Teacher educator perspectives on pedagogical modelling and explaining in Design and Technology: a Q Methodology Study.

Matt McLain: Liverpool John Moores University, IM Marsh Campus, Liverpool, L17 6BD, Merseyside, UK; phone: +44 151 231 4622, email: m.n.mclain@ljmu.ac.uk.

Abstract

This paper builds on a previous study on the demonstration as a signature pedagogy in design and technology, this paper explores teacher educators' values on teacher modelling and explanation. In a previous study the participating teachers identified "competent management of the learning experience" as a significant factor in effective demonstrations, and in particular teacher competency, clarity and subject knowledge. The demonstration is a fundamental pedagogical tool for practical subjects where procedural knowledge is developed over time from observation and imitation to independence and adaption of technique. As such, it tends to align itself at the restrictive end of an expansive-restrictive continuum. This study builds on the developing exploration of the nature of the demonstration, exploring the subjective values of teacher educators. Q Methodology is used to compare and analyse the responses of the participating teacher educators. A Q-Set of statements, developed and refined with D&T teacher educators, relating to modelling and explaining, represents the concourse of opinions and perspectives. The sample is purposive, comprised of teacher educators. The findings represent a snapshot of subjective values, informing the wider discourse on signature pedagogies in design and technology education.

Keywords: demonstration; teacher modelling, design and technology, initial teacher education; teacher educator; Q methodology.

Introduction

McLain, Barlex, Bell and Hardy (2015) and McLain, Bell and Pratt (2013) postulated that the demonstration was a signature pedagogy, but had received little attention in pedagogical and research literature for design and technology, both in the United Kingdom and internationally. This was despite acknowledgement by Petrina that it was the "single most effective method for the technology teacher" (2007: 1). The demonstration is important in other subjects and has received some attention in in subject disciplinary literature, such as science (Milne and Otieno, 2007) and physical education (Mosston and Ashworth, 2002).

This study aims to continue to dialogue begun by McLain et al (2015) on the subjective views on teacher modelling and explaining in design and technology, focusing on teacher educators in the United Kingdom.

Literature review

The aim of this literature review is to present a rationale for the theorisation of teaching and learning in design and technology in the context of a challenging, contemporary, educational and political environment in England.

Current educational context

Emerging from craft subjects, design and technology was recognised as “educationally important” (DES and WO, 1998) from the introduction of the national curriculum in England (NCC, 1990). However, around 20 years later an expert panel report for the Secretary of Education (DFE, 2011) considered that practical subjects, including design and technology, art and design, and computer science, had “weaker epistemological roots” (p.24). This has been more recently realised in the curriculum through the introduction of the English Baccalaureate and proposals to extend the “school day to include a wider range of activities, such as sport, arts and debating” (DFE, 2016: 88, 95), potentially widening the gap between the core academic and the practical and creative subjects. This is both a challenge for and to the subject community. ‘For’ in that it undermines the position it once held in the national curriculum, and ‘to’ as a prompt to address perceived disciplinary weakness and engage with research and theorisation subject and pedagogical knowledge.

Practical education and domains

Despite the importance laid on practical education in recent history (Claxton, Lucas and Webster, 2010a, 2010b; Dewey, 1916; Froebel, 1900), the emphasis in the current educational context has been on the cognitive aspects of learning. The popular taxonomy of educational objectives introduced by Bloom et al (1956) identified three domains of learning: cognitive, affective and psychomotor. The first, and most widely recognised, domain of the cognitive was initially defined by Bloom et al, though this was updated by Andersen and Krathwohl (2001) who were part of the original research team. The affective domain, relating to values and aspects of emotional intelligence, was defined by Krathwohl, Bloom and Masia (1964). However, the psychomotor domain remained untouched by those involved with the original identification of the three domains.

In her attempt to define the third domain, Simpson quotes Bloom (1956: 7-8) as having found “so little done about [the psychomotor domain]”, and “[did] not believe the development of a classification of these objectives would be very useful” at the time (1966: 2). As the principle investigator, Simpson drew from expertise in practical subjects to describe a psychomotor domain (Figure 1).

Figure 1 Simpson’s psychomotor domain

Perception	Observation and general perception
Set (or mindset)	Cognitive readiness for action
Guided Response	Imitation and mimicry when practicing actions
Mechanism	Emerging competence/proficiency, leading to independence
Complex Overt Response	Independence, automatic and accurate performance
Adaptation	Mastery and the ability to transfer skill/knowledge to other settings
Origination	The ability to create new approaches to activity

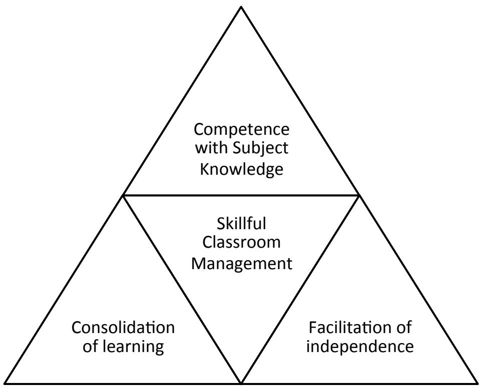
Several other researchers have also sought to define the psychomotor domain (Harrow, 1972; Dave, 1967) and redefine or update Blooms original work (Marranzo and Kendell, 2007; Andersen and Krathwohl, 2001). However, the role of the practical in education in the United Kingdom has arguably remained on the periphery, despite formal recognition of practical subjects in the National Curriculum since 1990.

Research of teacher modelling and explaining

In their small-scale study of 7 teachers, McLain et al (2015) identified the complexity of views on teacher modelling and explanation, which drew on generic and subject specific pedagogical knowledge. This, in turn, was viewed to rely on competent subject knowledge. The study correlated with Petrina's (2007) common components of a demonstration, in particular to the relevance' and application of practical knowledge, which rely on the specialist knowledge of the teacher.

The participants responses indicated that competence with subject knowledge was believed to "fundamental to effective teacher modelling" underpinned by "skilful pedagogical knowledge" and classroom management (p.274-275). The relationship and hierarchy of the teachers' beliefs was represented graphically (Figure 2), indicating the higher value placed on restrictive (teacher led and focused on the development of specific knowledge and practice) over expansive (learner led and open-end activity with multiple potential outcomes), which draws on Fuller and Unwin's (2003) work on learning environments.

Figure 2 Model of participant responses in McLain et al (2015: 275)



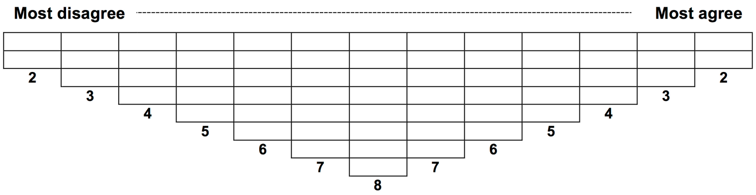
The restrictive-expansive framework, proposed by Fuller and Unwin, may be a useful tool for the design and technology community to consider when considering the intentions of a particular demonstration. For example, a restrictive demonstration might focus on specific procedures that must be correctly followed to achieve a successful outcome, which would tend to result in learners' made outcomes being similar. Whereas, an expansive approach would provide stimulus for open-ended, design-oriented activity, leading to a range of outcomes. The responses to McLain et al's study indicated that participant views on demonstration favoured statements on the restrictive end of the continuum (competence with subject knowledge and skilful classroom management), rather than the expansive (consolidation of learning and facilitating of independence).

Research design

The research question for this study was: What do design and technology teacher educators believe to be effective pedagogy modelling?

This study was conducted using Q Methodology (Watts and Stenner, 2012), which focuses on participants' subjective beliefs or "first person viewpoints" (p.4) "in pursuit of an explanation and new insight" (p. 39); in this case, into teacher educators' views on teacher modelling and explanation. The concourse of views is encapsulated in 62 statements developed for the initial study of teachers' views, conducted by McLain et al (2015), adopted for this study. The nature of these statements, developed through focus groups with school-based initial teacher education mentors and teacher educators, tends towards statements that would be generally supported as effective approaches. Within Q Methodology, Q-Sets tend to represent the broad range of views held by a community, and therefore include statements that would engender strong disagreement. This is not considered to be a requirement, but some participants can find it difficult (and reported in this study) to sort statements with in a *forced-choice frequency distribution* along a continuum from 'most agree' to 'most disagree' (Figure 3).

Figure 3 forced-choice frequency distribution



QSortWare (Pruneddu, 2014), an online Q-Sort survey tool, was used to capture responses from teacher educators across institutions in the United Kingdom. The sample is purposive (Guba, 1981) and was recruited through a design and technology teacher educator forum. The analysis of data was conducted using the PQMethod software (Schmolck, 2014).

Findings

There were 11 participating teacher educators (Figure 4) who responded to an invitation on a design and technology teacher educator email discussion group. The study continues to explore the subjective values or practitioner in relation to classroom practice.

Figure 4 Sample group (n=11)

Sorts	Main D&T specialism	Gender	Institution	ITE experience
1	Other	Male	Higher Education	More than 20 years
2	Graphic design	Female	Higher Education	10 to 20 years
3	Product design	Female	Higher Education	10 to 20 years
4	Other	Male	Higher Education	5 to 10 years
5	Graphic design	Female	Higher Education	5 to 10 years
6	Electronics and control	Male	Higher Education	5 to 10 years
7	Textiles and fashion	Female	Higher Education	10 to 20 years
8	Textiles and fashion	Female	School Direct	Less than 2 years
9	Product design	Female	Higher Education	More than 20 years
10	Electronics and control	Male	Higher Education	5 to 10 years
11	Electronics and control	Male	Higher Education	More than 20 years

Figure 5 Correlation matrix between Q Sorts

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**100**	40	26	53	22	24	27	16	18	-34	37
2	40	**100**	15	45	12	16	33	11	15	-33	45
3	26	15	**100**	29	25	31	1	20	30	-17	9
4	53	45	20	**100**	25	22	35	21	21	-35	59
5	22	12	25	25	**100**	23	0	12	15	-16	26
6	24	16	31	22	23	**100**	23	38	14	-41	32
7	27	33	1	35	0	23	**100**	-7	-6	-42	39
8	16	11	20	21	12	38	-7	**100**	25	-5	26
9	18	15	30	21	15	14	-6	25	**100**	-9	11
10	-34	-33	-17	-35	-16	-41	-42	-5	-9	**100**	-55
11	37	45	9	59	26	32	39	26	11	-55	**100**

Figure 5 shows the initial correlations between Q Sorts indicates correlations between the participants ranging from a positive 59 correlation between participants 4 and 11, to a negative 42 correlation between participants 7 and 10. Participant 10 shows a negative correlation to all other participants. This mirrors the findings of McLain et al (2015), acknowledging that there is “no ‘one size fits all’ approach” (p.272).

PQMethod initially extracted 8 factors, three of which had Eigenvalues (EV), or Kaiser-Guttmann criterion, above 1.00, indicating the statistical strength (Watts and Stenner, 2012, p. 105). Initially, factor one had an EV of 3.5994 and factor two 1.5627. Factor three, with an EV of 1.0299, was deselected prior to further analysis and factor rotation, Q Methodology experts tend to advise that one factor be extracted for every 6 to 8 participants (Watts and Stenner, 2012: 107). `Figure 6` indicated the factor loadings for the each participant after the data was rotated.

Figure 6 Factor Matrix with an X Indicating a Defining Sort

	Loadings			
Sorts	**1**		**2**	
1	-0.4489		0.5929	X
2	-0.2660		0.6944	X
3	-0.6533	X	-0.0252	
4	-0.4087		0.7064	X
5	-0.4829	X	0.1170	
6	-0.2836		0.0636	
7	0.2297		0.6701	X
8	-0.5187	X	-0.1445	
9	-0.7156	X	-0.0025	
10	0.0332		-0.5678	X
11	-0.2043		0.6772	X
% expl.Var.	19		24	

A full table of the rankings of statements for each factor can be found in Figure 7, and are discussed below.

Consensus and distinguishing statements

Figure 7 indicated 30 consensus and 32 distinguishing statements between factors 1 and 2, with the Q-Sort Value (Q-SV) and Z-Score (Z-SCR) indicating the rank order and strength of agreement, respectively, for each.

Figure 7 Consensus Statements

		Factor 1		Factor 2		Relevance	
Statement		**Q-SV**	**Z-SCR**	**Q-SV**	**Z-SCR**	**Cons.**	**Dist.**
1	The teacher gives an overview of the content of the skills or knowledge being demonstrated	4	1.31	4	1.45	✔	
2	The teacher uses technical language/terminology and key words	-4	-1.00	4	1.35		✔
3	The teacher presents their expectations	2	0.67	1	0.6	✔	
4	The teacher presents the learning objectives (knowledge/skills)	4	1.32	2	0.65	✔	
5	The teacher presents the learning outcomes (i.e. what learners will do or be able to do as a result)	0	-0.15	5	1.57		✔
6	The teacher refers to the application, of what is being demonstrated outside the classroom context	-5	-1.4	-2	-0.81	✔	
7	The teacher demonstrates skills and knowledge that learners will apply within the lesson	-1	-0.41	2	0.61		✔
8	The teacher uses staged demonstrations, breaking down more complex process into separate (linked) demonstrations	-4	-1.08	4	1.38		✔
9	The teacher models/explains the whole process in one demonstration	6	2.06	-6	-2.09		✔
10	The teacher adapts their approach and style of demonstration to the learners, dependent on age, ability, prior experience, etc.	-5	-1.71	3	0.97		✔

	Statement	Factor 1		Factor 2		Relevance	
		Q-SV	Z-SCR	Q-SV	Z-SCR	Cons.	Dist.
11	The teacher gives clear verbal explanations of processes and procedures	-5	-1.33	6	1.96		✔
12	The teacher provides a running commentary through the demonstration	-3	-0.94	-1	-0.34	✔	
13	The teacher gives clear models/examples processes and procedures	2	0.53	5	1.49		✔
14	The teacher makes reference to relationships with other related concepts (e.g. mathematical, scientific, technological, etc.)	-3	-0.8	-5	-1.31	✔	
15	The teacher make reference to cause and effect of decisions and/or actions	-2	-0.73	-4	-1.17	✔	
16	The teacher uses examples, analogies and/or similes to explain processes and procedures	-2	-0.62	-2	-0.68	✔	
17	The teacher identifies the main points/steps for the learners	5	1.42	5	1.83	✔	
18	The teacher 'signposts' or indicates the next steps (i.e. “later in the lesson…” or “in next lesson…”)	0	0.12	0	-0.12	✔	
19	The teacher models diagnostic processes, such as using testing equipment to fault-find or the application of scientific knowledge from an observation	4	1.41	-5	-1.23		✔
20	The teacher uses ICT to simulate or model process or products	6	2.34	-6	-2.18		✔
21	The teacher addresses learners misconceptions as they arise	-1	-0.34	1	0.42	✔	
22	As part of the planned demonstration, the teacher addresses common misconceptions around technical terms, concepts, etc.	-2	-0.59	1	0.25		✔
23	The teacher uses questioning to probe learners’ prior knowledge from within the unit/project	1	0.19	1	0.37	✔	
24	The teacher questioning to probe learners’ prior knowledge from previous D&T units/projects	-3	-0.75	1	0.44		✔
25	The teacher questioning to probe learners’ prior knowledge from other subjects	-2	-0.6	-3	-0.93	✔	
26	The teacher uses questioning to enable learners to recall aspects of the process demonstrated	1	0.42	2	0.63	✔	
27	The teacher uses questioning to probe understanding of concepts, process and procedures	-6	-2.34	2	0.73		✔
28	The teacher uses questioning to encourage learners to speculate (e.g. predicting the next step in a process)	-4	-1.12	-1	-0.55	✔	
29	The teacher uses visual resources, such as images, photographs and diagrams, to enhance their demonstrations	0	-0.07	-5	-1.43		✔
30	The teacher prepares and uses examples of the products/outcomes being demonstrated	1	0.37	0	-0.27	✔	
31	The teacher prepares examples showing the steps/stages of the process being demonstrated	1	0.14	0	-0.07	✔	
32	The teacher prepares the demonstration station/area in advance (e.g. before the lesson)	1	0.32	2	0.72	✔	
33	The teacher uses resources, such as instruction sheets, slideshows or videos, after the demonstration to support learners	1	0.36	-2	-0.59		✔
34	The teacher uses other support staff (i.e. technician or teaching assistant) during, and after, the demonstration to support learners	5	1.90	-1	-0.54		✔
35	The teacher identifies hazards and risks for the learners	3	0.77	4	1.12	✔	
36	The teacher prompts learners to identify hazards and risks for themselves	0	-0.28	0	-0.13	✔	
37	The teacher is competent to use equipment safely	-6	-2.57	6	2		✔
38	Appropriate information about risk is readily available to learners	3	0.91	1	0.6	✔	
39	The teacher sets high standards and expectations for the learners in designing and making activities	-2	-0.7	0	-0.2	✔	
40	The teacher identifies alternative actions or choices learners can or need to do (e.g. design, make, evaluate)	3	1.28	-4	-1.22		✔
41	The teacher enables learners to identify alternative actions or choices that they can make (e.g. design, make, evaluate, etc.)	-1	-0.43	-4	-1.13	✔	
42	The teacher plans and uses extension or enrichment activities for able learners	1	0.47	-1	-0.47		✔
43	The teacher encourages/supports learners to demonstrate skills and knowledge to their peers	0	0.13	-2	-0.69		✔
44	The teacher encourages learners to participate in fault finding and quality control	-1	-0.41	-2	-0.65	✔	
45	The teacher ensures that they make eye contact with members of the whole group	2	0.70	-1	-0.45		✔
46	The teacher scans and monitors the group, as they are teaching, to ensure that the learners are engaged	-3	-0.99	1	0.16		✔
47	The teacher scans and monitors the group to ensure that learners are safe	-3	-0.79	3	1.01		✔
48	The teacher has ‘presence’ within the classroom	3	0.72	-1	-0.34		✔

Statement		Factor 1 Q-SV	Factor 1 Z-SCR	Factor 2 Q-SV	Factor 2 Z-SCR	Relevance Cons.	Relevance Dist.
49	The teacher can modify their tone when talking to/with different sized groups and in different situations	5	1.46	0	-0.18		✔
50	The teacher encourages learners to 'think-out-loud' to consolidate knowledge and understanding	3	0.76	-3	-0.99		✔
51	The teacher explains the function and/or context of the matter (i.e. knowledge and/or skill) being demonstrated	0	0.13	-3	-0.84		✔
52	The teacher encourages learners to reflect on values (e.g. the impact of a technology on society, the environment, etc.)	-2	-0.5	-3	-1.09	✔	
53	The teacher scans the room after the demonstration to monitor learners' progress	2	0.54	0	0.14	✔	
54	The teacher waits for learners to attempt a task before intervening	-1	-0.3	-3	-0.94	✔	
55	The teacher encourages learners to support each other before seeking the assistance of the teacher	3	0.75	-4	-1.16		✔
56	After the demonstration, the teacher moves around the room to support learners	2	0.54	0	0.02	✔	
57	The teacher shows/explains the process/skill to individuals who have misunderstood processes or concepts shortly after a demonstration	0	0.11	-2	-0.75		✔
58	The teacher uses questioning to ascertain what a learner understands, when they have not fully understood the demonstration	-1	-0.41	2	0.76		✔
59	The teacher explains what learners are expected to do to make progress	0	0.00	3	1.04		✔
60	The teacher makes his/her expectations of the learners' outcomes clear	2	0.54	3	1.03	✔	
61	The teacher provides examples of outcomes of a process that exemplify the skills being modelled	-4	-1.04	-1	-0.57	✔	
62	The teacher ensures that all learners know what they need to do to make progress	-1	-0.30	3	0.81		✔

Discussion

The factors extracted represent two distinct groups of participants (factors) with similar trends in their responses, discussed below, focusing on the higher ranked statements. Figure 7

Factor 1: the teacher as a manager of the learning environment

Factor 1 is comprised of 4 teacher educators; all are female, with two identifying their main specialism as product design, one as graphic design and one as textiles and fashion.

The top responses indicate that the members of this group value didactic approaches through a planned and structured learning experience, where the knowledge is broken down into its components parts (17:5), modelling and explaining a process in one demonstration (9:6), supported by ICT to stimulate or support understanding of a process or product (20:6). The teacher should consider pedagogical approaches by differentiating for learners through support from other adults in the classroom (34:5), and modification of their approach in response to different groups and situations (49:5).

Also valued are clear expectations of learning and progress (1:4, 4:4, 3:2, 60:2), including "…models/examples processes…" (13:2); wider application of the knowledge being demonstrated, but recognising the role of the learner through peer support (55:3), consideration of how the knowledge can and will be applied in other contexts (40:4) and encouraging learners to speculate and synthesis knowledge (50:3). In addition, they identify classroom management, through safe use of equipment (37:3), identifying (35:3) and providing information about hazards and risks for learners (38:3), and whole class presence (48:3), awareness through visually scanning the room, during (45:2) and after (53:2) demonstrations, and moving "around the room to support learners" (60:2). This demonstrates a range of pedagogical and contextual knowledge in the planning and delivery.

Factor 2: the teacher as the mediator of knowledge

Factor 2 is comprised of 6 teacher educators (4 male and two female), with two identifying their main specialism as electronics and control, one as graphic design, one as textiles and fashion, and two as 'other', which may indicate either multiple specialism or one that was not listed as an option, such as engineering or resistant materials.

This group of teacher educators also value didactic approaches through a planned and structured demonstration, but the response focus on the learning outcomes (5:5), identification of the main points or steps (17:5) and use of clear models and examples (13:5) of processes and procedures, underpinned by clear verbal explanations (11:6).

The didactic focus is further emphasised through the importance placed on the teacher providing an overview of the skills or knowledge being demonstrated (1:4), in common with Factor 1, linking to learning and made clear through expectations of outcomes (60:4), what learners need to do (59:3) and the teachers role to enable them (62:3) to make progress. In contrast with Factor 1, the group of teacher educators in Factor 2 consider the breaking down of more complex process into separate, staged demonstrations (8:4), and the use of technical language and terminology (2:4) to be important, alongside demonstrating knowledge and skill in the context of the lesson in which it will be applied (7:2).

Factor 2 identify pedagogical dimensions in differentiation of approaches to the learners (10:3) and the use of questioning for recall (26:2) and probing understanding following a demonstration (58:2) and of concepts, process and procedures (27:2); highlighting an adaptive approach which is underpinned by teachers' pedagogical and subject knowledge.

In common with Factors 1, Factor 2 values the importance of learning objectives (4:2) and outcomes (60:3), identification of hazards and risks (35:4) and previewing content of a demonstration (1:4). Similar themes also emerge through other statements, including preparation (32:2), management of risk through identification of hazards (35:4), scanning and monitoring for learners' safety (47:3).

Comparing Factors 1 and 2

The teacher educators, in both factors, broadly agree on the role of didactic and pedagogic approaches. In this context, didactic relates to theory of teaching and specifically how subject knowledge is composed, reflected in how concepts or processes are broken down into main points, steps or stages. The teacher educators in Factor 2 extend the didactic theme to a process being staged in separate demonstrations (8:4), which Factor 1 do not consider to be as important (8:-4).

Both factors highlight pedagogical approaches, emphasising learning, with Factor 1 considering speculation and Factor 2 favouring questioning. Similarly, both value the skill of the teacher to differentiate, although Factor 1 ranks this higher than Factor 2

Conclusion

This study continues to explore the beliefs of the design and technology community in relation to teacher modelling and explaining. The participants broadly agree that a demonstration draws on didactic and pedagogic knowledge. In agreement with the teachers in McLain et al (2015), the teacher educators placed higher value on the teacher's engagement with procedural and strategic knowledge, although they did not hold that the teacher be "competent to use equipment safely" (statement 37) to be the highest ranked item. Figure 8 shows the top 10 consensus statements for the teacher educators in this study (with the average Q-Sort Value). These reinforce the role of didactics, in the teacher's ability to break down subject knowledge and present expectations, objectives and outcomes. Items indicate with an asterisk (*) feature in the top 10 statements for teachers in McLain et al (2015). Where the teacher educators differ to the teachers, in McLain et al, relate to the pedagogical role of the teacher to facilitate learning through questioning.

Figure 8 Top 10 consensus statements

No.	Ave.	Statement
*17	5.0	The teacher identifies the main points/steps for the learners.
*1	4.0	The teacher gives an overview of the content of the skills or knowledge being demonstrated.
35	3.5	The teacher identifies hazards and risks for the learners.
4	3.0	The teacher presents the learning objectives (knowledge/skills).
*60	2.5	The teacher makes his/her expectations of the learners' outcomes clear.
38	2	Appropriate information about risk is readily available to learners.
3	1.5	The teacher presents their expectations.
26	1.5	The teacher uses questioning to enable learners to recall aspects of the process demonstrated.
*32	1.5	The teacher prepares the demonstration station/area in advance (e.g. before the lesson).
23	1.0	The teacher uses questioning to probe learners' prior knowledge from within the unit/project.

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