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A multi-group modelling investigation of pharmacy practice training on the learning approach of Japanese pharmacy students

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Abstract

Background: The newly implemented six-year pharmacy course entails pre-clinical training and clinical rotation for fourth- and fifth-year students, respectively. Therefore, sustained learning motivation is crucial and is reflected through observed changes in the students' learning approach.

Objective: To investigate the effect of pharmacy practice training (PPT) programmes on the learning approach of fourth to sixth-year Japanese pharmacy students.

Methods: A revised two-factor study process questionnaire was administered to fourth- to sixth-year pharmacy students at the Josai International University. Changes in students' deep and surface learning approaches pre- and post-PPT were investigated using multi-group modelling.

Results: The 'deep approach' mean score significantly increased in sixth-year students. The effect size of the difference was medium (Cohen's d=0.51). The 'surface approach' mean score decreased with no significance per school year.

Conclusion: The PPT programmes raised students' 'deep approach' learning; thus, students could create meaning in their learning and construct ideas independently during PPT.

Keywords: *Learning Approach, Multi-group Modelling, Pharmacy Practice Training, Pharmacy Students*

Introduction

The traditional pharmaceutical education in Japan had been a basic science-oriented form of education with two pharmacy education programmes being offered: four-year and six-year courses. The six-year pharmacy education course, which started in 2006, aims to educate pharmacists in the improvement of the health of community and patients (Japan Pharmaceutical Association, 2015) and comprises of pharmacy practice training (PPT) programmes: (a) pre-clinical training for the fourth-year students and (b) a 22-week clinical rotation in community and hospital pharmacies for fifth-year students (Japan Pharmaceutical Association, 2015). As such, the long duration of the course requires sustained higher learning motivation for Japanese pharmacy students. In our previous paper, we reported that learning motivation based on self-determination increased after PPT for Japanese pharmacy students (Yamamura & Takehira, 2017).

The concept of learning approach, for tertiary level students, would chiefly relate to learning motivation, which positively influences their academic performance (Vansteenkiste *et al*., 2005; Liu, 2007). In deep approach learning, students are intrinsically interested; therefore, they would try to understand what they are studying, and the resultant problem-based learning was reported to enhance deep learning (Dolmans *et al*., 2016). Biggs *et al.* developed a Revised Study Process Questionnaire (R-SPQ-2F) to investigate the learning process of students with four defined components, namely, deep motive (DM), deep strategy (DS), surface motive (SM), and surface strategy (SS) (Biggs *et al*., 2001). The validity and reliability of R-SPQ-2F were confirmed in some education studies (Mokhtar *et al*., 2010; Mogre & Amalba, 2014). The R-SPQ-2F is also applied in professional education; for example, the questionnaire was used to investigate the study process for nursing students (Yardimci *et al*., 2017). In addition, Chen *et al.* (2015) examined the effect of progress testing on students' learning approach in a medical curriculum using R-SPQ-2F. Their study showed that R-SPQ-2F can evaluate the learning approach of medical students.

Thus, this questionnaire can be a tool to evaluate the style of learning approach and the effect of PPT on the learning approach of pharmacy students. Research that centres on the learning approach of medical and dental students has been published; however, studies that focused on pharmacy students remain scarce (Mann, 1999; Crossley & Mubarik, 2002; Shah *et al*., 2011).

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This study, thus, aimed to investigate the effect of PPT programmes on the learning approach of fourth- to sixth-year Japanese pharmacy students. In this study, we used a Japanese translated R-SPQ-2F to establish a model of the learning approach for Japanese pharmacy students, and with it, we investigated the effect of PPT programmes on deep and surface learning approach using multi-group modelling.

Methods

Sample

The participants comprised all 171 fourth- to sixth-year pharmacy students at the Josai International University, upon which 165 valid and complete responses were obtained. The survey was conducted in early April 2016 (the first semester commences every April in Japan). The students were informed about the purpose of the survey, and they were given instructions on how to complete the questionnaire. If students were willing to participate in the survey, they signed a consent form, after which they completed the questionnaire. The survey was approved by the ethics committee of the Faculty of Pharmaceutical Sciences at the Josai International University (approval ID: 45).

Questionnaire

The R-SPQ-2F was translated into Japanese by the two authors independently, after minor wording adjustments to fit certain Japanese expressions; as a result, the first Japanese version was developed. To countercheck the accuracy of the Japanese version, an independent translator retranslated it into English. If the English expressions were different between the original and translated versions, the authors translated the original R-SPQ-2F into Japanese again. The process was repeated until the retranslated English version reached almost the same expression to the original questions. The performance of R-SPQ-2F-J was determined by a confirmatory factor analysis described in the discussion section. The Japanese version of R-SPQ-2F is referred to as R-SPQ-2F-J. The 20 items were designed to serve as empirical indicators of the 'deep approach' and 'surface approach' components of students' learning.

The learning sub-scales, namely, deep motive (DM), deep strategy (DS), surface motive (SM), and surface strategy (SS), were calculated from the sum of responses to the respective items in R-SPQ-2F, as shown in Table I. The main scale for deep approach (DA) and surface approach (SA) was calculated by adding the item scores, as in DA=DM+DS and SA=SM+SS, respectively (Biggs *et al*., 2001). Students rated 20 items on a five-point scale: 1 means the item is never or only rarely true; 2 means the item is sometimes true for me; 3 means the item is true for me about half of the time; 4 means the item is frequently true for me; and 5 means the item is always or almost always true for me.

Table I: Question items in R-SPQ-2F

Item	Question
Q_01	I find that at times studying gives me a feeling of deep personal satisfaction.
Q_02	I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.
Q_03	My aim is to pass the course while doing as little work as possible.
Q_04	I only study seriously on what is given out in class or in the course outlines.
Q_05	I feel that virtually any topic can be highly interesting once I get into it.
Q_06	I find most new topics interesting and often spend extra time trying to obtain more information about them.
Q_07	I do not find my course very interesting so I keep my work to the minimum.
Q_08	I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.
Q_09	I find that studying academic topics can at times be as exciting as a good novel or movie.
Q_10	I test myself on important topics until I understand them completely.
Q_11	I find I can get by in most assessments by memorising key sections rather than trying to understand them.
Q_12	I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.
Q_13	I work hard at my studies because I find the material interesting.
Q_14	I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
Q_15	I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.
Q_16	I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.
Q_17	I come to most classes with questions in mind that I want answering.
Q_18	I make a point of looking at most of the suggested readings that go with the lectures.
Q_19	I see no point in learning material which is not likely to be in the examination.
Q_20	I find the best way to pass examinations is to try to remember answers to likely questions.
Deep motive (DM): Q_01+Q_05+Q_09+Q_13+Q_17	
Deep strategy (DS): Q_02+Q_06+Q_10+Q_14+Q_18	
Surface motive (SM): Q_03+Q_07+Q_11+Q_15+Q_19	
Surface strategy (SS): Q_04+Q_08+Q_12+Q_16+Q_20	
Deep approach (DM): DM+DS	
Surface approach (SA): SM+SS	

John Biggs and David Kember own the copyright of the original R-SPQ-2F; however, the questionnaire is allowed for research use upon fulfilling the conditions described in the paper (Biggs, Kember, & Leung, 2001). The questionnaire was administered to the sample participants before pre-clinical training (fourth-year students), before clinical rotation (fifth-year students), and after clinical rotation (sixth-year students), to ascertain the changes in the students' learning approach.

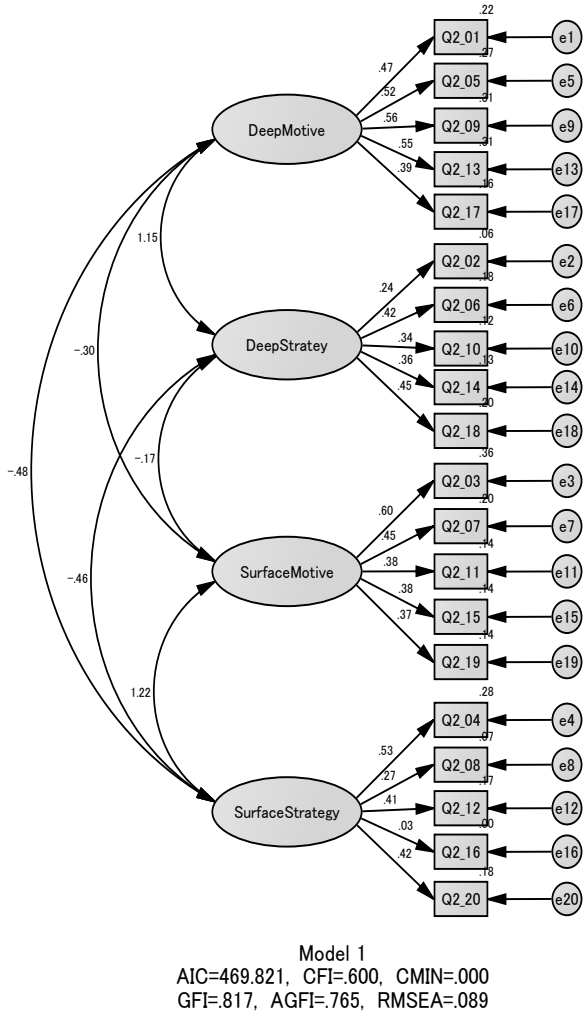
Statistical Analysis

We established two models by a confirmatory factor analysis as per Bigg's research: responses to items were used as the observed variable of latent variables of DM, DS, SM, and SS for Model 1, and DM, DS, SM, and SS were used as factor of Deep Approach (DA) and Surface Approach (SA) for Model 2. The goodness of fit of the model with the data was examined using several goodness-of-fit statistics, such as *chi*-square (CMIN/df), goodness-of-fit index (GFI), adjusted goodness-of-fit (AGFI), root mean square error of approximation (RMSEA), comparative fit index (CFI), and Akaike information criteria (AIC) (Schumacker & Lomax, 1996). Cronbach's *alpha* was calculated to examine the internal reliability of the latent variables in an item level model.

Multi-group analysis, particularly a multi-group confirmatory factor analysis, is a method used to investigate the measurement invariance and specifically, factor invariance. Multi-group analysis usually requires certain parameters in a model (*e.g.* factor loadings and intercepts among factors) to be constrained for model identification, which are assumed to be invariant across groups. A change in the remaining parameters among groups indicates the variance from the structural means identified (Byrne, 2001). For this reason, multi-group analysis is frequently applied in educational research (Steinmetz *et al*., 2009; Ryu, 2015).

Several models with imposing equality constrained for structural parameters and/or measurement parameters were built, and the best-fit model was determined using CFI and AIC. The confirmatory factor analysis and multi-group modelling were performed using AMOS version 23 (IBM Japan, Tokyo, Japan). Cronbach's *alpha* was calculated using SPSS version 23 (IBM Japan, Tokyo, Japan).

Figure 1: The structure of Model 1 with standardised estimators and goodness-of-fit statistics.



AIC: Akaike's information criteria; CFI: comparative fit index; CMIN: *p*-value of chi-square test; GFI: goodness-of-fit index; AGFI: adjusted goodness-of-fit (AGFI); RMSEA: root mean square error of approximation.

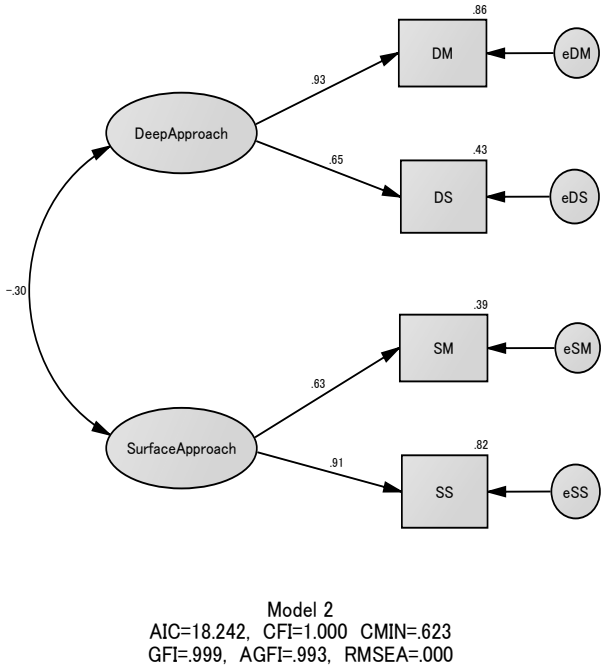
Results

Of the 171 pharmacy students who had participated in the study, 165 completed responses were obtained and used in the analysis: 65 out of 69 fourth-year students, 43 out of 45 fifth-year students, and 57 out of 57 sixth-year students. Overall, an effective response rate was 93.2%.

In the two models established by Briggs *et al.* (2001), Model 1 indicates the structure of the competent instrument from the items level, whereas Model 2 concentrates on testing the dimensionality of the whole instruments and thus treats the sub-scales as indicators of two latent variables DA and SA. The four indicators of DM, DS, SM, and SS in Model 2 are treated as observed variables instead of latent variables in Model 1. Model 1 and Model 2 examine whether the individual items would conform to the expected factor and test the anticipated dimensionality, respectively (Biggs *et al*., 2001).

Figure 1 shows the structure of Model 1 with values of standardised estimators by confirmatory factor analysis. Results from goodness-of-fit statistics of Model 1 did not meet conventional criteria in parentheses (Geiser, 2014): the *p*-value of *chi*-square test was 0.000 (p>0.05), CFI=0.600 (CFI>0.9), GFI=0.817 (GFI>0.9), AGFI=0.765 (AGFI>0.9), and RMSEA=0.089 (RMSEA <0.05). Cronbach's *alpha* of the latent variables in DM, DS, SM, and SS were 0.626, 0.430, 0.546, and 0.636, respectively, suggesting that the internal reliability of each latent variable was fair. Model 1 was not so good, but its internal reliabilities of latent variable were not inferior to the original model (Biggs *et al*., 2001). As will be described later, Model 2 was superior to Model 1; therefore, Model 1 was not considered to be a reasonable model for further discussion.

Figure 2: The structure of Model 2 with standardised estimators and goodness-of-fit statistics.



AIC: Akaike's information criteria; CFI: comparative fit index; CMIN: *p*-value of *chi*-square test; GFI: goodness-of-fit index; AGFI: adjusted goodness-of-fit (AGFI); RMSEA: root mean square error of approximation.

Figure 2 shows the structure of Model 2. The results of all goodness-of-fit statistics of Model 2 fulfilled conventional criteria in parentheses: CFI = 1.000 (>0.90), GFI = 0.999 (>0.90), AGFI = 0.993 (>0.90), RMSEA = 0.000 (<0.05), and CMIN = 0.623 (>0.05). The correlation coefficient between DA and SA in Model 2 was -0.30 (p=0.031), indicating a negative relation, as expected.

Using Model 2, multi-group modelling was conducted to investigate the change in students' learning approach within the school year. The multi-group modelling method could investigate the possibility of any change in the students' learning approach before and after the PPT programmes. By comparing the models with various equality constraints, changes in the learning approach framework over the years could be investigated. We investigated three constraint models: (a) Model A with measurement weights and intercepts that were constrained equal among three groups, (b) Model B, similar to Model A but with structural covariates that were constrained equal among three groups, and (c) Model C, similar to Model B but with measurement residuals that were constrained equal among three groups.

Table II shows the goodness-of-fit statistics for the three models with different equality constraints. The model with the best fit was Model A, evaluated from CFI or Model C, evaluated from AIC and RMSEA. The result suggests that either Model A or Model C could be the model with the best fit to investigate the change of learning approach per school year.

Table II: Fitting profile of various constrained models by multi-group modelling

Model	No. of parameters	*df*	CFI	AIC	RMSEA	*p*-value
Model A: Equal measurements weights and intercepts	31	11	0.996	73.559	0.018	0.395
Model B: Model A + Equal structural covariances	25	17	0.983	69.412	0.030	0.305
Model C: Model B + Equal measurement residuals	17	25	0.970	63.212	0.032	0.225

No. of parameters is the number of distinct parameters to be estimated.

df: degree of freedom; CFI: comparative fit index; AIC: Akaike information criteria;

RMSEA: root mean square error of approximation; p-value: chi-square test.

The threshold of the criteria of goodness-of-fit statistics could be contentious. Usually, a value of CFI would be a more important criterion for a best-fit model with data as compared to AIC (Geiser, 2013). However, both Model A and Model C were considered good fit models. Overall, despite a higher AIC, we selected Model A for the learning approach profiles of the sample pharmacy students.

Table III illustrates the mean score of four components with test statistics and effect size of Cohen's *d* (Cohen, 1988). The mean score of DA in the model was found to

Table III: Estimated value of the mean value of components

Component	Fourth-year students		Fifth-year students					Sixth-year students				
	Estimates	s^2	Estimates	s^2	C.R.	*p*	*d*	Estimates	s^2	C.R.	*p*	*d*
Deep Approach	0	10.175	0.614	5.338	0.854	0.393	0.18	1.355	3.431	2.428	0.015	0.51
Surface Approach	0	3.682	0.084	12.247	0.162	0.871	0.47	-0.579	5.911	-1.514	0.130	0.27

Because the means scores of components for fourth-year students were fixed to be 0, the estimates were the expressed difference of the mean score between fourth-year students and fifth or sixth-year students.

s^2: Variance; C.R.: Critical ratio; *d*: Cohen's *d* as effect size.

increase gradually with school year. A significant difference between fourth- and sixth-year students was found (p=0.015) with the effect size at d=0.51 (Cohen, 1988; Mayer, 2008). The mean score of SA in the model was found to decrease progressively with school year; however, the change was not significant.

Discussion

In order to investigate the learning approach of Japanese pharmacy students according to their year of study, we established two models, Model 1 and Model 2, using R-SPQ-2F-J. Model 1 was not good enough as a good fit model with data, as illustrated in Figure 1, because the response to item would be influenced by cultural and social circumstances surrounding the students. The questions translated into Japanese may also impress differently on the Japanese students, as compared with the original questions that were designed for English speaking students. The Cronbach's *alpha* of the internal consistency of each sub-scale of the Model 1 was not good enough (0.626 for DM, 0.430 for DS, 0.546 for SM and 0.546 for SS), but it was not so inferior to the original model (0.62 for DM, 0.63 for DS, 0.72 for SM and 0.57 for SS) (Biggs *et al*., 2001). These results suggest that the items in R-SPQ-2F-J are acceptable for the analysis of the learning profiles of the sample Japanese pharmacy students. Model 2 showed a better fit in the DA and SA with sub-scale data statistically and conventionally. These results indicate that responses to the items were not good enough to conform to each respective factor but could model the anticipate dimensionality of the learning approach of the sample Japanese pharmacy students.

The result of multi-group modelling suggests that Model A and Model C could be reasonable models to differentiate the learning approach of Japanese pharmacy students. Model C with its parameter constraints for all model parameters (*i.e.* measurement weights, measurement intercepts, structural covariates, and measurement residuals) except for structural means also showed good fit as Model A, thus indicating that the frameworks of the learning approach across school years would be almost the same. Based on CFI, we selected Model A as the best-fit model, but considerations of other models are also possible.

As shown in Table III, however, the mean score of DA increased, whereas the mean score for SA decreased with each school year. The mean score of DA between fourth- and sixth-year students was found to be statistically different (p=0.015), and a medium effect size of this difference was observed, as the Cohen's d is at 0.51.

In the curriculum of the six-year course of pharmacy education in Japan, the fourth-year students spend substantial amount of time in university in pre-clinical training, in which they learn not only basic clinical knowledge but also the skills and attitude required to receive practice training at clinical sites. Meanwhile, the fifth-year students are required to undergo clinical rotation for 22 weeks at clinical sites (*i.e.*, 11 weeks in hospital pharmacies and 11 weeks in community pharmacies). The survey was conducted with a three-point administration of the questionnaire: before pre-clinical training, before clinical rotation, and after clinical rotation. Changes in the students' learning approach based on the year of study would show the effect of PPT because fourth-year students would commence their pre-clinical training while fifth-year students would begin their clinical rotation of the PPT programme. Sixth-year students, on the other hand, would have completed the core components of the PPT programme, and they, thus would demonstrate the effect of the PPT programme on their learning approach.

The deep approach to learning-the parameters of DM and DS-would come from students' intrinsic interest and ability to maximise meaning (Dolmans *et al*., 2016; Yardimci *et al*., 2017). The increase of DA mean value suggests that intrinsic interests in learning motivation, and the skill to maximise meaning would increase with PPT for Japanese pharmacy students. Furthermore, fear of failure (SM) and simple memorisation by rote (SS) decreased with PPT. Thus, the negative correlation coefficient between DA and SA was found. The increase of DA with PPT training can be reasonably accepted because PPT in university and practice sites would raise students' learning motivation to become pharmacists.

Our findings, in which the mean value of a deep approach in learning increased after the PPT programmes, suggests that this is because students would have had experience in learning these skills during the PPT programmes in their fourth- and fifth-year of study at the university, as well as at the clinical sites.

Conclusion

The key outcome of this study suggests that the mandatory fourth- and fifth-year PPT programmes in the six-year pharmacy course can increase students' learning using the deep approach. This increase, as a result, will positively affect their learning motivation and skills to maximise meaning during their practical experience at clinical sites. These results also suggest that PPT programmes (fourth-year pre-clinical training and fifth-year clinical rotation) are meaningful in not only providing practical clinical experience but also deepening and extending their learning. As the present study was conducted in only one pharmacy school, future research using a cross-survey of other pharmacy schools may provide a more reasonable and solid model to examine the learning approach of Japanese pharmacy students.

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Author Disclosure

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