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Factors Influencing the Growth in Knowledge of Trainees in General Practice

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Abstract. Objectives: The relation between the content of postgraduate training for general practice and the outcome in terms of the growth in knowledge of trainees was investigated. The training variables included were: (1) the number of patients seen per day, (2) the trainer, (3) the practice and (4) the theoretical curriculum.

Methods: Subjects were 58 trainee-trainer pairs. Growth in knowledge was assessed by two written tests administered with eight months interval. Training variables were evaluated by means of questionnaires and logbook-registration. The correlation was explored between each of the training variables and the knowledge tests scores. To correct for interactional effects, a step-wise multiple regression analysis was performed with the second test as dependent variable and the first test as well as the training variables as independent variables.

Results: Significant growth in knowledge was demonstrated. Non of all training variables investigated explained the variance in scores on the second test equally good or better than the scores on the entry test.

Conclusions: The impact of the separate training-components on the growth in knowledge, remains unclear. We may speculate, that the sort of knowledge assessed with the written literature based true/false test is different from the sort of knowledge transferred during every day training: evidence based knowledge versus experience based knowledge. Equally valid is the conclusion that these findings fit into the theory that in adult learning the outcome is more learner' than teacher' dependent.

Key words: general practice, postgraduate education, growth in knowledge

Introduction

In the UK, the Netherlands and some of the Nordic countries postgraduate training for general practice has a long tradition. Despite differences in structure and content of the curriculum, there is considerable similarity (Lawrence and Pritchard, 1992; Boerma et al., 1993). In most countries trainees work and learn in general practice under the supervision of a GP trainer for a substantial part of the time. Gradually the trainer has evolved from 'host' to 'teacher' and 'role model'; the theoretical curriculum – courses and seminars – has become well elaborated and increasing attention is paid to formal assessment of the trainee's competence and performance (Pereira Gray, 1982; Lawrence and Pritchard, 1992). As is often the

case in education, reforms in structure and content of the training have mainly been based on perceived shortcomings in the prevailing system rather tha on outcomes of evaluative research (Nelson et al., 1990).

Literature search of studies on the outcome of postgraduate training in general practice in relation to the input yields only two publications that provide relevant information. In the UK Freeman et al. (1982) demonstrated a significant influence of the trainer's competence on the growth in competence of the trainee, measured by written tests. This would argue for a selection of trainers on the basis of their competence. In the Netherlands Grol et al. (1989) produced evidence that a more structured theoretical curriculum provides better outcome, in terms of competence and performance. However, neither of these studies reckon with the interaction of the different components of the practical and theoretical curriculum, such as trainer and practice or faculty and theoretical curriculum. As a result, their relative contribution to the outcome in terms of the trainee's competence remains unclear and questions relevant for further development of the training remain unanswered.

In this study the relative contribution of the different components of the training to the outcome in terms of the trainee's clinical knowledge is explored.

Methods

Context of the study

Postgraduate training for general practice in the Netherlands has a uniform structure and a nationally endorsed curriculum. The departments of general practice of the eight faculties of medicine in the Netherlands, in the context of postgraduate training usually addressed as 'training institutes', are responsible for the organization of the training. The main differences between institutes lie in the content of the 'day-release courses': seminars, group discussions and skills training, organized for groups of trainees.

The training, originally two years but changed to three years from September 1994, consists of three blocks of equal length. The first and last period are spent in general practice, the second in hospitals and other medical institutions. During the whole training period one day a week is reserved for day-release courses and one half day a week for self-directed learning. This study focuses on the outcome of the first training period.

Instruments

Knowledge was assessed by a written test that measures knowledge relevant to daily patient care. This test is routinely administered to all trainees in general practice in the Netherlands at fixed intervals during the whole period of their training. It consists of about 80 patient cases as they are usually presented to the general practitioner, each followed by one or more items. Test content is selected on the basis of a blueprint, established by consensus among general practitioners

(Pollemans, 1994). The items – 160 in total – focus on the 'key features' of the problem (Bordage and Page, 1987). Every item is followed by a literature reference, which provides the 'evidence' that established knowledge is tested. The response format of the test is of the true-false-type with an additional 'I don't know' option. The final score is expressed as the percentage correct minus incorrect answers. The test has a progress-testing format, implying that (a) the test is set at the level of the qualified general practitioner at the moment of certification, (b) tests of similar format but different content are periodically administered, and (c) all trainees take the same test regardless of their training level. Progress during training can accordingly be monitored.

The components of the training to be investigated are described in several publications on postgraduate training for general practice in the Netherlands (Dubois et al., 1987), and represent the primary sources for the learning of the trainee: daily patient encounters, trainer as role model and supervisor/teacher, training practice, theoretical curriculum, staff and self-directed learning. The variable 'theoretical curriculum' was represented by the item: (name of) training institute/university.

The eight different training institutes correspond in broad outlines in their day-release courses but differ in the selection of concrete topics and in the extent to which the programme is structured versus tailored to the trainee-groups' needs. Thus, only the site of training institute and the trainee's satisfaction with the day-release-course training as a whole represents the variable 'theoretical curriculum'. Trainee and trainer features as well as the components of the training were measured by questionnaires. Items referred either to facts (e.g. the practice equipment) or to perceived quality (e.g. the trainees evaluation of the trainer as a teacher). The items on features of the trainer and the training practice were derived from literature (Ronalds et al., 1981; Freeman et al., 1982; McDonald and Bass, 1983). Trainer items reflected the trainer's quality as a teacher/supervisor (e.g. motivation for teaching, approachability, clarity of instruction) and his quality as a GP (e.g. motivation, level of knowledge, approach of patients). Practice items reflected the practice organization and practice facilities. The items required a 'yes' or 'no' answer, or used a five-point Likert scale, ranging from 'totally disagree' to 'totally agree' or from 'unsatisfactory' to 'excellent'. For some clusters of items (e.g. items referring to the perceived quality of the trainer as GP) a sum score was computed. The internal consistency (α) of all of these clusters was more than 0.80.

The trainee's overall satisfaction for trainer, practice, theoretical curriculum (day release-course programme) and faculty (one item each) was rated on a scale from 1 to 10.

Time spent on education by the trainer-trainee pairs was assessed by means of a logbook. All trainer-trainee encounters with an educational purpose were registered by the trainee in minutes. The logbook used in this study contained a written instruction for completion and preprinted pages, one for each registration

day. The types of educational trainee-trainer encounters to be registered were precoded and defined on an instruction page.

PROCEDURE

At seven training institutes a group of 12–13 trainees started their training in January 1992. All these trainees and their trainers, 85 pairs, agreed to participate in the study. All were asked to take two knowledge tests, the 'pre-test' one month after the start of training and the 'post-test' shortly after the end of the first training period in general practice, eight months later. The tests were taken under standard test conditions. Questionnaires were completed after each test administration. In the fourth and sixth months of training the trainees completed the logbook registration during a total of 12 days.

ANALYSIS

The analysis aimed at relating the increase of the trainee's score on the knowledge test to training, trainer and trainee variables as expressed in the questionnaires, to the trainer's knowledge test score and to the registration of time spent on education. To allow correction for test difficulty the two knowledge tests were equated using the horizontal linear equation procedure with a set of common items (approx. 20%) as 'anchor test' (Crocker and Algina, 1986).

Time spent on education as registered with the logbook method was recorded as the mean time per individual in minutes per day.

In order to investigate the univariate relation between the training variables and growth in knowledge, questionnaire items, as well as total time spent on education and trainer's knowledge score were correlated with trainee's pre- and post-test score (zero order correlation). In order to assess the relation of these variables with 'growth in knowledge' the first order partial correlations were computed between these variables and the post-test score, controlling for the pre-test score. To correct for interactional effects between variables, the multivariate association was estimated of the post-test score with all independent variables in combination. In this analysis the pre-test score of the trainee was included as independent variable allowing correction of the explained variance in post-test scores for the variance in pre-test scores. Consequently, 'growth in knowledge' was the actual dependent variable (Cronbach, 1970). The pre-test score was the only variable introduced as 'fixed'. The remaining items were entered step-wise to determine their additional contribution to variance in growth in knowledge. In order to allow analysis on nominal variables, such as gender and training institute, these variable values were transformed to dummy variables in accordance with standard regression procedures (Blalock, 1984).

Table I. Mean score (M) and standard deviation (sd) of trainees and trainers on pre-test and post-test and corresponding test reliability (Cronbach's alpha)

	Trainees		Trainers		alpha
	M	sd	M	sd	
Pre-test	35.4	9.0	45.2	11.7	0.70
Post-test	47.0	10.3	45.7	9.5	0.73

Results

Complete data on all instruments were available for 58 trainer-trainee pairs. Only these were introduced in the analysis. Missing values were found predominantly for the questionnaire and logbook items. The mean pre-test and post-test score on the knowledge test for those who completed all instruments and those who did not, did not differ significantly ($t = -1.74$ resp. -0.59; df 79 $p > 0.05$).

Table I presents the trainees' and trainers' mean score and standard deviation on test 1 and 2 and the corresponding test-reliabilities.

The trainees' mean score on the pre-test was 35.4% (sd 9.0) and 47.0% (sd 10.3) on the post-test. The difference is statistically significant ($t = -8.20$; df 57; $p < 0.05$).

Table II presents the descriptive statistics of the questionnaire items, the univariate associations (Pearson's r) between the independent variables and the pre-test and post-test score and the partial correlations.

The average *number of patients* seen by the trainee each day is 21, which meets the (informal) standard of most institutes of 20–30 patients. The mean scores within the category *the trainer as general practitioner* show a mean number of years of experience as GP of 15 years. The mean time reported for study of the literature is 2.5 hours a week, for Continuing Medical Education (CME) half a week a year. Nearly half of the trainers participate in audit groups on a regular basis. The mean score for the trainee's appreciation of the trainer as GP (5 items) is 19.0 (range 5–25). The variation is small (sd 2.8).

The third section shows the trainer's performance and experience as supervisor. The average time spent on educational activities in practice is more than one hour per day, with a large standard deviation (half an hour). The trainer's average number of trainees previously supervised, the present trainee included, is 5. The standard deviation of 4.4 indicates that there is a wide variation in 'experience as a trainer'. On average the trainer has seven years of experience in education (either pregraduate or postgraduate). The mean score for the trainee's appreciation for the trainer as supervisor (4 items) is 14.9 (range 4-20) with a standard deviation of 3.4, which means that most trainers are rated as 'satisfactory'.

In the category *training practice* the mean score for the equipment is 11.9 (range 0–47), with a standard deviation of 3.8, implying that most training practices lack

Table II. Independent variables: Scale, Mean (M), and Standard Deviation (sd) of other than nominal variables, frequency counts for nominal variables, zero order Pearson correlations with the pre-test and post-test score and the first order partial correlations

Variables	Scale	Descriptive statistics		Zero order correlations		First order partial correlation
		M	sd	With pretest	With posttest	
Morbidity						
Number of trainee's patient encounters/day	R	20.6	5.4	−0.01	−0.00	−0.00
Trainer as general practitioner						
Pre-test score trainer (−100% − +100%)	R	45.2	11.7	−0.04	0.03	0.01
Years of experience as GP	R	15.4	5.1	0.23	0.10	0.07
Received (one year) postgraduate training	N	Yes:31 No: 37		−0.02	−0.14	−0.14
Study of the literature (hours/week)	R	2.5	1.4	0.37*	0.07	−0.38*
Participation in CME (half days/year)	R	5.0	3.7	−0.02	−0.26	−0.30*
Participation in medical audit	N	Yes:24 No: 34		0.20	0.01	−0.07
Trainee's appreciation for the trainer as GP (sumscore, max. 25)	O	19.0	2.8	−0.07	−0.36*	−0.28*
Trainer as supervisor						
Time spent on education (registration, min/day)	R	70.3	31.6	−0.07	−0.18	−0.17
Number of trainees trained	R	5.4	4.4	0.16	0.28*	0.16
Years of experience in education	R	7.0	4.9	0.14	0.07	−0.03
Trainee's appreciation for the trainer as supervisor (sumscore, max. 20)	O	14.9	3.4	−0.27*	−0.20	−0.10
Practice						
Equipment (sumscore, max. 47)	R	11.9	3.8	−0.05	−0.27*	−0.19
Number of trainer's patient encounters/week	R	187	67	0.16	−0.01	−0.05
Organization (solo: 1 vs group: 0)	N	1:35 0:23		−0.12	−0.10	0.05
Urbanization []	O			0.19	0.33*	0.31*
Trainee						
Gender	N	M:24 F:33		−0.06	−0.22	−0.22
Age	R	30.9	2.6	0.03	−0.20	−0.22
Pre-test score trainee (−100% − +100%)	R				0.45*	
Wait between graduation and postgraduate training (months)	R	40.5	20.8	−0.02	0.11	0.10
Number of jobs in the medical sector, preceding postgraduate training (each >three months)	R	2.2	1.0	0.03	0.16	0.07
Study of the literature (hours/week)	R	4.2	2.9	−0.00	−0.24	0.01
Trainer's appreciation (sumscore, max. 35)	O	26.3	4.4	0.19	−0.08	−0.08

* = significant ($p < 0.05$) scale: N = nominal, O = ordinal (Likert), R = ratio
[] the number of inhabitants of the area of the training practice (four categories) from <5000 to >100000.

Table III. Satisfaction of the trainee with the main components of training, expresssed as a mark between 1 and 10: mean (M), standard deviation (sd); zero order correlation with pre- and post-test score and first order partial correlation

Variables	M	sd	Zero order correlation		First order
			With pre-test	With post-test	partial correlation
Trainer	7.4	1.5	−0.29*	−0.26*	−0.04
Practice	7.7	1.1	−0.11	−0.28*	−0.26
Day-release courses	6.9	0.9	0.11	0.28*	0.12
Faculty	7.2	1.0	−0.01	0.10	0.08

* = significant ($P < 0.05$).

certain training facilities. The majority of the training practices are (still) single handed.

The majority of the participating *trainees* are female and older than 30 years. The mean time reported by the trainees for study of the literature is about four hours a week, corresponding to half a day a week reserved for self-directed learning.

The score for the trainer's appreciation of the trainee as pupil and future general practitioner (7 items) is 26.3 (range 7–35), which may be interpreted as 'amply satisfactory'.

The correlations of the training variables with the pre-test and post-test are reported to interpret the partial correlations appropriately. The partial correlation, representing the relation of each variable with the growth in knowledge during the 'intervention-period' is significant for four variables ($p < 0.05$) of which three refer to the trainer as general practitioner. All these associations are negative: the more time spent by the trainer on the study of literature (−0.38) or on CME (−0.30), the less growth in the trainee's knowledge. The more the trainees appreciate their trainer as general practitioner (−0.28), the less their growth in knowledge. The fourth significant (positive) association is reported for the urbanization of the practice area: the more urban the practice, the more growth in knowledge (0.31).

Table III shows the mean rating (scale 1–10) of the trainees for trainer, practice, theoretical curriculum and faculty, representing overall satisfaction with each of these.

The averages do not differ widely, clustering around 7 with a standard deviation of no more than 1.5. Although three of these variables are significantly associated with the post-test score, the partial correlations are not significant, meaning that satisfaction with the training is not related to growth in knowledge. Both may be a 'restriction of range' effect.

Table IV presents the results of the stepwise regression analysis. Only the variables with a significant contribution to the prediction are reported.

The pre-test score explains 25% of the variance in post-test score, all variables in combination about 50%. Three of the four items significantly associated with the corrected post-test score (partial correlation), emerge again: the trainers of

Table IV. Step-wise regression analysis with the post-test score as dependent variable: the expained variance (R-square), parameter estimate – non standardized (b) and standardized (β) – of the five items that explain the variance in post-test score

	R-square	Parameter estimate	
		b	β
Pre-test score	0.25	0.549	0.499
Trainer's study of the literature	0.36	−2.281	−0.294
Trainee's appreciation for the trainer as GP	0.41	−0.958	−0.274
Training institute F	0.47	−5.998	−0.248
Urbanization grade	0.52	4.307	0.226

the trainees showing least growth in knowledge spend more time on study of the literature and are appreciated more; more urban practices are associated with better performing trainees. Table III shows that only one institute is negatively associated with growth in knowledge after correction for interactional effects.

Discussion

The results show that there is considerable growth in the trainees' knowledge during the first eight months of training in general practice. This study aimed at establishing the relation between this growth in knowledge and training variables. The number of the trainee's patient encounters per day, the trainer as GP and supervisor, the practice and the trainee's prior and present activities appear not to explain the variation in growth in knowledge.

Four separate items explain only a small part of the variance. The reverse relation of three of them with growth in knowledge is difficult to interpret. Trainees who show more growth in knowledge appear to be those who appreciate their trainers less. It is unlikely that trainers who act as relatively bad 'role models' induce better trainee performance. It may be that the better performing trainees are more critical towards their trainers or value independent learning more. Puzzling is the finding that trainers who spend more time on studying the literature have less well performing trainees. Are they too busy with their own learning? It should be noted that questionnaires like those used here elicit socially desirable answers, but it leaves open that there is no plausible explanation for a reverse relation. One training institute appears to differ from all others in the extend to which its trainees grow in knowledge. This training institute is known for its less structured day-release-course programme and its low priority for transfer of knowledge. The last item shows a positive correlation with growth in knowledge: the urbanization-grade of the practice area: the more urban, the more growth. The fact that this finding is sustained after correction for interactional effects (regression analysis) implies that urban practice do not have the most knowledgeable trainers, nor the best equipment, nor do trainees in these practices see more patients. A recent

study suggests that the type of patient problems is positively related to the level of knowledge of general practitioners (Pollemans, 1994). The variation in patient morbidity may be more pronounced in urban than in rural practices.

Whatever the explanations, the extent of explained variance of the separate variables is small and may even be attributed to 'chance'. The overall conclusion might be that the differences encountered in the training situation of the 58 trainees are of minor importance as far as the acquisition of knowledge is concerned. There are, however, different alternative explanations.

The first is, that qualitative data play a more important role that quantitative data: the sort of patients seen by the trainee, the activities displayed during self-directed learning and the topics covered during trainer-trainee encounters.

These should be explored in further study. The second is, that, indeed, characteristics of the learner are more important that characteristics of the teacher or the teaching, as is outlined in the theory of adult learning (Knowles, 1980; Zimmerman and Schunk, 1989; Paris and Newman, 1990).

The third is, that 'knowledge' as outcome measure was not well chosen. Knowledge is only one aspect of the outcome of postgraduate training: skills, attitude, working style and motivation are equally relevant and may have shown a more substantial relation with the process of training. The acquisition of knowledge, however, is one of the major goals of postgraduate training. Moreover, the relation between knowledge and medical expertise has been theoretically outlined and empirically confirmed. Knowledge appears to be one of the essential elements of medical expertise, while knowledge test scores at graduation predict future performance fairly well (Norman, 1991).

Our last explanation of the actual findings lies in the method used. It may be, that the test only partially represents general practice knowledge and is therefore inadequate to measure the effect of vocational training as a whole. It may be interesting to elaborate on this a little further. The test items are sustained by literature references, which implies that knowledge not reflecting research findings or broad consensus, is not represented in the test. The test thus reflects the 'state of the art' of diagnosis and treatment and of approaches to specific complaints. Trainer-trainee encounters, however, regularly focus on the approach of complex problems in which knowledge of the patient or the patient's family and the trainer's prior knowledge of similar situations play a central role.

One could argue that the test reflects 'evidence based knowledge', whereas what is taught and learned in practice is 'experience based knowledge'.

In sum, postgraduate training for general practice remains, to a large extent, a 'black box'. Factors expected to influence growth in knowledge appear to be of little or no importance. Different plausibel explanations for this finding are at hand and should be further explored. The content of patient-encounters, trainer-trainee encounters and trainee features like learning styles (Bligh, 1992) may yield better clues as to what induces growth in knowledge. At the other hand, a more restricted concept of the validity of a written reference based knowledge test (evidence based

knowledge) may explain why the increase in test scores shows no relation with the mainly experience based training and teaching.

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