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WEB PAPER

Comparison of three problem-based learning conditions (real patients, digital and paper) with lecture-based learning in a dermatology course: A prospective randomized study from China

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Abstract

Background: The precise effect and the quality of different cases used in dermatology problem-based learning (PBL) curricula are yet unclear.

Aim: To prospectively compare the impact of real patients, digital, paper PBL (PPBL) and traditional lecture-based learning (LBL) on academic results and student perceptions.

Methods: A total of 120 students were randomly allocated into either real-patients PBL (RPBL) group studied via real-patient cases, digital PBL (DPBL) group studied via digital-form cases, PPBL group studied via paper-form cases, or conventional group who received didactic lectures. Academic results were assessed through review of written examination, objective structured clinical examination and student performance scores. A five-point Likert scale questionnaire was used to evaluate student perceptions.

Results: Compared to those receiving lectures only, all PBL participants had better results for written examination, clinical examination and overall performance. Students in RPBL group exhibited better overall performance than those in the other two PBL groups. Real-patient cases were more effective in helping develop students' self-directed learning skills, improving their confidence in future patient encounters and encouraging them to learn more about the discussed condition, compared to digital and paper cases.

Conclusion: Both real patient and digital triggers are helpful in improving students' clinical problem-handling skills. However, real patients provide greater benefits to students.

Introduction

Numerous obstacles were encountered in teaching dermatology to undergraduates, such as a shortage of trained faculty and limited class time (Burge 2002; Alahlafi & Burge 2005). Recent technological and computational advances have allowed the development of teaching modules such as self-learning digital modules, computer-assisted instruction and the online lectures for students to improve the quality of dermatology teaching and learning (Jenkins et al. 2008; Nast et al. 2009; Kaliyadan et al. 2010). However, dermatology is a profession that requires the lifelong ability to work through unique and challenging patient problems (Stratman et al. 2002). In this respect, lifelong effective learning skills, e.g., self-directed learning skills as well as problem-solving skills may be more helpful than modern information instruments. Moreover, in China and some other countries with limited financial resources, advanced modern informatics tools could not be widely used in dermatology courses. Conventionally, the teaching programme was under a didactic model. Added to this, dermatology is a subsidiary course in the medical curriculum system. Students usually view dermatology as inconsequential to their career objects, and put less energy and

Practice points

- The nature of student learning in PBL to a large extent depends on the quality of the case presented to the student.
- The precise effect used in dermatology PBL curricula is yet unclear.
- Real patients and video triggers in PBL dermatology curricula were well accepted.
- Both triggers could improve students' clinical problem-handling skills.
- Both triggers could complement with each other.

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effort into the study of this subject. Therefore, it is necessary that a more self-directed and motivated learning style be introduced to dermatology curricula.

It is well-known that problem-based learning (PBL) is an instruction method that is to promote students with knowledge suitable for problem solving, and has proved attractive to those teachers who seek improvements for their courses (Schmidt 1983; Taylor & Miflin 2008). Being different from modern informatics tools, this learning style is a powerful classroom process which motivates students to analyse and solve problems independently, work collaboratively and communicate effectively (Shamsan & Syed 2009). Previous studies have indicated that introducing PBL into dermatology is of benefit (Stratman et al. 2002; Goodyear 2005). However, there are few research works regarding academic performance of undergraduate students in a dermatology PBL curriculum.

The nature of student learning in PBL to a large extent depends on the quality of the case presented to the student (Shahabudin 1987; Dammers et al. 2001). Some worthwhile investigations supported that combining e-Learning components in PBL courses is of benefit (Huwendiek et al. 2009; Kong et al. 2009). In a recent survey, video triggers were superior to paper triggers in helping students to better understand the cases and providing the motivation to learn (Chan et al. 2010). However, visual nature of dermatology makes it important that the case should be real and be regarded by the students as being relevant to real-world clinical situations. According to previous reports, real patients are potent trigger stimuli in PBL (Diemers 2007), and virtual patients 'engage students effectively in learning' (Conradi et al. 2009). Moreover, it has been suggested that the use of real patients creates a strong motivational context, fosters sense of responsibility, brought complexity and encouraged an elaborated learning and empathic dimension, which is unlikely to be experienced with a paper case (Dammers et al. 2001). We hypothesized that using real patients would be an effective stimulus in improving students learning skills and academic results in dermatology. The major object of this study was to compare three PBL conditions (real patients, digital and paper) with traditionally lecture-based learning (LBL) for evaluation of the learning outcomes of different teaching styles.

Methods

A total of 120 fourth-year undergraduate students were enrolled in this study. They were randomly assigned into four age- and sex-matched groups: one LBL group and three PBL groups, each consisting of 30 students. The LBL group received traditional didactic lectures. The three PBL groups were divided into nine subgroups total, each consisting of 10 students and a tutor. Three of these subgroups studied via real patient cases, three studied cases in digital form and the other three were given paper-based descriptions of cases. All teaching processes were accomplished by the same teaching faculty. Oral informed consent was obtained from each participant including patient, student as well as teacher. The study was approved by the local Ethics Committee.

Table 1.
Comparison of academic performances before the start of the course between LBL, PPBL, DPBL and RPBL groups (mean ± SD).

	Group	Written examination[a]	Overall performance[b]
Internal medicine	LBL	77.5 ± 5.5	2.83 ± 0.4
	PPBL	75.2 ± 10.0	2.73 ± 0.7
	DPBL	74.8 ± 17.2	2.67 ± 0.3
	RPBL	74.7 ± 7.8	2.63 ± 0.6
	p-Value	> 0.05	> 0.05
Surgery	LBL	76.8 ± 1.2	2.74 ± 0.4
	PPBL	77.3 ± 9.0	3.00 ± 0.5
	DPBL	73.8 ± 9.7	2.84 ± 0.4
	RPBL	74.6 ± 8.9	2.90 ± 0.5
	p-Value	> 0.05	> 0.05
Pathology	LBL	84.0 ± 7.5	–
	PPBL	85.9 ± 3.4	–
	DPBL	81.8 ± 10.9	–
	RPBL	82.4 ± 9.2	–
	p-Value	> 0.05	–

Notes: [a]Analysed by means of the one-way ANOVA.
[b]Analysed by means of the Kruskal–Wallis test.

Methods for each course

After an informal survey, five usual dermatology conditions in clinical practice including eczema, superficial mycosis (e.g. tinea corporis/cruris/manus/pedis), psoriasis, urticaria and drug eruptions were chosen as PBL problems. And, the training sessions for the teaching faculty and questionnaire were standardized before investigation. Before the study, we tested the similarity of the groups in terms of their previous academic performances by comparing their written examination sores as well as overall performance in major subjects (e.g. internal medicine, surgery and pathology). As presented in Table 1, there are no differences between four conditions among the treatment groups.

Each PBL group had tutorials before the presentation to introduce information about PBL, assign students to different subgroups and give them cases to work on. The problems consisted of the results and procedures for the case presentation, medical history, demographic data, physical examination, dermatologic examination, laboratory tests and assistant examination (when necessary) of the suitable patients were recorded by means of photography and video. Photos and videos were edited to create digital case modules, which included PowerPoint presentations and instructive videos demonstrating signs in dermatological examination. The digital case modules were given to the digital PBL (DPBL) group and the corresponding paper prescription cases were given to the paper PBL (PPBL) group. Real-patients PBL (RPBL) group studied similar cases as those addressed by the other two PBL groups. The RPBL course is designed according to the published literature (Dammers et al. 2001). In the LBL group, the teacher made a presentation and then described the solution to similar clinical cases to those addressed by the PBL groups. Besides, each group had equal amount of outpatient/bedside teaching time to see patients with typical symptoms

Table 2.
Grades of student performances evaluated by tutors ($n = 30$/group)[a] (mean ± SD).

Items	LBL group	RPBL group	DPBL group	PPBL group
1. Analytical skills	1.97 ± 0.96*	3.93 ± 0.907****	3.83 ± 0.95	3.66 ± 0.84
2. Problem-solving skills	1.57 ± 1.01*	3.83 ± 0.75*****	2.63 ± 0.81	2.23 ± 0.73
3. Demonstrates viewpoints of initiative and curiosity	2.17 ± 0.59*	3.10 ± 0.92****	2.80 ± 0.81	3.03 ± 0.96
4. Utilizes relevant materials to get appropriate information actively and effectively	1.67 ± 0.99*	3.50 ± 0.90*****	2.27 ± 1.05	2.10 ± 0.96
5. Be capable of proposing hypotheses and issues	2.17 ± 1.01**	2.90 ± 0.88****	2.67 ± 0.84	2.70 ± 0.95
6. Be engaged in the course actively	1.80 ± 1.00*	2.80 ± 0.81****	2.40 ± 1.00	2.43 ± 0.82
7. Applies knowledge to new situations to solve problems and to reach decisions	1.93 ± 0.87*	3.43 ± 0.94*****	2.43 ± 0.82	2.63 ± 0.61
8. Interaction/collaboration skills	2.23 ± 1.04*	3.73 ± 0.74*****	2.86 ± 0.82	2.70 ± 0.75
9. Expression/communication skills	2.43 ± 0.97***	2.67 ± 1.03****	2.67 ± 0.84	2.47 ± 1.20
10. Shares thoughts and opinions with peer actively	2.93 ± 0.87***	3.47 ± 1.14****	2.80 ± 1.10	3.03 ± 0.81
Overall performance	2.09 ± 0.27	3.34 ± 0.25*****	2.74 ± 0.27	2.70 ± 0.34

Notes: [a]Analysed by means of the Kruskal–Wallis test.
*$p < 0.001$, compared with the three PBL groups.
**$p < 0.05$, compared with the three PBL groups.
***$p > 0.05$, compared with the three PBL groups.
****$p > 0.05$, compared with the other two PBL groups.
*****$p < 0.001$, compared with the other two PBL groups.

and signs. Each condition lasted seven weeks and there were no differences in instruction time for the four groups.

Relevant resource materials were available for every student, including textbooks, journal articles, clinical photos and Internet to gather information regarding the problem presented by the case.

The assessments

Each participant was informed that both written examination and clinical examinations had to be taken to pass the subject. The written examination comprised three sections, with a maximum score of 100. The first section included 20 multiple choices questions. In the second section, students were asked to write 10 short answer questions and two discussion essays, both theoretically (e.g. aetiology, histopathology). The third section consisted of two clinical application questions (e.g. case management, writing of prescriptions). The duration of the written examination was 120 min. Also the clinical examination, had five stations (eczema, superficial mycosis, psoriasis, urticaria and drug eruptions), each lasting for 10 min. Students were given brief information sheets totalling about 20 photographed clinical cases, with a maximum score of 50. The students were expected to have at least met the following objectives: (1) to recognize and describe rashes correctly; (2) to make correct diagnosis and management of the cases and/or (3) to assess the situation of the patient based on the available data. Standard score sheets were filled in by two tutors, one was an attending doctor of Dermatology, and the other was an Associate Professor of Dermatology. Student performance during the interval practice was evaluated by the tutors, rating their performance on a five-point scale which ranged from 1 to 5. The scale consisted of 10 items and specifically addressed the student skills, knowledge and their initiative of practice and thinking (Table 2).

A five-point Likert scale questionnaire with 16 items was used to evaluate student perceptions of the effectiveness of lecture-based and three PBL styles, ranging from 1 (strongly disagree) to 5 (strongly agree) (Table 3). The questionnaire was designed based on previous literature works and modified (Chen et al. 2006; Kong et al. 2009; Kaliyadan et al. 2010), categorized into two areas namely: (1) student's self-evaluation on skills and (2) student's attitude towards the teaching method, quality of cases and the content of the course. Each form also had space for comments. Examinations and evaluations were completed by students and tutors immediately at the end of the course.

Statistical analysis

The results of both written and clinical examinations were analysed using the one-way ANOVA. The grades of student performance in the practice procedure were analysed using the Kruskal–Wallis test. Student perceptions were analysed using the Kruskal–Wallis test or χ^2 test. SPSS for Windows, version 13.0 (IBM SPSS, Chicago, IL), was used for all analyses.

Results

The assessments

All students participated in both the written and clinical examination and answered the structured questionnaire at the end of each course. Figure 1 depicts the academic results from the comparison of the written and clinical examination scores for the LBL group and the three PBL groups that used real patients, digital and paper-based cases, respectively. Compared with the LBL group, the mean written examination sores of the three PBL groups were significantly higher (74.5 ± 8.3, 71.8 ± 10.7 and 71.3 ± 10.8) than the LBL group (60.3 ± 12.5; $p < 0.05$), but there was no significant difference ($p > 0.05$) between the three PBL groups.

Moreover, results of the clinical examination in the three PBL groups (36.3 ± 6.9, 30.7 ± 8.8, 27.5 ± 8.3) were better than

Table 3.
Comparison of student opinions on the learning style, quality of cases, and the content of the course in lecture-based ($n = 30$) and three PBL groups ($n = 30$/group)[a] (mean ± SD).

Summary of student opinion	LBL group	RPBL group	DPBL group	PPBL group	*H*-value	*p*-Value
1. The learning style was effective in helping develop my self-directed learning skills	3.40 ± 0.93	4.70 ± 0.53	4.00 ± 1.05	4.17 ± 0.99	26.49	< 0.001[b]
					7.89	0.019[c]
2. The learning style was effective in helping increase my problem-solving skills	3.80 ± 1.00	4.63 ± 0.67	4.60 ± 0.567	4.53 ± 0.82	17.21	0.001[b]
3. The learning style was effective in helping sharpen my analytical skills	4.20 ± 1.10	4.37 ± 0.96	4.07 ± 1.23	4.53 ± 0.82	2.47	NS[b]
4. The learning style was effective in helping improve my expression/communication skills	3.87 ± 0.97	4.67 ± 0.61	4.40 ± 0.77	4.53 ± 0.73	15.02	0.002[b]
5. The learning style was effective in helping increase my interaction/collaboration skills	2.97 ± 1.10	4.73 ± 0.64	4.50 ± 0.78	4.53 ± 0.78	46.12	< 0.001[b]
6. The learning style greatly impacts my way of learning	3.53 ± 1.31	4.77 ± 0.43	4.83 ± 0.38	4.90 ± 0.31	35.95	< 0.001[b]
7. The learning style motivated and inspired my interest to learn	3.10 ± 1.06	4.60 ± 0.67	4.80 ± 0.41	4.43 ± 0.77	47.04	< 0.001[b]
8. The learning style improved my confidence in future patient encounters	3.67 ± 1.03	4.50 ± 0.82	3.87 ± 1.07	4.03 ± 0.89	11.65	0.01[b]
					7.46	0.024[c]
9. The same should be replicated in other subjects (other than dermatology)	3.70 ± 0.88	4.47 ± 0.82	3.93 ± 1.20	4.03 ± 1.22	9.69	0.02[b]
10. Cases were well designed	4.63 ± 0.56	4.77 ± 0.50	4.83 ± 0.38	4.50 ± 0.73	5.03	NS[b]
11. Cases demonstrate appropriate knowledge of the subject area	4.40 ± 0.77	4.27 ± 0.78	4.57 ± 0.68	4.47 ± 0.78	2.75	NS[b]
12. Cases are relevant to real-world clinical situations	4.10 ± 0.92	4.93 ± 0.25	4.70 ± 0.65	3.93 ± 0.94	28.27	< 0.001[b]
					24.66	< 0.001[c]
13. Using the cases has encouraged me to learn more about the discussed condition	3.13 ± 1.41	4.83 ± 0.38	4.10 ± 0.99	4.27 ± 0.98	29.82	< 0.001[b]
					10.64	0.005[c]
14. The course was well organized in a way that helped me achieve the learning objectives and outcomes	4.33 ± 0.96	4.53 ± 0.78	4.33 ± 0.92	4.27 ± 1.08	0.94	NS[b]
15. The course created a positive learning environment where I felt supported in my learning	4.30 ± 0.84	4.37 ± 0.89	4.40 ± 0.97	4.23 ± 0.82	1.88	NS[b]
16. Overall, I was satisfied with the quality of this course	3.83 ± 0.79	4.53 ± 0.68	4.13 ± 1.28	4.00 ± 1.26	10.88	0.012[b]

Notes: NS, not significant.
[a]Analysed by means of the Kruskal–Wallis test.
[b]Compared between the four groups (i.e. LBL, RPBL, DPBL and PPBL groups).
[c]Compared between the three PBL groups (i.e. RPBL, DPBL and PPBL groups).

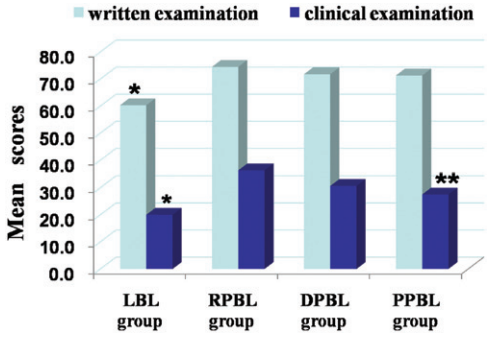

Figure 1. Comparison of LBL, RPBL, DPBL and PPBL groups regarding learning effectiveness measured in terms of the examination scores.
Notes: *$p < 0.05$, compared with the three PBL groups.
**$p < 0.05$, compared with the other two PBL groups (i.e. RPBL and DPBL groups).

the LBL group (20.0 ± 9.9; $p < 0.05$). No significant difference was found between RPBL and DPBL groups ($p > 0.05$), but both groups had better results than PPBL group ($p < 0.05$).

For the overall performance, three PBL groups (3.34 ± 0.25, 2.74 ± 0.27, 2.70 ± 0.34) were better than those of the LBL group (2.09 ± 0.27; $p < 0.001$). Students in RPBL group exhibited better overall performance than those in the other two PBL groups ($p < 0.001$). But no significant difference in grades of student overall performance was found between DPBL and PPBL groups ($p > 0.05$). With regard to each item (Table 2), there was significant difference between LBL and the three PBL groups ($p < 0.05$ or $p < 0.001$), except items 9 and 10. In addition, students in RPBL group exhibited better performance in problem solving and interaction/collaboration skills, applying knowledge to new situations and utilizing relevant materials to get appropriate information actively and effectively than those in DPBL and PPBL groups (all $p < 0.001$).

Student perceptions

As presented in Table 3, students felt that the PBL system is superior to the conventional study in helping develop their skills including self-directed learning skills ($p < 0.001$), problem-solving skills ($p = 0.001$), interaction/collaboration skills ($p < 0.001$) and expression/communication skills ($p = 0.002$), motivating their interest to learn ($p < 0.001$) and impacting their way of learning ($p < 0.001$). Compared to those in the LBL group, more participants in PBL groups strongly agreed that their learning style should be replicated in other subjects ($p = 0.02$), and using the cases encouraged them to learn more about the discussed condition ($p < 0.001$). Moreover, both real patients and digital cases were considered to be more relevant to real-world clinical situations than paper cases ($p < 0.001$). As shown in Figure 2, more students in RPBL group strongly agreed that the course was effective in helping develop their self-directed learning skills ($p = 0.019$), improving their confidence in future patient encounters ($p = 0.025$), and using the cases encouraged them to learn more about the discussed condition ($p = 0.005$) than those in the other two PBL groups. Greater satisfaction with the teaching model was higher for students in RPBL group, DPBL group or PPBL group than in their counterparts in the LBL group ($p = 0.012$), but there was no difference between all the PBL groups ($p > 0.05$).

Of all the PBL participants, 15.6% (14 out of 90) stated that they had spent many hours on tutorials, discussion with classmates and information retrieval outside the classroom.

Discussion

There is dearth of research conducted to investigate an educational methodology for dermatology curricula improvement (Stratman et al. 2008). This study was undertaken to compare the effectiveness of LBL and PBL, and investigate features that characterize effective cases in dermatology PBL curricula. In this study, students reported greater satisfaction with the PBL model compared to the LBL. Moreover, student academic results as measured by written and clinical examination as well as student performance of all the PBL groups were much better than those of the conventional group. According to questionnaire data, the improved academic results may be partly due to the motivated student's interest in learning and the improved initiative of practice and thinking. Although 15.6% of our students in PBL groups stated that they consumed much time on tutorials, discussion with classmates and information retrieval outside the classroom, PBL does not require an increase in number of faculty, time and cost. In addition, there are previous literature works which provided excellent resources about the benefits of PBL in dermatology (Stratman et al. 2002; Goodyear 2005; Hamdy & Agamy 2011) or the tips for PBL success (Azer 2011).

In contrast to the above optimistic view of the effect of PBL on academic results, some investigators argued that PBL does not show improved learning outcomes compared with traditional educational methodology (Antepohl & Herzig 1999; Likic et al. 2009). The inconsistent findings about PBL and its effect on academic results may be explained by several factors: (1) students in China have for a long time studied under a didactic model, thus a change of learning style may dramatically impact their perceptions and learning outcomes; (2) the effectiveness of PBL system on student learning outcomes may be dependent on specific features of the subject itself and (3) the sample size in this study was relatively small, and may result in sampling bias.

Dermatology is a subject with an inherited visual nature, and the recognition of rashes is often gleaned by the senses. This is somewhat 'seeing is believing'. Only when the student witnesses the rashes does he or she truly know what 'plaque' or 'patch' is and, on the next encounter with these rashes, the student will require less time to make a correct answer. This prominent feature of dermatology makes it perfectly suited to incorporate real patient or digital technology in its teaching.

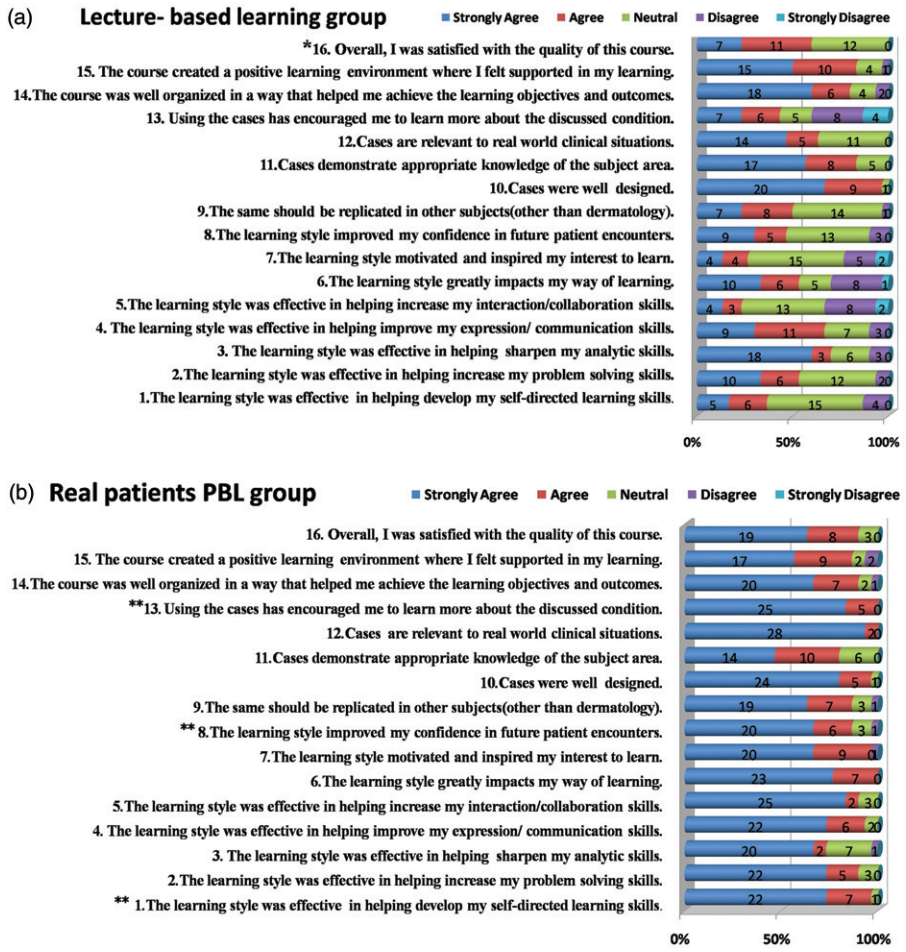

Figure 2. Student opinions on the effectiveness of lecture-based and three PBL styles. The 16 items in the questionnaire ranges from strongly disagree to strongly agree. Numbers of respondents were shown in the corresponding areas, and data were analysed by means of the χ^2 test.
Notes: $^*p < 0.05$, compared with the three PBL groups.
$^{**}p < 0.05$, compared with the other two PBL cases (i.e. digital and paper cases).

In this study, both real patients and digital cases were considered to be more relevant to real-world clinical situations than paper cases. Similarly, virtual patients trigger is reported to be more helpful in encouraging students to explore their learning (Poulton et al. 2009) or providing a more authentic learner environment than paper-based PBL cases (Conradi et al. 2009). Furthermore, in this investigation, students using real patients or digital cases had better results of clinical examination than those using paper cases. Because expert patients can influence and enhance the educational experience for students (Alahlafi & Burge 2005), real-patient triggers meant less lecture time, more student–patient interaction, which is helpful in overcoming some obstacles in dermatology teaching. In the present investigation, students in RPBL group exhibited better performance in problem-solving skills, interaction/collaboration skills, utilizing relevant materials to get appropriate information, and applying knowledge to new situations to solve problems and to reach decisions than those in the other two PBL cases. One previous investigation indicated that real-patients stimulate the use of a very wide range of resources and imaginative presentation of what had been learned, and improve their study motivation and confidence in future patient encounters (Dammers et al. 2001), which is supported by this study.

Compared to creating digital case modules which needs to record and edit many image/video fragments, using real patients needs fewer resources in terms of time, labour and funding. Moreover, in this investigation and in an another one (Dammers et al. 2001), the use of real patients presented no organizational or ethical difficulties. The major obstacle in using real-patient triggers was that there may be no patients with the relevant condition during outpatient/bedside teaching when digital cases can be used as supplement.

This study had some limitations. Firstly, the sample size was limited, which might impact on the power of these results. Secondly, we only performed evaluation immediately after the teaching intervention, but delayed testing of students for learning retentions was needed in evaluating a novel teaching methodology. The finding, however, could be of sufficient interest to warrant further investigation with larger samples and delayed testing of academic results.

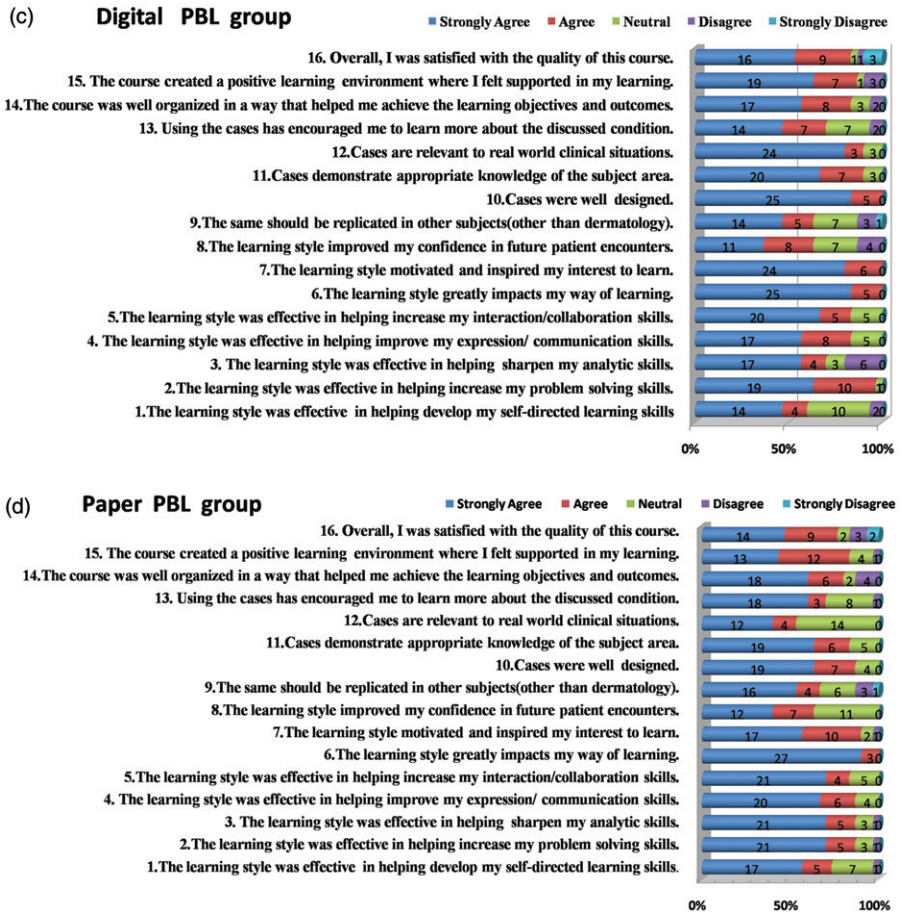

Figure 2. Continued.

Conclusion

These observations suggest that the incorporation of PBL into dermatology curricula could improve the quality and effectiveness of medical education in dermatology provided. Despite the limitations of the study, real-patients trigger in PBL is a beneficial learning style to improve academic performance and clinical skills in dermatology. In addition, real patients as well as digital cases could complement each other in a dermatology PBL curriculum. However, their usage could be generalized to provide guidance to curriculum development in other visual sciences like ophthalmology.

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Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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