and scope of technology
- the core concepts of technology
- the relationships among technologies and the connections between technology and other fields of study

I England och Wales förekommer teknik i form av det obligatoriska ämnet 'Design and Technology'. Det introducerades 1990 för elever i åldern 5-16 år, och utgjorde en sammanslagning av Home Economics, Craft, Art and Design, Business Studies och Information Technology. När man undersöker kursplanen ser man dock att designprocessen är det dominerande inslaget. Förståelse av sociala och miljömässiga frågor, även om de nämns i den allmänna beskrivningen av ämnet, framstår som perifera, liksom teknikens väsen.

Den svenska kursplanen i teknik fastslår att 'utbildningen i teknik utvecklar en förtrogenhet med teknikens väsen'. Formuleringen tyder på att man väntar sig att detta kommer att ske som en allmän effekt av teknikundervisningen, vilket nog är lite väl optimistiskt. Teknikens väsen eller natur är dock inte så lätt att fånga i några distinkta satser, vilket heller inte görs i kursplanen. Snarare är det så att denna i sin helhet uttrycker olika aspekter av teknikens väsen.

Kursplanen tar alltså inte explicit upp frågan om vad teknik är och anger ingen definition. Däremot är det ingen tvekan om att texten i sin helhet kommunicerar en uppfattning som kan kondenseras till att teknik är människans metoder att tillfredsställa sina önskningar genom att använda fysiska

föremål. Kursplanen anger också på vad sätt teknik skiljer sig från natur- och samhällsvetenskap: För att man skall kunna förstå tekniken och dess betydelse måste den också relateras till kunskap från andra områden, såsom naturvetenskap och samhällsvetenskap. Samtidigt finns tydliga skillnader. Naturvetarens drivkraft är nyfikenhet på naturen och samhällsvetarens är nyfikenhet på samhället, medan teknikerns utmaning är människors olösta praktiska problem.

En jämförelse med ITEAs standarder angående teknikens väsen visar att den svenska kursplanen inte tar upp tekniska grundbegrepp (core concepts of technology). Exempel på sådana i det amerikanska arbetet är system, delsystem, input, process, output, feedback, optimering och kompromiss (trade-off). Om tekniska grundbegrepp skall ingå i grundskolans undervisning, och i så fall vilka, är ett intressant problem att diskutera.

Ovanstående genomgång visar att det bara är i ITEAs dokument som *the nature of technology* är väl framskrivet i form av standards 1-3. I styrdokument i England och Wales saknas detta och i Sverige är betoningen svag.

TIDIGARE UNDERSÖKNINGAR

En stor kanadensisk undersökning kallad 'Provincial learning assessment in technological literacy' genomfördes i provinsen Saskatchewan 1999 (Saskatchewan Education, 2001). Omkring 3500 elever i skolår 5, 8 och 11 deltog från 182 skolor. En av testuppgifterna bestod av en lista med exempel på teknik, såsom dator, bro, klocka och stenyxa, samt exempel på annat än teknik, såsom en flod. För varje exempel skulle eleverna avgöra om det är teknik eller inte. Eleverna uppvisade med stigande ålder en bredare syn på vad som är teknik, men likväl menade bara 30 % av de äldsta att en stenyxa är exempel på teknik, till skillnad mot 100 % för en dator.

I början av 1990-talet administrerades i USA ett test kallat Pupils' Attitudes Toward Technology (PATT) till omkring 10 000 elever i åldrar motsvarande grundskolans senare del och gymnasiet (Bame, Dugger, deVries & McBee, 1993). Testet utgörs av 100 påståenden som man skall instämma i eller ej enligt en femgradig skala. Några gäller vad eleverna uppfattar som teknik. Det var 54 % som instämde i "When I think of technology I mostly think of computers", och 30 % som inte höll med. Ett annat påstående var "In my opinion, technology is not very old." Det var 35 % som höll med om detta och 27 % svarade att de inte visste.

Yasin (1998) undersökte uppfattningar om teknik hos malaysiska elever i high school och fann att de i högre utsträckning kopplade moderna redskap och processer till teknik än äldre/traditionella redskap och processer. Även Rennie och Jarvis (1994) redovisar liknande resultat.

En intressant skillnad mellan yngre och äldre elever redovisas i en studie av Mather och Jones (1995). De fann att 5-6-åringar i högre utsträckning kopplade teknik till människor än 9-13-åringar som tenderade att uppfatta teknik som artefakter skilda från människan.

I en grekisk undersökning (Solomonidou & Tassios, 2007) intervjuades sextio 9-12-åringar om sina uppfattningar om teknik. Vid en del av intervjun användes 20 bilder på teknik eller natur. Eleverna ombads att avgöra om bilderna representerade teknik eller inte och berätta vilka kriterier de använt för att avgöra detta. Resultatet visade att eleverna använde fem olika kriterier:

1. Ett objekt eller en process som uppfattas som modern (22 elevsvar)
2. Ett objekt eller process som har en funktion eller kräver energi (14 elevsvar)
3. Nyttan/användningen av objekt eller processer (7 elevsvar)
4. Strukturen hos objekt eller processer (6 elevsvar)
5. Objektens relation till naturvetenskap (2 elevsvar)

Solomonidou och Tassios (2007) drar slutsatsen att det är objektets eller processens moderna

karaktär som avgör för eleverna om det är teknik eller inte. Majoriteten av eleverna likställer teknik med moderna verktyg och tillämpningar, särskilt datorer, tv, mobiltelefoner, satelliter medan erfarenhetsbaserade tekniker som handtvätt av kläder eller äldre jordbruksteknik inte uppfattas som teknik.

Collier-Reed (2006) har undersökt vad teknik är för 15 sydafrikanska elever i skolår 11. En del av undersökningen bestod i att eleverna fick till uppgift att ta ett antal fotografier som representerade teknik i deras liv: *You can take a photograph of ANYTHING as long as it is about technology in your life* (sidan 169). Efter att fotografierna framkallats genomfördes intervjuer med fotografierna som utgångspunkt. Collier-Reed presenterar fem olika uppfattningar om teknik:

1. En artefakt
2. Att använda artefakter
3. Utveckling av artefakter
4. Att använda kunskaper och erfarenheter för att utveckla artefakter
5. Lösningar på ett problem

Collier-Reed menar att det finns en skillnad mellan att uppfatta teknik som produkt (kategori 1-2) eller process (kategori 3-5). Själva skiljelinjen finns mellan kategori 2 och 3 där den tekniska aktiviteten antingen är att använda teknik eller att utveckla teknik. Uppfattningen om teknik som process innebär en mer utvecklad och vidare syn på teknik eftersom den även involverar samhällsaspekter. Dessa blir ännu mer tydliga när man går från kategori 3 till 5.

En gallupundersökning genomfördes i USA (Rose, Gallup, Dugger & Starkweather, 2004). Man telefonintervjuade 800 vuxna (18+) om teknik. En av frågorna löd: *When you hear the word technology, what first comes to mind?* De vanligaste kategorierna av svar var: datorer (68 %), elektronik (5 %), framsteg (2 %), Internet (2 %). Volk och Dugger (2005) jämför i en senare studie de amerikanska resultaten med vad 750 vuxna (18+) i Hong Kong anser om teknik. I Hong Kong var synen på teknik vidare, de vanligaste kategorierna av svar var datorer (47 %), framsteg (7 %), uppfinningar (7 %), elektronik (5 %).

De ovan redovisade undersökningarna tyder på att många elever och vuxna har en relativt begränsad uppfattning om vad teknik är. Teknik handlar ofta om moderna redskap och verktyg och inte om processer. Några undersökningar antyder också att kopplingen mellan människa, teknik och samhälle är svag.

Mot bakgrund av detta blev vi intresserade av att undersöka svenska elevers uppfattningar om vad teknik är och jämföra dessa med resultat från tidigare studier.

SYFTE OCH METOD

Syftet med vår undersökning är alltså att undersöka några aspekter av hur svenska elever ser på teknik. De frågor vi ställer oss är följande:

- Vad uppfattar eleverna som exempel på teknik?
- Skiljer eleverna mellan teknik och natur?
- Inser eleverna att tekniken är mycket gammal?

Undersökningen är en pilotstudie. Den innefattar tre skriftliga individuella uppgifter som besvarats av tre olika grupper i årskurs 7-9. Sammanlagt deltog 547 elever från 10 olika klasser som alla haft teknikundervisning. Eleverna har varierande social bakgrund och skolorna finns i både större och mindre orter.

Uppgifterna

Vad blir kvar av staden?

Denna uppgift fick vi idén till då vi läste en skildring av vad som skulle bli kvar om allt som tekniken har tillfört en stad försvann (National Research Council & National Academy of Engineering, 2002:48). Eleverna fick frågan:

Vad blir kvar av en stad om man tar bort alla tekniska produkter och system?

Sedan följde en lista där eleverna för 15 exempel fick kryssa i ett av alternativen 'blir kvar', 'blir inte kvar' eller 'jag vet inte' (se tabell 1 i resultatavsnittet).

Vad tillhör teknikens värld?

Nästa uppgift inleddes med frågan:

Vad av följande räknas som teknik och vad gör det inte? Sätt kryss!

Sedan följde en lista där eleverna för 16 exempel fick kryssa i ett av alternativen 'räknas som teknik', 'räknas inte som teknik' eller 'jag vet inte' (se tabell 2 i resultatavsnittet).

Vad är teknik?

Den tredje uppgiften började så här:

I skolan får du lära dig vad teknik är. Här följer några påstående om tekniken i vår omvärld.

Håller du med eller ej? Sätt kryss!

Sedan gavs åtta påståenden för eleverna att ta ställning till genom att välja ett av alternativen 'håller med', 'håller inte med' och 'jag vet inte' (se tabell 3 i resultatavsnittet).

Insamling och analys av data

Uppgifterna ingick som en del av en utprovning av uppgifter till en nationell utvärdering i teknik och gavs våren 2007. Vi kontaktade ett antal tekniklärare och bad dem att genomföra testet i sina klasser. Elevsvaren skickades sedan till oss för bearbetning och analys.

Eftersom uppgifterna var av flervalstyp och inte medgav möjligheter för eleverna att motivera sina svar innebar analysen enbart att sammanfatta de olika gruppernas svarsfrekvenser och relatera dessa till våra frågeställningar.

RESULTAT

Här presenteras först resultatet på de tre uppgifterna varefter följer en övergripande sammanfattning av resultatet utifrån våra frågeställningar.

Uppgifterna

Vad blir kvar av staden?

Uppgiften besvarades av 190 elever. I redovisningen har vi slagit ihop årskurs 7 och 8 till en grupp eftersom det bara var 21 elever i årskurs 7. Resultatet framgår av tabell 1. Av tabellen framgår en förbättring av resultatet med stigande ålder.

Vad tillhör teknikens värld?

Uppgiften besvarades av 154 elever. Resultatet visas i tabell 2. Det finns också på denna uppgift en tendens till förbättrat resultat med stigande ålder.

Vad är teknik?

Uppgiften besvarades av 203 elever. Resultatet framgår av tabell 3. En ganska stor andel (14%) väljer alternativet "vet ej" när det gäller påståendet om att teknik funnits så länge som det funnits människor.

Några uppgifter som belyser elevers uppfattningar om vad som är teknik

Tabell 1. Andel elever (%) i årskurs 7 & 8 respektive 9 som anger att olika saker blir kvar i en stad då man tar bort alla tekniska produkter och system.

	Åk 7 & 8 n=115	Åk 9 n=75		Åk 7 & 8 n=115	Åk 9 n=75
Flugor	93	93	Hus	42	36
Luft	91	93	Dricksvatten	34	33
Regnvatten	89	93	Mediciner	21	19
Ogräs	92	89	Avloppsledning	17	13
Bröd	60	55	Tidningar	21	13
Gator	57	49	Bilar	10	5
Statyer	57	49	Datorer	6	5
Kläder	48	39			

Tabell 2. Andel elever (%) i årskurs 8 respektive 9 som anger att olika saker räknas som teknik. N=154.

	Åk 8 n=80	Åk 9 n=74		Åk 8 n=80	Åk 9 n=74
Dator	96	96	Tvål	30	34
Bro	81	91	Stickad luva	29	27
Kärnkraftverk	81	90	Målad tavla	28	20
Kulspruta	77	81	Rödvin	20	16
Vävstol	66	72	Spagetti	10	8
Roddbåt	56	65	Regnvatten	10	5
Aspirin	36	47	Gran	5	4
Stenxyxa	51	42	Maskros	4	3

Tabell 3. Andel elever (%) i åk 8-9 som instämmer i olika påståenden om teknik. N= 203.

	Åk 8 n=68	Åk 9 n=135
Tekniken har en stor påverkan på oss människor.	93	96
Datorer, elektronik och robotar hör till det tekniska området.	93	93
Jag använder olika tekniska produkter dygnet runt.	79	87
Teknik har funnits så länge som det funnits människor.	46	66
Att sy med sytråd och väva tyger är en del av teknikens värld.	41	58
Tandborstar, plåster och toapapper räknas till området teknik.	41	43
Teknik är något ganska nytt som bara funnits några hundra år.	31	14
I mitt dagliga liv använder jag inte särskilt många tekniska produkter.	6	5

Sammanfattning av resultat

Vad uppfattar eleverna som exempel på teknik?

Analysen tyder på att en majoritet i vår undersökningsgrupp (över 80%) uppfattar datorer, bilar, tidningar, bro, kärnkraftverk, avloppsledning, mediciner och kulspruta som teknik: Dock markerar mindre än halva vår undersökningsgrupp att aspirin, stenyxa, bröd, tvål, stickad luva, vin och spagetti är teknik. När det gäller vardagsbetonade tekniska produkter är det bara ca en tredjedel som tycks uppfatta dessa som exempel på teknik. Sammantaget tyder detta på att högteknologiska produkter i större utsträckning uppfattas som teknik än lågteknologiska/vardagsbetonade produkter.

Skiljer eleverna mellan teknik och natur?

Analysen tyder på att i vår undersökningsgrupp och i denna kontext skiljer eleverna mellan natur och teknik. Det är bara en minoritet (3-11%) som markerar att maskros, gran, flugor, luft, regn, vatten och ogräs är teknik.

Inser eleverna att tekniken är mycket gammal?

Analysen tyder på att insikten om teknikens höga ålder inte finns i vår undersökningsgrupp. Det är mindre än hälften (42-51%) som markerar att stenyxa är teknik och ungefär halva gruppen håller med om påståendet: 'Teknik har funnits så länge som det funnits människor.' Det är ca en femtedel av gruppen (14-31%) som håller med om påståendet: 'Teknik är något ganska nytt som bara funnits några hundra år.'

DISKUSSION

De resultat som redovisats bygger som beskrivits enbart på uppgifter av flervalstyp. En brist med våra uppgifter är att eleverna ej getts möjlighet att motivera eller förklara sina svar, exempelvis med resonemang om vilka kriterier de använt för att avgöra om något är teknik eller inte (Solomonidou & Tassios, 2007). Denna typ av resonemang skulle gjort datamaterialet rikare och givit möjligheter till djupare analyser. Ytterligare en begränsning i vår undersökning är att vi enbart använt tekniska produkter som exempel på teknik, ej tekniska processer. Både resultat från Solomonidou och Tassios (2007) och Collier-Reed (2006) antyder att det finns tecken på att elever uppfattar produkter som teknik men inte alltid processer. Det hade varit intressant att jämföra dessa resultat med svenska elevers uppfattningar, särskilt mot bakgrund av vår kursplan i teknik som visserligen inte explicit betonar tekniska processer men enligt vår uppfattning ändå ger uttryck för ett processperspektiv på teknik, bl.a. i de fem centrala perspektiv som tas upp: Utveckling; Vad tekniken gör; Konstruktion och verkningsätt; Komponenter och system; Tekniken, naturen och samhället (Utbildningsdepartementet, 1994).

Resultatbilden i vår undersökning stämmer väl med den som framträder när man studerar tidigare forskning inom området. Uppfattningar om teknik som något modernt och/eller högteknologiskt har redovisats i ett flertal tidigare undersökningar (Bame et al., 1993; Rennie & Jarvis, 1994; Rose et al., 2004; Saskatchewan Education, 2001; Solomonidou & Tassios, 2007; Volk & Dugger, 2005; Yasin, 1998).

Att bara en tredjedel av vår undersökningsgrupp uppfattar vardagsbetonade tekniska produkter som teknik kan vara ett tecken på att teknik inte kopplas till människans aktiviteter och behov, något som även Mather och Jones (1995) rapporterar. Även elever i Collier-Reeds (2006) undersökning tycks ge uttryck för detta.

Eftersom alla tillfrågade elever har mött skolämnet teknik drar vi för svensk del den preliminära slutsatsen att undervisningen inte leder till en generell kunskap om vad som hör till området teknik. Om uppfattningarna om teknik inskränker sig till 'high-tech' kanske många ungdomar inte

ser teknik som en

möjlig framtida yrkesinriktning.

En fråga vi ställer oss efter att ha genomfört denna undersökning är om lusten hos lärare för yngre elever att undervisa om teknik påverkas av deras uppfattning om vad som hör till området. Om läraren, som i de flesta fall är en kvinna, ser datorer, elektronik och arbete med skiftnyckel, skruvmejsel och andra verktyg framför sig kan området te sig både oöverstigligt och svårt. En bred teknikuppfattning öppnar däremot för stora möjligheter att välja teknikområden efter lärarens intresse och kunnande. Därför ser vi det som angeläget att i våra framtida styrdokument bättre tydliggöra en sådan bred teknikuppfattning.

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