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BEME GUIDE

The educational effects of portfolios on undergraduate student learning: A Best Evidence Medical Education (BEME) systematic review. BEME Guide No. 11

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Abstract

Introduction: In recent years, the use of portfolios as learning and assessment tools has become more widespread across the range of health professions. Whilst a growing body of literature has accompanied these trends, there is no clear collated summary of the evidence for the educational effects of the use of portfolios in undergraduate education. This systematic review is the result of our work to provide such a summary.

Methods: We developed a protocol based on the recommendations of the Best Evidence Medical Education (BEME) collaboration. Citations retrieved by electronic searches of 10 databases were assessed against pre-defined inclusion/exclusion criteria by two independent reviewers and full texts of potentially relevant articles were obtained. Studies were identified for inclusion in the review by examination of full text articles by two independent reviewers. At all stages, discrepancies were resolved by consensus. Data relating to characteristics of the student population, intervention, outcome measures, study design and outcomes were collected using a piloted data extraction form. Each study was assessed against 11 quality indicators designed to provide information about how well it was designed and conducted; and against the Kirkpatrick hierarchy as modified for educational settings. Comparisons between different groups were carried out using the Kruskal–Wallis test (non-parametric ANOVA) or the Mann–Whitney U test as appropriate.

Results: Electronic searches yielded 2,348 citations. A further 23 citations were obtained by hand searching of reference lists. Five hundred and fifty four full articles were retrieved and assessed against our inclusion criteria. Of the 69 studies included in our review, 18 were from medicine, 32 from nursing and 19 from other allied health professions, including dentistry, physiotherapy and radiography. In all professional groups, portfolios were used mainly in the clinical setting, completion was mostly compulsory, reflection required and assessment (either formative, summative or a combination of both) the norm. Three studies used electronic portfolios. Whilst many studies used a combination of data collection methods, over half of all included studies used questionnaires, a third used focus group interviews and another third used direct assessment of portfolios. Most studies assessed student or tutor perceptions of the effect of the use of portfolios on their learning. Five studies used a comparative design, one of which was a randomized controlled trial. Studies were most likely to meet the quality indicators relating to appropriateness of study subjects, clarity of research question and completeness of data. However, in many studies, methods were not reported in sufficient detail to allow a judgement to be made. Nineteen of the 69 included studies (27%) met seven or more quality indicators. Across all professions, such 'higher quality' studies were more likely to have been published recently. The median 'quality score' (number of indicators met) rose from two for studies published in 2000 or earlier to seven for studies published in 2005 or later. Significant differences were observed between the quality scores for studies published in or before 2000 and those published between 2001 and 2004 ($p = 0.027$), those published in or before 2000 and those published in 2005 or later ($p = 0.002$) and between all studies ($p = 0.004$). Similar trends were seen in all professional groups. Fifty nine (85%) of the included studies were assessed at level 1 of the modified Kirkpatrick hierarchy (i.e. 'participation' effects, including '*post hoc*' evaluations of student perceptions of the effects of keeping a portfolio on their learning). Nine (13%) of the studies reported direct measurement of changes in student skills or attitudes and one study reported a change in student behaviour. The main effects of portfolio use identified by the included studies were: Improvement in student knowledge and understanding (28 studies, six at Kirkpatrick level 2 or above), greater self-awareness and encouragement of reflection (44 studies, seven at Kirkpatrick level 2 or above) and the ability to learn independently (10 studies, one at Kirkpatrick level 2). The findings of higher quality studies also identified benefits in these areas. They reported improved student knowledge and understanding, particularly the ability to integrate theory with practice, although a correlation with improved scores in other assessments was not always apparent. Greater self-awareness and

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engagement in reflection were also noted, although some studies questioned the *quality* of the reflection undertaken. Higher quality studies also suggest that use of portfolios improves feedback to students and gives tutors a greater awareness of students' needs, may help students to cope with uncertain or emotionally demanding situations and prepares students for postgraduate settings in which reflective practice is required.

Time commitment required to collate a portfolio was the major drawback identified. In two of the studies, this was found to detract from other clinical learning.

Conclusions: At present, the strength and extent of the evidence base for the educational effects of portfolios in the undergraduate setting is limited. However, there is evidence of an improving trend in the quality of reported studies. 'Higher quality' papers identify improvements in knowledge and understanding, increased self-awareness and engagement in reflection and improved student–tutor relationships as the main benefits of portfolio use. However, they also suggest that whilst portfolios encourage students to engage in reflection, the quality of those reflections cannot be assumed and that the time commitment required for portfolio completion may detract from other learning or deter students from engaging with the process unless required to do so by the demands of assessment. Further work is needed to strengthen the evidence base for portfolio use, particularly comparative studies which observe changes in student knowledge and abilities directly, rather than reporting on their perceptions once a portfolio has been completed.

Introduction

In general terms, a portfolio can be defined as a collection of evidence that learning has taken place (Challis 1999). However, the term is used to describe a plethora of learning tools that differ widely in content, usage and assessment requirements (Rees 2005a and b). Portfolios are seen as tools to increase students' self-awareness, to foster students' ability to learn independently and to encourage students to reflect on their own performance (Challis 1999; Pitts 2007).

In recent years, the use of portfolios as learning and assessment tools in undergraduate medical education has become more widespread, partly due to the trend towards competency–based medical education (Driessen et al. 2007a), and partly due to an increased emphasis on reflective practice (General Medical Council 2003 and 2006). Similar developments have occurred in undergraduate nursing (Glen & Hight 1992; Nursing and Midwifery Council 2008) and in other allied health professions (Paschal et al. 2002).

Whilst there is a growing body of literature on portfolio use and assessment (Ben David et al. 2001), there is no clear, collated summary of the evidence for their educational effects among undergraduate students from a range of health professions. We conducted a systematic review to provide such a summary.

Practice points

To realize the benefits to student learning, it is important that:

- the time demands of the portfolio are reasonable
- support is in place to build students' reflective skills, particularly in the early stages of portfolio use
- undergraduate portfolios reflect as far as possible the requirements of postgraduate training.

To ensure reasonable time demands, portfolios should:

- have specific aims and objectives that are well understood by tutors and students
- align to course outcomes
- include clear guidelines on requirements, word limits and expected time commitments.

To develop students' reflective skills, portfolios should:

- be used for as long a duration as practicable (to allow skills to improve over time).

Review methodology

We prepared a protocol for review based on the methodology recommended by the Best Evidence Medical Education (BEME) collaboration (http://www.bemecollaboration.org/beme/pages/index.html).

Framing the question

Figure 1 summarizes the relationships between the participants, interventions and outcome measures that make up our review. At the centre of this conceptual framework are the students (participants) and their learning (outcomes). Student learning is mediated both by the portfolio (intervention) and by various contextual factors such as the portfolio type and the way in which it is used. Learning may also be affected indirectly when using a portfolio causes tutors to change their approach to teaching (shown on the framework by the dotted line). In our review, assessment of the strength of the evidence-base for effects on learning takes three forms: Estimation of impact (via the Kirkpatrick hierarchy), consideration of the proportions of studies reporting particular educational effects and review of the main messages from the studies estimated to be of higher quality.

Sources of papers, search strategies and selection process

Electronic searches of 10 databases, Medline, EMBASE, Cinahl, PsycInfo, British Nursing Index (BNI), Australian Education Index (AUEI), British Education Index (BEI), ERIC, Web Of Science (Social Science Citation Index and Science Citation Index) and Applied Social Science Index and Abstracts (ASSIA) were carried out from database inception to February 2007.

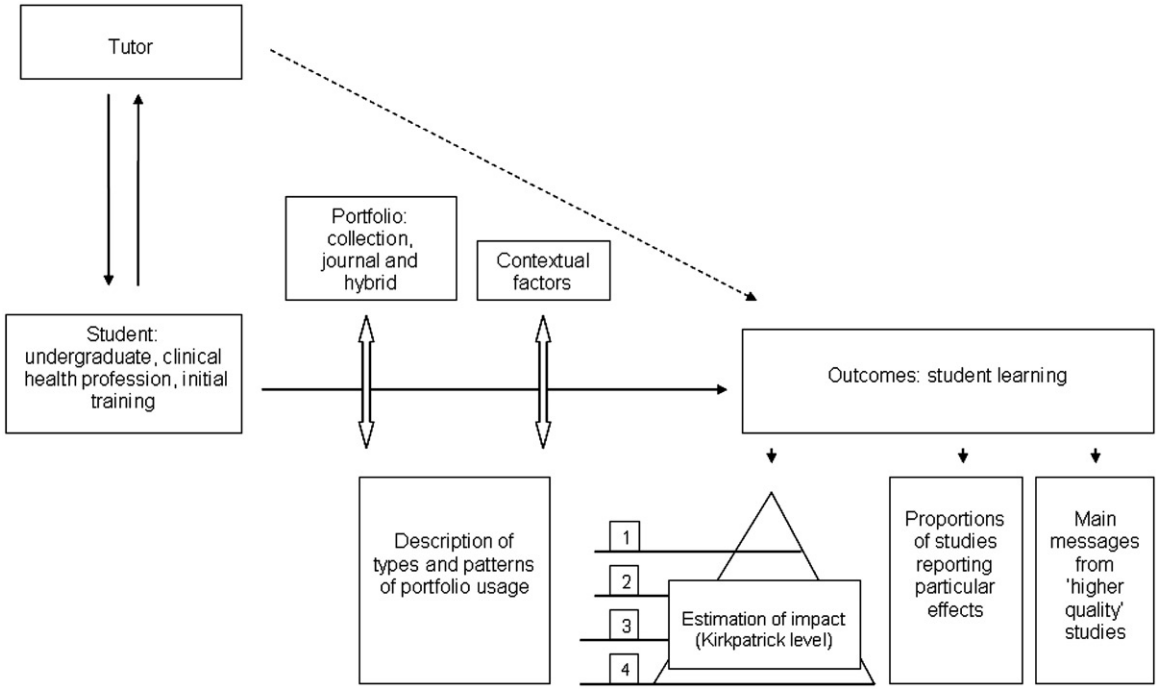

Figure 1. Conceptual framework summarizing the relationships between the participants, interventions and outcome measures included in our review. Contextual factors were explored through a description of the types and patterns of portfolio usage. Effects on student learning were measured according to impact as measured by the Kirkpatrick hierarchy, by estimation of the proportions of included studies reporting particular effects on learning and by a qualitative description of the main messages from studies assessed as being of higher quality.

Appendix I (on BEME website: www.bemecollaboration.org) lists the keywords and synonyms used for the concepts 'portfolio', 'undergraduate' and 'medical education'. Appendix II (on BEME website: www.bemecollaboration.org) gives full search strategies for each database. Reference lists of selected papers were searched manually to identify papers that may have been missed by electronic searching. All references identified through searching were entered into a Reference Manager database (Thomson ISI. Reference Manager Version 11.0 Philadelphia 2004). Duplicate citations were removed, first automatically, and then manually.

Figure 2 summarizes our literature search and study selection. Two independent reviewers used our inclusion/exclusion criteria to assess the text of all electronic citations for relevance to our review, including title, indexing words and, where available, abstract. Apart from theses and books, we obtained full texts of all articles available in the UK that appeared potentially relevant. Full articles retrieved were then assessed against our inclusion/exclusion criteria, again by two independent reviewers. Wherever possible, a reviewer with a clinical background was teamed with a reviewer with an educational background. Discrepancies were resolved by discussion between team members and the lead reviewer, and a consensus reached. Selections of articles in languages other than English were carried out either by a native speaker on the review group (Spanish) or by a member of the review group working with a translator (all other languages). It was agreed that should multiple articles reporting the same study be found, only the most informative would be cited, with other papers retained for clarification of particular points as necessary.

Inclusion/exclusion criteria

Table 1 summarizes the inclusion/exclusion criteria used in our review.

Participants. Studies involving undergraduate students from medicine, nursing and other clinically–based health professions were included. The term 'undergraduate' was interpreted in terms of 'initial training' within a higher education setting. This meant that all graduate entry courses such as medical training in the US, were included. For UK medical education, this included all courses up to graduation and prior to Foundation Year training. For nursing students, initial training up to first degree level was included (including post-registration first degree courses). Advanced practitioner training was not included. Articles relating to purely academic undergraduate courses and to other professions such as social work, teaching and law were excluded, as were studies involving postgraduate trainees or residents.

Interventions. Whilst other models of portfolio content have been suggested (Pitts 2007), for the purposes of our review, we have adopted a definition that takes into account two broad categories of portfolio content: The assembly of a collection of evidence of student learning and achievement, and the requirement for students to complete a learning journal or diary. Our review includes portfolios that are primarily collections of evidence, those that are primarily learning journals or diaries, and 'hybrid' portfolios that include both of these components. However, all portfolios included in our study required an element of intellectual engagement by

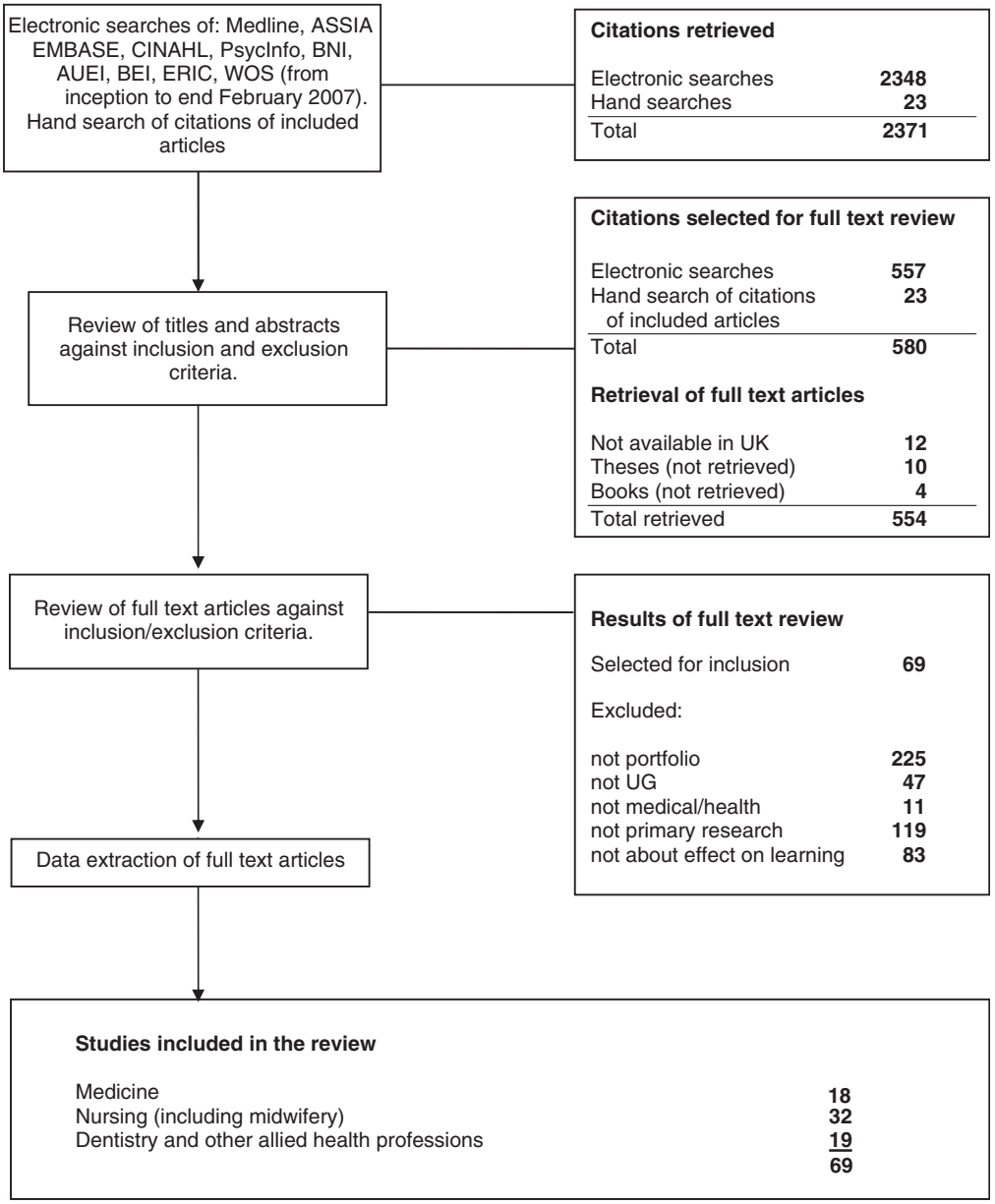

Figure 2. Flow diagram of literature search and study selection.

Table 1. Inclusion/exclusion criteria.

Criterion	Inclusion	Exclusion
Population	Undergraduate education (defined as initial training) in medicine and allied health professions. Initial training courses where entrants are graduates in another discipline, such as in US medical education.	Postgraduate or continuing professional education, advanced skills training
Intervention (portfolio)	A collection of evidence of student activity, whether paper–based or electronic) *that* Outlines the student's own learning experience (e.g. patients seen, study subject covered, articles read) *and* Requires some 'intellectual processing' on the part of the student *and* Draws together more than one item, clinical case, task, report, reflective task, etc.) or Is a learning journal, a collection of student reflections on their learning	Logbooks using 'tick box' collation of student experiences Collections of photocopied information/articles, raw patient data without interpretation Single assignments.

the student with the portfolio content and associated learning. This most commonly took the form of reflection and so our review primarily covers portfolios that include a reflective component.

For an intervention to meet our definition of 'portfolio', it must:

- be a collection of evidence of student activity
- outline the student's own learning experience (e.g. patients seen, study subject covered, articles read)
- involve some 'intellectual engagement' with information (e.g. not just raw patient data, photocopies of articles etc.)
- draw together more than one item (e.g. more than one case, paper etc.).

All interventions which met these criteria were included. However, a portfolio had to be put together by the *student*, not by faculty members or others on behalf of the student. Logbooks involving a purely 'tick list' approach to the recording of clinical experiences observed, etc. were not included as they did not require the student to engage with the material being studied.

Outcome measures. For our review, we interpreted effects on student learning as either

- a change in the knowledge, skills, attitudes or behaviours of students as a result of the use of a portfolio, or
- a change in the perceptions or behaviour of tutors that may influence indirectly the effectiveness of student learning.

Articles relating to the use of portfolios as an assessment tool were included only if they included such data.

Studies. Primary research studies that included data about the effects of portfolios on student *learning* were included. Descriptive articles without evaluative methodology or data (either qualitative or quantitative) were counted as 'not primary research' and excluded from the review.

Data extraction

Using the BEME coding sheet as a basis, a detailed data extraction form was prepared and piloted on a sub set of papers. As a result of the pilot, the data extraction form was modified and a minor clarification of the research question made (a bracket round the term medical to indicate that professions other than medicine would be included). The final data extraction form is given in Appendix III (on BEME website: www.bemecollaboration.org). Data relating to characteristics of the student population, intervention, outcomes measures, study design and quality and outcomes were collected. This included the type of portfolio (electronic or paper), the time for which the portfolio was kept (duration), the nature of any assessment, whether its completion was compulsory or voluntary, the type of supervision and whether it included individual reflection.

For the first 217 papers analyzed, data extraction was carried out by two independent reviewers. For the remainder, full data extraction and annotation of the paper was carried out by the first reviewer, and a second reviewer confirmed or queried the findings of the first. Discrepancies were resolved by discussion and consensus. In one study where information about the nature of the portfolio used was required, the author was contacted for further information.

All data were collated onto an Excel spreadsheet (Microsoft Office Suite 2003) to enable subsequent analysis.

Quality assessment of studies

To assess the quality of included studies, a series of 11 quality 'indicators' was developed. These related to the appropriateness of the study design, conduct, results analysis and conclusions (Table 2). Higher quality studies were considered to be those which met a minimum of seven of these 11 indicators.

Impact of portfolio use

The Kirkpatrick hierarchy as adapted by BEME for use in educational contexts was used to assess the impact of portfolio use (Harden et al. 1999; Tochel et al. 2009). In this adaptation, level 1 (participation) considers participants' views on the learning experience. Levels 2a (modification of attitudes/perceptions) and 2b (modification of knowledge or skills) consider changes in the attitudes of participant groups towards the intervention and changes in their knowledge and skills as a result of the intervention, respectively. We wished to

Table 2. Quality indicators for included studies.

Quality Indicator	Detail
Research question	Is the research question(s) or hypothesis clearly stated?
Study subjects	Is the subject group appropriate for the study being carried out (number, characteristics, selection, and homogeneity)?
'Data' collection methods	Are the methods used (qualitative or quantitative) reliable and valid for the research question and context?
Completeness of 'data'	Have subjects dropped out? Is the attrition rate less than 50%? For questionnaire based studies, is the response rate acceptable (60% or above)?
Control for confounding	Have multiple factors/variables been removed or accounted for where possible?
Analysis of results	Are the statistical or other methods of results analysis used appropriate?
Conclusions	Is it clear that the data justify the conclusions drawn?
Reproducibility	Could the study be repeated by other researchers?
Prospective	Does the study look forwards in time (prospective) rather than backwards (retrospective)?
Ethical issues	Were all relevant ethical issues addressed?
Triangulation	Were results supported by data from more than one source?

Quality indicators against which all studies were assessed are given, together with clarification of meaning in each case.

distinguish between *post hoc* evaluation studies in which students gave their perceptions of the effect of the portfolio on their learning and those studies which observed 'directly' changes in students' knowledge, skills or attitudes, by sampling student perceptions at two or more points in time. In order to do this, we interpreted participation as including *post hoc* evaluations of student perception and reserved level 2 classification for studies which measured effects of student learning directly. Level 3 (behavioural change) considers the transfer of learning to the workplace or the willingness of learners to apply new knowledge/skills, whilst levels 4a (change in organizational practice) and 4b (benefit to patients/clients) consider changes in organizational practice or benefits to patients as a direct result of the educational programme.

Data synthesis

Descriptive statistics of data extracted from the included studies were derived. Quality scores were summarized by the median and inter-quartile ranges and categorical variables were described by the number and percentage in each category.

Comparisons by year of publication or between different professional groups were carried out using the Kruskal–Wallis test (non-parametric ANOVA) for overall differences and the Mann–Whitney U test for pairwise comparisons. In all cases, a 5% significance level was used. For comparison by year of publication, studies were grouped, as far as possible, according to the tertiles of publication year i.e. approximately one third of studies was included in each comparison group.

Data extracted from included studies were not appropriate for statistical analysis.

Results

Study search and selection

Electronic searches yielded 2,348 potentially relevant citations and manual searching of the reference lists of studies included in the review a further 23 citations (Figure 2).

Of the 580 studies identified for full text review, 554 were obtained. 12 studies were not available in the UK and 14 were books or theses, which were not retrieved. Assessment of retrieved studies against our inclusion criteria resulted in 69 (>5000 participants) being selected for inclusion. The most common reasons for exclusion of an article from the review were that it was not about or did not meet our definition of portfolios (225 studies), it was not a primary research study (119 articles) or it did not include information about the effects of portfolio use on student learning (83 studies). Of this last group, one paper was a preliminary description of a study that was reported in full in a later, included, publication. The preliminary report was used as necessary to clarify or provide additional information not present in the main paper.

Of the 69 studies included, 18 were from medicine, 32 nursing or midwifery and 19 from a range of other health professions, including physiotherapy, radiography and dentistry. Where a study included students from more than one health care profession, it was grouped with the profession from which the majority of students were drawn (one study). Participant numbers were not always clearly reported. However, of the studies where information was clearly stated, the median numbers of students involved for medicine, nursing and other allied health professions respectively were 128 (range 13–405), 37 (range 3–430) and 47.5 (range 21–204).

Among the included studies, 29 were from the UK and Europe, 28 from the US and Canada and the remainder from Australia and New Zealand (five), Malaysia and the Far East (four), South Africa (three) (see Table 3 on BEME website: www.bemecollaboration.org). Studies involving medical students were mainly from the UK and Europe (13 studies), whilst those involving nursing or midwifery were mainly from the USA or Canada (18 studies).

Of the 69 included studies, 64 used a non-comparative study design. Five comparative studies were included, two from medicine and Three from nursing. One randomized controlled trial was identified (Finlay et al. 1998) in which medical students taking a clinical oncology module were randomly allocated to either a 'portfolio' or 'control' group. The portfolio group recorded patient encounters and received tutorial support in portfolio development.

Half of all included studies collected data using a questionnaire. Just under one third used focus groups or group interviews and one third assessed or analyzed the portfolio itself (see Table 4 on BEME website: www.beme collaboration.org). Combinations of data collection methods were frequently used, particularly supplementing information from questionnaires with focus groups or group interviews.

Three studies used an electronic or partly electronic portfolio, two from medicine (Cotterill et al. 2005; Duque et al. 2006) and one involving both nursing and medical students (Garrett & Jackson 2006). Articles relating to electronic portfolios tended to be descriptive accounts of systems used rather than studies of the effects of electronic portfolios on student learning or comparisons of the differences between electronic and paper–based portfolios and so were not included in this review.

Methodological quality of included studies

Figure 3 (on BEME website: www.bemecollaboration.org) shows the assessment of all included studies against 11 quality indicators. The three indicators most likely to be assessed as met were the appropriateness of study subjects, clarity of research question and completeness of data. However, in many cases, methods used were not reported in sufficient detail to allow a judgement to be made.

The proportion of papers meeting the quality indicators was similar for the different professional groups. However, nursing studies were more likely than other professions to address ethical issues, whilst medical studies were more likely to be assessed as having suitable study subjects and completeness of data, to draw appropriate conclusions and to be reproducible by other researchers (data not shown).

Nineteen of the 69 included studies were assessed as having met seven or more quality indicators (See Table 5 on BEME website: www.bemecollaboration.org). This included

Table 7. Assessment of studies reviewed against the Kirkpatrick hierarchy.

Kirkpatrick 'level'	Detail	Medicine (%)	Nursing (%)	Other allied health (%)	All groups (%)
1	Learners' views on the portfolio	15 (83.3)	27 (84.3)	17 (89.4)	59 (85.5)
2a	Change in learners' views or attitudes	0 (0.0)	2 (6.25)	2 (10.0)	4 (5.7)
2b	Change in learners' knowledge or skills	3 (16.7)	2 (6.25)	0 (0.0)	5 (7.1)
3	Change in learners' behaviour	0 (0.0)	1 (3.1)	0 (0.0)	1 (1.4)
4a/b	Change in organizational practice/benefit to patients	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Numbers and % of studies assessed at each Kirkpatrick level are shown for each professional group and for all groups.

50% of those from medicine (nine studies), 25% of those from nursing (eight studies) and 11% of those from other allied health professions (two studies).

Of the three professional groups, studies involving medical students were more likely to have been published recently, with 83% published since the year 2000 and almost half (44%) published since 2004 (See Table 6 on BEME website: www.bemecollaboration.org). In contrast, approximately one third of nursing studies were published in 2000 or earlier, half between 2001 and 2004 and only 12% since then. Publication dates for studies from other allied health professions were similar to those of nursing, with approximately half of the included studies being published in 2000 or earlier (See Table 6 on BEME website: www.bemecollaboration.org).

'Higher quality' studies were more likely to have been published recently. Figure 4 (on BEME website: www.bemecollaboration.org) shows a comparison of the quality scores for studies published in 2000 or earlier, those published between 2001 and 2004 and those published in 2005 or later. Median quality scores rose from two for studies published in 2000 or earlier to seven for those published in 2005 or later. Significant differences were found between the quality scores for studies published before 2000 and those published between 2001 and 2004 ($p=0.027$), those published before 2000 and those published in 2005 or later ($p=0.002$), and between all studies ($p=0.004$). Similar trends occurred in each professional group (See Table 6 on BEME website: www.bemecollaboration.org), with the median scores for medical studies increasing from 3.0 in 2000 and before to 7.0 in 2005 and later; that for nursing studies increasing from 1.5 to 7.0 over the same period; and that for other allied health professions increasing from 2.5 to 5.0. The small number of medical and allied health studies included in our review prevented statistical analysis of quality scores within these professional groups. However, a statistically significant increase in the quality score for nursing studies was apparent ($p=0.023$).

Assessment of studies against the Kirkpatrick hierarchy

Table 7 summarizes the proportion of included studies assessed at each level of the modified Kirkpatrick hierarchy (Harden et al. 1999; Tochel et al. 2009). Fifty-nine (86%) of the included studies involved student or tutor views of the effects of portfolio use on their learning (Kirkpatrick level 1), with only 10 (14%) of studies reporting direct observation of changes in knowledge, skills or attitudes/behaviours (Kirkpatrick levels 2 or higher). Only one study (from nursing) reported changes in learner behaviour (Kirkpatrick level 3). As would be expected of the use of portfolios in an undergraduate setting, no studies reported effects involving a benefit to patients or change in organizational practice (level 4).

How portfolios are used in the undergraduate setting

Tables 8(a) and 8(b) illustrate how portfolios were used in included studies. In the majority of studies and in all professional groups, portfolios were used solely in the clinical setting. Completion of the portfolio by the students was mostly compulsory, reflection mostly a required rather than voluntary activity and sharing of reflections with staff or other students the norm. Staff gave students clear guidance on what to include in their portfolio, either specifically prescribing content or allowing students limited choice within set guidelines.

Students were mainly required to keep a portfolio for one academic year or less, with portfolios kept for one semester or less common, particularly in nursing and other allied health professions. Portfolios used with medical students tended to be of the 'hybrid' type and those used with nursing students were more likely to be purely reflective journals or learning diaries. In other allied health professions, predominance of one type of portfolio was less apparent.

In all professions, the majority of portfolios included some form of assessment, either formative, summative or both. In all, just over half of the portfolios studied included summative assessment.

Effects of portfolio use on student learning (all studies)

Table 9 and Table 10 (on BEME website: www.bemecollaboration.org), summarize the effects of portfolio use on student knowledge and understanding, skills, attitudes and behaviours as reported by all included studies and with all types of portfolio. Overall, studies reported many instances of positive effects of portfolio use on student learning, with many studies reporting multiple benefits. Reports of neutral or negative effects were much rarer.

Knowledge and understanding. Twenty studies reported that using a portfolio improved students' ability to meet course objectives and eight an improvement in their ability to integrate theory with practice.

Of these 28 studies, six were assessed at Kirkpatrick level 2 or above.

Table 8(a). Features of portfolio use within included studies: 1.

Feature	Detail	Medicine (no. (%)*)	Nursing (no. (%)*)	Other Allied Health (no. (%))	Total (no. (%)*)
Setting	Non or pre clinical only	2 (11)	2 (6)	2 (10)	6 (9)
	Clinical only	9 (50)	18 (56)	11 (58)	38 (55)
	Combination	6 (33)	10 (31)	2 (10)	18 (26)
	Unclear	1 (6)	2 (6)	4 (21)	7 (10)
Portfolio type	Learning journals/diaries	4 (22)	14 (44)	7 (37)	25 (36)
	Collection of evidence portfolios	5 (28)	6 (19)	5 (26)	16 (23)
	Hybrid portfolios	9 (50)	11 (34)	7 (37)	27 (39)
	Unclear	0 (0)	1 (3)	0 (0)	1 (1)
Duration	One semester or less	5 (28)	16 (50)	9 (47)	30 (43)
	One academic year	10 (56)	7 (22)	7 (37)	24 (35)
	More than one academic year	2 (11)	4 (13)	3 (16)	9 (13)
	Unclear	1 (6)	5 (16)	0 (0)	6 (9)
Assessment	None	1 (6)	5 (16)	0 (0)	6 (9)
	Formative	3 (17)	5 (16)	6 (32)	14 (20)
	Summative	7 (39)	5 (16)	5 (26)	17 (25)
	Formative and summative	4 (22)	10 (31)	5 (26)	19 (27)
	Unclear	3 (17)	7 (22)	3 (16)	13 (19)

The number and % (*rounded to nearest %) of studies using particular settings, types of portfolio, durations and types of assessment are shown by professional group.

Table 8(b). Features of portfolio use within included studies: 2.

Feature	Detail	Medicine (no. (%)*)	Nursing (no. (%)*)	Other Allied Health (no. (%)*)	Total (no. (%)*)
Content choice	Freely chosen by the student	1 (6)	1 (3)	4 (21)	6 (9)
	Chosen by the student within guidelines	4 (22)	20 (63)	7 (37)	31 (45)
	Prescribed by staff	11 (61)	7 (22)	7 (37)	25 (36)
	Unclear	2 (11)	4 (13)	1 (5)	7 (10)
Completion	Voluntary	3 (17)	4 (13)	2 (10)	9 (13)
	Compulsory	14 (78)	25 (78)	15 (79)	54 (78)
	Unclear	1 (6)	3 (9)	2 (10)	6 (9)
Reflection	Voluntary	4 (22)	3 (9)	3 (16)	10 (15)
	Required	13 (72)	25 (78)	11 (58)	49 (71)
	Combination	0 (0)	1 (3)	1 (5)	2 (3)
	Unclear	1 (6)	3 (9)	4 (21)	8 (11)
Use of reflections	For private use	0 (0)	2 (6)	0 (0)	2 (3)
	For sharing with students/staff	16 (89)	21 (66)	15 (75)	52 (75)
	Combination	0 (0)	3 (9)	2 (10)	5 (7)
	Unclear	2 (11)	6 (19)	3 (15)	11 (16)

The number and % (*rounded to nearest %) of studies in particular methods of content choice, completion and reflection are shown by professional group.

Skills. Improvements in students' self-awareness and ability to engage in reflection were reported by 44 of the 69 included studies, of which seven were assessed at Kirkpatrick level 2 or above. A further three studies reported no change in these skills. 10 studies noted improved ability to learn independently, one of which was assessed at Kirkpatrick level 2. Two studies reported no change in this skill. Other positive effects on student skills included improved decision-making (six studies, two at level 2) and improved critical thinking (five studies). For communication skills, four studies reported an enhancement and one study no change.

Attitudes and behaviours. Eight studies, of which two were assessed at Kirkpatrick level 2 or above, found that keeping a portfolio improved student self-confidence. However one study, in which final year medical undergraduates were assessed by portfolio, found that some students missed the 'rite of passage' associated with traditional finals and felt less prepared for their junior doctor training as a result (Davis et al. 2001).

Other reported attitudinal benefits included improved willingness to take responsibility for their own learning (five studies) and professionalism (four studies). Ten studies reported an improvement in student views of learning and teaching or with their satisfaction with the learning process.

Only one study reported a statistically significant change in behaviour. In a study of nursing students, Fakude and Bruce (2003) found that those who completed a reflective journal showed a statistically significant improvement in skills associated with clinical decision making compared to those who did not.

Table 9. Effects of portfolio use on student learning.

		Effects reported (no. (%))		
Aspect of learning	Detail	Positive	None	Negative
Knowledge and understanding	Achievement of course objectives	20 (29)	1 (1)	
	Integration of theory and practice	8 (12)	3 (4)	
Skills	Reflection/self-awareness	44 (64)	3 (4)	
	Patient management	3 (4)	1 (1)	
	Decision-making	6 (9)		
	Communication skills	4 (6)	1 (1)	
	Ability to learn independently	10 (14)	2 (3)	
	Critical thinking	5 (7)		
	Organizational skills	2 (3)		
	Selecting information	2 (3)		
	Coping (with uncertainty)	2 (3)		
	Practical procedures	1 (1)		
Attitudes/behaviours	Views of learning and teaching	4 (6)		
	Responsibility	5 (7)		
	Self-confidence	8 (12)		1 (1)
	Satisfaction	6 (9)		
	Professionalism	4 (6)		
	Empathy	5 (7)		

Reported effects of portfolio use on student knowledge/understanding, skills and attitudes/behaviours shown as number of studies reporting each effect and as a % of all included studies.

Effects of portfolio use on tutor perceptions and behaviour. Nine studies reported that, through reviewing and providing feedback on students' portfolio work, tutors developed a greater understanding of student needs, which in turn led to changes in the way they approached their teaching.

Time requirements of portfolios. Nineteen studies reported that students found completing a portfolio time-consuming and stressful, sometimes to the extent that it detracted from clinical learning (two studies).

Main messages from 'higher quality' studies

Findings from the 19 studies assessed as meeting seven or more quality indicators reflected those of all included studies. The main messages from these higher quality studies are given below.

Effects on student knowledge and understanding. In their UK study, (Grant et al. 2006) explored the perceptions of year 3 medical students who voluntarily kept a learning journal for two terms and attended fortnightly facilitated tutorial groups to discuss their reflections. In subsequent group interviews, these students reported that they felt better able to identify their learning needs and were better able to integrate learning from different sources, particularly integrating theory with practice. However, these authors found no difference in the exam results of these students compared with those who had not kept the journal.

Similarly, in a study of fifth year medical students taking an obstetrics and gynaecology rotation, Lonka et al. reported that using a collection-type reflective portfolio allowed students to clarify their learning needs and to monitor their achievement of learning objectives (Lonka et al. 2001). There was also a correlation between students' use of the portfolio (as measured by the amount of text written) and their performance in a separate final examination. However, students who used the portfolio extensively were also more active in observing procedures etc, and the authors suggest that this result may reflect the general commitment of the student, rather than portfolio use.

Rees and Sheard (2004) found a positive correlation between students' views of keeping a portfolio and their score in the summative portfolio assessment and, in a second study (Rees et al. 2005), suggested that keeping a collection-type reflective portfolio allowed students to develop an overview of their academic progress.

In their randomized, controlled study of medical students taking a clinical oncology rotation, Finlay et al. (1998) reported that students who completed a 'hybrid' type portfolio showed greater factual knowledge of oncology compared to those who did not (Finlay et al. 1998). Student knowledge was measured using 'hidden' questions in their final OSCE examinations, and the difference between student groups was only statistically significant for weaker students. These authors also found that students who submitted their portfolios for formative assessment achieved higher overall scores in finals examinations than those who did not.

In their study of nursing students, Fakude and Bruce (2003) compared a group who had kept a learning journal for 8 weeks with a group who did not. At the end of the 8 weeks, each group was assessed by a clinical exercise. The 'journalling' group were better at formulating an appropriate response to similar future situations.

In their qualitative study of nursing students from Hong Kong, Tiwari and Tang (2003) reported that students felt building a collection–type portfolio had given them a better understanding of nursing theory, encouraged deeper learning and helped them apply their learning in practice.

Effects on student reflection and self-awareness. In their study of third year medical students who kept an electronic journal-type portfolio during their 1 month rotation in geriatric medicine, Duque et al. (2006) found that keeping the portfolio encouraged student reflection, as measured by the number of reflective evaluations posted by students and tutors during the course of the study. Driessen et al. (2005) reported that, providing that particular conditions for success are in place, using a portfolio may enhance students' reflective abilities, foster a critical attitude towards their own performance and help them to manage their development. Student confidence in their ability to reflect may be enhanced by sharing their experiences with other students and staff (Grant et al. 2006). Studies of nursing students have reported similar positive effects of portfolio use on reflection and self-awareness (Kok & Chabeli 2002; Schaffer et al. 2005).

In a study of year 4 students taking a course in paediatric dentistry, Dahllof et al. (2004) investigated student perceptions of the effects of using an interactive logbook (which met our definition of a portfolio) on their learning. Students reported that using the logbook encouraged them to reflect, increased their self-awareness and promoted their learning from clinical experience. Students who were already well-disposed towards reflection and the idea of keeping a logbook were more likely to report these effects.

In their study of the views of practice teachers, Spence and El-Ansari (2004) questioned the quality of the reflections found in student portfolios. These authors reported that, whilst most respondents to their questionnaire felt that their portfolio encouraged nursing students to reflect on their practice, some expressed concerns about the quality of evidence provided by the students. Richardson and Maltby (1995), who analyzed reflective diaries completed over a 4 week period by nursing students in the second year of their course, also found that diary writing promoted reflective practice and the development of skills of reflection and learning. However, diary entries were weighted towards the lower levels of reflection such as discussion and description of experiences and awareness of feelings, with higher level skills of critical enquiry and problem-solving only rarely apparent. These authors also suggested that assessment may inhibit the development of reflection but that, without assessment, students may be unwilling to engage in reflective activity.

More positively, in her qualitative study of the use of interactive journals in the mental health component of an undergraduate occupational therapy course, Tryssenar (1995) noted increasing maturity in the themes emerging from students' reflections as the module progressed and, notwithstanding the acknowledged limitations of their study, that keeping a reflective journal had the potential to promote student reflection.

Effect on feedback and student–tutor relationships. Studies from a range of professions have reported that using a portfolio improves the relationship between students and their tutors. In medicine, Lonka et al. (2001) found that using a portfolio allowed students to give better feedback to their teachers, which in turn made tutors more aware of student needs. In dentistry, Dahllof et al. (2004) reported that students felt that keeping an interactive logbook (portfolio) gave a structure to their discussions with their tutors, particularly with regard to feedback on their progress. The logbook encouraged tutors to give students feedback on the management of patients and therapy planning, not only on the technical procedures relating to operative treatment. In occupational therapy, Tryssenar (1995) noted the positive effects of providing feedback on student journal entries on the ability of the staff to adapt to the course, to meet student needs and to reflect on and to share mental health practice issues with other staff. She also noted an increasing trust between students and staff that allowed students to share their feelings and concerns in a safe environment, supplementing discussions in what was often limited class time.

Emotional support for students in difficult situations. In medicine, Grant et al. (2006) reported that the reflection required for keeping a portfolio provided emotional support for students experiencing difficult situations such as coping with a patient death. Similarly, Finlay et al. (1998) found that the tutorial support associated with portfolio learning provided students with emotional support for dealing with difficult situations. However, in the study by Driessen et al. (2005), one mentor suggested that the reflection required for keeping a portfolio could highlight situations in a student's personal life with which the student may find it difficult to deal.

In nursing, Nairn et al. (2006) found that their students appreciated the use of portfolios as a vehicle for the expression of their feelings. In contrast, other students (Kok & Chabeli 2002) have expressed a certain amount of distrust, with one student commenting

> *'I don't want to write down my emotions for others to read'.*

In dentistry, Dahllof et al. (2004) reported a decrease in the percentage of students who reported feeling uncomfortable in vague and ambiguous situations over the course of a year in which they kept an interactive logbook, suggesting an improvement in their ability to cope with uncertainty.

Preparation for postgraduate training. In two different studies involving medical students, Rees and Sheard (2004) and Rees et al. (2005) found that completing a reflective portfolio as an undergraduate increased students' self-confidence in their ability to complete a portfolio in the future and suggested that this was an important preparation for postgraduate training in which use of portfolios is increasingly widespread (Tochel et al. 2009).

Time requirement and effects on other learning. For medical students, constructing a portfolio was often seen as burdensome and time consuming, sometimes to the point where it detracted from their clinical learning, as in the study by Davis et al. (2001), in which some final year students felt that the demands of completing the portfolio had led to their becoming deskilled in clinical competences. In a heartfelt

comment, one student in the study by Rees et al. (2005) suggested that

> '*you end up spending so much time on the paperwork... that in actual fact your patient has probably dropped dead in the bed.*'

Whilst students in the study by Finlay et al. (1998) expressed similar concerns, these authors found that, in general, students who completed a portfolio did no worse in examinations than other students.

Nursing students have expressed similar concerns (Kok & Chabeli 2002).

Reviewing portfolios, whether for assessment or otherwise, may also be time-consuming and burdensome for tutors Davis et al. (2001).

Other effects. In their studies of undergraduate medical students, Davis et al. (2001) and Rees et al. (2005) reported that keeping a portfolio enhanced students' IT and organizational skills, respectively. Tiwari et al. (2003) found that nursing students based in Hong Kong who used a portfolio engaged in spontaneous collaborative learning, with students forming their own learning groups.

The influence of assessment. Whilst the majority of included studies assessed their portfolios and approximately half used summative assessment, either alone or with formative assessment, reports of the effect of assessment on student learning are mixed. In medicine, Grant et al. (2006) reported that students often see keeping a portfolio as an additional burden and are unlikely to engage in it voluntarily without the stimulus of assessment. In this study, of the 35 students who began their voluntary portfolio, 15 did not complete, citing burden of work as a factor in their decision to drop out of the programme. In their exploration of the conditions required for successful reflective use of portfolios, Driessen et al. (2005) also identified assessment as a motivating factor for student completion.

As noted earlier, amongst the final year students at Dundee Medical School, where final year assessment is by portfolio, there was a perception that missing the 'rites' of passage associated with traditional finals would leave them less confident as junior doctors (Davis et al. 2001)

In nursing, Richardson and Maltby (1995) have reported that assessment may inhibit students' willingness to express their feeling openly in their portfolio, with one student commenting:

> *'so you didn't want to write anything on there that was going to reflect negatively on your assessment'.*

Effects of an electronic format (e-portfolios). Duque et al. (2006) used a Virtual Learning Environment (VLE) based electronic portfolio with medical students on a geriatric medicine attachment. They found that the electronic format allowed tracking of situations in which students demonstrated particular skills and attitudes and provided a means of monitoring skills development over time. Students were able to post evaluations of learning to date and plans for future learning. Tutors and facilitators were able to post immediate feedback to students, both of which transformed the portfolio from a static record to a dynamic learning tool.

Garrett and Jackson (2006) gave final year medical and nursing students a 'clinical e-portfolio' consisting of a handheld device that combined electronic referencing and communication technology with the opportunity to reflect on clinical experience 'at the bedside'. In this small study, the six nursing and four medical students who took part used the technology mainly as a reference tool, preferring to complete the reflective requirements of their portfolio via a PC, away from the clinical setting. The authors concluded that interface limitations and time restrictions may make it difficult to 'engender an ethos of recording professional reflection' in the clinical setting. However, students found that the device reduced their feelings of isolation within the clinical setting.

Discussion

Main findings

Strength and extent of the evidence-base for the educational effects of portfolio use. In assessing the overall strength and extent of the evidence-base, it is appropriate to consider the methodological quality of relevant studies and the size, strength and impact of the effects seen. On all these measures, our review indicates that, for the undergraduate setting, the evidence base for the educational effects of portfolios is limited. Only approximately one quarter of the included studies met seven or more of our quality indicators, with a substantial proportion of items being unclear to our reviewers. Very few findings of statistical significance were apparent and most included studies were assessed at level 1 on the Kirkpatrick hierarchy, reporting student perceptions of the effects of portfolio use on their learning rather than direct changes in skills, attitudes or behaviours.

Given that, in our review, particular aspects of many studies were unclear to our reviewers even on close study of the full article, we would support calls made by other authors for more comprehensive, clear and thorough reporting of studies (Cook et al. 2007). However, our findings do suggest an improvement in the quality of studies published more recently. Across all professional groups, our analysis of included studies by year of publication indicates that studies published more recently were more likely to meet our quality criteria than those published before the year 2000. If such improvements are maintained, the next few years should see a welcome strengthening of the evidence-base for the educational effects of portfolios on learning.

In a recent article relating to medical education (Cook et al. 2008), researchers from the US and the Netherlands have identified three main purposes of educational research: Description (What was done?), justification (Did it work?) and clarification (How and why did it work?). Of the articles reviewed by these authors, relatively few addressed questions of description or clarification, leading these authors to call for a greater emphasis on clarification studies. Our review suggests that, in the case of the educational effects of portfolio use, further justification studies are also needed.

Features of portfolio use in the undergraduate setting

In recent years, much of the debate about portfolio use has concerned methods of implementation. Whether to make completion of a portfolio compulsory, whether reflection should be private to the individual or for sharing with other students and staff and how, when and whether portfolios should be assessed, have all been discussed (McMullan et al. 2003). Our findings show that, across all professional groups, completion is mostly compulsory; reflection by students required and shared with others; and assessment, whether formative or summative, included. Some differences between professions are apparent, such as the greater likelihood of nursing students to have portfolios that are primarily learning journals or diaries or to have portfolios that are not summatively assessed. However, a level of consistency of approach across the professions is apparent. Our findings may reflect a degree of pragmatism in the implementation of portfolios, with faculty prepared to accept potential disadvantages such as lack of honesty in reflection, 'writing for the assessment' and 'jumping through hoops' in favour of ensuring that all, or at least most, students engage with the process to some extent.

The educational effects of portfolio use and implications for practice. Within the limitations of the current evidence-base in this area, it is possible to identify some main messages about the educational effects of portfolios that will be of use to teachers and researchers and which have implications for the implementation of portfolios in the undergraduate setting.

The 'higher' quality studies identified by our review suggest benefits to student reflection and self-awareness, knowledge and understanding (including the integration of theory and practice) and preparedness for postgraduate training in which the keeping of a portfolio and engagement in reflective practice are increasingly important. Benefits to student–tutor relationships and support for students facing difficult emotional situations are also reported. Our included studies clearly suggest that implementing a portfolio at the undergraduate level can have important educational benefits that relate not only to student learning directly, but also to the way in which tutors approach their work when they have the feedback provided by student portfolio entries to guide them. However, several caveats are apparent, which institutions implementing portfolios would be well advised to take into consideration.

Firstly, whilst encouragement to engage in reflection and improved self-awareness are widely reported, the quality of student reflections seems to be very variable, with some evidence that sophisticated reflection by students is relatively rare. Kok and Chabeli (2002) suggest that portfolio programmes should be accompanied by detailed guidance to students on how to reflect and by feedback from tutors on at least some of their reflections, particularly when students are new to the reflective process. Systematic and structured approaches to the development of students' reflective abilities over time, encouraging increasingly sophisticated levels of reflection as courses progress also seem appropriate.

Secondly, the substantial time commitment required for completion of a portfolio may detract from other important aspects of learning and reduce students' willingness to engage in portfolio work unless compelled to do so by the requirements of assessment. This suggests that it is vital for faculty to ensure that portfolios can be completed as easily and efficiently as possible, perhaps through encouraging students to include fewer, but more telling, pieces of evidence and by applying strict word limits to content. Similarly students need to understand clearly the purposes of the portfolio and the types of evidence or journal entries that are appropriate to include; and portfolios need to be an integral, rather than additional, component of an undergraduate course, with appropriate credit given to the work that students produce.

In these respects, the findings of our wide-ranging review support the recommendations of Driessen et al. (2005) whose review of success factors for portfolio use in medical education identified appropriate structure, assessment and supervision, together with appropriate experiences on which to reflect, as key factors. This last is not always easy to attain, as noted by Davis et al. (2001) who reported that medical students found it difficult to meet the requirements of a prescriptive list of case discussions based on particular curriculum themes.

Whilst various authors have considered the potential benefits, challenges and desirable features of an e-portfolio format (Sikba 2005; Butler 2006; Duncan-Pitt & Sutherland 2006; Hudson 2006), direct evidence for the educational effects of this format is limited; and much work remains to be done to investigate whether an electronic format merely makes keeping a portfolio more convenient or changes fundamentally the nature of the learning that takes place. The small study by Garrett and Jackson (2006), in which the ability to reflect '*in situ*' was not found to be useful given the hurly burly of the clinical setting, suggests that perceived benefits may not always be realized in practice.

Methodological considerations

Search results and study selection. Our approach to this review has been exploratory. We have sought to survey and draw conclusions from the full range of literature available. However, partly for reasons of manageability, but also because we wished to consider portfolio use in courses with a clinical focus and a context of developing professionalism, our review included only studies of medical, nursing and other allied health professions such as dentistry, physiotherapy and radiography and excluded studies in professions such as teaching or law.

In keeping with the exploratory nature of our review, our definition of portfolio was broad, including the whole spectrum from collections of evidence type portfolios through to learning journals and diaries. In selecting studies, we found that the title of a learning tool was not always a good guide to its nature: for example, a 'logbook' could contain reflective elements and so fulfil our inclusion criteria (Dahllof et al. 2004).

Data extraction. We developed a comprehensive data extraction form which looked for extensive information about the type of portfolio, the ways in which the portfolio was used, the student population, study methods and quality

and effects on learning. Whilst all sections of the form yielded some data, some areas were difficult to code appropriately, particularly sections dealing with study design and with some of the quality indicators. For the main list of quality indicators (applicable to all studies), methods were often not reported in sufficient detail to allow a judgement to be made. For the additional detailed quality indicators for qualitative and comparative studies, so little useful information was available that these sections of the form were not analyzed.

Strengths and limitations of our work

Our review explores the use of portfolios by all the major clinical health professions. Papers were not excluded on the grounds of language, geography or date of publication; or by study design or quality, giving a comprehensive overview of the published literature in this field. At all stages, duplicate assessment of studies was carried out, with two independent reviewers at the article selection stages and confirmation by a second reviewer at the data extraction stage. We used a series of quality indicators to provide detailed insight into the strengths and weaknesses of the evidence-base in this area. Furthermore, our analysis of quality assessment scores by publication date provides evidence for an improving trend in the quality of published studies in this area.

Our review was limited to studies that were available from sources within the UK, which excluded 12 (2%) of studies identified as potentially relevant. Apart from published conference proceedings, our review did not explore the grey literature on this subject as it became apparent during the course of our review that there were significant limitations in the published literature which exploration of the grey literature was unlikely to contradict. In the circumstances, exploration of the grey literature was considered not to be an appropriate use of time and resources. Indeed, the detail we can provide in our review is limited by the fact that, in many published studies, particular features of methodology were not adequately reported.

We must also acknowledge that our review, as a systematic review derived from the methods of medicine and the biological sciences, may contain a bias towards more 'scientifically' designed studies at the expense of more qualitative research. Whilst some authors have argued strongly for rigour in educational research equivalent to that in clinical research (Hutchinson 1999), others have questioned the applicability of a medical model to education research (Evans 2001). In a heartfelt piece that compares learners to laboratory rats, Gruppen (2008) highlights graphically the particular difficulties faced by researchers in medical education.

Whilst necessarily working within the paradigm of the systematic review, we have tried strenuously to reduce such bias, for example by not using study design as a criterion for inclusion, by including in our review group those from a clinical/scientific background and those from a more social science background; and by striving to use quality indicators that reflect intellectual rigour in primary research rather than a specifically scientific approach.

To estimate study quality, we used a checklist of 11 quality indicators, each of which was marked as met, not met or unclear. Only where the written text of the report was clear on the particular point was an indicator marked as met or unmet: No assumptions were made about methodology where the text was not clear. Given that methodological quality and reporting quality are not necessarily synonymous (Huwiler-Muntener 2002), it is possible that, in some cases, an indicator may be met in the study but not reported clearly. In such cases, we may underestimate study quality. However, we feel that this is a valid approach given that the study report is the only evidence on which a reader can base a judgement about the appropriateness of the work.

Implications for further research

The majority of studies we identified reported student or tutor perceptions of the educational effects of portfolios. Very few used a comparative design. As such, there is clearly scope for further studies that observe directly the effects of portfolio use on student knowledge, skills and attitudes/behaviours. Similarly, few studies investigated the differential effects of portfolio use in particular student groups. Are portfolios equally beneficial for students with different levels of academic attainment? What is the optimum stage in a degree programme to introduce a portfolio? Given the time commitment required on the part of both students and tutors, the answers to such questions would allow institutions to focus their energies and resources in the most beneficial way.

In our study, it has not been possible to separate out the effects on learning of the different portfolio types, 'collection', 'journal' and hybrid. Studies of the effects of different types of portfolio on student learning, particularly with regard to encouraging students to undertake 'high quality' reflection, would be very valuable. Whilst many studies in our review identified encouragement to engage in reflection and greater self-awareness as benefits of portfolio use, few considered the quality of the reflections produced by students and those that did reported that reflections tended to be at a very elementary level. Studies that consider how best the insights of the literature on developing reflective skills may be applied in the context of portfolio use would be extremely valuable in furthering our understanding.

Some authors (Driessen et al. 2005) have suggested that appropriate coaching and mentoring are important for successful use of portfolios by students. In our study, it has not been possible to separate out the effects on *learning* of factors such as this. Comparative studies to investigate the effect of different portfolio types and methods of implementation would be a valuable addition to the evidence-base.

Current studies of electronic portfolios tend to concentrate on descriptions of systems implemented rather than direct investigation of educational effects, for example (Cotterill et al. 2005). Comparative studies of paper and electronic portfolios could clarify whether the additional facilities available on-line, such as discussion boards and blogs, change the nature of student learning with portfolios; or whether learning with electronic and paper portfolios is essentially the same, with perceived differences between the two relating to ease, or

otherwise, of use. Whilst such comparative studies are now beginning to appear in the literature (Driessen et al. 2007b), there is clearly considerable scope for further work. In particular, given the suggestion that using a portfolio may improve student–tutor relationships, it is appropriate to consider whether such benefits are enhanced or otherwise by the use of an electronic format.

An interesting finding of this review is the possible effect of portfolio use on the pedagogical approach of tutors, who adapt their teaching style in the light of the greater awareness of student need provided by the portfolio. Qualitative studies that explore this aspect directly would be able to assess the extent and value of this effect in greater depth than is apparent in the current literature.

And finally, it is very encouraging that our study suggests that, across a range of health care professions, the quality of reported studies is improving. Longitudinal studies of the quality scores of educational studies would provide a useful measure of trends in the quality of educational research, particularly if carried out across a range of subject areas.

Conclusions

Our review has collated the available evidence for the educational effects of portfolio use by undergraduate students from a range of health care professions. Whilst the strength and extent of the current evidence base for such effects is limited, the quality of reported studies in this area is improving across a range of health care professions. If such a trend continues and is replicated in other areas, substantial improvements in the quality of the evidence-base may emerge over the next few years.

The higher quality studies included in our review provide some evidence for a range of educational benefits of portfolios, including improvement in student knowledge and understanding, students' self awareness and engagement in reflection and improved student–tutor relationships that can lead to better feedback to students and to changes in pedagogic practice.

Whilst portfolios may encourage students to reflect, the quality of those reflections cannot be assumed. Furthermore, any benefits of portfolio use may be negated if the portfolio is seen by students as time-consuming, burdensome and an addition to the main requirements of their course. Attention to the manageability of portfolio completion is therefore essential (Box 1).

Our findings highlight the need for further studies that measure directly changes in student knowledge, skills or attitudes/behaviours; that tease out the relative benefits of different portfolio formats and that explore the possible differential effects of portfolio use with particular student groups. Further exploration of the development of reflective skills in the context of portfolio use and of the benefits to be gained from improved student–tutor relationships are also appropriate, as are longitudinal studies of trends in the quality of reported studies (Box 2).

As recent articles in the medical education press illustrate (Driessen 2008; Norman 2008), the debate about the pros and cons of portfolios is alive and well. Our review will allow faculty to take into account the available evidence for the educational effects of portfolio use across a range of health professions in deciding whether to implement a portfolio programme for undergraduate students in their institution.

Box 1. Key messages.

Higher quality studies suggest that portfolios:
- Improve knowledge and understanding, especially the ability to integrate theory with practice
- Lead to greater self-awareness and engagement with reflection
- Improve tutor feedback to students and tutor awareness of student needs
- Help students to cope with uncertain or emotionally demanding situations
- Prepare students for the postgraduate setting and reflective practice.

But that:
- The quality of student reflection in portfolios cannot be assumed
- The time commitment required for portfolios may detract from other clinical learning.

The strength of the evidence base for these effects is limited since most studies:
- Assessed student or tutor perceptions, with few comparative designs
- Were at level 1 of the Kirkpatrick hierarchy (participation effects including *post hoc* evaluations).

The quality of reported studies may be increasing since for all professional groups:
- The median quality score increased significantly with more recent publications.

Further work is needed to improve the evidence base, especially:
- Comparative studies that assess directly the effects of portfolios on student learning.

Box 2. Implications for further research.

Some unanswered questions:
- How do the different types of portfolio compare in their effects on student learning?
- Do electronic formats change how students learn with portfolios?
- Does academic attainment affect how students benefit from portfolios?
- When is it best to introduce portfolios into a course?
- How best can portfolios develop students' reflective skills?
- How does using a portfolio affect the pedagogical approach of the tutor?
- How do electronic formats affect student–tutor relationships?

The evidence base would be strengthened by:
- Comparative studies that measure educational effects directly
- Qualitative studies of effects on tutor practice
- Greater attention to comprehensive, clear and thorough reporting
- Monitoring of changes in the quality of reported studies over time.

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Note: The references list includes studies selected for inclusion in the review; some of which are not cited in the text.

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