DOCUMENT RESUME

ED 383 706 SP 036 061

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TITLE Wait-Time: Effective and Trainable.
INSTITUTION Appalachia Educational Lab., Charleston, W. Va.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE 22 Apr 95
CONTRACT RP91002002
NOTE 15p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 18-22, 1995). For a related document, see SP 036 057.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Elementary School Teachers; Elementary Secondary Education; *Inservice Teacher Education; *Program Design; Program Effectiveness; Program Evaluation; *Questioning Techniques; Secondary School Teachers; Teaching Methods; Teaching Skills; *Wait Time
IDENTIFIERS *QUILT (Staff Development Program)

ABSTRACT

This study sought to identify variables related to higher levels of elementary and secondary school teacher use of wait-time I and whether knowledge and skill can be increased by focused staff development. Wait-time I is the time a teacher pauses after asking a question before acknowledging a student's response. The study used research on QUILT (Questioning and Understanding To Improve Learning and Thinking), a staff development program designed to increase teacher use of effective classroom questioning techniques and procedures. Based on analysis involving 9,595 teacher initiated questioning episodes from 254 coded videotapes, several variables were significantly related to wait-time I: level of wait-time II, cognitive level of the question, whether the student to answer is designated before or after the question is asked, who actually answers the question, the number of students responding, cognitive level of student response, the teacher repeating or rephrasing the question, teacher probing, and teacher redirection of the question to other students. In addition, teachers who participated in the full QUILT program showed significant gains in knowledge and use of wait-time I, indicating that concentrated and focused staff development can affect this skill. (Contains 11 references.) (JB)

Wait-time: Effective and Trainable

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A paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA, April 22, 1995

This paper is based on work sponsored wholly or in part by the Office of Educational Research and Improvement, U. S. Department of Education, under contract number RP91002002. Its contents do not necessarily reflect the views of OERI, the Department, or any other agency of the U. S. Government.

The research reported here is an integral part of a staff development program developed by the Appalachia Educational Laboratory, Inc. (AEL) called Questioning and Understanding to Improve Learning and Thinking (QUILT). QUILT is designed to improve classroom teacher questioning skills through a comprehensive staff development program based on commonly recognized characteristics of effective staff development (Joyce and Showers, 1982).

It was field tested in 13 school districts across four states. QUILT includes extensive data collection and analysis to assess effectiveness including assessment of participant knowledge, attitudes, and classroom behaviors. The aspect of QUILT research reported here is the examination of variables, based on the observation and analysis of classroom teacher questioning behaviors, related to using wait-time and the development of wait-time use skills through intensive staff development. Two research questions will be dealt with:

1. What variables are related to higher levels of wait-time I (the time a teacher pauses after asking a question before acknowledging a student's response)?

2. Can the knowledge of and use of wait-time I be increased by focused staff development?

PERSPECTIVES

Research indicates that as much as 40% of classroom time is spent in a question-response mode (Johnson, Markle, & Haley-Olpihant, 1987). Nevertheless, many teachers do not ask questions effectively (Gall, 1984). Ineffective or inappropriate practices include asking questions at only lower cognitive levels (Ornstein, 1987), directing a disproportionate percentage of questions toward a limited number of students (Jones, 1990), or waiting too little time after asking a question before reacting to the student response, typically one second or less (Rowe, 1986). The importance of wait-time has been recognized by several others. Stahl (1994) indicates that several types of pauses referred to as "think-time" and "wait-time" result in positive outcomes for both students and teachers. He identifies eight different categories of silence, including what others have referred to as wait-time I and wait-time II. According to Stahl, using these silence behaviors results in students being more effective in completing cognitive tasks and improves the teacher's ability to manage and guide classroom instruction. Williams, et al. (1991) points out that teachers concentrate on asking lower level cognitive questions for three reasons: they believe there is a need for students to know facts before being able to use them in higher order thinking, the school curriculum is fact rather than thought oriented, and teachers lack the skills needed to formulate higher order questions. One of the five recommendations made is the use of wait-time. Atwood (1991), in a study of the literature in science education, concludes that increased wait time can stimulate reflective thinking and student involvement.

METHODS

QUILT was field tested using three randomly configured, group comparison configurations: condition A involved three days of staff development on classroom questioning and monthly collegium meetings, condition B involved only the three days of staff development, and condition C involved a three-hour presentation on classroom questioning. Changes on knowledge, questioning behaviors, and attitudes were compared across the three groups. During the field test year, more than 1300 teachers were involved in QUILT activities. More specific information on QUILT is found in Barnette, et al. (in press). This included data from knowledge assessment, classroom behavior (based on analysis of videptapes), and evaluation of induction training and post-program reaction.

In order to assess teacher questioning behavior, data specifications were determined. Variables to be assessed in this observation system were: number of questioning episodes per specified time period, whether the episode was initiated by the teacher or a student and, for questions initiated by the teacher, the amount of time the teacher waits before acknowledging a student's response (wait-time I), whether the question is directed to a specific student before or after the question, the cognitive level of the question, who responds to the question, the cognitive level of the student response, the nature of the answer, the amount of time the teacher waits before reacting to a student's answer (wait-time II), the type of feedback given by the teacher, and teacher use of the student's answer.

Observation scale developers observed several classrooms to determine the viability of observing and categorizing the variables. Based on these observations, a coding sheet was developed and field tested. Coders were selected and participated in a 15-hour training program where they became familiar with the behaviors to be coded and practiced coding transcripts and videotapes of questioning episodes. The coders' reliability was 90-94% agreement after the training program. More specific information on the development of the observation coding protocol are found in Barnette, et al. (1994).

As pre-program data collection, a ten-percent random sample of teachers was selected to be videotaped for a 15 minute period. These videotapes were coded by the trained coders and entered into a data file which, in addition to the coded data, included data on teacher grade level and subject. These same teachers were observed again at the end of the first year of QUILT participation.

RESULTS

Variables Related to Wait-time I

Based on chi-square analysis, involving 9595 teacher-initiated questioning episodes from 254 coded videotapes, several variables were

significantly related to wait-time I. The wait-time I variable was categorized as less than three seconds and three seconds or higher. Level of wait-time I was related to level of wait-time II, the cognitive level of teacher question, whether the student to answer is designated before or after the question is asked, who actually answers the question, number of students responding, cognitive level of student response, the teacher repeating or rephrasing the question, teacher probing, and teacher redirection of the question to other student(s).

Table 1 presents the results of wait-time I related to wait-time II. Wait-time II was categorized as less than two seconds and two seconds or more. There was a significant relationship.

Table 1. Relationship of wait-time I and wait-time II

Wait-time I		Less than 2 seconds	2 seconds or more	Total
Less than 3 seconds	O	8035 +	150 -	8185
	E	7964.9	220.1	
	CS	0.6	22.3	
	R%	98.2	1.8	
	C%	86.1	58.1	85.3
3 seconds or more	O	1302 -	108 +	1410
	E	1372.1	37.9	
	CS	3.6	129.6	
	R%	92.3	7.7	
	C%	13.9	41.9	14.7
Total	O	9337	258	9595
	R%	97.3	2.7	

O= Observed frequency
E= Expected frequency
CS= Cell chi-square contribution
R%= Row %
C%= Column %

Chi-square= 156.08, df= 1, p= .000
+Observed higher than expected -Observed lower than expected

Higher wait-time I is related to higher wait-time II. If wait-time I is less than three seconds, wait-time II is less than two seconds 98.2% of the time and two seconds or higher 1.8% of the time. If wait-time I is three seconds or more, wait-time II is less than two seconds 92.3% of the time and two seconds or higher 7.7% of the time.

Wait-time I is related to the cognitive level of the question. Table 2 presents the test for this relationship. Lower level questions (recall and check for understanding) and questions of undetermined cognitive level were more likely to be associated with lower wait-time I as compared with utilization level questions, which were more related to higher wait-time I as compared with the other types. When utilization questions were asked, wait-time I was three seconds or higher 17.2% of the time as compared with wait-time at three seconds or higher 13.8% of the time for non-utilization questions.

Table 2. Relationship of wait-time I and cognitive level of question asked

Wait-time I		Recall/Check for Underst.	Utilization	Creation	Unknown	Total
	O	5333	2121 -	645	86 +	8581
Less than	E	5285.5	2184.7	638.9	75.9	
3 seconds	CS	0.4	1.9	0.1	1.3	
	R%	65.2	25.9	7.9	1.1	
	C%	86.1	82.8	86.1	96.6	85.3
	O	863	440 +	104	3 -	
3 seconds	E	910.5	376.3	110.1	13.1	1410
or more	CS	2.5	10.8	0.3	7.8	
	R%	61.2	31.2	7.4	0.2	
	C%	13.9	17.2	13.9	3.4	14.7
Total	O	6196	2561	749	89	9595
	R%	64.6	26.7	7.8	0.9	

Chi-square= 25.03, df= 3, p= .000

Table 3. Relationship of wait-time I and designation of student to answer

Wait-time I		Student was designated Before the question	After the question	Total
	O	1296 +	6860 -	8156
Less than	E	1217.0	6939.0	
3 seconds	CS	5.1	0.9	
	R%	15.9	71.7	
	C%	90.8	84.3	85.3
	O	131 -	1276 +	1407
3 seconds	E	210.0	1197	
or more	CS	29.7	5.2	
	R%	9.3	90.7	
	C%	9.2	15.7	14.7
Total	O	1427	8136	9563
	R%	14.9	85.1	

Chi-square= 40.92, df= 1, p= .000

Table 3 presents the relationship between wait-time I category and whether the student is designated to answer before or after the question is asked. Designating a student to answer the question after asking the question was more related to higher wait-time I than the designation of the student before asking the question. When wait-time was less than three seconds, the designation of the student after asking the question occurred 71.7% of the time while this happened 90.7% of the time.

The relationship of wait-time I and who answers the question is described in Table 4. When wait-time I is three seconds or higher, it is more likely that the teacher or the student designated after the question is asked will answer the question and less likely that a student designated before the question is asked will answer.

Table 4. Relationship of wait-time I and who answers the teacher's question

Wait-time I		Teacher	Student was designated Before the question	After the question	Total
Less than 3 seconds	O	25 −	1228 +	6663 −	7916
	E	33.4	1157.1	6725.5	
	CS	2.1	4.3	0.6	
	R%	0.3	15.5	84.2	
	C%	64.1	90.8	84.8	85.6
3 seconds or more	O	14 +	124 −	1195 +	1333
	E	5.6	194.9	1132.5	
	CS	12.5	25.8	3.4	
	R%	1.1	9.3	89.7	
	C%	35.9	9.2	15.2	14.4
Total	O	39	1352	7858	9249
	R%	0.4	14.6	85.0	

Chi-square= 48.73, df= 2, p= .000

Table 5 examines the relationship of wait-time I and number of students responding to the question. When wait-time I was less than three seconds it was more likely that more than one student or a choral response occurred as compared with a single student answering more than expected when wait-time I was three seconds or higher.

Table 6 presents the relationship of wait-time I category and cognitive level of student response. When wait-time I is less than three seconds the cognitive level of student response is at the recall level more than expected and when wait-time I is three seconds or higher there is a higher than expected proportion of unknown cognitive

level of the answer.

Table 5. Relationship of wait-time I and number of students responding to the question

Wait-time I		Single	More than one	Choral response	Total
Less than 3 seconds	O	6698 -	689 +	626 +	8013
	E	6837.1	619.7	556.2	
	CS	2.8	7.8	8.8	
	R%	83.6	8.6	7.8	
	C%	84.1	95.4	96.6	85.8
3 seconds or more	O	1268 +	33 -	22 -	1323
	E	1128.9	102.3	91.8	
	CS	17.2	47.0	53.1	
	R%	95.8	2.5	1.7	
	C%	15.9	4.6	3.4	14.2
Total	O	7966	722	648	9336
	R%	85.3	7.7	6.9	

Chi-square= 136.56, df= 2, p= .000

Table 6. Relationship of wait-time I and level of student response

Wait-time I		Recall/Check for Underst.	Utilization	Creation	Unknown	Total
Less than 3 seconds	O	5273 +	1983	600	329 -	8185
	E	5172.9	1990.2	591.2	430.8	
	CS	1.9	0.0	0.1	1	
	R%	64.4	24.2	7.3	)	
	C%	87.0	85.0	86.6	?	85.3
3 seconds or more	O	791 -	350	93	-	1410
	E	891.1	342.8	101.8		
	CS	11.2	0.1	0.8	1:	
	R%	56.1	24.8	6.6	1	
	C%	13.0	15.0	13.4	34	14.7
Total	O	6064	2333	693	505	595
	R%	63.2	24.3	7.2	5.	

Chi-square= 177.93, df= 3, p= 0.000

Table 7 presents the relationship between wait-time I and the teacher repeating or rephrasing the question. This was more likely to occur compared with what would be expected when wait-time I was three seconds or higher. When wait-time I was less than three seconds this happened less than three percent of the time and when wait-time I was three seconds or more this happened 6.7% of the time.

Table 7. Relationship of wait-time I and repetition/rephrasing of question

Wait-time I		Teacher repeats/rephrases question: No	Yes	Total
Less than 3 seconds	O	7955	230 -	8185
	E	7908.6	276.4	
	CS	0.3	7.8	
	R%	97.2	2.8	
	C%	85.8	71.0	85.3
3 seconds or more	O	1316	94 +	1410
	E	1362.4	47.6	
	CS	1.6	45.2	
	R%	93.3	6.7	
	C%	14.2	29.0	14.7
Total	O	9271	324	9595
	R%	96.6	3.4	

Chi-square= 54.8, df= 1, p= 0.000

The relationship between wait-time I and teacher probing is presented in Table 8. When wait-time I was higher than three seconds there was a higher than expected use of teacher probing. When wait-time I was less than three seconds, this happened 12.4% of the time while it happened 17.1% of the time when wait-time I was three seconds or higher.

Table 9 presents the comparison of wait-time I and the teacher redirecting the question to other student(s). When wait-time I was three seconds or higher, there was a higher than expected proportion of time the teacher redirected the question to other student(s). When wait-time I was less than three seconds this happened 17.2% of the time and it happened 22.9% of the time when wait-time I was three seconds or higher.

Table 8. Relationship of wait-time I and teacher probing

Wait-time I		Teacher probes after question: No	Yes	Total
	O	7172	1013 −	8185
Less than	E	7115.3	1069.7	
3 seconds	CS	0.5	3.0	
	R%	87.6	12.4	
	C%	86.0	80.8	85.3
	O	1169	241 +	1410
3 seconds	E	1225.7	184.3	
or more	CS	2.6	17.5	
	R%	82.9	17.1	
	C%	14.0	19.2	14.7
Total	O	8341	1254	9595
	R%	86.9	13.1	

Chi-square= 23.5, df= 1, p= .000

Table 9. Relationship of wait-time I and teacher redirecting question to other student(s)

Wait-time I		Teacher redirects question: No	Yes	Total
	O	6775 +	1410 −	8185
Less than	E	6706.7	1478.3	
3 seconds	CS	0.7	3.2	
	R%	82.8	17.2	
	C%	86.2	81.4	85.3
	O	1087 −	323 +	1410
3 seconds	E	1155.3	254.7	
or more	CS	4.0	18.3	
	R%	77.1	22.9	
	C%	13.8	18.6	14.7
Total	O	7862	1733	9595
	R%	81.9	18.1	

Chi-square= 26.23, df= 1, p= .000

The first research question was:

1. What variables are related to higher levels of wait-time I (the time a teacher pauses after asking a question before acknowledging a student's response)?

Based on these results, it is clear that there are several variables which are related to level of wait-time I. While there are significant relationships, it needs to be noted that there is no basis for concluding that these are causal in nature. Such causal connections would need to be based on highly controlled experimental studies.

Wait-time I changes as a result of QUILT staff development

The second research question was:

2. Can the knowledge of and use of wait-time I be increased by focused staff development?

QUILT was designed as a focused staff development program for the purpose of improving classroom questioning practices. While it was designed to impact several variables associated with classroom questioning, which have been reported in other documents (Barnette, et al., in press), the focus of this paper is on wait-time I. Assessment of effects on wait-time I were based on four sources of data: feedback about wait-time components of QUILT training, knowledge gain related to wait-time, observation of use of wait-time in classroom, and perceptions of improved use of wait-time I of QUILT participants at the end of the field-test year.

Participants in the QUILT condition A, which received the full QUILT program, were training in QUILT behaviors and concepts at the start of the field-test year. In an evaluation of this induction training, 225 participants completed a session feedback form. One section of this form asked participants to rate the areas of QUILT training relative to knowledge gain on a 1 to 5 point scale where 1 was "not at all" and 5 was "very much." The two items dealing with wait-time had the highest means, $\underline{M}$= 4.3 for wait-time I and $\underline{M}$= 4.4 for wait-time II. When asked about understandability of QUILT components, using the same 1 to 5 scale, the two wait-time items again had the highest means, $\underline{M}$= 4.6 for wait-time I and $\underline{M}$= 4.5 for wait-time II. Thus, it is clear that those being trained felt they understood and learned about the two wait-times.

An instrument was developed by QUILT staff and consultants to assess knowledge of effective classroom questioning practices, referred to as the Questionnaire on Effective Classroom Questioning (QECQ). This instrument was given pre and post to all three QUILT conditions. The instrument had 49 items which were distributed on six subscales. One of the subscales, with seven items, related to aspects of the use of wait-time. Table 10 presents the results for the total QECQ

instrument score and the wait-time subscale score. Table 10 presents the percentage of items correct at pre and post, the effect size, and dependent t tests comparing the post-pre mean differences.

Table 10. Results on wait-time subscale and total QECQ by QUILT condition, Percent correct answers

		QUILT treatment Condition					
		A, n= 297		B, n= 200		C, n= 292	
		Pre	Post	Pre	Post	Pre	Post
Wait-time	M	50.5	78.8	49.4	68.9	46.3	56.2
subscale	SD	22.7	21.5	22.1	24.0	20.5	23.4
SD_{pre}= 21.8	ES	1.30		0.89		0.46	
Pre-Post M diff.	p	< .001		< .001		< .001	
Total QECQ	M	46.8	58.2	47.2	53.4	45.1	47.4
SD_{pre}= 9.7	SD	10.3	12.3	9.7	12.7	9.1	10.5
	ES	1.17		0.64		0.24	
Pre-Post M diff.	p	< .001		< .001		< .001	

It is clear from Table 10 that there were significant pre to post differences for all three groups on both the wait-time subscale and the total. However, when looking at the effect sizes, and based on ANOVA significance tests, there were significantly higher pre to post changes for condition A as compared with conditions B and C on the subscale and total. Of the six QECQ subscales, the wait-time subscale had the highest degree of pre to post knowledge gain. Thus, QUILT training was effective in increasing knowledge of wait-time.

As indicated before, a sample of QUILT teachers from the three conditions were selected for pre and post videotaping. These videotapes were coded for QUILT behaviors. Ninety-five QUILT participants provided both pre and post videotapes. Among the variables coded were wait-time I and wait-time II. Four wait-time variables are described here: mean wait-time I, percentage of time wait-time I was three seconds or higher, mean wait-time II, and percentage of time wait-time II was three seconds or higher. Table 11 presents results for these variables.

On wait-time I, there were significant pre to post differences for both conditions A and B, but not for condition C. Mean wait-time I for condition A was 0.90 seconds at pre and increased to 1.70 at post for condition A, an effect size of 1.29. Mean wait-time I for condition B was 0.83 seconds at pre and 1.32 at post, an effect size of 0.79. The percentage of time wait-time I was at three seconds or higher increased from 12.8% to 25.0% for condition A, an effect size of 0.99. For condition B, the percentage changed from 11.1% at pre to 20.7% at post, an effect size of 0.78. Looking at the effect sizes indicates that

condition A had higher level of change than condition B. This supports the notion that continued, long-term staff development is more effective than one-time presentations. Both conditions A and B had the same induction training, but condition A participated in a year-long organized and focused QUILT staff development while condition B received only the induction training.

Table 11. Pre and post comparisons on QUILT wait-time variables

Observation Variables		Treatment Condition A, n= 37 Pre	A, n= 37 Post	B, n= 28 Pre	B, n= 28 Post	C, n= 30 Pre	C, n= 30 Post
Mean wait time I	M	0.90	1.70	0.83	1.32	0.74	0.80
	SD	0.58	1.47	0.53	1.03	0.74	0.93
SD_{pre}= .62	ES	1.29		0.79		0.11	
Post-Pre M Diff.	p	< .01		< .01		nsd	
Wait time I at 3 seconds or more, %	M	12.8	25.0	11.1	20.7	10.1	11.5
	SD	11.9	24.9	10.1	19.5	14.8	16.5
SD_{pre}= 12.3	ES	0.99		0.78		0.11	
Post-Pre M Diff.	p	< .01		< .05		nsd	
Mean wait time II	M	0.08	0.43	0.03	0.18	0.06	0.16
	SD	0.12	0.53	0.04	0.31	0.14	0.33
SD_{pre}= 0.11	ES	3.13		1.37		0.92	
Post-Pre M Diff.	p	< .001		< .01		nsd	
Wait time II at 3 seconds or more, %	M	0.52	2.98	0.10	0.59	0.59	0.97
	SD	1.28	6.73	0.51	1.61	2.06	4.57
SD_{pre}= 1.44	ES	1.72		0.34		0.26	
Post-Pre M Diff.	p	< .05		nsd		nsd	

On wait-time II, there were significant pre to post differences for both conditions A and B, but not for condition C. Mean wait-time II for condition A was 0.08 seconds at pre and increased to 0.43 at post for condition A, an effect size of 3.13. Mean wait-time II for condition B was 0.03 seconds at pre and 0.18 at post, an effect size of 1.37. The percentage of time wait-time II was at three seconds or higher increased from 0.52% to 2.98% for condition A, an effect size of 1.72. While the use of wait-time II changed in the desired direction, particularly for condition A participants, clearly the use of wait-time II is at a much lower level than desired or recommended.

Teachers who participated in condition A, the full QUILT model were asked to complete a Participant Reaction Form at the end of the field test year. This form was completed by 372 condition A teachers. When asked to indicate which of the 13 QUILT behaviors they attempted in class, wait-time I had the highest mean response and it was also the

QUILT behavior which was rated most highly in terms of which behaviors they felt successful in using. It was interesting to note that they felt relatively unsuccessful in their use of wait-time II, which was consistent with the low levels of use of wait-time II reported previously.

In conclusion, there were four data sources which indicate that QUILT resulted in higher knowledge and use of wait-time, particularly wait-time I. In addition to establishing the positive effects the use of wait-time, it was clear that condition A had the highest increase in the use of wait-time as compared with the other conditions, thus the use of wait-time may be increased with concentrated and focused staff development.

EDUCATIONAL IMPORTANCE

It is the goal of the QUILT staff development program that teachers ask fewer, but better (higher cognitive level) questions, that questioning be planned and purposeful, that it stimulate higher level critical thinking, and that teachers use techniques such as wait-times I and II, probing, respondent selection, and variable response formats to increase the learning and skill development potential of questioning. The use of the observation coding scheme developed by the QUILT program permits assessment of program effects. While QUILT is designed to have multiple effects, the more effective use of wait-time is one of the primary targets of the program. It is clear that increased use of wait-time is related to other important learning variables. While it may not seem logical, getting teachers to say less, at specific times, may have positive effects on increasing the level of student answers, getting teachers to designate the student to answer after asking the question, the redirecting of questions to other students, and lower incidence of repeating student answers (which has been associated with students tending to discontinue thinking processes). Further research needs to be conducted to examine the causal connections between wait-time and other important classroom questioning variables. It is, however, very clear that the use of wait-time can be increased through comprehensive staff development.

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