

**LEARNING STYLES OF UNDERGRADUATE MEDICAL STUDENTS IN
PROBLEM BASED LEARNING (PBL)**

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ABSTRACT

Purpose: This study investigated the relationship between learning styles and Problem Based Learning (PBL). The Kolb Learning Style Inventory (LSI) 4 has yet to be used to measure learning styles in direct entry (school leaver) undergraduate medical students. This paper explored the relationship between learning styles and PBL in medical education. **Method:** In 2014 medical students ($n = 163$) in Year 1 and 2 in Australia and Malaysia completed an online demographic questionnaire and the Kolb Learning Style Inventory 4. **Results:** All nine learning styles were represented. Results indicated a distinct variation in styles, with the Analyzing style most prevalent (21.5%), “imagining” (3.7%) the least. The remaining seven were found in 14.7% to 8% of the students. **Conclusions:** Direct entry undergraduate medical students display a range of learning styles. PBL may require diversity in learning styles to ensure optimal functioning during PBL. Teachers and curriculum developers should acknowledge this diversity and support students to improve their ability to function in PBL and achieve better outcomes in their medical training.

Keywords: Problem Based Learning, Education, Kolb Learning Style Inventory.

I. INTRODUCTION

Problem Based Learning (PBL) is described as a vehicle to move to learn away from factual memorization towards problem-solving with the patient’s problem becoming the impetus for student learning [1]. According to Barrows and Tamblyn, PBL resulted in both the consolidation of integrated knowledge and the fostering of problem-solving skills, which assists to address some of the issues in medical education identified by Flexner [2]. Learning styles describe how individuals perceive, engage, interact with and transform a learning experience. Learning style include previous learning experiences, the social environment in which learning occurs and the level of cognitive functioning [3]. Kolb used the learning cycle to develop learning styles [4], which describe different approaches learners take to their learning. Ideally, effective learning occurs as an ongoing process between four modes within the learning cycle (Figure 1). Kolb postulated that most learners have an area of dominance within the cycle between two modes. This area of dominance is their preferred way of learning and represents their *learning style*. The learning cycle illustrates the process of learning represented through the tension of an individual working within the four modes of the learning cycle [5] i.e. reflecting, observing, conceptualizing and experimenting.

The application of the learning cycle to PBL is exemplified through a description of the steps of PBL related to each learning mode. Concrete Experience (CE) is represented in the first PBL session. Students are presented with the patient case and make sense of what has been presented through student led discussion of the patient illness and broader social and environmental context. Reflective Observation (RO) also begins in this first session as students reflect on the group experience and identify knowledge gaps. Abstract Conceptualisation (AC) occurs towards the end of the first session and in the time between sessions, when students are undertaking self-directed learning (SDL) to fill their identified knowledge gap. In the subsequent sessions, students synthesize the group learning

experience and the information they have discovered during their SDL. Active Experimentation (AE) therefore takes place in this second session. Between RO and AE, the learners' original idea of the case is modified. This session provides the learner an opportunity to share their information with the group and together the students test their newly formed solutions to the identified problems. Following this, the learning cycle begins again. In PBL this process occurs when each student introduces his or her AE to the group, which ideally triggers a new CE for their fellow learners.

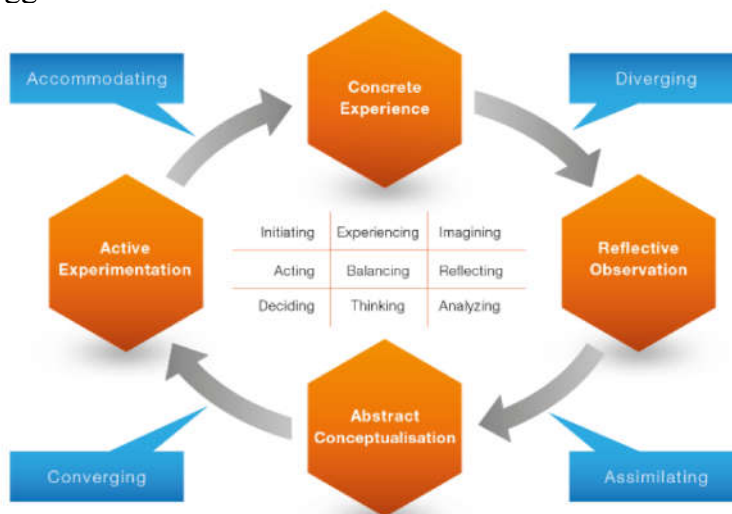


Figure 1. Kolb learning cycle and learning styles.

This study aims to explore the relationship between learning styles and PBL in order to inform educators of the compatibility of the learner compared to the implemented pedagogy. This study may provide information about how well a student may learn in PBL. The usefulness of profiling medical students includes the ability to investigate which learning styles would align with the process of PBL. Profiling learners could determine those less compatible with PBL and identify what possible challenges they may encounter. This information may allow educators to support students to improve their ability to function in PBL and achieve better outcomes in their medical training.

II. METHODS

In 2014, direct entry undergraduate medical students in Year 1 and 2 (N = 847) were invited to participate. Data was collected via anonymous online surveys. The University Research Ethics Committee approved the study. The analysis was conducted using SPSS v20. Fisher's exact test and descriptive statistical analyses (frequency distributions) were undertaken. The distribution of Year 1 and 2 medical students learning style preference and the difference in these according to gender, cultural background and location of the study were examined.

The sample included first- and second-year medical students (Year 1: n = 438, Year 2: n = 409) across two campuses (Australia & Malaysia) delivering an equivalent curriculum. Table 1 outlines the gender distribution and age ranges. After the exclusion of 46 students who either discontinued the degree or failed to complete study measures, the final sample totaled n=163. This represents a response rate of 19% of the total available students.

Table 1. Age and gender of participants by year level and combined location.

	Total (Australia & Malaysia)			Total N = 163
Gender	Male n (%)	Female n (%)	M Age (SD)	n (%)
Year 1	39 (44.3)	49 (55.7)	19.05 (0.86)	88 (54)
Year 2	40 (53.3)	35 (46.7)	20.05 (1.08)	75 (46)
Total	79 (48.5)	84 (51.5)	19.51 (1.09)	163 (100)

Measures

A Demographic Questionnaire was developed for the study. The Kolb LSI 4 was used to measure learning styles. The LSI includes 12 items each with 4 statements. Students' rank orders each statement in terms of how it best describes the way they learn. Statements are associated with each of the 4 modes of the learning cycle. Responses are used to categorize students into one of nine learning styles [5].

To the researcher's knowledge, there are no published papers using the revised version (4) of the Kolb LSI. All results are based on LSI 3.1 or earlier. Hay Group™, the company who administers the test, have compared version 4 and 3.1 and reported the two versions to be highly correlated. Therefore, they propose that version 4 maintains the validity of the previous versions of the measure, however, this has not yet been empirically established. Version 4 is also reported to maintain the scale reliability of version 3.1, but with a higher internal validity than the previous iteration of the measure [6]. Due to the license agreement, no raw data was provided therefore, the reliability of the measure in the current study could not be determined.

III. RESULTS

Frequency distributions were derived for the Kolb LSI (Table 2 & 3). The sample was divided into year level (combined Malaysian and Australian campuses), justified by the similarity between the student profiles at each campus. Gender, the campus of study, and cultural background - determined by the country of birth established the distribution of learning styles.

All nine learning styles were represented. The most frequently represented learning style in Year 1 (21.6%) and Year 2 (21.3%) was *Analyzing*. *Reflecting* (15.5%) was the most frequent style in females (n = 79) whereas *Analyzing* was the most frequent (29.1%) for males (n=84). Based on the more uniform distribution of learning styles females appeared to have more equal representation across all learning styles relative to males.

Supporting the acknowledged similarity in students between the two campuses, the campus location (Australia and Malaysia) had little impact on the distribution of learning styles. *Analyzing* remained the most common style on both campuses. *Experiencing* was more prevalent in the Malaysian (15.6%) relative to Australian (5.1%) campus. *Thinking* learning style was more prevalent in the Australian (16.9%) relative to Malaysian (8.9%) campus. Regardless of cultural background, *Analyzing* remained the most frequently represented style. The 'other' cultural background category (n = 13), which represented any other country of birth that was not Australia, New Zealand or Asia was comparatively small. Therefore, not surprisingly as seen in Table 3, another cultural background was only represented in five learning styles including *Analyzing*, *Balancing*, *Experiencing*, *Reflecting* and *Thinking*. The difference between the percentages of participants from either

Table 2. Kolb LSI descriptives by year level and gender.

	Acting	Analyzing	Balancing	Deciding	Experiencing	Imagining	Initiating	Reflecting	Thinking	Total
Total	14	35	19	22	13	6	14	16	24	163
Sample Total (%)	8.6	21.5	11.7	13.5	8	3.7	8.6	9.8	14.7	100
Year Level (combined campus location)	10	19	6	13	4	2	9	11	14	88
Year 1 (%)	11.4	21.6	6.8	14.8	4.5	2.3	10.2	12.5	15.9	100
Year 2 (%)	4	16	13	9	9	4	5	5	10	75
Year 2 (%)	5.3	21.3	17.3	12	12	5.3	6.7	6.7	13.3	100
Gender (combined year level & campus location)	6	23	9	12	3	2	7	3	14	84
Male (%)	7.6	29.1	11.4	15.2	3.8	2.5	8.9	3.8	17.7	100
Female (%)	8	12	10	10	10	4	7	13	10	79
Female (%)	9.5	14.3	11.9	11.9	11.9	4.8	8.3	15.5	11.9	100

Table 3. Kolb LSI descriptives by campus location and cultural background.

	Acting	Analyzing	Balancing	Deciding	Experiencing	Imagining	Initiating	Reflecting	Thinking	Total
Campus Location (combined year levels)	12	25	14	17	6	3	10	11	20	118
Australia (%)	10.2	21.2	11.9	14.4	5.1	2.5	8.5	9.3	16.9	100
Malaysia (%)	2	10	5	5	7	3	4	5	4	45
Malaysia (%)	4.4	22.2	11.1	11.1	15.6	6.7	8.9	11.1	8.9	100
Cultural Background (Combined locations)	8	16	11	15	5	2	10	6	11	84
Australian (%)	9.5	19	13.1	17.9	6	2.4	11.9	7.1	13.1	100
Asian (%)	6	12	7	7	6	4	4	9	11	66
Asian (%)	9.1	18.2	10.6	10.6	9.1	6.1	6.1	13.6	16.7	100
Other (%)	0	7	1	0	2	0	0	1	2	17
Other (%)	0	53.8	7.7	0	15.4	0	0	7.7	15.4	100

Australian or Asian backgrounds in each learning style was small. Results presented in Table 3 show that the smallest difference in the percentages of participants was represented in the learning style of *Acting* (0.4%) and the largest difference in *Deciding* (7.3%). Those from an Australian background were higher in *Deciding* and *Initiating* and lower in *Reflecting*, relative to those from an Asian background.

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Fisher’s exact tests determined differences in the frequency distributions of learning styles across year level, gender, campus location and cultural background. Table 4 shows that no significant differences were found across learning styles between Year 1 and 2 students, campus location gender, or cultural background (Asian and Australian).

Table 4. Fisher’s exact test results comparing Learning Styles between year level, gender, campus location and cultural background.

Grouping	P	Cramer’s V
Year Level	.194	.25
Gender	.051	.29
Campus Location	.360	.24
Cultural Background	.616	.20

IV. DISCUSSION

This study is novel as it is the first to utilize the most updated version of the Kolb LSI (4) to explore learning styles in direct entry undergraduate medical students undertaking PBL. The results revealed a diversity of learning styles present in the medical students. All nine learning styles were represented. This may suggest that each learner in PBL potentially contributes different strengths and abilities through their varied learning styles to achieve the desired learning outcomes of PBL. Supporting this idea are the conceptual links drawn between the modes (concrete experience, reflective observation, abstract conceptualization,

active experimentation) in the learning cycle and the process undertaken in PBL. Given that each learning style is a different combination of the learning modes, it is reasonable to suggest that all learning styles, to some degree would be found in a cohort of students as they move through the learning cycle while undertaking PBL.

A diversity of learning styles across Year 1 and 2 students were revealed. Certain learning styles do appear to be more compatible with the process of PBL. Analyzing, Thinking, Deciding and Balancing were the most frequently occurring learning styles and these learning styles align well with PBL. The remaining learning styles that were considered less compatible with PBL had a lower representation in the medical students in this study. The significance of this finding suggests that the curriculum design and learning pedagogy adopted in this study may be intrinsically influencing students learning styles, or the process of medical student selection may be conducive to admitting students with learning styles that are more compatible to PBL. Such inferences would require further evidence to substantiate the hypothesis however, a relationship between learning styles and PBL appears evident from the results. That said, the diversity of learning styles in this medical student cohort indicates that no single learning style is required to achieve successful engagement in PBL. The natural diversity of learning styles in the group allowed students to progress through the learning cycle and function with a high level of engagement and success in PBL. Therefore, current processes of selection into medical school in the current study appear to organically achieve a diversity of learning styles suitable to PBL, with a higher representation of those styles most suitable. From an individual student perspective, profiling students' learning styles could provide a process for medical educators to identify students that may require additional support to achieve the learning outcomes in PBL. Further investigation into the effect that the provision of additional support for students with learning styles less compatible with PBL has on performance may provide additional understanding of the relationships between learning styles and PBL. The results revealed non-significant differences across learning styles between campus locations and cultural backgrounds suggesting that a level of consistency in learning style profiles across the campus locations. This result was not surprising given the similarities between the groups. A large proportion of international students and many local students' parental heritage at the Australian campus were from the same regions as Malaysia. The cultural comparison between the two locations may therefore not be a 'clean' comparison given the cultural diversity in the Australia population, and the high representation of South East Asian students in the Australian based cohort. The consistency in learning styles found between cultural backgrounds supports the hypothesis proposed by Ryan and Louie [7] in relation to perceptions of learning between Western (individualistic culture) and Asian (collectivist culture) students. Ryan and Louie suggest that the large amount of geographical movement of students results in a more uniform style to learning and scholarship. The results from this study extend this concept from movement of students to include movement of family and therefore a similarity between the two campuses, which may have naturally influenced the consistency in students' learning styles. The results reveal the suitability of this learning pedagogy to varied cultural backgrounds based on the alignment of learning styles to PBL. The combined strengths and weaknesses apparent in the collectivist and individualistic cultural backgrounds [8] of the students in this study appear to integrate through the diverse learning styles to form a successful learning environment.

The findings from this study may provide an insight into the typical learning styles of undergraduate medical students from Australia and Malaysia. The diversity of learning styles found in this study were consistent with other tertiary student populations in both the United States [9] and Australia [10, 11], and in junior doctors in North America [12]. These studies used the LSI 3.1 which includes four learning styles. The results of this study demonstrate that even with further differentiation into nine styles, this diversity is retained, displaying a consistent pattern. A dissimilar outcome was found in regards to the influence of culture between the current study using the LSI 4 and a previous study with earlier versions of the tool. Kolb and Joy [5] reported that culture (defined by country of birth) was a significant source of variance for learning styles in a general adult population based on the effect it had on the AC – CE modes of the learning cycle. The disparity in results may be due to differences in the population and in the LSI tool. The LSI 4 defines learning styles into nine categories, which provides a more holistic representation of students' learning styles through the ability to further differentiate the influence of each mode (CE, RO, AC, and AE) within the learning cycle. The process of PBL is a reflection of students' working through the modes of the learning cycle. Therefore, in a PBL context, the lack of cultural influence on learning styles, given their diversity in the cohort, is understandable.

The study found no evidence of a difference in learning style based on student's gender. This contrasts the significant gender differences in Australian Nursing and Midwifery students found by D'Amore, James [10]. The study by D'Amore et al. used the LSI 3.1 and compared the learning modes rather than learning styles, which makes comparison difficult. Furthermore, there was a large gender imbalance in their study, which may have influenced the findings. An investigation in a general adult population of the effect gender had on learning modes by Kolb and Joy [5] using the LSI 3 found that gender was a significant source of variance for the modes of AC – CE. The use of the LSI 3 is of particular importance when comparing results to the current study which used LSI 4 as it defines learning styles by the dominance in more than two learning modes for most learning styles. This could provide an explanation for the divergent findings on the effect of gender between the two studies. Even after the consideration of the differences between the tools and the study population in all three studies, inconsistencies about the influence of gender still exist and future research in this area is required. No other studies using the LSI 4 have yet been published to allow comparisons of the influence of gender. Therefore, in conclusion, gender did not appear to have an effect on the relationship between learning styles in this sample of medical students.

V. CONCLUSION

Based on the profile of learning styles established in this study the pedagogy of PBL appears to be compatible and appropriate for the majority of these learners regardless of culture, gender or location of study. Additional learning support may be warranted for students identified as having less compatible learning style for PBL which may in turn results in higher success in their medical training.

Conflict of Interest: The authors declare that they have no conflict of interest.

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