

Portfolios in medical education: why do they meet with mixed success? A systematic review

ERIK DRIESSEN,¹ JAN VAN TARTWIJK,² CEES VAN DER VLEUTEN¹ & VAL WASS³

CONTEXT The move towards competence-based medical education has created a need for instruments that support and assess competence development. Portfolios seem suitable but mixed reports of their success are emerging.

METHODS To examine the effectiveness of portfolios, we searched PubMed and EMBASE using the keyword 'portfol*', PsychInfo and ERIC using the keywords 'portfol*' and 'medical education' and references of retrieved papers for empirical studies on portfolios in all phases of medical education. Thirty of 1939 retrieved papers met the inclusion criteria and were analysed. Data were collated against the research question, number of subjects, design, setting, findings and limitations, purpose and content, mentoring and assessment. We analysed impact using a modified version of Kirkpatrick's hierarchy.

RESULTS Because differences across studies precluded statistical meta-analysis, the data were analysed by context, goals and procedure. Positive effects were strongest in undergraduate education. Important factors for success were: clearly communicated goals and procedures; integration with curriculum and assessment; flexible structure; support through mentoring, and measures to heighten feasibility and reduce required time. Moderately good inter-rater reliability was reported and global criteria and discussions among raters were beneficial. Formative and summative assessment could be combined. Without

assessment, portfolios were vulnerable to competition from other summative assessment instruments.

CONCLUSIONS For portfolios to be effective in supporting and assessing competence development, robust integration into the curriculum and tutor support are essential. Further studies should focus on the effectiveness and user-friendliness of portfolios, the merits of holistic assessment procedures, and the competences of an effective portfolio mentor.

KEYWORDS review [publication type]; education, medical/*methods; educational measurement/*methods; teaching/*methods; *learning; documentation/*methods; observer variation; clinical competence/*standards; self-assessment (psychology).

Medical Education 2007; **41**: 1224–1233
doi:10.1111/j.1365-2923.2007.02944.x

INTRODUCTION

Over the last 2 decades, a significant change has occurred in medical education. The focus of curricula has shifted from the acquisition of knowledge to the achievement of competence.^{1,2} Competence has been defined as 'the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individuals and communities being served'.³ The challenge has been to find instruments that formatively support the development of competence in an integrated, coherent and longitudinal fashion and summatively assess whether competence is being achieved.^{4,5} The portfolio is acclaimed as such an instrument.⁶ The past 10–15 years have seen the introduction of portfolios in all stages of the medical education continuum: in undergraduate medical education;^{5,7}

¹Department of Educational Development and Research, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, The Netherlands

²Leiden University Graduate School of Teaching, Leiden University, Leiden, The Netherlands

³Community-based Medical Education, University of Manchester, Manchester, UK

Correspondence: Erik Driessen, Department of Educational Development and Research, Maastricht University, 6200 MD Maastricht, The Netherlands. Tel: 00 31 43 388 5774; Fax: 00 31 43 388 5779; E-mail: e.driessen@educ.unimaas.nl

Overview

What is already known on this subject

Despite claims that portfolios are an excellent instrument with which to enhance integrated, self-reflective, self-directed, longitudinal learning, they have met with mixed success.

What this study adds

Inter-rater reliabilities contradict the presumed 'subjectivity' of portfolio assessment. Portfolios can be used simultaneously for summative and formative purposes.

Effective portfolios require:

- a proper introduction and mentoring;
- integration within context and procedures;
- provision of information to students and teachers;
- provision of clear guidelines that do not curtail students' freedom,
- user-friendliness that includes limited time demands on students and mentors.

Suggestions for further research

Studies addressing the effectiveness and user-friendliness of portfolios, the merits of holistic assessment procedures, and the competences of effective portfolio mentors should be encouraged.

in postgraduate specialist training,^{8–10} and in the continuing medical education (CME) of practising doctors.^{6,11–14}

Portfolios that are used in education contain evidence of how trainees fulfil tasks and how their competence is progressing. Portfolios may be digital or paper-based and content may be prescribed or left to the students' discretion. Despite variations in content and format, portfolios basically report on work done, feedback received, progress made, and plans for improving competence. Additionally, portfolios may stimulate reflection, because collecting evidence for inclusion in a portfolio requires looking back and analysing what one has accomplished.

Reflection can be defined as the mental process of trying to structure or restructure an experience, a problem, or existing knowledge.¹⁵ This can help learners to understand their development¹⁶ and plan their learning.¹⁵ Reflecting on task performance and development of competence implies self-assessment or self-rating:¹⁷ learners have to compare their own performance with (external) standards. Reflection and self-assessment are essential skills for lifelong learning, but the literature on self-assessment is quite clear in showing that students and doctors have a limited ability to self-assess their competence and learning needs.¹⁷ Hence, it has been suggested that self-assessment should be supported by other (external) sources of information.^{17,18} Portfolios may have the potential to improve self-assessment, by combining external assessment, mentoring and self-assessment.¹⁹

Since their introduction into medical education in the early 1990s, portfolios have been the subject of educational research. The evidence to date suggests that their introduction has met with mixed success.^{20–22} There is little explanation for these differences, which may relate to many factors. The aim of this study was to conduct a systematic review of the literature on portfolios to seek evidence and clarify why in some contexts portfolios appear to be largely ineffective, whereas in others they are successful.

METHODS

Data sources

PubMed (1966–May 2007) and EMBASE (1989–May 2007) were searched using the keyword 'portfolio*'. The databases PsychInfo (1970–May 2007) and ERIC (1966–May 2007) were searched using the keywords 'portfolio*' and 'medical education'.

The searches were limited to publications in English and Dutch because it was not feasible to translate non-English or non-Dutch articles. To identify studies not picked up in the initial search, we contacted experts in the field and checked the references of the papers retrieved by the initial search.

Selection of studies

We used broadly defined inclusion criteria to ensure all aspects of the research question were addressed. We included studies that:

- 1 focused on portfolio use for educational purposes in medical training;
- 2 were performed within the context of undergraduate, postgraduate or continuing medical education, and
- 3 reported empirical data.

We excluded studies concerning: portfolios for other health professions (nursing, dentistry, dietetics, veterinary medicine), administrators, managers, teachers and trainers in hospitals, management, finance, education, teaching, specialist trainers and academic portfolios; portfolio-related instruments, such as logbooks, personal digital assistants, and personal development plans, and descriptive articles without evaluative data.

Data abstraction

The literature search was performed by 2 of the authors (ED, JvT) and an information specialist. Three of the authors (ED, JvT, CvdV) determined the inclusion criteria. Two of the authors (ED, JvT), supported by a third author (CvdV), reviewed the titles and abstracts of retrieved publications and selected relevant articles for possible inclusion. Data abstraction methods were developed by 3 of the authors (ED, JvT, CvdV) and were applied by 2 of the authors (ED, JvT). Disagreements about search criteria, data abstraction and classification of study results were resolved by consensus. The reviewers were not blinded to any portion of articles. The authors of 1 of the studies were contacted and asked to clarify some points, which they did.

The articles fulfilling the selection criteria referred to a wide range of studies where portfolios were used for different purposes in a variety of contexts within medical education, and methods and quality varied. Most of the selected studies used a variety of measurement methods and surveyed a range of portfolios which differed in purpose, content and format. With the exception of inter-rater reliability, statistical pooling of the results proved impossible. We made narrative descriptions of the findings and quality of the studies according to the criteria suggested by the Best Evidence Medical Education Collaboration (BEMEC).²³ Assessment of the quality of the studies was based on the study design, questionnaire validation, sampling frame and size, response rate and outcome measures.²⁴ Data were synthesised and reported where possible in relation to the influence of context and portfolio goals to address the aims of the review.

We used a modified version of the BEMEC coding sheet for data abstraction.²³ The form included details of the research question, number of subjects, study design, setting, findings and study limitations. Further details of the intervention (i.e. the goal, contents and structure, and the mentoring and assessment of the portfolio²⁵) were also included. The impact of the intervention was rated using a modified version of Kirkpatrick's hierarchy to analyse outcomes such as learner satisfaction, learning outcomes, performance improvement and patient or health outcomes.²⁶

The inter-rater reliability across all studies was estimated by averaging domain-referenced reliability coefficients or kappas. The Spearman–Brown prophecy formula was used to estimate the projection of inter-rater reliability for the use of multiple raters.²⁷

RESULTS

Search results

The search revealed 1939 publications. After reading titles and abstracts, we excluded 1853 articles that failed to meet the inclusion criteria. More detailed review of the remaining 86 publications yielded 30 articles that met the inclusion criteria (Fig. 1). Of these articles, 9 related to the use of portfolios in pre-clinical undergraduate medical education, 7 addressed undergraduate clinical clerkships, 9 concerned postgraduate medical training, and 5 dealt with CME (see Tables S1 to S4 published online as supplementary material).

Many of these studies had methodological limitations. With the exception of 2 studies,^{21,28} all had a single-group design. The majority were conducted in a single institution. In 5 studies, participants were self-selected volunteers.^{20,28–31} Many studies lacked a detailed description of the portfolio, how it was introduced to its users, the sampling frame, the study method, data analysis or outcomes, which limited our ability to fully appraise the quality of the study or generalise the findings.

A total of 19 studies evaluated outcomes at Kirkpatrick level 1 (i.e. surveying the satisfaction level of the users). Only 2 studies reported outcomes in terms of performance improvement (level 3).^{22,30} None of the studies measured patient outcomes.

We report the results in relation to the 2 broad portfolio goals: learning and assessment.

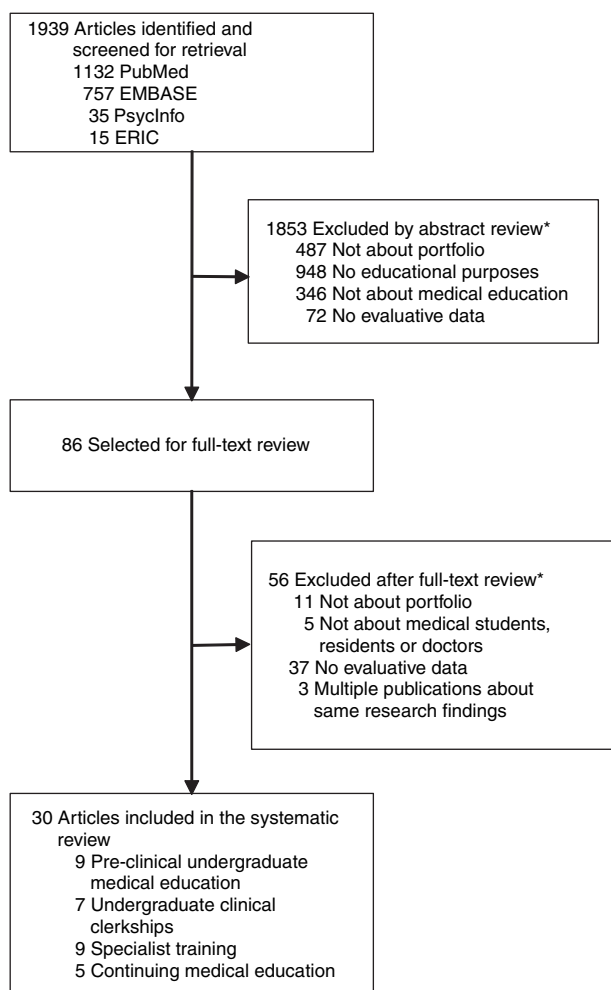


Figure 1 Selection of articles for review
*Some articles were excluded for multiple reasons

Goal 1. Learning

Two studies performed in the pre-clinical phase of medical school reported that portfolios contributed to Year 1 students' reflective learning^{32,33} and 1 study reported that portfolios contributed to students' personal and professional development.²² Two studies reported successful use of portfolios in organising, monitoring and evaluating a pre-clinical oncology programme and helping students understand the impact of malignant disease on patients.^{21,34} Studies where portfolios were used in CME yielded mixed results. Some reported that portfolios could stimulate reflective learning^{28,30} and support the planning and monitoring of CME.³⁰

Many studies across a range of contexts reported problems related to the poor preparation and introduction of portfolios by the institution. Examples of

this claimed either that the purpose of the portfolio was not clearly defined³⁵ or that learners and teachers were poorly or insufficiently informed about the portfolio and what it entailed.^{35–38} In 1 study this resulted in poor commitment from both residents and their trainers and limited use of the portfolio.³⁵ However, in 5 studies where portfolio design centred on informing, training and gaining commitment from both trainers and trainees, portfolios were found to be suitable for graduate training.^{39–43} One study demonstrated that hands-on introduction with a proper briefing of students by staff on the portfolio's purpose and procedures had a positive effect on portfolio scores and student satisfaction with the portfolio.⁴⁴

The use of the portfolio in undergraduate education was more successful when portfolios were not used in isolation but were part of other educational activities.^{21,22,32,34} These educational activities included pairing students with oncology patients,^{21,34} organising tutorial groups³⁵ or mentoring,³² or linkage to an interview.²²

Results of the use of portfolios in CME often suggested that portfolios were not used by doctors to their full potential. This was related mainly to time constraints imposed by high daily workloads^{20,31} and the perception that maintaining the portfolio was time-consuming.^{20,28,45} On occasion, studies referred to extraneous issues, including difficulties with information technology, such as problems with downloading necessary software²⁰ or lack of IT skills.³¹ Lack of time was also an issue for postgraduate training.^{38,41,46} Trainees and their supervisors were concerned that the portfolio might be too time-intensive and for this reason avoided using it.^{38,41,46} Mathers *et al.* made a plea for portfolios to be 'smarter' (less paperwork) to aid feasibility.²⁸ A study investigating the use of such an efficient portfolio supports this supposition, as undergraduate clerks did not find the portfolio labour-intensive.⁴⁷

The format of the portfolio also influenced the contribution it made to learning. An effective portfolio had a clear but flexible structure, allowing learners opportunities to describe their own unique development.^{32,35,48} Clear instructions were important. Most users wanted to know what kind of information they were expected to provide.^{29,44,49} In clinical contexts where the content of a portfolio was often highly prescribed, portfolios were experienced as bureaucratic instruments.^{35–37,45,46} Portfolios were more highly appreciated when

learners were given a certain amount of freedom to determine their content.^{32,50}

Many studies reported the lack of adequate support from mentors.^{20,31,35} Other studies confirmed that mentoring by teachers, trainers or educational supervisors made an important contribution to the success of the portfolio.^{21,28,32,37,39–41,48} Mentors included teachers, trainers, supervisors or peers.³¹ General practice trainees made more use of their portfolios when they had a supportive trainer.^{35,38,41} Because of the significant impact of mentoring, it was difficult sometimes to discriminate between the effects of the mentor and the practicalities of completing the portfolio itself.³⁵ Obviously, mentoring requires teacher and supervisor time.³² However, mentoring aimed at stimulating the development of reflective ability³² and deep learning strategies focused on comprehension and understanding^{28,43} merited the effort.

Goal 2. Assessment

A study investigating the validity of portfolio assessment⁵¹ demonstrated it was indeed a valid test of reflective ability. Quality of reflection was the strongest predictor of the final assessment grade. Other criteria, such as lay-out and writing style, had negligible effect. Six studies estimated the inter-rater reliability of portfolios.^{45,46,48,51–53} The average reliability across these 6 studies was 0.63, representing the estimated reliability if one assessor were to be randomly replaced by another. However, with 2, 3 or 4 raters, the reliability would increase to 0.77, 0.84 and 0.87, respectively. A value of 0.80 is usually required for high-stakes tests.²⁷ The studies suggested that a number of measures had a positive impact on inter-rater agreement: use of a small group of (trained) assessors;^{45,46,51–53} discussion among the raters before the actual assessment^{46,51–53} and after assessing part of the portfolio,^{46,53} and the use of global criteria with rubrics.^{45,46,53}

In general, there was more support for the formal assessment of portfolios from teachers and examiners than from students themselves.^{36,44,45} For example, in a study in which examiners were positive about the use of portfolios for assessment, final year undergraduate students reported that a comprehensive portfolio with prescribed content involved far too much paperwork and, if they were to be formally assessed, they needed more advance information about how to construct the portfolio.³⁶

The use of the portfolio for assessment and learning is often seen as conflicting: students may be less open

in their reflections when their portfolios are to be assessed. However, 2 studies examining the combination of formative mentoring and summative assessment in 1 portfolio reported that this was not an issue. One study described mentors' reports that portfolio assessment had no effect on students' openness³² and another claimed that the combination of support and assessment did not appear to be problematic for general practitioners and their CME tutors.²⁸ Two studies showed that if portfolios were not formally assessed, other summative assessment instruments were prioritised and the use of portfolios tailed off.^{35,43}

DISCUSSION

To our knowledge, this is the first systematic review of the literature on portfolio use in medical education. We found many descriptive articles, opinion papers and commentaries on portfolio use. Only 30 of the retrieved articles reported empirical data. The available evidence demonstrated that portfolios can support both the learning and assessment of more general, yet essential, competencies in pre-clinical undergraduate education, such as reflective ability, personal and professional development, communication skills, and empathy towards terminally ill patients and their families. This finding is consistent with the evidence from a recent literature review of portfolio use in nursing.⁵⁴ Portfolios also have potential as tools to organise workplace learning during clerkships and postgraduate specialist training. Here, a more mixed picture emerged of contrasting poor and successful examples of portfolio introduction at all stages of training. Our review is in agreement with earlier literature, showing that several key issues are decisive in the successful use of a portfolio,⁵⁵ and is consistent with findings from studies in other disciplines. For example, in 1996 a study in teacher education showed that, for a portfolio to stimulate reflection, certain conditions had to be met, including: a thorough introduction of the portfolio and its intended use; student ownership; a clear structure, and appropriate use of the portfolio in discussions with mentors or trainers.⁵⁶ McMullan concluded in a recent study in nursing that portfolios can be very effective as an assessment and learning tool, but only if both students and mentors receive clear guidelines and support for their use.⁵⁷ McMullan noted that, without support and clear guidelines, students and mentors became increasingly stressed and demoralised about the use of portfolios in practice.⁵⁷ The studies highlight several success factors for portfolio use.

Success factors

The various goals of working with a portfolio need to be clear but can be successfully combined.^{28,32}

Portfolios can be used concurrently in both the formative promotion of learning and summative assessment. This is in contrast to previous debate in the literature, where the use of portfolios for assessment and learning was seen as conflicting on the grounds that students may be less open in their reflections when their portfolios are to be assessed.^{58–60} From a systematic review of the literature, combining the 2 goals of learning and assessment does not appear to cause problems. On the contrary, summative assessment was found to be important to ensure that portfolio learning maintained its status alongside other assessed subjects.^{35,43}

It is advisable to regard a portfolio not as a separate, independent instrument but as an activity that can be integrated with other educational activities.^{21,22}

Effectiveness of learning is enhanced by providing a mentor to support the portfolio. Mentorship requires a substantial time investment, but appears to be crucial to successful portfolio use.^{21,28,32,35,37,39,41,43,48}

The effectiveness of assessment can be enhanced by combining the portfolio assessment with an interview.^{22,36,47}

A major challenge for the integration of a portfolio into medical education is that its status must be maintained in the eyes of assessment-driven students. This review suggests that it must be part of the institutional assessment procedures.^{32,35,43} We found surprisingly high levels of inter-rater reliability in the studies.^{45,46,48,51–53} This contrasts with findings in other domains, such as for the teaching portfolios of general practice trainers.^{61,62} The results of our review suggest that assessment panels may be limited to 2 or 3 assessors depending on the stakes of the assessment. Part of the success in achieving high reliabilities appears to be attributable to the use of a small group of trained assessors,^{45,46,51–53} specific assessor training exercises,^{46,51–53} including benchmarking, assessor discussion (before and intermediate) and use of holistic scoring rubrics (global performance descriptors).^{45,46,53} In her review of portfolio assessment in nursing, McCready⁵⁴ also calls for experienced assessors, explicit guidelines for portfolio construction and a holistic assessment procedure. The good news seems to be that putting these appropriate measures in place makes adequate assessment of portfolios possible, without the need to prescribe the content and structure of the portfolio in detail.⁶³

Another issue that impacts on portfolio success is a flexible learner-centred format. A rigid structure in which every detail of portfolio content is prescribed elicits negative reactions from portfolio users and is regarded as counterproductive.^{28,32,35,36}

Findings in this review and other literature^{56,57} appear to indicate that too much structure implies a greater risk than too little structure. This does not deny the fact that learners do need clear directions and guidance to support the development and assessment of broad competencies.^{29,57} However, direction should be achieved through clear guidelines and well defined portfolio goals rather than minute directives for every detail of the portfolio.⁵⁷ Striking the right balance is crucial here.

Time, or rather lack of it, is another key issue. Many learners who are asked to create a portfolio, and their supervisors or mentors, are concerned that building and judging portfolios will be exceedingly time-consuming or downright impossible.^{20,28,31,38,41,45,46,64} The finding that time constraints appear to be less of a problem for pre-clinical students may indicate that these students have relatively more time at their disposal. For learners in clinical settings, it is clearly difficult to find time amidst the pressures of clinical practice. Many of the portfolios described in the studies we reviewed were not user-friendly and involved huge amounts of paperwork, forcing portfolio users to comply with strict and detailed guidelines.^{35,36,45,46} Too much specific obligatory content makes portfolios bureaucratic, with the result that they both fail to serve any educational purpose and force learners to search for content outside their direct and lived experiences.^{32,57}

Table 1 summarises the factors promoting portfolio success that emerged from this review.

Study limitations

Several limitations in this review should be considered. Firstly, the label 'portfolio' refers to a broad range of instruments. The purpose, context, structure and content of the portfolios described in the literature reviewed here differed considerably. Because of these differences and the variety of study methods and study quality, it was not possible to use a statistical meta-analytic approach. We attempted to overcome this limitation by synthesising the data as much as possible per context and per goal. Secondly, the literature in medical education often lacks the use of extensive medical subject headings, which could have contributed to our non-retrieval of some

Table 1 Summary of factors promoting portfolio success

Factor	Recommendation
Goals	Clearly introduce the goals of working with a portfolio Combine goals (learning and assessment)
Introducing the portfolio	Provide clear guidelines about the procedure, the format and the content Be cautious for problems with information technology
Mentoring/interaction	Provide mentoring by teachers, trainers, supervisors or peers
Assessment	Use assessment panels of 2–3 assessors depending on the stakes of the assessment Train assessors
Portfolio format	Use holistic scoring rubrics (global performance descriptors) Use a hands-on introduction with a briefing on the portfolio's purpose and the procedures Keep the portfolio format flexible Avoid being overly prescriptive about the portfolio content Avoid too much paperwork
Position in the curriculum	Integrate the portfolio into other educational activities in the curriculum

studies. In addition, different labels were sometimes used in the text of articles. Because we excluded studies of instruments like logbooks, appraisals, personal digital assistants and personal development plans, we may have missed studies in which they were used similarly to portfolios if the authors did not use the term 'portfolio'. Although we manually searched reference lists to overcome these subject heading and label limitations, we may have missed some studies. Thirdly, many studies lacked a full description of the actual portfolio, the portfolio introduction, the study method, data analysis and outcomes. This limited our ability to describe the studies more fully or to generalise more. Finally, in some studies it was not possible to distinguish whether the observed outcomes were the result of working with a portfolio or of mentoring³⁵ or other educational activities.^{21,22,28} We believe, however, that future studies should not try to solve this limitation, as this review showed the crucial importance of integrating portfolios and mentoring in the curriculum.

Implications for research and practice

The results of this review show that many questions regarding portfolio use are still unanswered and this has important implications for both research and practice. We found many studies where the description of the portfolio structure and its implementation were inadequate. In view of the wide variation in portfolio formats, researchers and peer reviewers should insist that details of portfolio structure (purpose, content, mentoring and assessment)²⁵ are given, along with the context in which the portfolio was implemented, to ensure that papers can be critically appraised by others in an adequate fashion.

Although the literature indicates that portfolios are not always successful, many studies did not examine how they were implemented and why they failed. We found no studies investigating the influence of the context in which a portfolio is introduced. To claim success for an educational intervention, such as the portfolio, researchers need to look carefully at the intervention in practical settings.⁶⁵

The implementation of a portfolio requires greater rigour than we encountered in many papers. This lack of scientific rigour may account for our disappointing finding that there was no trend toward improvement in portfolio delivery over the time-span represented by these studies.

Future portfolio research could focus on the user-friendliness or feasibility of portfolios and address time constraints (e.g. by ensuring that portfolios are supported by curriculum arrangements, such as protected time for learning),⁶⁶ the merits of holistic assessment procedures, and the competences of effective portfolio mentors.

Contributors: ED and JvT conceived the study. ED and JvT, helped by an information specialist, performed the literature search. ED, JvT and CvdV determined the inclusion criteria, were responsible for the review of the titles and abstracts and selection of the relevant articles, and developed the data abstraction methods, which were applied by ED and JvT. All authors contributed to the analysis of the results. ED and JvT wrote the first draft of the paper, which was extensively revised by VW. All authors participated actively throughout the conduct, analysis and writing of the study.

Acknowledgements: the authors acknowledge Karlijn Overeem MD for her advice on the study design and for

reading and commenting on various drafts of the manuscript. The authors also wish to thank Victor Burger MSc our information specialist, for his invaluable help in performing efficient and comprehensive literature searches and Mereke Gorsira BA for help in preparing the paper and improving the English language of the first draft.

Funding: none.

Conflicts of interest: none.

Ethical approval: not required.

REFERENCES

- 1 Rabinowitz HK, Babbott D, Bastacky S *et al.* Innovative approaches to educating medical students for practice in a changing health care environment: the National UME-21 project. *Acad Med* 2001;**76**:587–95.
- 2 National Health Service. *Modernising Medical Careers Foundation Programmes*. <http://www.mmc.nhs.uk/pages/foundation>. [Accessed 29 August 2006.]
- 3 Epstein RM, Hundert EM. Defining and assessing professional competence. *JAMA* 2002;**287** (2):226–35.
- 4 Miller GE. The assessment of clinical skills/competence/performance. *Acad Med* 1990;**65** (9 Suppl):63–7.
- 5 Epstein RM. Assessment in medical education. *N Engl J Med* 2007;**356**:387–96.
- 6 Royal College of General Practitioners. *Portfolio-based Learning in General Practice: Report of a Working Group on Higher Professional Education: December 1993*. Occasional paper 63.
- 7 General Medical Council. *Tomorrow's Doctors: Recommendations on Undergraduate Medical Education*. <http://www.gmc-uk.org/education/undergraduate/tomdoc.pdf>. [Accessed 29 August 2006.]
- 8 Accreditation Council for General Medical Education, American Board of Medical Specialties. *Toolbox of Assessment Methods*, Version 1.1. <http://www.acgme.org/Outcome/assess/Toolbox.pdf>. [Accessed 29 August 2006.]
- 9 Hayden SR, Dufel S, Shih R. Definitions and competencies for practice-based learning and improvement. *Acad Emerg Med* 2002;**9** (11):1242–8.
- 10 Lynch DC, Swing SR, Horowitz SD, Holt K, Messer JV. Assessing practice-based learning and improvement. *Teach Learn Med* 2004;**16** (1):85–92.
- 11 Alliance for Academic Internal Medicine. *Portfolio for internal medicine residency programmes*. <http://www.im.org/AAIM/Tools/Docs/Forms/competencies.pdf>. [Accessed 29 August 2006.]
- 12 Bennett NL, Davis DA, Easterling WE Jr *et al.* Continuing medical education: a new vision of the professional development of physicians. *Acad Med* 2000;**75**:1167–72.
- 13 Lewis M, Elwyn G, Wood F. Appraisal of family doctors: an evaluation study. *Br J Gen Pract* 2003;**53**:454–60.
- 14 Zeiger RF. Toward continuous medical education. *J Gen Int Med* 2005;**20** (1):91–4.
- 15 Korthagen FAJ, Kessels J, Koster B, Lagerwerf B, Wubbels T. *Linking Theory and Practice: the Pedagogy of Realistic Teacher Education*. Mahwah, NJ: Lawrence Erlbaum Associates 2001.
- 16 Klenowski V. *Developing Portfolios for Learning and Assessment: Processes and Principles*. London: Routledge/Falmer 2002.
- 17 Davis DA, Mazmanian PE, Fordis M, van Harrison R, Thorpe KE, Perrier L. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. *JAMA* 2006;**296** (9):1094–102.
- 18 Eva KW, Regehr G. Self-assessment in the health professions: a reformulation and research agenda. *Acad Med* 2005;**80** (10 Suppl):46–54.
- 19 van Tartwijk J, Driessen E, Stokking K, van der Vleuten C. Factors influencing the successful introduction of portfolios. *Qual Higher Educ* 2007;**13** (1):69–79.
- 20 Dornan T, Carroll C, Parboosingh J. An electronic learning portfolio for reflective continuing professional development. *Med Educ* 2002;**36** (8):767–9.
- 21 Finlay IG, Maughan TS, Webster DJ. A randomised controlled study of portfolio learning in undergraduate cancer education. *Med Educ* 1998;**32** (2):172–6.
- 22 Gordon J. Assessing students' personal and professional development using portfolios and interviews. *Med Educ* 2003;**37** (4):335–40.
- 23 Best Evidence Medical Education Collaboration. *Information for prospective topic review groups*. <http://www.bemecollaboration.org/TRGInfo.htm>. [Accessed 19 June 2006.]
- 24 Reed D, Price EG, Windish DM *et al.* Challenges in systematic reviews of educational intervention studies. *Ann Intern Med* 2005;**142**:1080–9.
- 25 Zeichner K, Wray S. The teaching portfolio in US teacher education programmes: what we know and what we need to know. *Teach Teach Educ* 2001;**17**:613–21.
- 26 Curran VR, Fleet LA. A review of evaluation outcomes of web-based continuing medical education. *Med Educ* 2005;**39**:561–7.
- 27 Magnusson D. *Test Theory*. Stockholm: Addison-Wesley 1967.
- 28 Mathers NJ, Challis MC, Howe AC, Field NJ. Portfolios in continuing medical education – effective and efficient? *Med Educ* 1999;**33** (7):521–30.
- 29 Vink S, Cools HJM, Elsen GMF, Vermunt JD. Reflectie van eerstejaars studenten geneeskunde: wat willen we zien en wat doen de studenten? [Summary in English.] *Dutch J Med Educ* 2005;**24** (1):4–13
- 30 Campbell CM, Parboosingh JT, Gondocz ST *et al.* Study of physicians' use of a software program to create a portfolio of their self-directed learning. *Acad Med* 1996;**71** (10 Suppl):49–50.
- 31 Dagley V, Berrington B. Learning from an evaluation of an electronic portfolio to support general practitioners' personal development planning, appraisal and revalidation. *Educ Prim Care* 2005;**16**:567–74.
- 32 Driessen EW, van Tartwijk J, Overeem K, Vermunt JD, van der Vleuten CPM. Conditions for successful reflective use of portfolios in undergraduate medical education. *Med Educ* 2005;**39**:1230–5.

- 33 Driessen EW, van Tartwijk J, Vermunt JD, van der Vleuten CPM. Use of portfolios in early undergraduate medical training. *Med Teach* 2003;**25** (1):14–9.
- 34 Maughan TS, Finlay IG, Webster DJ. Portfolio learning with cancer patients: an integrated module in undergraduate medical education. *Clin Oncol* 2001;**13** (1):44–9.
- 35 Pearson DJ, Heywood P. Portfolio use in general practice vocational training: a survey of GP registrars. *Med Educ* 2004;**38** (1):87–95.
- 36 Davis MH, Friedman BDM, Harden RM *et al*. Portfolio assessment in medical students' final examinations. *Med Teach* 2001;**23** (4):357–66.
- 37 Elango S, Jutti RC, Lee LK. Portfolio as a learning tool: students' perspective. *Ann Acad Med Singapore* 2005;**34** (8):511–4.
- 38 Kjaer NK, Maagaard R, Wied S. Using an online portfolio in postgraduate training. *Med Teach* 2006;**28** (8):708–12.
- 39 Ryland I, Brown J, O'Brien N *et al*. The portfolio: how was it for you? Views of F2 doctors from the Mersey Deanery Foundation Pilot *Clin Med* 2006;**6** (4):378–80.
- 40 Webb TP, Aprahamian C, Weigelt JA, Brasel KJ. The Surgical Learning and Instructional Portfolio (SLIP) as a self-assessment educational tool demonstrating practice-based learning. *Curr Surg* 2006;**63** (6):444–7.
- 41 Snadden D. Portfolio-based learning and general practice vocational training. *Med Educ* 1996;**30**:148–52.
- 42 Fung MKF, Walker M, Fung KKF *et al*. An Internet-based learning portfolio in resident education: the KOALA-super(TM) multicentre programme. *Med Educ* 2000;**34** (6):474–9.
- 43 Snadden D, Thomas ML. Portfolio learning in general practice vocational training – does it work? *Med Educ* 1998;**32** (4):401–6.
- 44 Duque G, Finkelstein A, Roberts A, Tabatabai D, Gold SL, Winer LR. Learning while evaluating: the use of an electronic evaluation portfolio in a geriatric medicine clerkship. *BMC Med Educ* 2006;**6**:4.
- 45 Tate P, Foulkes J, Neighbour R, Campion P, Field S. Assessing physicians' interpersonal skills via videotaped encounters: a new approach for the Royal College of General Practitioners membership examination. *J Health Commun* 1999;**4** (2):143–52.
- 46 O'Sullivan PS, Reckase MD, McClain T, Savidge MA, Clardy JA. Demonstration of portfolios to assess competency of residents. *Adv Health Sci Educ* 2004;**9** (4):309–23.
- 47 Burch VC, Seggie J. Portfolio assessment using a structured interview. *Med Educ* 2005;**39** (11):1169.
- 48 Grant AJ, Vermunt JD, Kinnersley P, Houston H. Exploring students' perceptions on the use of significant event analysis, as part of a portfolio assessment process in general practice, as a tool for learning how to use reflection in learning. *BMC Med Educ* 2007;**7**:5.
- 49 Rees CE, Sheard CE. Undergraduate medical students' views about a reflective portfolio assessment of their communication skills learning. *Med Educ* 2004;**38** (2):125–8.
- 50 Amsellem-Ouazana D, van Pee D, Godin V. Use of portfolios as a learning and assessment tool in a surgical practical session of urology during undergraduate medical training. *Med Teach* 2006;**28** (4):356–9.
- 51 Overeem K, Driessen EW, Drenthe A, van Tartwijk J, van der Vleuten CPM. Kwaliteitscriteria voor portfolio-beoordeling van geneeskundestudenten. [Summary in English.] *Dutch J Med Educ* 2005;**24** (2):64–71.
- 52 Melville C, Rees M, Brookfield D, Anderson J. Portfolios for assessment of paediatric specialist registrars. *Med Educ* 2004;**38**:1117–25.
- 53 Rees CE, Sheard CE. The reliability of assessment criteria for undergraduate medical students' communication skills portfolios: the Nottingham experience. *Med Educ* 2004;**38** (2):138–44.
- 54 McCready T. Portfolios and the assessment of competence in nursing. *Int J Nurs Stud* 2007;**44** (1):143–51.
- 55 Pinsky LE, Fryer-Edwards K. Diving for PERLS – working and performance portfolios for evaluation and reflection on learning. *J Gen Int Med* 2004;**19**:582–7.
- 56 Wade RC, Yarbrough DB. Portfolios: a tool for reflective thinking in teacher education. *Teach Teach Educ* 1996;**12** (1):63–79.
- 57 McMullan M. Students' perceptions on the use of portfolios in pre-registration nursing education: a questionnaire survey. *Int J Nurs Stud* 2006;**43**:333–43.
- 58 Snyder J, Lippincott A, Bower D. The inherent tensions in the multiple uses of portfolios in teacher education. *Teach Educ Q* 1998;**25** (1):45–60.
- 59 Tigelaar DEH, Dolmans DHJM, Wolffhagen HAP, van der Vleuten CPM. Using a conceptual framework and the opinion of portfolio experts to develop a teaching portfolio prototype. *Stud Educ Eval* 2004;**30** (4):305–21.
- 60 Gallagher P. An evaluation of a standards-based portfolio. *Nurse Educ Today* 2001;**21**:409–16.
- 61 Pitts J, Coles C, Thomas P, Smith F. Enhancing reliability in portfolio assessment: discussions between assessors. *Med Teach* 2002;**24** (2):197–201.
- 62 Pitts J, Coles C, Thomas P. Educational portfolios in the assessment of general practice trainers: reliability of assessors. *Med Educ* 1999;**33**:515–20.
- 63 Frohna JG, Kalet A, Kachur E *et al*. Assessing residents' competency in care management: report of a consensus conference. *Teach Learn Med* 2004;**16** (1):77–84.
- 64 Lonka K, Slotte V, Halttunen M *et al*. Portfolios as a learning tool in obstetrics and gynaecology undergraduate training. *Med Educ* 2001;**35** (12):1125–30.
- 65 Collins A, Joseph D, Bielasyk K. Design research: theoretical and methodological issues. *J Learning Sci* 2004;**13** (1):15–42.
- 66 Mucklow JC. Continuing medical education in clinical pharmacology and therapeutics: report of a questionnaire survey. *Br J Clin Pharmacol* 2001;**52** (1):9–16.

SUPPLEMENTARY MATERIAL

The following supplementary material is available for this article:

Table S1. Studies examining the use of portfolios in pre-clinical undergraduate medical education.

Table S2. Studies examining the use of portfolio in undergraduate clinical clerkships.

Table S3. Studies examining the use of portfolio in specialist training.

Table S4. Studies examining the use of portfolio in Continuing Medical Education (CME).

This material is available as part of the online article from:
<http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365.2923.2007.02944.x>

(This link will take you to the article abstract).

Please note: Blackwell Publishing is not responsible for the content or functionality of any supplementary materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

*Received 14 August 2007; accepted for publication
20 August 2007*