WORK-BASED LEARNING MODEL TO DEVELOP SELF-DIRECTED LEARNERS IN OPTOMETRY EDUCATION

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ABSTRACT

This paper evaluated the effectiveness of the work-based learning (WBL) model to develop self-directed learning skills in optometry education. WBL model was introduced to Year 2 Diploma in Optometry students at Singapore Polytechnic. Fully integrated workplace learning was incorporated, where students were exposed to “real patients” (members of public) with various eye conditions. Students learned to merge theory with practice, knowledge with experience during their hands-on clinical training sessions at the Singapore Polytechnic Optometry Centre (SPOC). Content of four core optometry modules, self-directed learning skills and professional dispositions were integrated and delivered through flipped learning, in-class activities/discussions and clinical training sessions. Hands-on optometric examination skills were imparted through clinical training by following patients from each of the major clinical disciplines, across different venues of care under supervision (integrated clerkship). Through interaction with peers and public patients, students also develop their generic employability skills. Development of self-directed learning skills and professional dispositions were based on self-reporting by the students and observation by adjunct lecturers who were independent third party observers. Students take on an active role in this model since most activities of learning were student-led and faculty- or supervisor-guided. WBL model was shown to be a faculty- and resource-intensive model which worked better with smaller cohort size particularly for practical oriented modules and during clinical training. The learning points from WBL model can be adopted for similar resource-intensive engineering courses.

KEYWORDS

Work-based learning, self-directed learning, optometry, Standards: 1, 2, 3, 6, 7, 11, 12

INTRODUCTION

Self-directed learning (SDL) is a skill that has received increasing attention in recent years, particularly in the context of Singapore education. The Ministry of Education, Singapore, in its Masterplan for Information and Communications Technology in Education, has identified self-directed learning as one of the key 21st century skills that should be nurtured in our students. Broadly, SDL refers to the process in which an individual learner is motivated to take responsibility and accountability for his/her own learning (Knowles, 1975). Despite many approaches and models in the literature, there is general agreement that SDL involves the following iterative stages, irrespective of the specific terminology employed:

- Planning Learning
- Managing Learning Performance and Process
- Reviewing and Evaluating Learning

The use of learning strategies to develop the true understanding of learning how to learn is of significant importance in developing the SDL skills of students (Sale, 2019).

Work-based learning (WBL) is an educational model that provides students with real-life work experiences where they can apply academic and technical skills and develop their employability skills (e.g. confidence, communication, teamwork and other work-related attitudes and behaviours) (Alkema and McDonald, 2014). It is a series of educational courses which integrate the school or university curriculum with the workplace to create a different learning paradigm or an integrated learning experience. WBL deliberately merges theory with practice, knowledge with experience, and acknowledges the intersection of explicit and tacit forms of knowing (Raelin, 1997a, Raelin, 2010, Flanagan et al., 2000). Work-based learning prepares students for employment and is driven by the educational institution (IAL, 2016).

The WBL model also provides a scaffold to support a functional "*community of practice*" wherein students learn by directly co-managing patients under the supervision from lecturers or mentors. WBL is a learner-managed rather than academic-managed learning (Eraut, 2004) and therefore inculcates self-directed learning. WBL model using integrated clerkship is practised in medical schools such as Duke NUS Medical School, Singapore and Harvard Medical School, USA. It was reported that students in the integrated clerkship perform equally in terms of academic performance to peers in traditional block clerkships, but display enhanced patient-centered attitudes and develop meaningful relationships with faculty (Duke-NUS, 2020).

Work-based learning model in the Diploma of Optometry course at Singapore Polytechnic

The Diploma in Optometry (DOPT) curriculum aims to produce optometry graduates who are equipped with technical skills and generic skills like communication/presentation skills, organisational skills and independent learning skills. The course aims to produce professionally competent optometrists to serve as primary eye care practitioners who are self-directed and life-long learners (CDIO Standards 1 & 2).

Work-based learning (WBL) was first introduced to Year 2 Diploma in Optometry (DOPT) students at Singapore Polytechnic (SP) in semester one of the 2018/2019 academic year (AY1819S1) in response to curriculum review and pedagogy for the profession. It was introduced to address gaps in the traditional system of block rotations; in recognition that existing clinical training can be structurally and educationally enhanced and last but not least, to inculcate SDL. This WBL model is based on the integrated clerkship model in which the entire academic year of the student consists of a longitudinal, integrated curriculum approach to learning & assessment (Duke-NUS, 2020). The students get concurrent integrated exposure to multiple disciplines in a fully-equipped leaning space in preparation to employment (CDIO Standard 3). According to a study conducted by Hirsh et al. (2012), integrated clerkship model encourages the development of students' learning and improves students' professionalism.

To date, no study has been done on the impact of this teaching approach in optometry. This paper evaluated if WBL model could develop SDL skills and improve the academic performance in optometry students.

DESCRIPTION OF WORK DONE

The annual DOPT course intake comprises three classes of students of approximately 20 students per class. WBL model was first introduced in AY1819S1 for year 2 students, on an opt-in basis. To date, WBL model has been implemented for two cohorts of optometry students, 'WBL cohort 1' in AY1819S1 (the pilot cohort, one class only, n = 20) and 'WBL cohort 2' in semester one of the 2019/2020 academic year (AY1920S1) (all three classes, n = 65). The other two classes in AY1819S1 were taught using traditional/conventional mode of lesson delivery (n = 42) and they are called 'Trad cohort'. Students from AY1819S1 cohort are the cohort 1 and the students from AY1920S1 cohort are the cohort 2.

Four core optometry modules, CP3065 Binocular Vision, CP3066 Contact Lens, CP3056 Ocular Disease 1 and CP3062 Clinical Optometry 3 were traditionally offered in block rotations. Students in WBL cohorts were taught using WBL teaching approach (integrated curriculum), where the delivery of technical knowledge from the core modules where integrated along with development of professional dispositions (CDIO standard 3) (Figure 1). Professional dispositions such as confidence, independence, motivation, analytical, communication and interpersonal skills are the skills and attitude that optometry graduates should possess to be work-ready. Fully equipped learning space, the Singapore Polytechnic Optometry Centre (SPOC) provided the required integrated learning experiences (CDIO Standards 6 & 7). All students, regardless of the cohort they belonged, were taught the same content and same means of assessment were applied throughout the semester.

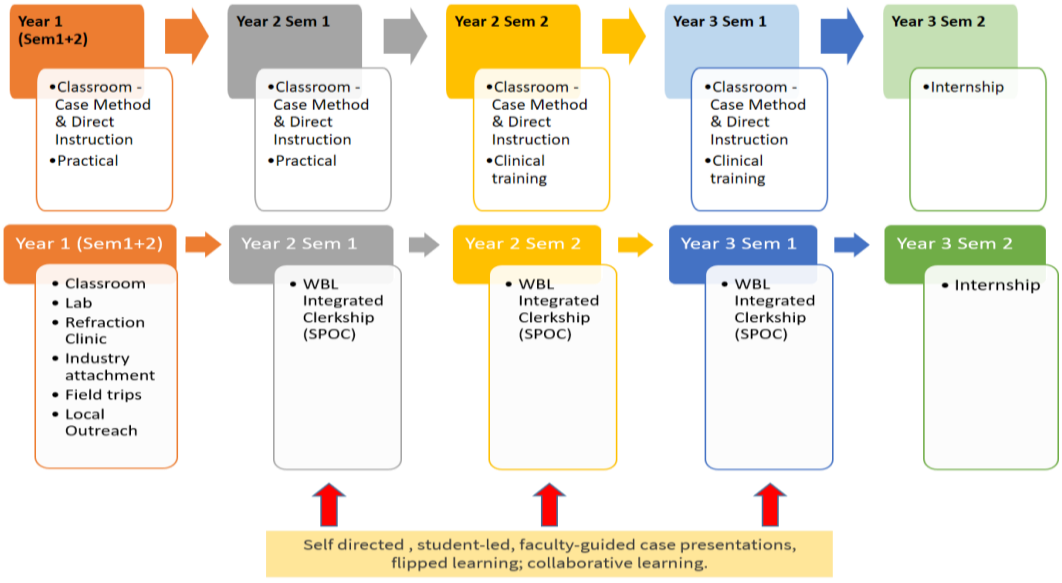

Figure 1. Traditional/conventional teaching approach (top) versus WBL (integrated clerkship) teaching approach (bottom) in Diploma of Optometry.

The traditional approach imparts learning of the core modules in blocks and students are led by teachers at each step. In the WBL, integrated clerkship approach the student learning takes place in an integrated manner as they follow the patients and perform history taking, the various clinical techniques and devise the management plan by following members of public at SPOC. The different components that guide the students in this self-directed learning in this model are the flipped learning materials, e-portfolio, practical and clinical training, peer teaching, simulated cases, and reflection journal. The lecturer's role is to facilitate the process and give

formative feedback in this approach. The different components of our WBL model and how they are mapped with SDL skills are summarised in Table 1.

Table 1. Mapping of WBL components with SDL skills

WBL teaching plan	**Mapping of WBL with SDL skills** (Sale, 2019) a) Planning Learning b) Managing Learning Performance and Process c) Reviewing and Evaluating Learning
Fully integrated workplace learning This was in the form of clinical training in the SP Optometry Centre (SPOC) where students were exposed to 'real patients'. The learning was supported by learning materials such as **e-portfolio** and **workplace portfolio. Weekly grand rounds** were conducted to review their learning. During clinical training, students were trained to apply the technical knowledge and skills learnt to examine patients at SPOC under supervision of their lecturers and adjunct lecturers. They were trained to integrate theory and knowledge from their learning into practice. **Four core modules** taught in the semester were integrated through various **in-class activities** including **Case method**. Content delivery was done through "**Flipped learning**". Students were paired during clinical training to facilitate **peer-tutoring** to develop inter-personal & collaborative skills. **Assessment** of student learning was carried out using variety of methods. Regular feedback was given for their portfolio entries, during clinical training, during class activities (formative assessment). Summative assessments included written and practical tests, end of semester exams, oral presentations and class participation. (CDIO standard 11) Students were given different **simulated case scenarios** to expose the students to a variety of cases that they may not see during their clinical training. Students were	**E-portfolio:** Students were guided to plan and complete the questions by a given timeline *(a).* It helped them to make sense of the concepts and put the pieces together *(b).* Feedback for improvement (formative) given by lecturers on the activity sheets & students' progress in mid- and end-semester assessments *(c).* **Workplace portfolio:** Students were exposed to 'real patients' to apply their skills and knowledge in an 'authentic workplace' (SPOC). This helped the students to apply what they learnt in a different situation, to continue review, evaluate and extend their learning *(c).* **Weekly reflection journal:** Students reflected on what they have learnt and how to improve. (*c).* **Weekly grand rounds:** Students discussed cases they have seen during clinical training, to review and evaluate their learning and seek improvements *(c).* **In-class activities/case discussions**: These were 'student lead, faculty guided'. Students were involved in active learning and they took ownership of their own learning *(b)*. **Through flipped learning:** Students planned their learning and went through the online material prior to the in-class discussion. Readiness check was done to track student's preparedness *(a).* **Peer-tutoring:** Students learn from each other and this inculcated collaborative learning and developed their inter-personal skills *(b).* **Case method:** Students discussed and reviewed different cases, facilitated by lecturers *(c).* Case method helped to develop few important skills essential for optometrists: Communication/collaborative skills, Adaptability/resilience, Sense making (include analytical-, critical-thinking and problem solving skills) and Empathy/Ethics. These are also important skills for lifelong learners.

trained to complete a task, activity or problem in an off-the-job situation that replicates the workplace context. This was done through various online software and also during face-to-face sessions.	**Simulated practice:** This encouraged students to 'think out of the box', a variety of cases that they are not exposed to at SPOC were covered using this approach. This helped to review, evaluate and extend their learning *(c)*.
Practical sessions: The work-based learning at SPOC was complimented by practical sessions for the four core modules, external placements and field-based activity such as community service.	**Practical sessions**: Students watched videos and prepared before they performed the practical in lab and completed their activity sheets *(a).* Practical tests were administered at the end of the semester to track students' performance. These sessions imparted all practical training covering the core clinical skills required in the later stage *(b).*
Internship: The students were sent for a seventeen weeks internship to eye clinics, hospitals, optical outlets, and ophthalmic/contact lens companies at the end of semester 1 of year 3 of their study.	**Internship:** Students were placed in a real workplace environment with minimal guidance from lecturers. This helped them to review, evaluate and extend their learning *(c)*.

To evaluate if the above WBL model had developed SDL skills, professional dispositions and produced good academic performance in the Optometry students, the following were investigated:-

i. Student survey (SS)*:* This was administered on WBL cohorts 1 and 2 as well as the Trad cohort. The survey was designed using a 5-point Likert scale. It consisted of six questions and focused on the following attributes: SDL, skills development, learning experience and professional dispositions/soft skills.

ii. Focus group interview (FGI)*:* This was done to gather more in-depth views from students in WBL cohorts 1 and 2. In total 40 students were randomly selected, 12 students from WBL cohort 1 and 28 students from WBL cohort 2. The questions were designed to understand the student's viewpoint on how the WBL model helped them develop SDL and the other professional dispositions such as confidence, communications skills, motivation to learn more, analytical skills, independence and to think out of the box.

iii. Adjunct lecturer survey (ALS)*:* Adjunct lecturers served as an independent ("third-party') observers on students as they were only involved during clinical training at SPOC. ALS was gathered on WBL cohorts 1 and 2 as well as the Trad cohort. A survey was designed using a 5-point Likert scale and consisted of 3 questions, focussing on the following attributes: interpersonal skills, critical thinking and traits of an independent optometrist.

iv. Final module score (FMS) in four core optometry modules*:* In order to study the academic performance of students. FMS was retrieved from the database on WBL cohorts 1 and 2 and compared with the Trad cohort. Final module score (summative assessment), includes assessment score of various components such as written assessments for application of concepts learnt, teamwork, class participation, communication and practical skills.

This study was granted exempt status by the Institutional Review Board of Singapore Polytechnic.

STUDY FINDINGS

Student survey (SS)

Twenty responses were collected from WBL cohort 1, 34 responses from WBL cohort 2 and 31 responses from Trad cohort. Mean ± SD score was 4.1 ± 0.3 for WBL cohort 1, 4.1 ± 0.2 for WBL cohort 2 and 4.1 ± 0.1 for Trad cohort which were very similar (Table 2).

Table 2**.** Students' evaluation on work-based learning and traditional teaching approach

Survey Questions	**WBL cohort 1 (n=20)**	**WBL cohort 2 (n=34)**	**Trad cohort (n=31)**
SS1. I am becoming a self-directed learner (meaning to some extent, you are able to study, reflect, evaluate/derive meaning)	3.7	3.9	3.9
SS2. WBL/the teaching approach helps me to develop useful optometry skills and knowledge, so can be work-ready.	4.3	4.1	4.0
SS3. WBL/the teaching approach helps me to develop useful professional soft skills and knowledge.	4.1	4.1	3.8
SS4. WBL/the teaching approach helps me to enhance my clinical practice knowledge.	4.4	4.4	4.2
SS5. WBL/the teaching approach provides engaging learning experience.	4.2	4.2	4.1
SS6. Overall, I have developed more confidence in my optometry skill sets and knowledge.	3.9	3.9	4.2
	4.1 ± 0.3	4.1 ± 0.2	4.1 ± 0.1

Rating scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

Students reported that the teaching approach they underwent enabled them to become self-directed learners (SS1, indicated "agree" or "strongly agree", 65% in WBL cohort 1, 70.6% in WBL cohort 2, 74.2% in Trad cohort), it helped them to develop useful optometry skills and knowledge, to be work-ready (SS2, 100% in WBL cohort 1, 82.3% in WBL cohort 2, 74.2% in Trad cohort), it helped them to develop useful soft skills and knowledge (SS3, 85% in WBL cohort 1, 91.2% in WBL cohort 2, 67.7% in Trad cohort), it helped them to enhance their clinical practice knowledge (SS4, 100% in WBL cohort 1, 91.2% in WBL cohort 2, 87.1 in Trad cohort), it provided them an engaging learning experience (SS5, 90% in WBL cohort 1, 91.2% in WBL cohort 2, 87.7% in Trad cohort) and overall, they developed more confidence in optometry skills set and knowledge (SS6, 80% in WBL cohort 1, 73.5% in WBL cohort 2, 80.6% in Trad cohort).

Focus group interview (FGI)

FGI results were encouraging especially from both WBL cohorts, especially WBL cohort 1. All 12 of them (100%) from cohort 1 and 96% from WBL cohort 2 agreed that WBL model helped to develop the three main iterative stages for SDL, that they were able to plan, manage and review their learning. It was observed that students managed their learning by following different strategies and regularly reviewed their learning. 83% of students from WBL cohort 1 and 54% from WBL cohort 2 agreed that WBL trained them to be self-directed learners. Again, 100% of the students from both cohorts agreed that this approach helped them to better apply their skills and knowledge to examine and manage patients as WBL provided early exposure to clinical training and allowed more hands-on at SPOC. Most of the students from both cohorts reported that WBL helped develop their professional dispositions in terms of confidence, communication skills, motivated to learn more, analytical skills and independence. However, they felt that WBL did not really help them 'think out of the box".

Adjunct lecturer survey (ALS)

For adjunct lecturer survey (ALS), 11 adjunct lecturers responded on WBL cohort 1 as well as the Trad cohort, and 6 adjunct lecturers responded on WBL cohort 2. The Mean ± SD score for the 3 cohorts is shown in Table 3.

Table 3. Adjunct lecturer evaluation on WBL cohorts 1 and 2 and traditional cohort

Survey Questions	**WBL cohort 1 (n=43)**	**WBL cohort 2 (n=35)**	**Trad cohort (n=90)**
AL1. This student exhibit interpersonal skills (e.g., build rapport with the patient, etc.)	4	3.5	3.5
AL2. This student exhibit critical thinking (e.g., suggest appropriate clinical test, etc.)	3.8	2.8	3.2
AL3. This student exhibits all traits of an independent optometrist (e.g. minimum guidance needed, etc.)	3.6	2.3	3.1
	3.8 ± 0.2	2.9 ± 0.5	3.3 ± 0.2

Rating scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

According to self-rated opinions of the ALS, the adjunct lecturers felt that WBL cohort 1 exhibited remarkably good (> 50% indicated “agree” or “strongly agree”) interpersonal skills (AL1, 74.4%), critical thinking (AL2, 72.1%) and had displayed traits of an independent optometrist (AL3, 65.2%). However, they felt that WBL cohort 2 was not as good. WBL cohort 2 only exhibited reasonably good interpersonal skills (AL1, 54.3%) but the other two attributes namely critical thinking and traits of an independent optometrist (AL2 and AL3) were not well exhibited (AL2, 28.6% indicated “agree” or “strongly agree” and 42.9% indicated “disagree” or “strongly disagree”; AL3, 17.1% indicated “agree” or “strongly agree” and 60% indicated “disagree” or “strongly disagree”). As for Trad cohort, it was better than WBL cohort 2 but poorer than WBL cohort 1. Trad cohort exhibited reasonably good interpersonal skills (AL1, 54.3%) but the other two attributes namely critical thinking and traits of an independent optometrist were again, not well exhibited (AL2, 43.3% indicated “agree” or “strongly agree” and 36.7% indicated “neutral”; AL3, 35.6% indicated “agree” or “strongly agree” and 44.4% indicated “neutral”).

Final module score (FMS) in the four core optometry modules

On comparing the final module score (FMS) in the four core modules, students performed differently in different modules. (Figure. 2)

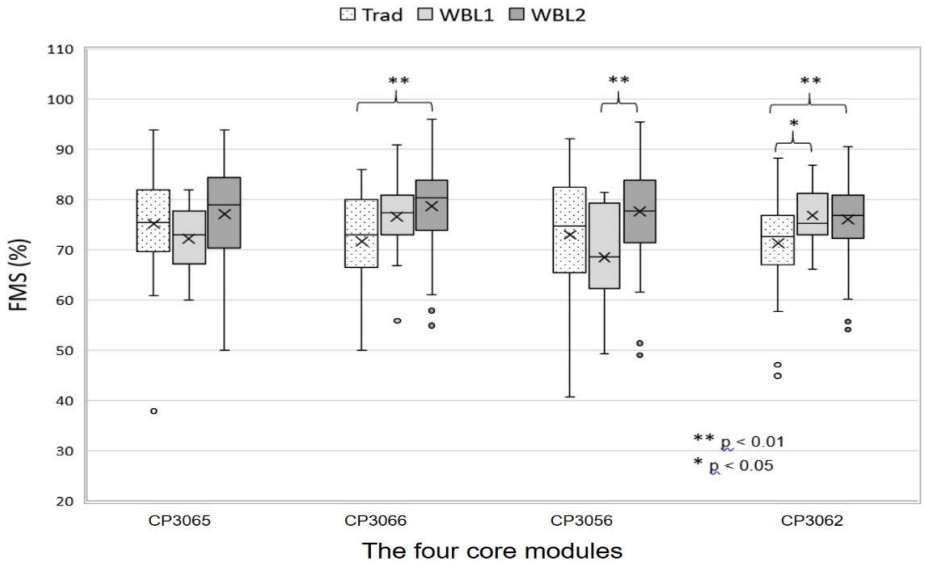

Figure 2**.** Box plots showing final module score (FMS) performance for WBL cohorts 1 and 2 versus traditional cohort in the four core modules.

As compared to Trad cohort, WBL cohorts 1 and 2 performed significantly better with higher mean marks in CP3062 (76.9 in WBL cohort 1, 76.2 in WBL cohort 2 vs 71.4 in Trad cohort) (one-way ANOVA, $p < 0.05$). For CP3066, only WBL cohort 2 did better with significant higher mean marks (78.8 vs 71.7 in Trad cohort) (one-way ANOVA, $p < 0.01$). For CP3056, WBL cohort 2 (mean marks: 77.7) did better than WBL cohort 1 (mean marks: 68.5) (one-way ANOVA, $p < 0.01$) but no differences were found when comparing with Trad cohort. Lastly, for CP3065, no significant differences were found in any of the cohorts studied (Figure. 2). So it is shown that WBL did not work consistently in all four core modules.

DISCUSSION

SDL had clearly been demonstrated in the WBL cohorts through the student survey (SS) and focus group interview (FGI). The adjunct lecturer survey (ALS) and final module score (FMS) in the four core modules showed that the WBL cohorts 1 and 2 performed differently which will be discussed below.

From students point of view (through SS and FGI)

Through FGI, students reported that WBL helped them to develop the three main iterative stages of SDL. They were able to plan, manage and review their learning and took ownership of their learning which is one of the key features of SDL (Sale, 2019).

Students liked the integrated learning experience of hands-on approach, merging theory with practice, the early clinical exposure to 'real patients' and learning by mimicking the lecturers/supervisors in a real workplace at SPOC. All of them indicated that WBL helped them to better apply clinical skills and knowledge to examine and manage their patients.

WBL helped develop their professional dispositions in terms of confidence, communication skills, motivation to learn more, analytical skills and independence. To the students, independence meant that they were able to take responsibility and ownership of their learning and to manage patients independently.

Based on the six questions given in SS, both WBL cohorts 1 and 2 strongly liked WBL. More than 60% of them reported that WBL enabled them to be self-directed leaners. More than 80% of them felt that it helped them to develop useful optometry skills and knowledge, both technical and soft skills, so as to be work-ready and provided them with an engaging learning experience. Last but not least, more than 70% felt that they were more confident in doing their job as optometrist. These attributes were also observed in the Trad cohort but not as much as compared to the WBL cohorts. SS2 and SS3 are attributes focusing on readiness in workplace which was well-developed in students in the WBL cohorts. Early clinical exposure and more hands-on in the WBL model may have played a role.

From adjunct lecturers' point of view and final module score (through ALS and FMS)
ALS has shown that the adjunct lecturers have remarkably better impression on WBL cohort 1 (mean score of 3.8) as compared to WBL cohort 2 (mean score of 2.9) and Trad cohort (mean score of 3.3). They felt that WBL cohort 1 had exhibited good interpersonal skills, critical thinking skills and traits of an independent optometrist. However, these were not as clearly evident when the cohort size was increased (in WBL cohort 2), which only exhibited reasonably good interpersonal skills but quite poor in the other two attributes namely critical thinking and traits of an independent optometrist, even poorer than the Trad cohort. This clearly showed that WBL model worked well for one cohort (the smaller cohort) but not the other (the larger cohort).

Based on the academic performance (with FMS as an indicator), WBL model produced variable outcomes in the four core optometry modules studied, and WBL cohorts 1 and 2 performed differently (Figures 2 & 3). It was clear that WBL model worked well for practical oriented modules like CP3062 and CP3066. On the other hand, it had no impact on CP3065 and CP3056 which were theory-oriented modules. The different FMS in WBL cohorts 1 and 2 in CP3056 indicated that the two cohorts performed differently although both cohorts went through the same teaching approach.

In our current version of WBL, content of the four core modules were delivered using flipped learning followed by in-class activities/case-discussions; and students learned hands-on optometric examination skills through clinical training by following patients from each of the major clinical disciplines and across different venues of care over a substantial period of time at SPOC. During clinical training, skills and knowledge of the above mentioned four modules were integrated, and students learned to apply theory and knowledge into practice. Alongside this, it also provided learners with the opportunity to gain their generic employability skills.

REFLECTION ON THE WBL MODEL AND AREAS FOR IMPROVEMENT

We have gained valuable insights from our experience with the 2 WBL cohorts. The feedback from the students and adjunct lecturers provided us with 2 different and independent perspectives in our endeavor for continual improvement of the model (CDIO Standard 12). Our WBL adoption may not be perfect but this paper showed that there are positive aspects and also identified several areas for improvements that need to be addressed.

Advantages: experiential learning with early exposure to real-life patients with lots of hands-on experience in a fully-equipped learning space, the SPOC. The integrated curriculum is designed to develop good technical skills and the professional dispositions essential for a practising optometrist.

***Assessment**:* a mix of formative and summative assessments was favoured by students in this study. Students preferred cumulative assessment over the entire semester, instead of one major heavy weightage summative assessment. This form of continual assessment helps students to gradually enhance their learning. The assessments have to be designed to integrate teaching content and the hands-on components.

Facilitation: students take on an active role since most activities of learning are student-led and faculty-guided. The role of the lecturer is that of a facilitator and not that of a direct instructor. Both students and lecturers have to be comfortable with this model to have successful and enriching learning experience. In addition to facilitation know-how, lecturers also have to build rapport with the students and be role models for the students to emulate.

***Peer learning/peer tutoring**:* students mainly managed their learning by discussing and clarifying with their peers, within their circle of friends. Chou et al. (2011) demonstrated that using peer groups helps in building supportive learning networks and facilitated reflection, and allows students to develop professional dispositions like communication, collaboration and teamwork.

Resources: WBL is a faculty intensive and resource intensive model (Hirsh et al., 2012), planning of details is critical since the learning and assessment needs to be integrated. Students require more personal attention and mentoring from their lecturers who follow through the entire semester with a small group "students-faculty learning communities". It also requires sufficient time for the continuity of care (Bentley, 2015). WBL model hence works better for smaller cohort size particularly in clinical training component. Manpower constraint and a larger student cohort may contribute to poorer students' performance. Moving forward, a "customised" WBL model may be needed for teaching different modules in optometry.

There are multiple benefits of the WBL model as clearly reflected in the learning outcomes for our optometry students, the most important of which is the development of SDL skills. However, training highly competent optometrists with good technical skills and who exhibit good interpersonal skills, critical thinking and good traits of an independent optometrist is a challenging journey.

CONCLUSION

The WBL model was able to develop self-directed learners and produced better academic performance in "practical-oriented" modules, as compared to the students taught the traditional way. WBL helped develop professional dispositions as well as generic employability skills among optometry students, thus enabling them to be work ready. To scale WBL i.e. to adopt WBL for larger cohorts of students and to achieve good learning outcomes, considerations must be given to faculty and resource availability, which it demands.

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