2016-05-04

The Effects of Problem-Based-Learning on the Academic Achievements of Medical Students in One Japanese Medical School, Over a Twenty-Year Period

Masayuki Niwa
*Medical Education Development Center, Gifu University, Japan, mniwa@gifu-u.ac.jp*

Takuya Saiki
*Medical Education Development Center, Gifu University, Japan*

Kazuhiko Fujisaki
*Medical Education Development Center, Gifu University, Japan*

Yasuyuki Suzuki
*Medical Education Development Center, Gifu University, Japan*

Phillip Evans
*Medical Education Development Center, Gifu University, Japan*

Follow this and additional works at: https://hpe.researchcommons.org/journal

Part of the Health and Physical Education Commons

**Recommended Citation**

Niwa, Masayuki; Saiki, Takuya; Fujisaki, Kazuhiko; Suzuki, Yasuyuki; and Evans, Phillip (2016) "The Effects of Problem-Based-Learning on the Academic Achievements of Medical Students in One Japanese Medical School, Over a Twenty-Year Period," *Health Professions Education*: Vol. 2: Iss. 1, Article 2.

DOI: 10.1016/j.hpe.2016.01.003

Available at: https://hpe.researchcommons.org/journal/vol2/iss1/2

---

This Original Research Reports is brought to you for free and open access by Health Professions Education. It has been accepted for inclusion in Health Professions Education by an authorized editor of Health Professions Education.
The Effects of Problem-Based-Learning on the Academic Achievements of Medical Students in One Japanese Medical School, Over a Twenty-Year Period

Masayuki Niwa*, Takuya Saiki, Kazuhiko Fujisaki, Yasuyuki Suzuki, Phillip Evans

Medical Education Development Center, Gifu University, Japan

Received 11 January 2016; accepted 19 January 2016
Available online 4 May 2016

Abstract

Purpose: This investigation considered the cognitive outcomes, expressed by the academic achievement scores in basic and clinical sciences and the National Licensing Examination results of medical undergraduates.

Method: Cognitive outcomes were compared using the academic achievement scores in basic and clinical science and the National Medical Licensing Examination pass rates, during the two periods pre- and post-PBL.

Results: The scores were significantly higher post-PBL. Scores in clinical science were significantly higher in both male and female students post-PBL. Before PBL, the scores for female students were higher, whereas no difference between males and females was observed post-PBL.

Discussion: The results suggest that PBL is equal or superior to the traditional methods of developing cognitive ability. A superior pace of knowledge acquisition by male students after PBL was observed. This supports the hypothesis that PBL is a suitable education model for Confucian countries in place of predominantly classical teacher-centred education.

Keywords: Cognitive outcome; Japan; Long-term trend; Problem based learning; Undergraduate medical education

1. Introduction

In 1984, The World Federation for Medical Education, in collaboration with the World Health Organization initiated it's on-going programme of global reforms in undergraduate medical education. The impact generated a number of national developments in both the content and the educational principles, the most significant being recognition that a medical doctor should be skilled in autonomous, or self-directed learning, equipped for a lifetime of clinical practice. Arising from the debate as to how this might be achieved, evidence that problem-based-learning (PBL) had a significant role to play was widely endorsed. In 1995, after careful consideration of the evidence, Gifu University Medical School (GUSM) adopted a PBL curriculum within an organ-system curriculum structure, with the first cohort graduating in 2000. Since 1990, there have been numerous reports on PBL from Western cultures, reporting mixed conclusions of its merit. However, the outcomes of PBL in Asian countries remains controversial, and the debate

*Corresponding author. Tel.: +81-58-230-6466; fax: +81-230+6468.
E-mail address: mniwa@gifu-u.ac.jp (M. Niwa).

Peer review under responsibility of AMEEMR: the Association for Medical Education in the Eastern Mediterranean Region.
continues as to whether PBL is effective in East Asian countries, where a traditional teacher-centred Confucian learning style, is prevalent. The influence of cultural attributes on PBL in a non-Western setting is also controversial. The conventional Confucian style of teaching is one of formal didactic, teacher-centred instruction, prevalent in formal institutions. However, in Japan, clinical medicine has, historically, been learned through a case-based, apprenticeship approach. Therefore, the assertion is that PBL can be applied in a Japanese cultural context, by employing appropriate clinical and culturally sensitive approaches.

It is generally acknowledged that evaluation of PBL is a challenge with respect to validity and reliability. However, this paper reports on the academic results between 1990 and 2009, and makes a comparison with the national results. The authors believe that the nature of the data is sufficiently specific and sensitive to provide the basis for a robust analysis. The study focuses on four main themes; gender, content, examination results and some psycho-social issues.

1.1. Gender

A consistent finding in the literature is that female students tend to perform better than male students in their medical training and are more likely to attain an honours degree. Female gender has been found to be a positive predictor of clinical reasoning scores in a PBL medical programme.

1.2. Content

The literature has mixed reports of basic science results and PBL. Whilst it was reported that PBL was more effective than traditional didactic methods in biochemistry. This was not the case for teaching anatomy. This suggests that the effectiveness of teaching basic medical science may be dependent on the institution/learning environment. Japan has a long tradition of basic science-oriented medical education, and there is speculation that PBL may lead to the decrease of knowledge in basic medical science.

Whilst no difference was reported between PBL graduates and conventional students, in the literature about clinical competencies, there is evidence of a positive effect on social and cognitive domains. We have previously reported that communication skills, commitment and attitude toward clinical clerkship in the 5th years (in the university hospital) and 6th academic years (in the community hospitals) were both significantly better than those of non-PBL students.

1.3. Examination results

Enarson reported no difference in the results of USMLE between students who received PBL curricula and those who received traditional lecture-base curricula, while other reports indicated better outcomes in USMLE.

1.4. Psycho-social issues

Psycho-social influences include students’ preferences in choosing a school, the University admission's criteria, nature of curriculum reform, assessment, cultural and attributes. The factors that influence students’ choice of medical school, and the University admission procedures remain basically unchanged, and there was no obvious selection by students, or for students, for a PBL approach.

1.5. GUSM curriculum overview

In 1947, GUSM adopted a 6-year medical programme which was broadly similar to those of other Japanese medical schools, following the Confucian style of subject-based, formal teaching, with an emphasis on the acquisition and retention of knowledge by passive learning.

In 1995, a revised curriculum adopted an organ-based structure with 21 integrated modules, including, “The Human Body”, “Metabolism and Functions”, “Pharmacology and toxicology”, “The Gastrointestinal system”, “Cardiovascular system” and “Growth, development and genetics”.

Students meet in groups of 8, for an hour, 3 times per week and discuss a Faculty selected patient-based problem case, in the presence of a tutor. Additional learning opportunities are arranged in the form of related lectures, laboratory work and practical, skills teaching, self-directed learning hours, and private discussion-time are scheduled within the course.

1.6. Assessment

The scores of internal and National examinations of GUSM students were considered. Internal examinations were set at the end of each of four pre-clinical modules and 6 clinical modules.

All students enter the national Japanese Medical Licence Exam (JMLE), which follows the style of the USMLE. It is a rigorous examination, taken over three days, at the end of Year 6. Five hundred items of multiple-choice questions (MCQ) are set, covering a
wide spectrum of topics ranging from public health to clinical medicine. About 50% cover basic clinical and health-related knowledge and about 50% are questions based on clinical vignettes.

The JMLE provides an independent benchmark for measuring the performance of students, noting any trend on a year-by-year basis, and comparing GUSM students with students from other schools.

2. Method

The study is a retrospective, quantitative analysis of the performance of students in one medical school, with respect to the introduction of a PBL curriculum. The population was considered to be culturally homogeneous Japanese, though a small number of students were from other Asian countries, (1990–1999 \( N=13 \), and 2000–2009 \( N=5 \)). A longitudinal section of the results of GUSM students was completed using data from records of course work and from the JMLE. Over the same period, the JMLE results were used to compare the performance of GUSM students with the national cohort.

More specifically, the academic achievement data and JMLE pass rates students who graduated between 1990 and 2009 (\( N=1632 \) students) were anonymised and analysed (Table 1). The population was divided into non-PBL students (\( N=826 \)) who graduated between 1990 and 1999, and PBL students (\( N=790 \)) who graduated between 2000 and 2009. Six hold-over students in 2000 were not included as the PBL students in the statistical processing because they received a non-PBL education.

Table 1

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum</td>
<td>Non-PBL</td>
<td>PBL</td>
</tr>
<tr>
<td>Entrance</td>
<td>829(^a)</td>
<td>805(^b)</td>
</tr>
<tr>
<td>Graduation</td>
<td>826</td>
<td>790</td>
</tr>
<tr>
<td>Male</td>
<td>613 (74.2%)</td>
<td>499 (63.6%)</td>
</tr>
<tr>
<td>Female</td>
<td>213 (25.8%)</td>
<td>291 (37.1%)</td>
</tr>
<tr>
<td>Non-Japanese(^c)</td>
<td>13 (1.6%)</td>
<td>5 (0.6%)</td>
</tr>
<tr>
<td>Hold-over</td>
<td>88 (10.7%)</td>
<td>71 (9.0%)</td>
</tr>
<tr>
<td>Male</td>
<td>80 (13.1%)</td>
<td>62 (12.4%)</td>
</tr>
<tr>
<td>Female</td>
<td>8 (3.8%)</td>
<td>9 (3.1%)</td>
</tr>
<tr>
<td>Enrolment</td>
<td>6.15 ± 0.07</td>
<td>6.13 ± 0.06</td>
</tr>
<tr>
<td>Attrition (dismissed)</td>
<td>7 (0.8%)</td>
<td>8 (1.0%)</td>
</tr>
</tbody>
</table>

\(^a\)Admitted between 1985 and 1994.
\(^b\)Admitted between 1995 and 2004.
\(^c\)China, Korea, and Taiwan.

Other variables, (for example, selection and admission criteria, change in the ratio of male-female students, change in academic content, and the evolution of the assessment instruments) were recognised as background variables and it was assumed that they had no significant influence on the long-term trend of the data.

2.1. Data analysis

The Scores were the basic medical sciences (2nd and 3rd academic year) and clinical sciences (6th academic year graduation examinations) from the two groups. The Scores were from written examination associated with the individual courses (as stated in the figures) and were set and marked with regular frequency, and consistency, over the period in question. Significant differences were determined by \( t \)-test, or ANOVA followed by the Tukey-test. Statistical significance by Chi-squared test was accepted as \( p < 0.001 \). Data were represented as mean ± SD. * and ** indicate statistical significance at \( p < 0.05 \) and \( p < 0.01 \), respectively. NS: not significant.

3. Results

Table 1 shows the total numbers of graduates during 1990–1999 and during 2000–2009, of which 826 were female (25.8%) and 790 female (37.1%), respectively. The increase of female students was statistically significant by Chi-squared test at \( p < 0.001 \), though this increase was not specific to GUSM but was parallel to the general trend seen in other Japanese medical schools. The number of hold-over students who graduated during 1990–1999 and 2000–2009 were 88 and 71, respectively; this difference was not statistically significant.

Similarly, male and female hold-over student numbers, mean-enrolment years of students who graduated during both periods, and student dropout rates were also not statistically different.

Fig. 1A shows the annual trend of mean scores in 4 basic medical science subjects in the 2nd and 3rd academic year, during 1990–1999 and 2000–2009. The mean scores of the 4 subjects appeared to be higher in 2000–2009. Statistical analyses revealed that the cumulative mean score of the 4 subjects in 2000–2009 were significantly higher than those of 1990–1999 (Fig. 1B). Of these 4 subjects, anatomy and physiology & biochemistry in 2000–2009 were significantly higher than those of the 1990–1999 generations (Fig. 1C).
Fig. 1. Comparison of scores in basic medical sciences between non-PBL students (1990–1999) and PBL students (2000–2009). A. The trend of mean scores of 4 basic medical science subjects in the ten years before and after adopting PBL. The arrow indicates the year in which PBL was adopted. B, Comparison of cumulative mean score of these 4 subjects before and after adopting PBL. C, Comparison of mean score in each subject before and after adopting PBL. Data were represented as mean ± SD. * and ** indicate statistical significance at \( p < 0.05 \) and \( p < 0.01 \), respectively. NS: not significant.

Fig. 2. Comparison of scores in clinical subjects between non-PBL students (1990–1999) and PBL student (2000–2009). A. Trend of mean scores of 6 clinical science subjects in the ten years before and after adopting PBL. Arrow indicates the year PBL was adopted. B, Comparison of cumulative mean score of these 6 clinical subjects before and after adopting PBL. C, Comparison of mean score in each subject before and after adopting PBL. Data were represented as mean ± SD. *** indicate statistical significance at \( p < 0.001 \). NS: not significant.
Fig. 2A shows the annual trend of mean scores in clinical science subjects in the 6th academic year 1990–1999 and 2000–2009. The mean scores of the 6 clinical subjects appeared to be higher in the 2000–2009. Statistical analyses revealed that the cumulative mean score of 6 clinical subjects in the 2000–2009 were significantly higher than those of the 1990–1999 (Fig. 2B). Of these 6 subjects, 2nd internal medicine and 1st surgery in 2000–2009 were significantly higher than those of 1990–1999 (Fig. 1C).

Fig. 3A shows the annual trend of pass rate of JMLE in the study population, and that of national trend. The mean pass rate, in the university exams of 2000–2009 were significantly higher than that of 1990–1999 (p = 0.003) (Fig. 3B). The mean pass rate in the national examination was also higher in the 2000–2009 group (p = 0.05).

Fig. 4A shows the comparison of male and female students in the period of study. The mean cumulative scores of the 4 basic medical science subjects in both male and female students appeared to be higher in 2000–2009, though the differences were not significant. However, the mean cumulative scores in female students were significantly higher than those of male students in both groups: 1990–1999 (p < 0.01) and 2000–2009 (p < 0.05). Fig. 4B shows the comparison of cumulative clinical science scores. The mean cumulative scores of the 6 clinical subjects were significantly higher in both male and female students in the 2000–2009 (p < 0.001). In 1990–1999, the cumulative mean score of female students was higher than that of male students, whereas no difference between male and female students was observed in 2000–2009. Fig. 4C shows the mean pass rate of JMLE in the students of GUSM before and after PBL adoption. The mean pass rate of JMLE in female students was relatively higher than male students in both groups. The mean pass rate in 2000–2009 male students was significantly higher than that in the 1990–1999 groups (p < 0.05), whereas no difference was observed in female students.

4. Discussion

This study focused on the impact of the introduction of PBL in an undergraduate programme, over a twenty year period, taking into account the influence of four main themes; gender, content, examination results and some psycho-social issues.

4.1. Gender

The study confirmed that female gender is a positive predictor of clinical reasoning scores in a PBL medical programme. The cumulative scores of female students were better in basic medical sciences both in 1990–1999 and 2000–2009 generations. In clinical sciences, the cumulative score of male students in 1990–1999 generations were significantly lower than that of female students, however, the scores of male students improved significantly in 2000–2009, but no
difference was observed between male and female students during this later period. Furthermore, in male students, the mean pass rate of JMLE of the 2000–2009 generations was significantly higher than that of 1990–1999 generations. This suggests that a PBL approach improves knowledge acquisition in both genders.

4.2. Content

Our results show that mean score of the 4 basic medical sciences in 2000–2009 generations were superior to those of 1990–1999 generations, and the long-term data suggest that PBL has equally or better learning outcomes in basic medical science education (Fig. 1).

4.3. Examination results

With respect to assessment, the results suggest superiority of academic scores of clinical science in PBL generations. Better attitudes of PBL generations during the clerkship in the 5th and 6th academic years might have influenced the better academic scores in the final year examination, and have led to the better pass rate of the JMLE. Clinically oriented case-based discussions in the PBL may have improved the problem-solving ability through integrating bio-medical sciences into a clinical context and requiring critical thinking. Our results of better pass rates in the JMLE in 2000–2009 suggest that PBL may also improve clinical knowledge acquisition in a different cultural context. There were no additional discernable factors that would account for such a significant shift in overall performance.

4.4. Psycho-social issues

There is no evidence to suggest any adverse effect of PBL on students from a Japanese culture. The additional advantage of greater student satisfaction in clinical years, as has been previously reported.19,20 Furthermore, there is now a suggestion of an association between better student satisfaction and better clinical performance in a PBL programme.

5. Conclusions

The study suggests some superiority of PBL in the acquisition of medical knowledge. The study is valuable because there are no previous studies that have observed changes in cognitive ability over a 20-year period, with comparison before and after implementing PBL.
Furthermore, although it has been suggested that PBL is not suitable for medical schools in Asian or Confucian countries, our long-term data refutes this assumption, though the authors acknowledge that the study is limited to the experience of one medical school, and therefore we call for similar studies in other schools.

Disclosure

Ethical approval was granted by Gifu University School of Medicine Ethics Committee. There was no specific funding for this investigation, and the authors do not have a potential conflict of interest.

Acknowledgements

The authors thank Ms. Yumi Furuta and Ms. Yu Ando to help the analysis and interpretation of data. We also thank to staff of educational affairs section to decline to be named of all data.

References

3. Barrows MD Howard S, Tamblyn BScN Robyn M. Problem-Based Learning, An Approach to Medical Education. Springer; 1980.
24. Transition of mean national exam pass rate in all Japan. In MEAL (Medical Education Assets Library) in the web site of Japan Society for Medical Education: (http://www.meal-jsme.jp/blog/?page_id=12); Accessed 7.01.16.

Masayuki Niwa, Ph.D., is professor at the Medical Education Development Center, Gifu University, Japan.

Takuya Saiki, MD, Ph.D., is associate professor at the Medical Education Development Center, Gifu University, Japan.

Kazuhiko Fujisaki, MD, is professor at the Medical Education Development Center, Gifu University, Japan.

Yasuuyuki Suzuki, MD, Ph.D., is professor at the Medical Education Development Center, Gifu University, Japan.

Phillip Evans, B.Sc (London), M.Ed. (Wales), M.Sc. (CNAA), FHEA, was affiliated to the universities of Edinburgh and Glasgow prior to his appointment as Special Professor at MEDC Gifu.