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Relationships between Language Background, Secondary School Scores, Tutorial Group Processes, And Students' Academic Achievement in PBL: Testing a Causal Model

Veena S. Singaram, Cees P. M. van der Vleuten, Arno M. M. Muijtjens, and Diana H. J. M. Dolmans

Abstract

Little is known about the influence of language background in problem-based learning (PBL) tutorial groups on group processes and students' academic achievement. This study investigated the relationship between language background, secondary school score, tutorial group processes, and students' academic achievement in PBL. A validated tutorial group effectiveness questionnaire was administered to undergraduate medical students in a PBL curriculum at the Nelson R. Mandela School of Medicine (NRMSM) in South Africa. Although 58 percent of the students did not speak English as their first language, the tutorials were in English. Furthermore, secondary school scores differed strongly due to inadequate resources between secondary schools. A path analysis was conducted to test a causal model in which the two independent variables were English as the First Language (EFL) and secondary school scores. These variables were assumed to influence the process variables (cognitive, motivational, and demotivational group processes). Input and process variables were assumed to influence the two output variables, being overall group productivity and students' academic achievement. All data were analyzed at the individual student level ($N = 387$). A very good model fit was found ($\text{CMIN/DF} = 0.68$, $\text{GFI} = 1.00$, $\text{TLI} = 1.02$, $\text{CFI} = 1.00$, $\text{RMSEA} = 0.00$). EFL and secondary school scores positively affected students' academic achievement (respectively $\beta = 0.24$ and $\beta = 0.16$). EFL negatively affected motivational group processes ($\beta = -0.22$). Cognitive group processes positively influenced overall group productivity ($\beta = 0.31$) and so did motivational group processes ($\beta = 0.27$). Demotivational group processes negatively predicted academic achievement and overall group productivity ($\beta = -0.15$, and $\beta = -0.25$). The model resulted in an R-square of 0.15 and 0.45 for academic achievement and overall

group productivity, respectively. EFL and secondary school scores had a positive effect on academic achievement. Cognitive and motivational group processes had a positive effect on overall group productivity, while EFL negatively impacted motivational group processes. We recommend English language development courses to be formally included into curricula to enhance student learning.

Keywords: PBL, tutorial group learning, causal model

Introduction

In his summary of three decades of problem-based learning (PBL) research, Ravitz (2009) noted concerns about the use of PBL with diverse students who lack language skills. He called for studies that consider the effects of language background on the use of PBL and its outcomes. In general, discussion in tutorial groups has been found to have positive cognitive effects and positively influences students' intrinsic interest in the subject under discussion (Dolmans & Schmidt, 2006). But most of the studies in this area were conducted in PBL settings with a rather homogenous student population. Little is known about the effects of PBL on tutorial group processes and academic achievement in PBL settings in which students differ from one another in terms of language proficiency and secondary school scores.

Singaram, van der Vleuten, Stevens, and Dolmans (2011) reported in their qualitative study that English second language students felt constrained from contributing in English spoken tutorial group sessions and were less active participants within the groups. The PBL teachers in this study reported that the language and academic limitations of these students hindered group effectiveness and perhaps student achievement. This study was conducted in South Africa (SA), where the diversity of students entering medical school has been increased in order to redress past injustices from the apartheid regime (Benator, 2010). As a consequence, students differ in terms of English language background and secondary school scores. Students with an English second language background and with lower secondary school scores might benefit less from the PBL tutorial group sessions as compared to students with English first language background and students with higher secondary school scores. Studies conducted so far in SA indeed demonstrate that secondary school scores and language background have a significant effect on academic achievement (Sommerville, 2010). So far, little is known how these variables influence cognitive and motivational group processes in PBL.

The influence of cognitive, motivational, and demotivational group processes in PBL on overall group productivity has been investigated in earlier studies (Dolmans, Wolhagen, & Van der Vleuten, 1998; Carlo, Swadi, & Mpofu, 2003). These studies demonstrated that cognitive group processes and motivational group process have a positive effect on overall group productivity. However, these studies were conducted in a PBL environment in which students in the tutorial groups were homogenous in terms of language background and prior educational training.

This study investigates the perceived overall productivity of tutorial groups and student academic achievement using structural equation modeling (SEM). According to Violato and Hecker (2007), SEM is a group of related statistical techniques that has the potential for testing complex, integrated theoretical models in education and to analyze data for underlying hypothetical constructs or latent variables and their interrelationships.

We hypothesize that EFL and higher secondary school scores will have a positive impact on student academic achievement. Furthermore, we expect that cognitive and motivational group processes will have a positive influence on student academic achievement and overall group productivity.

Method

Context

At NRMSM, the majority of the students have a first language other than English, the language used in tutorial group discussion. Due to socioeconomic and educational infrastructure imbalances inherited from the apartheid era, secondary schools differ considerably in terms of resources, teaching aids, and basic facilities; hence, certain students are disadvantaged and enter university with lower secondary school scores (Benator, 2010). There are two main types of schools: public schools, which are controlled and funded by the government, and private schools, which are independently funded. The latter have more human resources (such as subject teachers and assistants), infrastructural facilities, up-to-date teaching equipment, and well-furnished class rooms.

The NRMSM school has a PBL curriculum in which students work in tutorial groups. The curriculum is organized around themes that last six to eight weeks. Within a PBL theme, clinical and basic science content is integrated. Themes are organized around PBL cases. A limited number of lectures are included in each theme as well as practical sessions and skills trainings. Medical students work in tutorial groups of 10-12 students. These groups stay together for the duration of the PBL theme, but are changed after six to eight weeks. Together with a facilitator, students meet twice a week for a two-hour session to discuss PBL paper cases. After a first brainstorming session around the PBL case, students define learning issues for the next tutorial meeting. In this second tutorial, students' self-study activities in relation to the learning issues are discussed.

Participants

In this study, 490 undergraduate medical students participated by filling out a questionnaire (response rate 82%). Of these students, 186 were first-year students, 161 second-year, and 143 third-year. After the removal of questionnaires with missing variables, a data set of 387 student records was used in the analyses. The sample consisted of 62% female students and 38% male. Approximately 42% of the students spoke English as their first language and 58% of them spoke it as a second language.

Instrument

The Tutorial Group Effectiveness Questionnaire (TGEQ), validated in a previous study (Singaram, Van der Vleuten, Van Berkel, & Dolmans 2010), was used. This instrument measures cognitive, motivational, and demotivational processes of group functioning. The TGEQ is based on Slavin's (1996) theoretical framework of collaborative learning, which emphasizes the cognitive advantages of small group work (i.e., interactions and discussions that facilitate learning) as well as the motivational advantages of small group work (i.e., encouragement by group peers to contribute actively). The 20-item questionnaire was based on seven items related to cognitive processes in the tutorial group (e.g., "In the tutorial group misconceptions about the subject matter were corrected by other group members") and seven to motivational processes (e.g., "I felt myself as a group member responsible for the progress of the group"). Five items were related to demotivational processes (e.g., "During the course of the tutorial some group members contributed less to the tutorial group discussion") and one item reflected the overall rating of group productivity. An earlier study demonstrated that this instrument and its three scales are valid and reliable (Singaram et al., 2010). Students rated their response to the questionnaire's statements on a Likert scale (1 = strongly disagree – 5 = strongly agree). The questionnaire was administered in the last week of a PBL theme during the last PBL tutorial.

Information related to whether English was the students' first or second language was documented and the students' secondary school scores (i.e., their average secondary school score related to admission into the medical school) were collected. Students' academic achievement scores from the end of the PBL theme were also used. In each of the years, the end of the PBL theme test consisted of 120 true-false questions based on the content covered in the theme.

Analysis

A SEM analysis was conducted to test a causal model with EFL and secondary school scores as independent variables. These independent variables were assumed to affect the process variables, that is, the cognitive, motivational, and demotivational processes of tutorial group functioning. Independent and process variables were assumed to affect the two dependent variables, that is, the overall group productivity score and the students' academic achievement scores.

All data were analyzed at the individual student level (N = 387) because the relationship between a student's language background, secondary school score, perceptions of tutorial group processes, and individual academic achievement was investigated.

For the analyses, the original sample was divided into two random subsamples of N = 194, and N = 193, respectively. The first subsample was used as a model building set, the second one as a model testing sample. Analyses started with a theoretical model

which could be modified according to the indications obtained in the analysis of the model building phase. The fit of the final model resulting from this model building phase was evaluated within the testing sample. The latter analysis yielded the final results of fit indices and estimated parameters.

Since the factor structure of the TGEQ was tested in a previous study (Singaram et al., 2010), we restricted the analysis to the structural model (i.e., path analysis) by replacing the latent variables with the corresponding observed scale scores (mean of the scores of the factor's items). This procedure was legitimate since, as mentioned before, the scales of the instrument were extensively validated in an earlier study (Singaram et al., 2010). As a consequence of this procedure, the number of observed variables reduced to seven and a sample size of 140 provided sufficient statistical power. Hence, the sample sizes of model building and testing sets, amounting to 193 and 194, were appropriate. The program AMOS was used to perform the path analyses. Model fit will be determined using the following fit indices and cut-off scores: CMIN/DF < 3, GFI > 0.95, TLI > 0.95, CFI > 0.95, and RMSEA \leq .0.06 (Garson, 2008).

Results

Table 1 shows the descriptive statistics and the correlation analyses of the variables included in this study. Also, reliability coefficients (Cronbach's alpha) of the three group processes (cognitive, motivational, and demotivational) are indicated for the current data. The levels of these reliability coefficients are similar to those found in the validation study of the instrument (Singaram et al., 2010). As illustrated in table 1, the mean of the overall group productivity and group processes ranged from 3.04 to 3.31, with standard deviations of 0.8 to 1.11. The average secondary school score was 41.9 with standard deviation of 7.1 and the academic achievement score was 65.1 with a standard deviation of 10.8. Pearson correlations indicate that cognitive and motivational processes correlate significantly positive ($p < 0.001$) and both correlate negatively with demotivational group processes. English as a first language correlates positively with secondary school scores ($p < 0.05$).

The resulting final model is shown in figure 1. It is equal to the hypothesized theoretical model, but with two additional relations: motivational group processes affect cognitive group processes positively, and cognitive group processes affect demotivational group processes. The analysis of the model building data set indicated that these two relations should be included in the model in order to obtain a satisfactory fit. Resulting fit indices are shown in the second column of table 2. Testing this model with the model testing set resulted in the estimated coefficients (beta, i.e., standardized regression coefficients) presented in figure 1. The corresponding fit indices are shown in the third column of table 2. The fit indices in the second and third column with the cut-off values, shown below

Table 1. Descriptive statistics of latent variables: cognitive group processes (n = 8), motivational group processes (n = 7), and demotivational group processes (n = 5), and overall group productivity score (GP) (scale 1-5, 1 = totally disagree, 5 = totally agree) with percentage of EFL (English first language) students, SSC (secondary school score), academic achievement scores (achievement), Cronbach’s alphas, and Pearson correlations (N = 387).

Variable	Mean	SD	α	2	3	4	5	6	7
1 Cognitive	3.19	0.80	0.84	0.66***	-0.16**	-0.03	0.00	0.08	0.59***
2 Motivational	3.31	0.82	0.82		-0.12*	-0.20***	-0.15**	0.10	0.55***
3 Demotivational	3.17	0.82	0.62			-0.03	-0.02	-0.12*	-0.28***
4 EFL	41.6%	49.4					0.57***	0.34***	-0.03
5 SSC	41.9	7.1						0.32***	0.03
6 Achievement	65.1	10.8							0.09
7 GP	3.04	1.11							

Note: *p < 0.001; **p < 0.1; ***p < 0.05; SD = Standard Deviation; α = Cronbach’s alpha

Figure 1. Structural equation model with standardized regression coefficients reflecting the effects of English first language and secondary school score on cognitive, motivational, and demotivational group processes, overall group productivity, and student academic achievement.

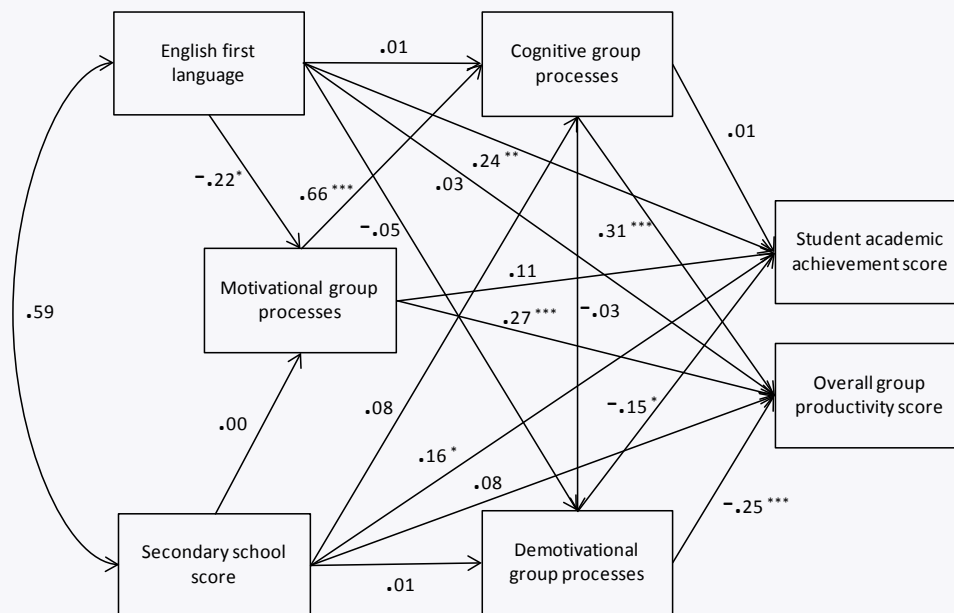


Table 2. Fit indices for the two split-half random subsets, i.e., the model building and the model testing set.

Criteria	Random split-half	
	Model building	Model testing
N	193	194
χ^2	0.54	1.36
df	2	2
p	0.76	0.51
CMIN/DF	0.27	0.68
GFI	1.00	1.00
TLI	1.04	1.02
CFI	1.00	1.00
RMSEA	0.00	0.00

Note: N = number of student responses; DF = Degrees of freedom; CMIN/DF = CMIN divided by the degrees of freedom < 3; GFI = General Fit Index > 0.95; TLI = Tucker-Lewis Index > 0.95; CFI = Comparative Fit Index, > 0.95; RMSEA = Root mean square error of approximation < 0.06

in table 2, shows that for both subsamples the fit of the model is very good. Hence, the model appears stable.

The causal model presented in figure 1 demonstrates that EFL and the secondary school score positively affect the student academic achievement score (respectively, $beta = 0.24$ and $beta = 0.16$). EFL negatively affects motivational group processes ($beta = -0.22$). Cognitive group processes positively affect the overall group productivity score ($beta = 0.31$). Motivational group processes positively affect cognitive group processes ($beta = 0.66$), and also positively affect overall group productivity ($beta = 0.27$). Demotivational group processes negatively affect overall group productivity ($beta = -0.25$) as well as the academic achievement score ($beta = -0.15$). The model resulted in proportions explained variance (R-square) amounting to 0.15 and 0.45 for the academic achievement score and the overall group productivity score, respectively.

Discussion

The model developed in this paper highlights that students with English as their first language have higher academic achievement scores and that higher secondary school scores also result in higher academic achievement scores. Students with English as their second language obtain lower academic achievement scores. These findings are similar to the findings from Sommerville (2010) and hence bear testimony to the challenges still experienced (almost 20 years post apartheid), by students from rural and under-resourced secondary schools. The impact of the difference in home language and the language of instruction at the tertiary level can be viewed as an obvious negative influence on learner performance. This finding supports other studies conducted in primary and secondary schools investigating how language shapes learners (McDermott, 2001; Howie, Venter, & van Staden, 2006; Heugh, Diedericks, Prinsloo, Herbst, & Winnaar, 2007). The model further displays a significant positive relationship between motivational group processes and student academic achievement and motivational group processes and overall group productivity. This implies that the more a student feels motivated or stimulated by his group mates in the tutorial sessions to exert maximum effort, the higher the student's academic achievement scores. Furthermore, motivational group processes have a positive impact on cognitive group processes.

Cognitive tutorial group processes did not seem to have a significant positive impact on academic achievement from the students' perspectives. That this important relationship was not found to be significant may be attributed to the nonalignment of PBL tutorial group learning with the way in which academic achievement was measured in this study. The test that is used to measure academic achievement predominantly contains items that measure factual knowledge as opposed to measuring deep understanding, which is the focus in PBL tutorial groups (Sommerville, 2010). The academic impact of PBL is best favored in assessments that are based on the understanding and application of knowledge (Ravitz, 2009). In a meta-analysis on the effects of PBL from the perspective of assessment, it was also concluded that PBL had the most positive effects when the assessment was aimed at testing understanding of principles that link concepts (Gijbels, Dochy, Van den Bossche, & Segers, 2005).

The results also demonstrate that cognitive and motivational group processes have a significant positive effect on overall perceived group productivity and that demotivational group processes have a negative significant impact on group productivity from the students' perceptions. These findings are in line with our expectations. If students ask each other critical questions and motivate each other to contribute to the discussion, the overall group productivity is perceived as higher. If some students do not contribute actively, the overall group productivity score will be lower. Overall, the findings of this study demonstrate that cognitive and motivational group processes have a positive impact on

group productivity from the students' perceptions and support previous studies that had similar findings (Dolmans et al., 1998; Carlo et al., 2003).

Another observation in this study is that EFL students seem to have a negative impact on motivational group processes, probably because they may dominate the group discussion, as reported previously by Singaram et al. (2011). Engelbrecht and Wildsmith (2010) observed in their study that "in classes consisting of student nurses from various language backgrounds . . . English first language speaking students tend to take the lead in the conversation, thus not necessarily allowing the English second language speakers to make a contribution" (p.108). They attributed the nonparticipation of English second language students to insecurity and inhibition. This finding highlights the need for English language development courses to be included formally in the medical curriculum to improve and encourage tutorial group discussions and interactions, which would then enhance the quality of collaborative group learning and academic success in higher education settings.

Finally, using students' perceptions, this study demonstrates that EFL, higher secondary school scores, and PBL tutorial group processes have a positive effect on academic achievement and overall group productivity.

A limitation of this study is that the data collected related to the problem-based tutorial group were only based on students' self-perceptions. Future studies can extend the model by adding more observational data or peer ratings of small group processes and students' contributions to the group processes. Another limitation is that this study is based on cross-sectional data. The model developed in this study should be tested using longitudinal data as well. Furthermore, it is recommended that future investigations use English proficiency scores that will perhaps reflect a student's English proficiency better than home language background (mother tongue). These data were not available for this study. Finally, further research is needed in other contexts in which students with diverse language backgrounds participate in tutorial groups and in PBL settings where the objectives of the curriculum and assessment are better aligned.

An implication of this study is that tutorial groups should be optimally balanced in terms of English first and English second language students to avoid certain groups having only advantaged or disadvantaged students and to ensure that group meetings are motivating for both advantaged and disadvantaged students, as language and prior educational background have an impact on group productivity. We recommend that PBL groups be balanced in terms of language background and secondary school scores. Further, we suggest that attention is directed to developing the ESL students' literacy skills to address the gap between EFL and ESL students. In addition, more use of nonverbal forms of communication such as figures and visualized relations could be beneficial for students' understanding, since language and secondary school backgrounds are ruled

out to a greater extent. Finally, adequate training for PBL students and teachers to work optimally in groups with students with diverse language backgrounds is needed.

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