Effectiveness of postgraduate education in occupational medicine

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Factors predictive for successful learning in postgraduate medical education

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Abstract

Purpose
To study personal and contextual factors predictive for successful outcome of postgraduate medical education

Method
A follow-up study of 118 physicians in a postgraduate occupational health training programme on management of mental health problems. The following personal and contextual variables were measured as potential predictors of outcome: gender, age, years of experience as a doctor, university of graduation, learning style (Kolb), present employer (occupational health service) and educational format (problem-based or lecture-based). The main outcome measures were: scores on knowledge tests consisting of true/false and open answer questions and performance in practice based on self-report and performance indicators.
To determine the effect of potential predictive factors univariate analyses of variance and repeated measurement analysis of variance was applied.
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Results
Mean scores of knowledge (p<.001) and performance (p=.001) of the participants increased after the educational programme. After multivariate analysis female gender was positively related to both knowledge and performance (both p<.05) independent of the influence of other factors. Learning style showed a non-significant relation with knowledge (p=.054), but had no influence on performance (p=.79). The problem-based educational format yielded a better performance outcome (p=.05), but had no influence on knowledge tests (p=.31).

Conclusion
Gender and learning style turned out to be variables independently related to an increase in knowledge (gender and learning style) and performance (gender) after a postgraduate medical education programme. When new educational programmes are constructed these factors should be taken into account. We found no interactions with course design (i.e. problem-based learning or non-problem-based learning format), but further research could reveal other cues, suggesting practical consequences of student characteristics for course design in postgraduate training.

Keywords
Introduction

There are many differences in learning between undergraduate medical students and physicians in training for specialists or physicians working in practice. In postgraduate and continuing medical education learners are practicing physicians. For these adult learners education is more regarded as facilitation of learning than as formal teaching. The way physicians learn or study seems to change during their career from medical students to practicing physicians. Even more than with medical students the outcome of the learning process of practicing physicians aims at changing performance in practice and improving health of patients. To improve the quality of the learning process it is important to have insight in how doctors learn and how and why they change their practice. One way to get more insight in this process is to study factors that predict successful learning outcome. In medical students, it has been shown that gender influences the learning process by means of different interaction with the learning environment between men and women. In addition, students’ learning style can provide information for educators in facilitating learning. Less is known about the learning experiences of physicians working in practice or being in training to become a specialist. As part of a study of the effectiveness of problem-based learning we were able to measure potentially important personal and contextual factors like years in practice and learning style. The objective of this study is to get more insight in possible predictors of outcome of postgraduate medical education and to contribute to the discussion and theory about how practicing doctors learn.

Our research question is

Do personal and contextual factors predict learning effects on knowledge or performance in practice of participants after a postgraduate medical educational programme and secondly, do these characteristics interact with course design?

Methods

Design and participants

The study was set up as a follow-up study of a medical specialist training programme with pre-test and post-test measurement of knowl-
Participants' personal predictive factors:
- Gender
- Age
- Years of experience
- University of graduation
- Learning style

Specialist training programme
Educational format

Outcome
- Knowledge
- Performance

Predictive factor in context:
- Present employer

**Figure 6.1.** Study design

Knowledge and performance and a follow up measurement of knowledge after 12 - 17 months. At baseline personal and contextual factors were recorded by means of a questionnaire. *(see figure 6.1)*

We were able to engage participants (n = 118) of 10 complete year groups of physicians of all four schools of occupational medicine in the Netherlands. These physicians work in occupational health practice during their four years of specialist training and attend the school of occupational medicine one day each week. They were in their first or second year of training and all still had to learn the Dutch Guidelines on occupational management of workers with mental health problems. As part of the randomised controlled trial half of each year group was randomly assigned to a four-day problem-based training programme. The other half received traditional lecture-based training. Both programmes had the same content.
Measures

At baseline, three months before the educational programme, personal and contextual factors were recorded. The personal factors are gender, age, learning style, years of experience as a doctor and university of graduation. The contextual factor is present employer (occupational health service). We used the learning style inventory of Kolb, which is used widely, especially in medical education.\textsuperscript{12,13,14,15} Kolb describes experiential learning as a cyclical process, including four stages (see figure 6.2):

1. the learner has a concrete experience,
2. this experience is observed and reflected upon,
3. the result of this observation and reflection is abstracted, conceptualised and generalized and
4. the generalisation is tested in new situations which leads to a new concrete experience.

There are two opposite elements in this process model of learning: concrete experience versus abstract conceptualisation and active experimentation versus reflective observation. With the learning style inventory, a questionnaire of nine sets of four words, the respondent’s score is located into a matrix of four quadrants:
1 converger (abstract/active),
2 accommodator (active/concrete),
3 diverger (concrete/reflective) and
4 assimilator (reflective/abstract).
This score reflects the preferred (but not necessarily exclusive) personal learning style. Kolb assumes that individuals operate in all modes and will do so during the learning cycle.\textsuperscript{12,14,16} (see figure 6.2)

Knowledge tests and performance indicators were used to measure the outcomes of the educational programmes. Knowledge was assessed four times, at baseline three months before the start of the educational programmes, at the beginning of the programme, on completion of the programme and after a follow up of 12 - 17 months. Each knowledge test consisted of 70 true/false and 10 open answer questions, randomly selected from a question-bank of items reflecting the topics of the guidelines. The test was developed according to rules described by Van der Vleuten.\textsuperscript{17} The open answer questions were scored independently by two of the authors (PS, JV). A correct answer to a true/false question yielded one point and to an open answer question three points. Answers left open or false answers received zero points. Performance in practice was measured by means of twelve performance indicators. These were derived from the guidelines for management of workers with mental health problems by two of the authors (PS, JV) as described by Van der Weide et al.\textsuperscript{18} The indicators were made operational by criteria that distinguish good from poor care. These criteria can be met, not be met or be inapplicable. The participants were asked to collect randomly and to register from their own practice, five people with mental health problems in the three months before and five cases in the six months following the educational programmes. Structured forms were used. The data from these forms were used to calculate the performance score. This score (for correct care) was calculated in each case by dividing the number of performance indicators for which the criteria were met by the number of all indicators that were applicable and expressed as a percentage. We calculated the average percentage of correct care of the cases before and after the training for every physician. The scoring of the performance indicators from the forms was done blind by an automatic SPSS programme procedure.
Table 6.1. Description of personal and contextual factors of 118 physicians in training for occupational medicine at the start of the study. Percentages (numbers).

### Personal and contextual factors

#### Gender
- Men: 62% (73)
- Women: 38% (45)

#### Age
- < 30 years: 9% (11)
- 30 - 34: 38% (44)
- 35 - 39: 35% (41)
- 40 years and more: 18% (21)
  (min 27 and max 51 years)

#### Years of experience as a doctor
- < 5 years: 34% (40)
- 5 - 9 years: 43% (50)
- 10 years and more: 23% (27)
  (min 1 and max 23 years)

#### University of Graduation
- University of Amsterdam: 18% (21)
- Free University Amsterdam: 17% (20)
- University of Utrecht: 9% (10)
- University of Leiden: 11% (13)
- University of Rotterdam: 14% (16)
- University of Nijmegen: 14% (16)
- University of Maastricht: 6% (7)
- University of Groningen: 10% (12)

#### Learning style (Kolb)
- Converger (abstract/active): 18% (20)
- Accomodator (active/concrete): 23% (26)
- Diverger (concrete/reflective): 19% (21)
- Assimilator (reflective/abstract): 40% (45)

#### Present employer
- Arbo Unie: 17% (20)
- ArboNed: 21% (25)
- Commit Arbo: 13% (15)
- Maetis: 14% (17)
- Occupational service military forces: 10% (12)
- Other: 25% (29)

#### Educational format
- Problem-based learning: 50% (59)
- Lecture-based learning: 50% (59)
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**Statistical analysis**

To determine the effect of potential determinants of outcome we first conducted univariate analyses of variance or repeated measures analysis of variance with each of the potential personal and contextual factors, using SPSS. Next we conducted a repeated measurement analysis of variance with the significant factors of the first analysis as between-subject factor or covariate.

**Results**

**Subjects and data, compliance, participant flow**

Participants are 118 physicians in training for occupational physician. *Table 6.1* gives a description of the measured personal and contextual factors.

Forty percent of the participants have a reflective/abstract learning style and are assimilators according to the learning style theory of Kolb *(see table 6.1)*. Learning styles (Kolb) are not evenly distributed over the four learning styles *(X2 test, p<.01)*. Most participants completed the knowledge tests: at baseline 112 (95%), start of training 109 (92%), end of training 102 (86%) and at follow up 96 (81%). In the analyses missing values in knowledge tests were accounted for by substituting mean values. Overall the knowledge tests showed a satisfactory internal consistency for evaluation purposes: at start of training Cronbach’s alpha was .60, at end of training .66 and at follow-up .64.19 On base line however the internal consistency was low with alpha is .33. Before the educational programmes 103 participants (87%) provided 513 cases from their own practice. Following the programmes 81 participants (69%) provided 399 practice cases. A comparison of performance indicators before and after the educational programmes was possible in 78 participants.

**Predictive factors: Univariate analyses**

In the univariate analyses gender, learning style and educational format appeared to influence either knowledge or performance outcome or both. The factors age, years of experience as a doctor, university of graduation and present employer (occupational health service) were not significantly related to the outcome measures.
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Figure 6.3. Gender and knowledge outcome
Repeated measurement analysis of variance of knowledge test scores at 1 = baseline, 2 = before the programme, 3 = after the programme and 4 = at follow-up. Gender and learning style are between-subjects factors and educational format is a covariate. Mean percentage correct of knowledge tests for female (n=42) and male (n=70) participants.

Multivariate analysis: relations with results on knowledge tests
In a further repeated measures analysis of variance gender and learning style were used as between-subjects factors and educational format as a covariate. In these analyses the increase of knowledge in time is significant (within-subjects factor time $F(3,309) = 21.29$ $p < .001$) and significantly related to gender (between subjects factor gender $F(3,309) = 3.50$ $p < .05$). Female doctors have a better knowledge score. (see figure 6.3)

The increase of knowledge is also related to learning style (between subjects factor learning style $F(9,309) = 1.89$ $p = .05$). Participants with an active/concrete learning style (accommodators) have a lower score compared to participants with other learning styles, especially at follow-up. (see figure 6.4)

The educational format was a non significant covariate for increase of knowledge ($p = .31$).
Figure 6.4. Learning style and knowledge.
Repeated measurement analysis of variance of knowledge test scores at 1 = baseline, 2 = before the programme, 3 = after the programme and 4 = at follow-up. Gender and learning style are between-subjects factors and educational format is a covariate. Mean percentage correct score for learning styles (Kolb): abstract/active (n=20), active/concrete (n=26), concrete/reflective (n=21) and reflective/abstract (n=45).

Multivariate analysis: relations with results of performance indicators
In the repeated measures analysis of variance the increase in performance in time is significant (F(1,66) = 11.34 p < .01) and significantly related to gender (F(1,66) = 5.02 p < .05). There is no significant relation with learning style (p=.79). The educational format is a significant covariate (p=.05), which means that the problem-based educational format yielded a better performance outcome. (see figure 6.5)

Discussion
In this study on predictors of successful studying gender appears to have a significant influence on both outcome variables knowledge and performance in practice. Learning style slightly influences knowledge scores, but not performance. Educational format is related to
Figure 6.5. Gender and performance.
Repeated measurement analysis of variance of performance indicator scores in the months before (1) and after (2) the training programme, with gender and learning style as between-subjects factors and educational format as covariate. Mean percentages good scores for female (n=37) and male (n=38) participants.

Performance, where problem-based learning leads to a better outcome. Learning style shows no interaction effects with the used educational format (problem-based and lecture-based). The other measured potential predictors of outcome were not significant.

In this study, which was originally designed to measure the influence of two educational formats in a random design, a number of potential personal and contextual factors were analysed with a multivariate model. We were able to follow a considerably large group of occupational physicians in training during a year with four well-designed knowledge tests. In addition, we were able to assess their performance in practice by means of a performance score derived from self-report. We found only few studies that investigated learning styles in physicians even though it is advocated to shape continuing medical education based on the natural processes learners use.
We could measure only a limited number of predictive factors. More specific personal and contextual factors could also be important, e.g. specific experience or former education, specific working conditions or contacts with experienced colleagues (opinion leaders). More qualitative research is needed to find out which factors might be of importance.

We measured the outcome variables knowledge and performance. It has also been argued that in post-graduate and continuing medical education the health of patients should be a variable of outcome.\(^6\) We think that measuring self-reported performance is already a substantial improvement from measuring knowledge alone.

The concept of learning styles is being accepted as a potential predictor of learning outcome. According to Kolb’s learning style inventory a high percentage of our participants (doctors in training for occupational health physician and working in occupational health practice) have a reflective/abstract (assimilator) learning style. The ‘opposite’ style, the active/concrete (accommodator) learning style seems to be a determinant of a lesser knowledge score, especially at follow-up. (see figure 6.3) This is comparable with the results of a study in public health students where assimilators scored significantly higher on theoretical exams than other learning styles.\(^9,13\)

For general practitioners contradictory findings about learning styles have been reported. In some studies they are found to predominantly have a active/concrete learning style (accommodator) and in others general practitioners were reported to have reflector-theorist styles (assimilator).\(^11,12\) Surgeons have been assessed as predominantly active/abstract (convergers).\(^21\) These differences in learning styles between specialties are in line with what would be expected from the content of the specialties: more concrete specialties attracting more concrete learners and vice versa.

We used the learning style inventory of Kolb. It is widely used, despite doubts about the psychometric qualities of the inventory.\(^14,16\) Fox et al found no significant relationship between learning styles (Kolb) and expected preferences of assimilators for lecture and accommodators for small group methods. Newstead criticises the learning style inventory but does find a correlation between scores on the active/passive dimension and academic success.

The finding that female physicians did better than male physicians
could be related to differences in learning styles, although we found no differences in this study. It has been reported that achievement in male medical students demands arousal, which has a different effect on female medical students.\(^8\) Drop-out rates of female physicians in training for a specialty are higher than for male physicians. This could also be due to the fact that the training programme is not modelled according to their needs.\(^{22}\) Apparently, the programme that we offered was more adapted to the learning style of female physicians.

We did not find an influence of work-setting of the participants, age, university, or years of professional experience. This could mean that person-related factors like learning style are of greater importance in the success of learning than contextual factors.

There was no interaction between learning style or gender and the educational format. It could be argued that assimilators would benefit more from the lecture-based programme and accommodators more from the problem-based format. In our analysis of the results of the RCT we did find that satisfaction with the problem-based format was significantly less than with the lecture-based format. This might be caused by the predominance of assimilators whose learning preference is more theoretical. However, the lack of a relationship could also be due to a lack of power of our study, because the accommodators were only a small fraction of the total group.

This study has shown that apart from educational format there are several person-related factors that may predict the educational result, both in terms of knowledge and in terms of performance in practice. But since we could not find interaction effects of learning style with the used educational formats (problem-based and lecture based learning), we cannot yet conclude about the type of education that should match learning styles or gender.

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