Web- or paper-based portfolios: is there a difference?

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OBJECTIVE To determine the differential effects of a paper-based versus a web-based portfolio in terms of portfolio quality, user-friendliness and student motivation.

METHODS An experimental design was used to compare Year 1 medical students' reflective portfolios. The portfolios differed in presentation medium only (i.e. web-based versus paper-based). Content analysis, a student questionnaire and mentor interviews were used to evaluate portfolio quality, user-friendliness and student motivation. A total of 92 portfolios were scored independently by 2 raters using a portfolio quality-rating instrument.

RESULTS Portfolio structure, quality of reflection and quality of evidence showed no significant effects of presentation medium. Multi-level analysis showed a significant effect for student motivation: web-based portfolios scored 0.39 more than paper-based portfolios ($P < 0.05$; effect size 0.76). The mentors reported no differences in portfolio quality, except that there were more visuals in web-based portfolios. Students spent significantly more time preparing the web-based than the paper-based portfolios (15.4 hours versus 12.2 hours; $t = 2.1$, $P < 0.05$; effect size 0.46). The 2 student groups did not differ significantly in terms of their satisfaction with the portfolio. The mentors perceived the web-based portfolios as more user-friendly.

CONCLUSIONS The web-based portfolios were found to enhance students' motivation, were more user-friendly for mentors, and delivered the same content quality compared with paper-based portfolios. This suggests that web-based presentation may promote acceptance of portfolios by students and teachers alike.

KEYWORDS comparative study [publication type]; documentation/*standards; *motivation; education, medical, undergraduate/*standards; Internet; students, medical/*psychology; teaching materials; humans.

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INTRODUCTION

Portfolio use is on the increase in medical education. Portfolios are used not only as a source of information for assessments of functioning in authentic situations, but also as tools with which to stimulate learners to reflect on their learning experiences.[1] Web-based portfolios (WBPs) are often preferred over paper-based portfolios (PBPs).[2,3] This preference is generally based on the following purported advantages of WBPs:

- hyperlinks in WBPs facilitate presentation and promote diversity of reflection and evidence (*portfolio quality*);[3–5]
- students are inclined to present their reflections in a more concise and well structured fashion in WBPs because the documents must be easy to read on screen; in many cases this improves both portfolio structure and readability (*portfolio quality*);[6]
- WBPs are easier to use and can be accessed by several persons simultaneously (*user-friendliness*),[7,8] and
- students enjoy presenting themselves in WBPs; WBPs enhance students' motivation and sense of ownership (*student motivation*).[5]

Thus, on the surface, WBPs appear to offer many advantages. It has been suggested that a possible drawback is that electronic presentation may

Overview

What is already known on this subject

Portfolios can provide information about functioning in authentic situations and stimulate reflection on learning experiences. Presumed advantages of web-based over paper-based portfolios are: greater diversity of presentation modalities; greater ease of use; better organisation and structure of content, and enhanced student motivation.

What this study adds

A comparison between a web-based and a paper-based version of the same reflective portfolio showed that the web-based portfolio enhanced student motivation, improved ease of use for mentors and delivered a quality of content equal to that of the paper-based portfolio.

Suggestions for further research

We recommend a similar comparison study of portfolios aimed at assessing residents' clinical competence.

diminish depth of reflection[5] because it may deflect students' attention from content to form. So far, however, there is little evidence to substantiate either the positive or the negative claims. What evidence is available is mostly confined to descriptions of individual portfolios or different types of portfolios,[2,9] and measurements of students' and/or teachers' satisfaction with WBPs.[7,10]

Usage of WBPs suffers from a problem, pinpointed by Cook,[11] which is encountered with many computer applications in medical education: '…evidence supporting the use of these [web-based learning] tools is scant and often lags far behind technology, and there are some who fear that fascination with technology may outstrip actual learning gains.' As Cook[11] suggested, '…the time has come for hypothesis-driven comparative research in CBL and WBL' (i.e. in computer-based and web-based learning). In view of the growing popularity of WBPs in medical education and elsewhere, it is high time that we gathered some sound empirical evidence that can either support or refute claims that electronic portfolios offer added value compared with paper portfolios. The study we present in this paper was performed to gather such evidence. The key question of the study was: what are the differential effects of a WBP versus a PBP regarding portfolio quality, user-friendliness and student motivation?

METHODS

Design

We used an experimental design to compare WBPs and PBPs prepared by Year 1 medical students. The portfolios differed only in terms of the medium used (i.e. they were either web- or paper-based). Content, purpose and procedure were identical. We compared the WBP with the PBP format on *portfolio quality*, *user-friendliness* and *student motivation*.

Context

In the 6-year undergraduate medical curriculum at Maastricht University, the Netherlands, the learning environment in Year 1 is characterised by the use of authentic and real (patient) cases. The students in Year 1 use a portfolio to foster the development of their reflective skills. The design of this portfolio was based on experiences with portfolios described in the medical education literature and elsewhere.[12] Over the 4-year period since the introduction of this portfolio, we have refined the portfolio design guided by portfolio research conducted inside and outside our medical school.[1,13]

The WBP and PBP compared in this study include the same 3 components:

- written self-assessments of the student's personal development in 4 professional roles and the learning goals derived from these self-assessments, which are used to guide the student's ongoing development in these roles;
- evidence (artefacts, evaluations, etc.) underpinning the self-assessments, and
- feedback on the first 2 parts of the portfolio from the student's personal mentor.

The students have at least 2 one-to-one meetings with their personal mentor per year to discuss their portfolios. The mentor evaluates the student's reflective skills, as demonstrated in the portfolio, and suggests how these might be improved. This feedback is included in the portfolio.

On the basis of the portfolio, students' reflective skills are assessed (pass or fail) annually by the portfolio assessment committee. Although all mentors sit on the committee, they do not assess the portfolios of their own mentees. The portfolio and the assessment procedure have been described in detail elsewhere.[12,14]

Sample

Five of the total of 17 mentors for Year 1 of the undergraduate programme were randomly selected and asked to participate in this study. Participation was voluntary and each of the 5 mentors agreed to participate. Each mentor guides 2 groups of 9–10 students. One group of each mentor was randomly assigned to use the WBP ($n = 45$) and the other to use the PBP ($n = 47$). The differences in sample size reflect the differences in mentor group size. All students gave informed consent for the use of their portfolios for research purposes.

Treatment

The WBP and PBP we compared were homogenous in configuration and instructional methods[11] (i.e. goals, structure, integration in the learning environment, instruction, coaching and assessment). The only difference was the presentation medium:

- the PBP was presented in an A-4 ring binder with separate sections for the 4 professional roles, and
- the WBP was composed in the portfolio module of the medical school's electronic learning environment (Blackboard Content System), with a digital template for each of the professional roles.

Data collection

A mixture of methods was used to evaluate portfolio quality, user-friendliness and student motivation (Table 1). We will briefly describe which research instrument provided information on which aspects of the research question.

Table 1 Study design: research methods and research variables

	Portfolio quality	*User-friendliness*	*Student motivation*
Content analyses	WBP/PBP		WBP/PBP
Student questionnaire		WBP/PBP	WBP/PBP
Mentor interviews	WBP/PBP	WBP/PBP	

WBP = web-based portfolio; PBP = paper-based portfolio

Table 2 Items on the Modified Portfolio Quality Analysis Scoring Inventory

Quality of form and structure
- The portfolio is easy to use and information is easy to find

Quality of reflection
- The portfolio looks back to previous entries (i.e. what went wrong before, what went well this time and why, what did I say this time?)
- The analysis of strengths and weaknesses focuses on explanations for both (internal as well as external); the analysis goes beyond a mere listing of facts and situations
- The student has developed logical (following from the analysis of strengths and weaknesses) and clear learning goals in accordance with the SMART principle

Quality of evidence
- Whenever possible, statements are consistently supported by evidence
- Different types and sources of evidence are used

Additional effort put into the portfolio
- The student clearly made an effort to arrange the layout
- The student has put more effort into portfolio content than was strictly required

SMART = specific, measurable, acceptable, relevant, time framed

Content analysis

A slightly modified version of the Portfolio Quality Analysis Scoring Inventory[15] was used for the content analysis of the portfolios. The Inventory was constructed in an earlier study and consists of 15 items derived from interviews with experienced mentors and the literature.[15] The analysis yielded information about *portfolio quality and student motivation*. For the present study, only the most relevant items of the instrument were used (Table 2). The items were to be rated on a Likert scale of 1–5 (1 = definitely not applicable, 5 = definitely applicable).

Students' and mentors' perceptions

We developed a short questionnaire to assess students' perceptions regarding *user-friendliness and student motivation* (Table 3). Items 1–4 were to be rated on a Likert scale of 1–5 (1 = totally disagree, 5 = totally agree).

Mentors' opinions about *user-friendliness and portfolio quality* were gathered in brief semi-structured interviews with the mentors. The topics addressed in each interview were:

- ease of use of the portfolio;

Table 3 Student questionnaire about the portfolio's user-friendliness and its effect on students' motivation to work on the portfolio

1	The portfolio is easy to use
2	I think it is a good thing that my mentor can access my portfolio via the Internet (WBP only)
3	I enjoyed working on my portfolio
4	I am satisfied with my portfolio
5	Would you give a global estimate of the number of hours it took you to prepare your portfolio?

WBP = web-based portfolio

- differences in portfolio quality (form and content), and
- preference for portfolio medium.

Procedure

Each of the 92 portfolios were scored independently by 2 raters using the Portfolio Quality Analysis Rating Inventory. Three raters formed 3 different pairs and each pair scored approximately 61 portfolios. After rating 2 WBPs and 2 PBPs, the raters discussed the criteria in order to enhance inter-rater reliability.[16] Thereafter, they rated the portfolios independently. Rater agreement was analysed using generalisability theory.[17] With 2 raters, the dependability coefficient across items varied from 0.71 to 0.91. Of the 45 students in the WBP group and the 47 students in the PBP group, 42 (93%) and 42 (89%), respectively, filled in the questionnaire after they had completed their Year 1 portfolios. Non-response reflected the absence of students in the week the questionnaire was administered. The first author (EWD) interviewed the 5 mentors and took notes.

Data analysis

Content analysis

To estimate whether there was an effect of the medium used, (i.e. web versus paper), we investigated differences in *portfolio quality and student motivation* by analysing the rater pairs' mean ratings for question 1 (*Structure*), for question clusters 2–4 *(Quality of reflection)*, 5 and 6 *(Quality of evidence) and* 7 and 8 (*Additional effort*). Because the portfolios were nested within mentors, the data had a multi-level structure, so the effect of the medium used was estimated by multi-level analysis. The analysis was based on a model defined on 2 levels, level 1 (Portfolio) and level 2 (Mentor), according to:

$$\text{level 1}: Score_{ij} = \beta_{0j} + \beta_{1j} * Medium + \varepsilon_{ij} \quad (1)$$

$$\text{level 2}: \beta_{0j} = \gamma_{00} + u_{0j}; \beta_{1j} = \gamma_{10} + u_{1j} \quad (2)$$

where *Score* refers to the analysed rating; *Medium* is WBP or PBP (coded as 1 and 2); indices i and j refer to portfolio i and mentor j; β_{0j} is the level 1 intercept; β_{1j} is the difference in *Score* reflecting the different values of *Medium* (the effect of the medium used); u_{0j} and u_{1j} represent (random) mentor effects for the intercept and the slope of the level 1 equation; γ_{00} and γ_{00} are the fixed effects for the level 1 intercept and slope; and ϵ_{ij} is the level 1 residual. The computer program MLwiN Version 1.10[18] was used for multi-level analysis.

Students' and mentors' perceptions

T-tests were performed to estimate the differences in students' perceptions of *student motivation and user-friendliness*. Effect sizes were calculated and qualified according to Cohen.[19] We compared the results of the mentor interviews using a cross-case display matrix.[20]

RESULTS

Portfolio quality

Content analysis

The results of the content analysis (5-point Likert scale) are shown in Table 4.

Table 4 Mean scores (using a 5-point Likert Scale), standard deviations, standard errors and number of respondents for the content analyses of the web-based and paper-based portfolios

	Web-based portfolio				*Paper-based portfolio*			
	Mean	*SD*	*SE*	*n*	*Mean*	*SD*	*SE*	*n*
Structure	4.3	0.75	0.11	45	4.0	0.77	0.11	47
Quality of reflection	4.1	0.58	0.09	45	4.1	0.68	0.10	47
Quality of evidence	4.2	0.83	0.12	45	4.1	0.73	0.11	47
Additional effort	3.1	0.47	0.07	45	2.7	0.54;	0.08	47

SD = standard deviation; SE = standard error

The multi-level analysis according to the model specified in Equation 1–2 showed a significant effect of portfolio medium for *Additional effort*: the WBP scored 0.39 higher than the PBP (joint chi-square test, $P < 0.05$). The corresponding effect size is 0.76, which is considered large.[19]

For the clusters *Structure*, *Quality of reflection* and *Quality of evidence*, no significant effects of the portfolio medium were found, although the WBP had considerably, albeit not significantly, higher scores for *Structure* compared with the PBP. No significant effects for mentor were found.

Mentors' perceptions

The mentors observed no differences between the WBP and PBP with regard to content, except that more visuals were included in WBPs.

User-friendliness

Mentors' perceptions

The 5 mentors were unanimous in their appraisal of the WBPs as easier to read. The reason they gave was that they did not have to leaf through the WBPs when they were looking for specific evidence. Hyperlinks made the WBPs easy to navigate. The mentors also indicated that looking for specific evidence took more time in the PBPs than in the WBPs. One mentor said:

> '…in a paper portfolio I sometimes really have to search the appendices of the portfolio for the evidence the student refers to in the reflections. In the electronic portfolio I just click the hyperlink to go to the relevant evidence.' (Mentor 3)

Access from different locations was also cited as a positive point:

> 'I usually read the portfolios outside office hours. Therefore, it is nice that I can access the portfolios from my PC at home and don't have to carry the ringbinders between the faculty and home.' (Mentor 1)

Students' perceptions

The 2 student groups did not differ significantly in their evaluations of ease of use or enjoyment in working with the portfolios. The WBP group did not consider their format portfolio more user-friendly than that of the PBP group, but they did consider it advantageous that their mentors could access portfolios via the Internet (mean = 4.1, standard deviation [SD] = 1.0).

Student motivation

Students' perceptions

The WBP group spent significantly more time preparing their portfolios (WBP mean = 15.4 hours, SD = 7.6; PBP mean = 12.2 hours, SD = 5.7; $t = 2.1$, $P = 0.05$). This difference is of moderate practical importance, with an effect size of 0.46, which is considered a medium-sized effect. The 2 groups did not differ significantly in terms of satisfaction with their respective formats.

DISCUSSION

We investigated the effects of the medium used (i.e. web or paper), on *portfolio quality*, *user-friendliness and student motivation*. There was no significant difference between formats for 3 out of 4 portfolio qualities. Any apprehension that WBPs might induce more superficial reflection was not confirmed by the results. However, the quality of the WBPs was not superior to that of the PBPs, so claims that students provide better and more diverse evidence in WBPs were equally unconfirmed. Both types of portfolio yielded a highly satisfactory quality of both reflection and supporting evidence. Structure differed, but not significantly so, although it was rated considerably more highly for WBPs than for PBPs.

The WBP scored significantly higher than the PBP on *Additional effort*. The students added more personal touches to WBP content and form. Moreover, they spent significantly more time on WBPs than on PBPs. This more substantial time investment in WBPs compared with PBPs cannot be explained by extra effort required for electronic presentation of the portfolio. The students were quite familiar with the electronic learning environment, and WBPs and PBPs take similar amounts of time to construct. Possibly, electronic presentation of the portfolio motivates the students and encourages them to spend more time on the portfolio. Several authors have stated that WBPs can have a motivating effect on students.[5,21] Students are thought to enjoy presenting WBPs, which probably motivates them and enhances their sense of ownership.

The interviews showed that the mentors were unanimous in their appreciation of the greater ease of use

of WBPs. They mentioned that information was easy to locate without having to turn pages to find certain content and that the portfolios could be accessed from different locations, citing these as the reasons they preferred the WBP. Other authors have also reported the user-friendliness of electronic portfolios.[7,8] Tutors appreciated the easy electronic access and reduction in the amount of paper used.[7] However, the same authors also reported certain situations that make WBPs less user-friendly than PBPs. For instance, limited computer access in the workplace cancels out the advantages of user-friendliness and may even have an opposite effect. The students in our study rated WBPs and PBPs equally in terms of user-friendliness.

What are the implications of the findings of this study? Ownership and motivation have been regarded as crucial factors for effective portfolio use.[22] Students have generally reported that maintaining portfolios takes up a great deal of time.[23] Moreover, students are generally not very keen to engage in self-reflection and do not readily do so of their own accord.[24,25] In light of these reports, it seems important that the students in our study spent more time on the WBPs and showed a greater sense of ownership of portfolios in this format with respect to both form and content. This suggests that web-based presentation may enhance acceptance of portfolios among students.

The increased user-friendliness of WBPs for mentors can be viewed in the same light. Support by coaches has been shown to be a crucial factor in effective portfolio use.[13,26] For teachers, reading portfolios can make heavy claims on already limited time. The mentors in this study said that WBPs were easier and quicker to read than PBPs. We think this is a strong argument in favour of WBPs. With regard to content, there were no differences to support arguments in favour of or against either type of portfolio. Apparently, the quality of portfolio content is not affected by the presentation medium.

Although we did not explicitly investigate this, the study appears to provide support for the reliability of the assessment of the quality of portfolios, as we found acceptable levels of agreement between the raters (0.71–0.91). Another interesting finding is that the mentors had no significant impact on portfolio quality. This may suggest that the mentor training and peer assessment meetings that are regularly organised for mentors at Maastricht Medical School promote uniformity in the way mentors coach their students.

A striking finding is that reflection was rated quite highly for both types of portfolio (4.1 on a 5-point scale). Very different experiences with reflective portfolios have been reported in the literature. Pearson and Heywood[26] reported that the majority of registrars and their trainers failed to use the portfolio for reflection, as was intended. Most of the students in our study succeeded in producing a reflective portfolio of very satisfactory quality. This may be explained by the portfolio in our study meeting a number of conditions for effective portfolio usage, such as mentoring, a portfolio structure that stimulates reflection, and an adequate assessment procedure.[13]

A limitation of this study is that the students themselves were unable to compare WBPs and PBPs because each student used only 1 type of portfolio. Another limitation concerns the relatively small sample size of 5 mentors and 92 students for the survey part of the study (students' and mentors' perceptions). The results of the survey should therefore be interpreted with caution.

Finally, portfolios are used for a variety of purposes in medical education. The portfolio examined in our study was expressly aimed at stimulating reflection in Year 1 medical students. A similar study of a portfolio aimed at assessing residents' clinical competence may yield very different outcomes.

In summary, the WBP enhances student motivation, improves ease of use for mentors and delivers a quality of portfolio content equal to that of the PBP. These outcomes of our comparison between a web-based and a paper-based portfolio appear to warrant an overall conclusion in favour of the web-based format.

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