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Twelfth Issue of the Journal of Problem Based Learning in Higher Education

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INTRODUCTION

Welcome to the second issue of the eighth volume of the Journal of Problem Based Learning in Higher Education. The first issue of this volume was a special issue on "PBL for Sustainability and Sustainable Cities", which we published earlier this year. This second issue is a regular issue and contains five papers and four cases. Once again, we are pleased to be able to gather a wide variety of authors and topics, all with their specific input to the field of problem based learning in higher education. The two issues in this eighth volume nicely express the rich and deep flavors of our research field; and we as an international journal in the field, are proud to publish the scientific insights that spring from the dedicated research performed all over the globe. Here, at the end of a year so profoundly affected by the COVID-19 pandemic, it is most gratifying to be able to publish this issue, and to show that the world of scholarship goes on, and that some of the regularities remain.

As in previous issues, here we provide two tables for you. The tables give you an overview of the papers and cases, informing you of the papers' and cases' country of origin, education program in focus, and a brief statement on the topic. This allows you to view the content of the issue, and quickly find your way to the reading that is most intriguing for you.

THE FIVE PAPERS

Country of origin	Education program	Topic
Kuwait, Australia	Engineering	Arab and Chinese managers' evaluation of engineering competencies gained from PBL versus traditional learning.
Denmark	Medicine	A scoping review presenting papers and perspectives on the relationship between PBL and professional identity in medical education.

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Finland	Law, Social Science	An analysis of an interdisciplinary PBL simulation allowing students to gain insight into conflict analysis, management and resolution.
Denmark	Engineering	Applying the structure of IMRaD as a systematic organizational strategy for PBL project reports.
Azerbaijan	Educational management	Benefits and obstacles that follow the implementation of PBL pedagogic at two Azerbaijani universities.

Table 1. The five papers

Table 1 shows the five papers and their distribution across countries, programs and topics. It is always nice for us to have papers focusing on education programs from all faculties. It is an important issue for the PBL research to find ways to incorporate the varieties and differences that disciplinary conditions and traditions inevitably demands, without losing the core values, ideas and principals of PBL. This is truly where PBL must prove itself as a *university* pedagogic.

The topics in this issue has something for almost everyone. There is one paper on a broader or general implementation of PBL; that addresses the ongoing effort, some might say struggle, of expanding the PBL awareness and activity. Another paper gives us a fresh and concrete look at the never-ending issue of PBL versus traditional formats. Two papers reflect the use of specific didactics or models, aimed at aiding the students learning process, while incorporating a PBL pedagogic. These two papers are fascinating reading for educators and supervisors looking for new and well-grounded inspiration. It is most satisfying to conclude that the models in these two papers are explicitly shaped and suited for higher education. Finally, there is a review paper. In general, we do not have many of them, but they represent a valuable part of scholarship and are appreciated by many of us. We hope to see more of them in the future.

THE FOUR CASES

Country of origin	**Education program**	**Topic**
USA	Interdisciplinary course	Design of a course with a service-learning project aimed at social problems is at the core of the project.
Brazil	Project management	Problems that impact the quality of a Project Elaboration and Management course, developed following a project-based learning approach.
USA	Law School	The opportunity to learn creative problem solving and collaboration skills in a classroom setting.
Kuwait	Engineering	How students worked in a bachelor project in mechanical engineering.

Table 2. The four cases

The four cases give a wide range of examples of how to apply the principles of PBL. The first three cases are focused on PBL at course level. Here, one case focuses on the design of a course, in which students identified a social problem with a culturally diverse, high-need community and subsequently designed a service-learning experience. Another case also focused at the level of a course, evaluated the quality of a course that has been taught numerous times and discussed how problems in both setting up and delivering the course impacted the quality of the course. A third case describes an example of how a Law School implemented problem-based learning into a course. The fourth case describes a bachelor project in a mechanical engineering program in the school of engineering where students needed to design, analyze, and optimize a solar car chassis. The main elements of the process are described in detail. Overall, we hope that these four cases will provide inspiration for educators throughout the world, in various disciplines.

As we close the book on 2020, an issue or a volume of our journal is probable not at the top of anyone's mind. This year has been far too exciting, frustrating, tragic and perhaps significant and a game-changer, for anyone to take much notice of this publication. But we, the new editor in chief and the editorial team, are proud of the achievement and glad for everyone's effort and commitment. We thank the authors for choosing us, and wish the readers an inspiring journey into our twelfth issue.

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Finally, we would also like to thank all the reviewers who have donated their time and wisdom to help to improve the papers and cases in this issue:

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Project Based Learning *versus* Traditional Learning – Comparing Perpectives of Arab Managers with Chinese Managers

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ABSTRACT

The perspectives on Project Based Learning (PBL), traditional learning and engineering competencies are influenced by national and organizational culture. Based on Hofstede's cultural dimensions theory and grounded in constructivist learning theory, the purpose of this study is to identify the perspectives of Arab and Chinese managers on the effectiveness of PBL versus traditional learning.

Utilizing descriptive and inferential statistics (Wilcoxon and Mann Whitney U test), findings show that Arab managers perceive 13 and Chinese managers 2 competencies to be more effectively developed by PBL, while the difference between PBL and traditional learning is perceived smaller among Chinese managers. A higher desire of avoiding uncertainty among Arab managers, higher achievement orientation among Chinese managers and an influence of educational systems were identified. Higher Education Institutions (HEIs) are advised to consider these findings, in order to compare with their institutions' utilization of PBL versus traditional learning and to prepare engineers for global employment.

Keywords: Project Based Learning, PBL, engineering, competency, industry perspective, Gulf Cooperation Council, GCC, China.

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INTRODUCTION AND BACKGROUND

Various models and approaches related to Problem Based Learning (PBL) have been developed over the past decades (e.g. Savin-Baden, 2007). Anecdotal evidence indicates that Problem-Based Project-Organized Learning (Garcia, Bollain and Del Corral, 2011) is the predominant variant applied in engineering education within the geographic region of the Gulf Cooperation Council (GCC). However, engineering educators and industry representatives within this region prefer to use the shorter label, Project Based Learning, along with the abbreviation PBL.

The goal of students' learning is the development and delivery of a set of complementary and interrelated competencies. Sets of competencies are used as frameworks for exit or employer satisfaction surveys (e.g. Christoforou *et al.*, 2003; Ramadi *et al.*, 2016), and sets of competencies can also be used to analyse the effectiveness of PBL principles in general (Jaeger *et al.*, 2018) or of specific PBL models (Schmidt *et al.*, 2006; Ulseth and Johnson, 2015).

In engineering education, instructors, students and employers are the main stakeholders of the competency development process. Students have a certain level of competency when entering this process (i.e. entry qualification), instructors and educational institutions further develop these competencies (i.e. learning facilitation), before employers receive graduates with an enhanced level of competencies (i.e. programme attributes) and continue to develop these competencies based on their specific needs (i.e. professional development). Individuals of each group of stakeholders experience directly or indirectly this competency development process, and they have distinct perceptions on the utilized learning approaches.

Earlier studies (Rumberger and Thomas, 1993; Vermeulen-Kerstens, 2006) showed that the analysis of career success should use two dimensions to ensure reliable measurements, namely the subjective/intrinsic dimension (i.e. employee perspective) and the objective/extrinsic dimension (i.e. employer perspective). This approach is also applicable to the evaluation of learning approaches such as PBL and its variants. Student evaluations and faculty feedback can provide the subjective dimension, whereas employers can provide the objective dimension.

It could be argued that only instructors and students are able to evaluate learning approaches such as PBL since managers of engineers may not have experienced such approaches. However, this perspective ignores that employers are at the receiving end of the competency development process, and their perspective on employees' performance provides an ultimate evaluation of employees' competencies. Managers and work supervisors with several years of experience and line responsibility for engineers realize

the differences in competency levels among their employees and frequently relate these to different learning approaches and learning environments employees have been previously exposed to. Also, managers and work supervisors are frequently involved in training on the job and professional development and have experience with the effectiveness of different learning approaches. Therefore, managers and supervisors are in a good position to provide important feedback on learning approaches, albeit they may not have experienced these approaches themselves. As is the case with PBL in the GCC region, employers' feedback becomes even more important when educational institutions apply a new learning approach (such as PBL) and the number of graduates who have been exposed to the new approach is not yet large enough, or their duration of employment is currently too short, to draw any reliable conclusion from graduates' evaluations.

The perspective on PBL is influenced by national culture (e.g. Walker *et al.*, 1996) and organizational culture of the educational institution (e.g. Camacho *et al.*, 2018). In a similar manner, the importance of specific engineering competencies has been found to vary across different geographic regions (Lucena *et al.*, 2008) and to be shaped by cultural backgrounds (Jaeger *et al.*, 2019). Therefore, there is a need for region specific research related to engineering competencies (Ramadi *et al.*, 2016) as well as the application of the PBL approach in order to adequately develop engineering competencies within the region at question. This study is contributing to meeting this need regarding the perspectives of PBL within the region of the GCC. The focus is on the perspectives of Arab and Chinese managers of engineers as justified below.

It has been shown before that countries of the GCC region have many particularities in common (Ellaboudy, 2010). Three of the six countries of the GCC region, namely Kuwait, Saudi Arabia and the United Arab Emirates, were included in Hofstede's study of cultural dimensions and the four culture dimensions of the analysis were identical for these countries (Hofstede, 1980, 1984). It is typical for all countries of the GCC region that engineers from diverse cultural backgrounds work for organizations with different organizational cultures and collaborate on projects within the same socio-economic context, i.e. the GCC region.

However, the national cultures in the GCC region are clearly different from the national culture of China in that "uncertainty avoidance", one of the four culture dimensions used by Hofstede when comparing national cultures and indicating the extent to which members of a society feel threatened by ambiguity (Hofstede, 1980; Hofstede-insights, 2019), is in China with 30 much lower than in the GCC region with 80 (Hofstede-insights, 2019). Furthermore, "masculinity", another dimension of Hofstede's country scores and indicating how much a society is driven by competition, achievement and success (Hofstede-insights, 2019), is with 66 in China higher than with 40 in the GCC region.

This means, Chinese culture is more success driven and achievement oriented than GCC culture (Hofstede-insights, 2019).

Chinese organizations and engineers are increasingly involved in engineering activities in the GCC region (Pacheco and March, 2014). In 2020, China is expected to be the biggest market for the oil exporting countries of the GCC region, which in turn draws Chinese companies to the GCC region (EIU, 2014). Ambitious Chinese projects such as the 'one belt, one road' initiative (Qian and Fulton, 2017) contribute further to activities of Chinese companies in the GCC region and beyond. The increasing involvement of Chinese managers of engineers in the GCC region and their involvement in employing engineering graduates from local educational institutions justifies comparing their perspective of PBL with the perspective of their Arab counterparts. The insights will allow conclusions regarding the influence of cultural backgrounds on the perspectives of PBL, which in turn can inform instructors and educational institutions in China and the GCC region when applying PBL *versus* traditional learning at their institutions.

PURPOSE OF STUDY

The purpose of this study is to identify the perspectives of Arab and Chinese managers of engineers in the GCC region on PBL *versus* traditional learning. This means, the intention is to provide the 'objective/extrinsic' dimension (Vermeulen-Kerstens, 2006), of the perspective on PBL *versus* traditional learning and to provide region specific research results which can be used to close the gap between industry's expectations of engineering competencies and satisfaction with these competencies (Ramadi *et al.*, 2016).

Furthermore, the purpose of this study is to utilize a set of engineering competencies for the identification of perspectives on PBL *versus* traditional learning, in order to apply a framework that is equally relevant for the three main stakeholders of the competency development process. For this study, Engineers Australia's sixteen competency elements for Engineering Technologists (EA, 2017) are used, since they are similar to graduate attributes listed by other engineering accrediting bodies such as the student outcomes of ABET (Abet.org, 2014) or the graduation requirements of the China Engineering Education Accreditation Association (Wu, 2015) which are adopted from the graduate attributes of the Washington Accord (IEA, 2013). These competency elements cover all essential skills identified in an earlier study (Nguyen, 1998) as distinct competencies, and a summary of these competency elements is shown in Table 1.

Competency area	Competency element
1. KNOWLEDGE AND SKILLS	1.1. Theory based understanding of the underpinning natural sciences
	1.2. Conceptual understanding of mathematics, numerical analysis, statistics, etc.
	1.3. In depth understanding of specialist knowledge areas
	1.4. Discernment of current knowledge development, such as new methods and materials
	1.5. Knowledge of contextual factors such as business, culture, laws, etc.
	1.6. Understanding of the scope, principles, accountabilities of contemporary engineering
2. ENGINEERING APPLICATION ABILITY	2.1. Application of established engineering methods to problem solving
	2.2. Application of engineering techniques, tools and resources
	2.3. Application of systematic synthesis and design processes
	2.4. Application of systematic approaches to the management of projects
3. PROFESSIONAL AND PERSONAL ATTRIBUTES	3.1. Ethical conduct and professional accountability
	3.2. Effective oral and written communication
	3.3. Creative, innovative and pro-active demeanour
	3.4. Professional use and management of information
	3.5. Orderly management of self and professional conduct
	3.6. Effective team membership and team leadership

Table 1. Competency areas and elements (Source: EA, 2017).

The following sections present the research questions and methodology, results, discussion and conclusions.

RESEARCH QUESTIONS AND METHODOLOGY

Based on the background and purpose of this study as described above, the research questions are composed as follows:

1) What is the contribution of PBL *versus* traditional learning to develop the sixteen competency elements from the perspective of a) Arab managers and b) Chinese managers?
2) Is there a statistically and practically significant difference between the contribution of PBL and traditional learning in developing the sixteen competency elements from the perspective of a) Arab managers and b) Chinese managers?
3) Is there a statistical and practical significant difference between the perspective of Arab managers and the perspective of Chinese managers regarding the development of the sixteen competencies by a) PBL and b) traditional learning?

Questionnaire-based interviews were conducted with Arab and Chinese managers of engineers in Kuwait, a country typical of those found in the GCC region. In order to ensure comparable experience of respondents, only managers with at least five years of

experience as a line manager and active involvement in supervision and leadership of engineers were approached based on personal contacts.

The questionnaire included the sixteen elements of competency shown in Table 1, and the managers were asked to rate them on a 5-point Likert scale regarding their perception of the contribution of PBL in developing these competencies (very little (1) to very much (5)) and regarding their perception of the contribution of traditional learning in developing these competencies (very little (1) to very much (5)).

Prior to rating, the difference between PBL and traditional learning was explained based on a schematic graphic shown on Figure 1. Because of managers' time constraints for interviews and because of different levels of experience with PBL, this simplified and condensed comparison was developed, and it was found applicable. It reduced biased responses resulting from different definitions and backgrounds without neglecting the main characteristics of PBL (Barrows, 1996).

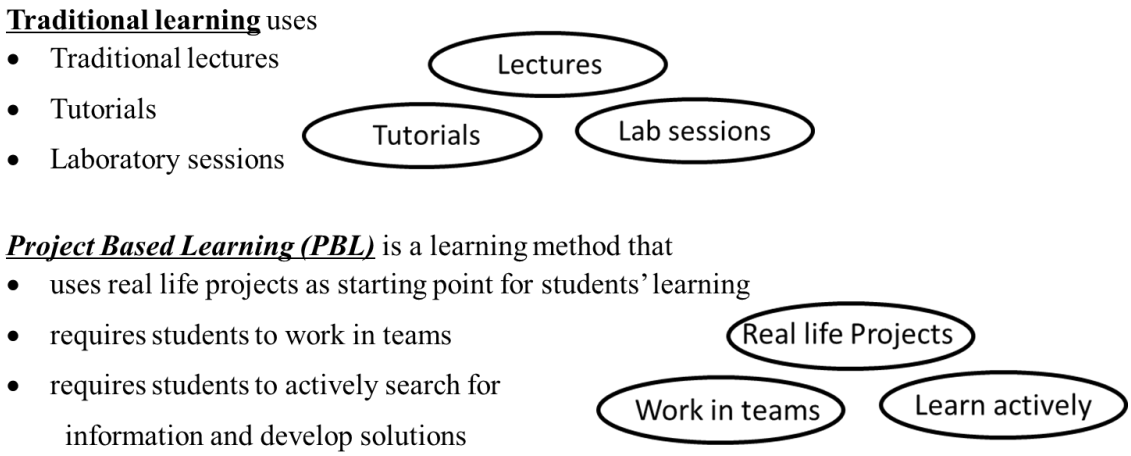

Figure 1. Simplified comparison PBL versus traditional learning.

In addition to respondents' perspectives on PBL and traditional learning, demographic data has been collected and is shown on Table 2.

Variable	**Respondents**			
	Arab managers		Chinese managers	
	#	%	#	%
Education				
Bachelor	73	80	29	56
Master	17	18	23	44
Ph.D.	2	2	0	0
Total Education	92	100	52	100
Position				
Upper management	37	40	26	50
Lower management	55	60	26	50
Total Position	92	100	52	100
Industry				
Petroleum	32	35	0	0
Construction	40	44	49	94
Manufacturing	5	5	2	4
Telecommunication / Electrical	15	16	1	2
Other	0	0	0	0
Total Industry	92	100	52	100
Sector				
Private	35	38	15	29
Public	57	62	37	71
Total Sector	92	100	52	100
Size of Organization				
<10	6	6	1	2
10-100	30	33	31	60
>100	56	61	20	38
Total Size	92	100	52	100
Industrial experience				
Average number of years	12.7		7.1	

Table 2. Demographic data of respondents.

The collected data is analysed using descriptive statistics to answer research question one, Wilcoxon test to answer research question two and Mann Whitney U test to answer research question three. The Wilcoxon test was chosen since the same group of respondents was evaluating two different aspects, i.e. the contribution of PBL and the contribution of traditional learning; the Mann Whitney U test was appropriate since two different groups of respondents evaluated the same aspects, i.e. contribution of PBL and the contribution of traditional learning (Cohen *et al.*, 2011). Both tests convert collected scores to ranks, before they evaluate if the number of times the score of one aspect is significantly different from the score of the other aspect, and the tests do not require similar sample sizes (e.g. Mann and Whitney, 1947). Since the scores are converted to ranks, the analysis does also not require normal distribution of scores. Following common

practice, the level of significance alpha was set to 0.05. The following sections summarizes the results of the statistical analysis.

RESULTS

The descriptive statistics (Mean, Standard Deviation (SD)) of the perceived contribution to development of competencies by PBL and traditional learning for each of the sixteen competency elements and for both groups of respondents (i.e. Arab managers and Chinese managers) is shown on Table 3. Arab managers perceived *Effective team membership…* (4.6) to be highest developed by PBL and *Conceptual understanding of mathematics…* (3.6) to be lowest developed by PBL, whereas they perceived *Conceptual understanding of mathematics…* (4.0) to be highest developed by traditional learning and *Knowledge of contextual factors…* (2.7) to be lowest developed by traditional learning. Chinese managers perceived *Effective team membership…* and *Creative, innovative and pro-active…* (3.9) to be highest developed by PBL and *Theory based understanding…* (3.2) to be lowest developed by PBL, whereas they perceived *Effective team membership…*, *Ethical conduct…* and *Application of established engineering…* (3.5) to be highest developed by traditional learning and *Knowledge of contextual factors…* and *Theory based understanding…* (3.1) to be lowest developed by traditional learning. The Standard Deviation (SD) of the evaluations by Chinese managers is in general larger than by Arab managers.

Competency Element	Arab managers				Chinese managers			
	PBL		Trad		PBL		Trad	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1.1. Theory based understanding…	3.7	1.0	3.9	1.0	3.2	1.2	3.1	1.1
1.2. Conceptual understanding of mathematics…	3.6	1.0	4.0	0.9	3.3	1.1	3.2	1.3
1.3. In depth understanding…	4.1	0.9	3.6	0.9	3.8	0.9	3.2	1.1
1.4. Discernment of current knowledge…	4.3	0.8	3.2	1.0	3.6	1.0	3.4	1.1
1.5. Knowledge of contextual factors…	4.1	0.9	2.7	1.1	3.5	1.1	3.1	1.4
1.6. Understanding of accountabilities…	4.2	0.8	3.4	0.9	3.5	1.1	3.3	1.1
2.1. Application of established engineering…	4.4	0.8	3.2	1.0	3.6	1.1	3.5	1.3
2.2. Application of engineering techniques…	4.3	0.8	3.2	1.0	3.5	1.1	3.4	1.4
2.3. Application of systematic design…	4.1	1.0	3.6	1.0	3.4	1.1	3.2	1.2
2.4. Application of systematic management…	4.3	0.8	3.1	1.0	3.4	1.1	3.3	1.1
3.1. Ethical conduct…	4.2	0.9	3.2	1.2	3.6	1.1	3.5	1.1
3.2. Effective oral and written communication…	4.4	0.7	3.4	1.1	3.6	1.2	3.4	1.2
3.3. Creative, innovative and pro-active…	4.2	0.8	3.0	1.1	3.9	1.0	3.4	1.1
3.4. Professional use of information…	4.2	0.7	3.3	1.1	3.7	1.0	3.3	1.1
3.5. Orderly management of self…	4.3	0.7	3.3	1.0	3.6	1.2	3.3	1.3
3.6. Effective team membership…	4.6	0.6	3.2	1.1	3.9	1.1	3.5	1.3

Table 3. Descriptive statistics (Mean, Standard Deviation) of competency elements developed by Project Based Learning (PBL) and traditional learning (Trad).

The difference between development by PBL and by traditional learning, as perceived by Arab managers, is summarized on Table 4. A statistically different contribution to development of competencies was found for all competency elements, except *Theory based understanding…* (p = 0.175). Accordingly, the difference regarding this competency element will be excluded from interpretation in the following discussion section.

Competency Element	**PBL**		**Trad**		**Wilcoxon test**	
	Median	SD	Median	SD	Z	*p*
1.1. Theory based understanding…	4.0	1.0	4.0	1.0	-1.356	0.175
1.2. Conceptual understanding of mathematics…	4.0	1.0	4.0	0.9	-3.142	0.002
1.3. In depth understanding…	4.0	0.9	3.0	0.9	3.557	< .0001
1.4. Discernment of current knowledge…	4.0	0.8	3.0	1.0	6.511	< .0001
1.5. Knowledge of contextual factors…	4.0	0.9	3.0	1.1	3.945	< .0001
1.6. Understanding of accountabilities…	4.0	0.8	3.0	0.9	4.579	< .0001
2.1. Application of established engineering…	5.0	0.8	3.0	1.0	7.607	< .0001
2.2. Application of engineering techniques…	4.5	0.8	3.0	1.0	6.489	< .0001
2.3. Application of systematic design…	4.0	1.0	4.0	1.0	3.242	0.001
2.4. Application of systematic management…	4.0	0.8	3.0	1.0	5.711	< .0001
3.1. Ethical conduct…	4.0	0.9	3.0	1.2	4.161	< .0001
3.2. Effective oral and written communication…	5.0	0.7	3.0	1.1	7.380	< .0001
3.3. Creative, innovative and pro-active…	4.0	0.8	3.0	1.1	4.919	< .0001
3.4. Professional use of information…	4.0	0.7	3.0	1.1	4.330	< .0001
3.5. Orderly management of self…	4.0	0.7	3.0	1.0	5.484	< .0001
3.6. Effective team membership…	5.0	0.6	3.0	1.1	10.838	< .0001

Table 4. Difference between Project Based Learning (PBL) and traditional learning (Trad) – perspective of Arab managers.

The difference between development by PBL and by traditional learning, as perceived by Chinese managers, is summarized on Table 5. Different from the perspective of Arab managers, all differences are statistically in-significant, except *In-depth understanding…* ($p = 0.007$) and *Creative, innovative and pro-active…* ($p = 0.022$).

Competency Element	**PBL**		**Trad**		**Wilcoxon test**	
	Median	SD	Median	SD	Z	*p*
1.1. Theory based understanding…	3.5	1.2	3.0	1.1	0.679	0.497
1.2. Conceptual understanding of mathematics…	3.0	1.1	3.0	1.3	0.283	0.777
1.3. In depth understanding…	4.0	0.9	3.0	1.1	2.711	0.007
1.4. Discernment of current knowledge…	4.0	1.0	3.0	1.1	1.219	0.223
1.5. Knowledge of contextual factors…	4.0	1.1	3.0	1.4	1.557	0.119
1.6. Understanding of accountabilities…	4.0	1.1	3.0	1.1	0.689	0.491
2.1. Application of established engineering…	4.0	1.1	4.0	1.3	0.507	0.612
2.2. Application of engineering techniques…	3.0	1.1	4.0	1.4	-0.111	0.912
2.3. Application of systematic design…	4.0	1.1	3.0	1.2	0.618	0.537
2.4. Application of systematic management…	4.0	1.1	3.0	1.1	0.819	0.413
3.1. Ethical conduct…	4.0	1.1	3.0	1.1	0.728	0.467
3.2. Effective oral and written communication…	4.0	1.2	3.5	1.2	0.579	0.563
3.3. Creative, innovative and pro-active…	4.0	1.0	3.0	1.1	2.295	0.022
3.4. Professional use of information…	4.0	1.0	3.0	1.1	1.612	0.107
3.5. Orderly management of self…	4.0	1.2	4.0	1.3	1.173	0.241
3.6. Effective team membership…	4.0	1.1	4.0	1.3	1.271	0.204

Table 5. Difference between Project Based Learning (PBL) and traditional learning (Trad) – perspective of Chinese managers.

The difference between the perspectives of Arab managers *versus* Chinese managers on the development of competency elements by PBL is shown on Table 6. A statistically significant difference was found for all competencies except *Conceptual understanding of mathematics…* ($p = 0.067$) and *Creative, innovative and pro-active…* ($p = 0.072$).

Competency Element	**Arab**		**Chinese**		**MWU test**		
	Md.	*SD*	*Md.*	*SD*	*U*	*Z*	*p*
1.1. Theory based understanding…	4.0	1.0	3.5	1.2	1826.0	2.352	0.019
1.2. Conceptual understanding...	4.0	1.0	3.0	1.1	1950.5	1.834	0.067
1.3. In depth understanding…	4.0	0.9	4.0	0.9	1893.0	2.073	0.038
1.4. Discernment of current…	4.0	0.8	4.0	1.0	1403.5	4.109	< .0001
1.5. Knowledge of contextual…	4.0	0.9	4.0	1.1	1656.5	3.057	0.002
1.6. Understanding of…	4.0	0.8	4.0	1.1	1468.0	3.841	< .0001
2.1. Application of established...	5.0	0.8	4.0	1.1	1370.0	4.249	< .0001
2.2. Application of engineering...	4.5	0.8	3.0	1.1	1295.0	4.561	< .0001
2.3. Application of systematic…	4.0	1.0	4.0	1.1	1491.0	3.745	< .0001
2.4. Application of systematic…	4.0	0.8	4.0	1.1	1252.0	4.739	< .0001
3.1. Ethical conduct…	4.0	0.9	4.0	1.1	1616.5	3.223	0.001
3.2. Effective oral and written…	5.0	0.7	4.0	1.2	1370.5	4.247	< .0001
3.3. Creative, innovative…	4.0	0.8	4.0	1.0	1959.0	1.799	0.072
3.4. Professional use of…	4.0	0.7	4.0	1.0	1649.5	3.086	0.002
3.5. Orderly management…	4.0	0.7	4.0	1.2	1762.5	2.616	0.009
3.6. Effective team…	5.0	0.6	4.0	1.1	1363.5	4.276	< .0001

Table 6. Difference between Arab and Chinese managers using Mann Whitney U (MWU) test – competency elements developed by Project Based Learning.

In order to facilitate interpretations of the difference between the perspectives of Arab managers and Chinese managers, the competency elements developed by PBL have been ranked based on their Mean value as shown on Table 7. The three competency elements developed most effectively by PBL (i.e. rank one to three) from the Arab managers' perspective are *Effective team membership…*, *Application of established engineering…* and *Effective oral and written communication…*. The same competency elements are on rank 2, 5 and 9 from the Chinese managers' perspective.

The three competency elements developed least effectively by PBL (i.e. rank 14 to 16) are from the Arab managers' perspective *Application of systematic design…*, *Theory based understanding…* and *Conceptual understanding of mathematics…*. The same competency elements are ranked 14, 16 and 15 from the Chinese managers' perspective.

Ran #	Arab managers	Chinese managers
1	3.6. Effective team membership…	3.3. Creative, innovative and pro-active…
2	2.1. Application of established engineering...	3.6. Effective team membership…
3	3.2. Effective oral and written communication…	1.3. In depth understanding…
4	1.4. Discernment of current knowledge…	3.4. Professional use of information…
5	2.2. Application of engineering technique...	2.1. Application of established engineering…
6	2.4. Application of systematic management…	3.5. Orderly management of self…
7	3.5. Orderly management of self…	1.4. Discernment of current knowledge…
8	3.3. Creative, innovative and pro-active…	3.1. Ethical conduct…
9	1.6. Understanding of accountabilities…	3.2. Effective oral and written communication…
10	3.4. Professional use of information…	1.5. Knowledge of contextual factors…
11	3.1. Ethical conduct…	2.2. Application of engineering techniques…
12	1.5. Knowledge of contextual factors…	1.6. Understanding of accountabilities…
13	1.3. In depth understanding…	2.4. Application of systematic management…
14	2.3. Application of systematic design…	2.3. Application of systematic design…
15	1.1. Theory based understanding…	1.2. Conceptual understanding of mathematics…
16	1.2. Conceptual understanding of mathematics...	1.1. Theory based understanding…

Table 7. Ranking of competency elements developed by Project Based Learning (most effectively developed to least effectively developed).

The difference between the perspectives of Arab managers *versus* Chinese managers on the development of competency elements by traditional learning is shown on Table 8. A statistically significant difference was only found for three competency elements, namely *Theory based understanding…* ($p < 0.0001$), *Conceptual understanding of mathematics…* ($p < 0.0001$) and *Creative, innovative and pro-active…* ($p = 0.038$).

Competency Element	**Arab**		**Chinese**		**MWU test**		
	Md.	*SD*	*Md.*	*SD*	*U*	*Z*	*p*
1.1. Theory based understanding…	4.0	1.0	3.0	1.1	1365.0	4.269	< .0001
1.2. Conceptual understanding...	4.0	0.9	3.0	1.3	1455.0	3.895	< .0001
1.3. In depth understanding…	3.0	0.9	3.0	1.1	1981.0	1.707	0.087
1.4. Discernment of current…	3.0	1.0	3.0	1.1	2150.5	-1.002	0.317
1.5. Knowledge of contextual…	3.0	1.1	3.0	1.4	2029.0	-1.508	0.131
1.6. Understanding of…	3.0	0.9	3.0	1.1	2366.5	-0.104	0.920
2.1. Application of established...	3.0	1.0	4.0	1.3	2077.0	-1.308	0.190
2.2. Application of engineering...	3.0	1.0	4.0	1.4	2034.0	-1.487	0.136
2.3. Application of systematic…	4.0	1.0	3.0	1.2	1927.5	1.930	0.054
2.4. Application of systematic…	3.0	1.0	3.0	1.1	2186.5	-0.853	0.395
3.1. Ethical conduct…	3.0	1.2	3.0	1.1	2049.0	-1.425	0.156
3.2. Effective oral and written…	3.0	1.1	3.5	1.2	2093.5	-1.239	0.215
3.3. Creative, innovative…	3.0	1.1	3.0	1.1	1895.0	-2.065	0.038
3.4. Professional use of…	3.0	1.1	3.0	1.1	2312.0	-0.331	0.741
3.5. Orderly management…	3.0	1.0	4.0	1.3	2309.0	-0.343	0.728
3.6. Effective team…	3.0	1.1	4.0	1.3	1948.5	-1.843	0.066

Table 8. Difference between Arab and Chinese managers using Mann Whitney U (MWU) test – competency elements developed by traditional learning.

The competency elements developed by traditional learning have been ranked based on their Mean value as shown on Table 9. The three competency elements developed most effectively by traditional learning (i.e. rank one to three) are from the Arab managers' perspective *Conceptual understanding of mathematics…, Theory based understanding…* and *Application of systematic design….* The same competency elements are on rank 13, 15 and 12 from the Chinese managers' perspective.

The three competency elements developed least effectively by traditional learning (i.e. rank 14 to 16) are from the Arab managers' perspective *Application of systematic management…, Creative, innovative and pro-active… and Knowledge of contextual factors….* The same competency elements are ranked 11, 6 and 16 from the Chinese managers' perspective.

Rank #	Arab managers	Chinese managers
1	1.2. Conceptual understanding of mathematics…	3.6. Effective team membership…
2	1.1. Theory based understanding…	3.1. Ethical conduct…
3	2.3. Application of systematic design…	2.1. Application of established engineering…
4	1.3. In depth understanding…	3.2. Effective oral and written communication…
5	3.2. Effective oral and written communication…	2.2. Application of engineering techniques…
6	1.6. Understanding of accountabilities…	3.3. Creative, innovative and pro-active…
7	3.5. Orderly management of self…	1.4. Discernment of current knowledge…
8	3.4. Professional use of information…	1.6. Understanding of accountabilities…
9	2.1. Application of established engineering…	3.4. Professional use of information…
10	3.1. Ethical conduct…	3.5. Orderly management of self…
11	2.2. Application of engineering techniques…	2.4. Application of systematic management…
12	3.6. Effective team membership…	2.3. Application of systematic design…
13	1.4. Discernment of current knowledge…	1.2. Conceptual understanding of mathematics…
14	2.4. Application of systematic management…	1.3. In depth understanding…
15	3.3. Creative, innovative and pro-active…	1.1. Theory based understanding…
16	1.5. Knowledge of contextual factors…	1.5. Knowledge of contextual factors…

Table 9. Ranking of competency elements developed by traditional learning (most effectively developed to least effectively developed).

The following section summarizes the interpretation and discussion of the presented results.

DISCUSSION

Based on the presented findings, each of the three research questions will be answered and discussed in the following.

The first research question is related to the contribution of PBL *versus* traditional learning to develop the sixteen competency elements from the perspective of a) Arab managers and b) Chinese managers.

The descriptive statistics (Table 3) allow the following interpretations. The Arab managers' difference between the highest and lowest Mean values is larger than the Chinese managers' difference between the highest and lowest Mean values. This means, Chinese managers perceive the development of competency elements by both approaches (i.e. PBL and traditional learning) to be more similar for all competency elements than the Arab managers do. Since the questionnaire was translated into Arabic for the Arab managers and into Chinese for the Chinese managers, an effect of language related differences in understanding the competency elements can be excluded. Furthermore, since all the interviewed managers did not experience PBL during their formal education, and since the difference between PBL and traditional learning was explained in the same

manner to all respondents, varying understanding of the two learning approaches (i.e. PBL and traditional learning) can be excluded too. However, the difference between GCC national culture and Chinese national culture, in particular the difference in "uncertainty avoidance", is reflected in Chinese managers being more comfortable with ambiguity than Arab managers (Hofstede-insights, 2019). This may have reduced the felt need to position themselves more distinct when evaluating the two learning approaches. Furthermore, the difference in "masculinity" (Hofstede-insights, 2019) may have caused a tendency among Chinese managers to evaluate a newer and less familiar learning approach (such as PBL) lower since the focus is more on achievement *versus* the method towards achievement. The latter interpretation is confirmed by the results presented here in that Chinese managers evaluated the development by PBL for all competency elements lower than the Arab managers, whereas they evaluated the development by traditional learning for eight out of 16 competency elements higher than the Arab managers. The differences between the development by PBL *versus* traditional learning for the individual competency elements is covered by research question two and will be covered in the following paragraph.

The second research question is related to the significance of differences between the contribution of PBL and traditional learning in developing the sixteen competency elements from the perspective of a) Arab managers and b) Chinese managers.

The results shown on Table 4 show in conjunction with Table 3 that Arab managers perceive a statistically significant higher development by PBL for all competency elements except *Conceptual understanding of mathematics…* and *In depth understanding…*. This means, all elements of the competency areas "engineering application ability" and "professional and personal attributes" (c.f. Table 1) are developed more effectively by PBL. Regarding the competency area "knowledge and skills", three competency elements are perceived to be developed more effectively by PBL (i.e. *Understanding of accountabilities…, Knowledge of contextual factors…, Discernment of current knowledge…*), two competency elements are perceived to be developed more effectively by traditional learning (i.e. *In depth understanding…, Conceptual understanding of mathematics…*) and one competency element did not show a statistically significant difference between the two learning approaches (i.e. *Theory based understanding…*). Arab managers are very much in favour of PBL, which might be related to an unsatisfied learning experience during their own formal education and/or an unsatisfying level of competencies among early career engineers. Anecdotal evidence seems to indicate that both aspects contributed to their perspective on PBL to develop engineering competencies.

The results on Table 5 and Table 3 show that Chinese managers perceive both competency elements *In-depth understanding…* and *Creative, innovative and pro-active…* to be statistically significantly more effectively developed by PBL. They seem to realize potential for students to go more into detail (i.e. *In-depth understanding…*) and to explore creative solutions (i.e. *Creative, innovative and pro-active…*) when learning is based on projects. However, the result means also that only one of six competency elements of the competency area "professional and personal attributes", and only one of six competency elements of the competency area "knowledge and skills" is perceived to be more effectively developed by PBL. In total, 14 out of 16 competency elements are not perceived to be developed more effectively by one of the two learning approaches. In line with the interpretation of the findings related to research question one, the high emphasis of achievement and success might result in a lower emphasis of the way towards success. From the perspective of Chinese managers, either way (i.e. PBL or traditional learning) has potential to develop these 14 out of 16 competency elements. Interestingly, the earlier described low level of "uncertainty avoidance" does not result in more openness towards a newer learning approach (i.e. PBL). This might be related to Chinese managers' being satisfied with the current competency levels among engineers. Also, two further dimensions of Chinese culture, namely high "power distance" (80) and low "individualism" (20) (Hofstede-insights, 2019), may have contributed to the perspective of Chinese managers in that they don't feel authorized to comment on the efficiency of learning approaches on developing competency elements (i.e. high "power distance") and they don't feel comfortable to voice an individual opinion related to this topic (i.e. low "individualism").

The third research question is related to the difference between the perspective of Arab managers and the perspective of Chinese managers regarding the development of the sixteen competencies by a) PBL and b) traditional learning. Regarding the development of competency elements by PBL (i.e. part a) of research question 3), Table 6 shows a statistically significant difference regarding all competency elements except *Conceptual understanding of mathematics…* and *Creative, innovative and pro-active*…, and in conjunction with Table 3 it is found that Arab managers perceive a higher contribution of PBL to developing these 14 competency elements than Chinese managers. However, and as described above, the cultural background may have contributed to a narrower range of Mean values, as well as generally lower Mean values, among Chinese managers. Therefore, it is more conclusive to investigate the difference between Arab managers' and Chinese managers' ranking of competencies based on the perceived contribution of PBL in developing competencies. The interpretation is based on the ranking shown on Table 7 and is given in the following paragraph.

The competency element *In depth understanding…* shows the biggest difference in ranking in that Arab managers ranked it 13 and Chinese managers 3 regarding the effectiveness of PBL in developing this competency. This difference can be explained again with the difference of cultural backgrounds. Although Arab managers were found to be in favour of PBL as shown above, the higher "uncertainty avoidance" of Arab managers (Hofstede-insights, 2019) leads to a lower expectation among Arab managers that in-depth understanding of specialist knowledge can be developed by students' group work based on a real life project, whereas the higher focus on achievements as reflected by the higher "masculinity" of Chinese managers (Hofstede-insights, 2019) leads to a higher expectation among Chinese managers that in-depth understanding can in fact be developed by PBL. These perceptions might be supported by the state of the educational system in the GCC region *versus* China. It has been found that education in the GCC region focusses much on rote-learning (Webb, 2008) and is influenced by students' expectation of spoon-feeding (Randeree, 2006), whereas education in China focusses much on solid theoretical foundations (Li and Guo, 2007). The latter focus enables students better to learn in-depth knowledge in a self-directed manner. In addition, the higher focus on achievement in Chinese culture is also reflected in a high focus on competition and success among Chinese students (Hofstede-insights, 2019).

Similar interpretations seem plausible regarding the two second biggest ranking differences, namely the differences regarding *Creative, innovative and pro-active…* and *Application of systematic management…*. The first competency is ranked 8 by Arab managers *versus* 1 by Chinese managers. Cultural background and educational preparation are supporting efficient development of creativity and innovation by the application of PBL in China, whereas Arab managers don't perceive the same efficiency in developing creativity and innovation by PBL in the GCC region. The second competency is ranked by Arab managers 6 and by Chinese managers 13. The higher "uncertainty avoidance" in the GCC region may cause a general higher appreciation of a systematic approach to project management, whereas the higher focus on achievement in China may cause a stronger focus on project outcomes and project success *versus* systematic approaches to project management. This interpretation is supported by a case study involving a Chinese contractor and Arab client of a construction project in the UAE (Ullah Khan, 2014).

Regarding part b) of research question three, namely the differences regarding the development of competencies by traditional learning (c.f. Table 8 and Table 3), and following the above justified reasoning that it is more conclusive to investigate the differences between Arab managers' and Chinese managers' rankings of competencies, the three biggest differences are interpreted as follows. The biggest ranking difference is related to the competency element *Theory based understanding…*. For Arab managers it

is on rank 2, whereas for the Chinese managers it is on rank 15. Similar to the previous interpretation, this difference can be explained by the lower focus on achievement as reflected by a lower "masculinity" in the GCC region (Hofstede-insights, 2019) which increases the efficiency of traditional learning in developing understanding based on theories. In addition, and as described above, Arab managers' perception of the educational system in the GCC region necessitates a traditional learning environment for developing this competency. Finally, the higher "uncertainty avoidance" in the GCC region (Hofstede-insights, 2019) may have contributed to this evaluation since Arab managers would expect a lot of uncertainty among students if they would need to develop *Theory based understanding…* based on student self-directed studies within a project and group environment. Arab managers' low satisfaction with their own educational journey and/or satisfaction with this competency among graduates may have had an impact on their perception too. The same interpretation applies to the second biggest difference, namely the difference related to *Conceptual understanding of mathematics…*, which is on rank 1 for the Arab managers and on rank 13 for the Chinese managers.

The third biggest difference, namely the difference related to *Effective team membership…*, which is ranked 12 by Arab managers and 1 by Chinese managers can be interpreted as follows. The lower "masculinity" in GCC culture is more focussed on quality of life and "standing out from the crowd is not admirable" (Hofstede-insights, 2019). This aspect of GCC culture is in line with the aspect of group work when utilizing a PBL approach and Arab managers did not see that effective team membership is effectively developed by traditional learning. In addition, the higher level of "uncertainty avoidance" in GCC culture (Hofstede-insights, 2019) contributes to appreciating teamwork since it has potential to identify and avoid uncertainties. Although both cultures share similarities regarding "power distance" and "individualism", a higher emphasis on hierarchy in Chinese organizational cultures when comparing with Arab organizational cultures (Jaeger *et al.*, 2017) points towards a stronger emphasis on uniformity and structure in social interactions such as teamwork. Uniform and structured group norms can be more effectively developed by traditional learning since group norms in PBL are likely to develop differently in each student group dependent on social interaction, personalities and experiences in each group. Of course, the size of society, history, tradition and education have an impact on the perception of managers too. Like Chinese managers' perception on the development of *Ethical conduct…* (rank 2, Table 9), *Effective team membership…* is seen by Chinese managers' to be developed very effectively by traditional learning environments.

In summary, national culture and organizational culture of Arab managers and Chinese managers have a strong impact on their perspectives of the effectivity of PBL and traditional learning in developing engineering competencies. Since managers of engineers

are at the receiving end of the engineering competency development process, engineering programs of Higher Education Institutions (HEIs) in both regions (i.e. GCC and China) may want to compare their utilization of PBL and traditional learning with the perspectives of managers of engineers from their region. However, if HEIs aim at developing "global engineers", i.e. engineers who are well prepared for work in a cross-cultural context, they are advised of comparing their learning approaches with the perspectives of managers of engineers from different cultures. The perspectives of managers from the GCC region and from China were presented in this study.

Before concluding this study, its limitations as well as recommendations for future investigations of this topic are summarized.

LIMITATIONS AND FUTURE STUDIES

The chosen methodology of semi-structured questionnaire-based interviews, as well as using respondents' native language for questionnaires and conducting interviews and a common definition of key concepts (i.e. PBL and traditional learning), contributed to a robust construct validity. Respondents reflected a high-level seriousness during the interviews and maturation effects resulting from respondents' familiarization with questions were controlled. At the same time and as noted earlier (e.g. Jaeger *et al.*, 2017), these advantages may also have potential to lead to a distortion of responses.

External validity of results can be assumed for the perspectives of the managers of engineers who were interviewed here. The scope of this study was limited to two learning approaches (i.e. PBL and traditional learning), one specific set of competency elements (EA, 2017), two cultural backgrounds (i.e. GCC and China) and one organizational perspective (i.e. managers of engineers).

Comparison of results with perspectives of managers of engineers from other cultural backgrounds was not within the scope of this study since it would require a comparable framework in order to be conclusive. However, future studies could fill this gap.

Future studies could also investigate the influence of other independent variables on the perspective on PBL *versus* traditional learning in developing engineering competencies, such as gender, educational background, duration of cross-cultural experience and duration of management experience. However, this would require the availability of an adequate number of responses for each answer category of these variables in order to ensure reliable comparisons.

CONCLUSION

This study aimed at identifying the perspectives of Arab and Chinese managers on the effectiveness of PBL *versus* traditional learning in developing engineering competencies. In general, it was found that Chinese managers perceive the effect of PBL *versus* traditional learning on developing competencies less different than Arab managers. Chinese managers evaluated the effect of PBL lower than their Arab counterparts, which might be related to the higher achievement orientation of Chinese culture, leading to a lower focus on the method towards achievement (i.e. PBL).

Arab managers perceive higher development by PBL for all competencies except *Conceptual understanding of mathematics…* and *In depth understanding…*, whereas Chinese managers perceive only two competencies to be more effectively developed by PBL *versus* traditional learning, namely *In-depth understanding…* and *Creative, innovative and pro-active….*

Comparing the perspectives of Arab managers with Chinese managers, the difference of national culture backgrounds, specifically, the higher "uncertainty avoidance" of Arab managers and the higher achievement orientation of Chinese managers, have been identified to cause Arab managers to perceive the development by PBL to be lower regarding *In-depth understanding of specialist knowledge*, lower regarding *Creative, innovative and pro-active demeanour* and higher regarding *Application of systematic management of projects*. At the same time, Arab managers perceive the development by traditional learning to be higher regarding *Theory based understanding…,* higher regarding *Conceptual understanding of mathematics...* and lower regarding *Effective team membership….* In addition, an influence of the educational systems in China and GCC region, as well as a higher pronounced hierarchy culture in Chinese organizations, were identified as reasons for the different perspectives on PBL *versus* traditional learning.

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A Scoping Review of the Relation Between Problem-based Learning and Professional Identity Development in Medical Education

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ABSTRACT

There is a substantial amount of research pointing to the benefits of pedagogical approaches such as problem-based learning (PBL) and the importance of developing professional identity as a physician in medical education. The aim of this review is to investigate the existing literature concerned with the relation between PBL and professional identity development in undergraduate medical students. We performed a scoping review of six electronic databases to map out how the relation between PBL and professional identity development in undergraduate medical students is presented in the existing literature. Eight peer-reviewed full text articles were retrieved as eligible for review. The most important conclusion from our work is that even though the topic of professional identity development in medical education has been studied quite extensively, there is a lack of knowledge about how new types of pedagogical approaches such as how a PBL curriculum influences medical students' professional identity development.

INTRODUCTION

Today medical educations around the world have to meet the demands from the fast-changing societies and healthcare systems, and furthermore medical knowledge and the way of treating complex diseases are rapidly expanding (Boyd & Fortin, 2010; Stenberg, Haaland-Øverby, Fredriksen, Westermann & Kvisvik, 2016). To keep pace with such requirements and changes,

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a high-quality education and practice that prepare medical graduates for the work as a physician is essential (Boyd & Fortin, 2011).

Professional identity development is a substantial theme in the research field of medical education, and is also acknowledged as a way of preparing graduate medical students for the work as physicians (Cruess, Cruess, Boudreau, Snell & Steinert, 2014; Passi, Doug, Peile, Thistlethwaite & Johnson, 2010). Similar research indicates that a strong sense of professional identity enhances robustness and preparedness to the transition from medical student to physician (Dolmans, De Grave, Wolfhagen & Van Der Vleuten, 2005; Lohfeld, Neville & Norman, 2005; Sharpless et al.,2015; Tweed, Bagg, Child, Wilkinson & Weller, 2010). Therefore, the importance of developing professional identity has been emphasised by international guidelines in medical education by organisations as Royal College of physicians and surgeons of Canada, Accreditation Council for Graduate Medical Education and Tomorrows Doctor (Franco, Franco, Severo & Ferreira, 2015; Maudsley & Strivens, 2000) and seems to have high priority on the medical educational agenda (Hefler & Ramnanan, 2017; Passi, Doug, Peile, Thistlethwaite & Johnson, 2010; Sharpless et al., 2015). Besides medical expert knowledge, medical students have to learn to think and act appropriately in their professional positions, understanding workplace cultures, meet the expectations of patients, relatives and other professionals, be effective in working with different stakeholders, and discerning in making judgements about ethical issues (Alba & Barnacle, 2007; Cruess, Cruess, Boudreau, Snell & Steinert, 2014; Sharpless et al., 2015). This leads us to the point that the curriculum in medical education has an important and meaningful role to play in supporting students' professional identity development and is to be seen as a vital source in the transformation to becoming a physician.

Parallel to the increasing interest of professional identity development in medical education, research in PBL has been given much attention over the last decade (Barnett, 2009; Savery, 2006; Walke, Leary, Hmelo-Silver, Ertmer & Lafayette, 2015).

Most researchers agree that PBL displays the following four characteristics: (a) a focus on complex, real world problems that has no one right solution, (b) based on group work, (c) students gain new information via self-directed learning and (d) teachers facilitate the learning process (Boud & Feletti, 2013; Hmelo-Silver, 2004; Walke, Leary, Hmelo-Silver, Ertmer & Lafayette, 2015). A PBL curriculum that involves these characteristics facilitates medical students to learn in ways that mirror professional practice and to attain high-level competencies and transferable skills, and therefore assists the demands of preparing the medical graduates for clinical practice (Barrows, 1990; Murray & Savin-Baden, 2000).

The competencies that PBL a curriculum offers the graduate students as collaborative skills, self-reflection, critical thinking, self-directed learning and solving real-life problems is the key to assisting medical students in making a smooth transition to the clinical setting (Barrows &

Tamblyn, 1980; Boud & Feletti, 2013; Tan, Van Der Molen & Schmidt, 2016). In addition to these competencies, PBL also brings the medical students into real-life situations either with real patients or cases that mirrors real life situations as a learning resource and the need for cooperation and communication with other professionals, which enhance confidence, motivation and satisfaction (Bleaklet & Bligh, 2008; Maudsley & Strivens, 2000).

Having noticed that PBL curriculum and professional identity development independently were prevalent in the field of medical education research we set out to explore the scope of existing literature which present the relation between PBL and professional identity development in a medical education context.

To identify and uncover the volume of medical education research about the relation between PBL and professional identity development we decided to conduct a scoping review and thus the research question we seek to answer is as follows:

> How is the relation between problem-based learning and professional identity development represented in the field of medical education research?

Since it is not unreasonable to assume that PBL curricula reinforce a certain professional identity development and mindset, which is unique to the PBL pedagogy, it is important to explore the existing research to gain new knowledge about how PBL a curriculum affects the professional identity development of medical students.

METHOD

This scoping review used the established scoping review framework delineated by Arksey and O'Malley because it enabled researchers to identify and summarize known literature on a given topic regardless of study design (Arksey & O'Malley, 2005; Levac, Colquhoun & O'Brien, 2010). Furthermore, Arksey and O'Malley drew four common reasons why a scoping review might be conducted: (a) to examine the extent, range and nature of research activity, (b) to determine the value of undertaking a full systematic review, (c) to summarize and disseminate research findings, (d) to identify research gaps in the existing literature (Arksey & O'Malley, 2005; Levac, Colquhoun & O'Brien, 2010). All four of these reasons supported our aim for conducting this scoping review as we sought to examine the volume, range and nature of papers that investigates the relation between PBL and professional identity development in medical education.

To guide the search strategy, we used the five key phases that one must go through when conducting a scoping review as outlined by Arksey & O'Malley (2005) and Levac, Colquhoun & O'Brien (2010): First starting point was to identify and formulate the research question to

guide the search strategy. Second, to identify relevant studies, through scoping the literature as comprehensively as possible. Third, to select the relevant studies which, involved inclusion and exclusion criteria based on the research question. Fourth, the charting was used to extract data from each of the included studies and a descriptive analytical method was used to extract contextual or process-oriented information from each study. Finally, collating, summarizing, and reporting the results which demanded consistency and clarity.

We have chosen to follow Arksey & O'Malley's (2005) and Levac, Colquhoun & O'Brien (2010) guidelines for scoping reviews. We consider this approach to be appropriate to the topic of our study in accordance with what has been defined as the overall purpose of conducting scoping reviews; a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence and knowledge gaps in the literature.

Search strategy and selection criteria

Based on our research question, the following keywords were identified to manage the literature search: medical education OR medical student OR medical students AND identity AND problem based learning OR problem-based learning. These keywords in the mentioned order together with relevant synonyms were combined to reflect the specific search string that was used to search relevant databases:

((“medical education” OR “medical student” OR “Medical students”) AND identity AND (“problem based learning” OR “problem-based learning”)).

We systematically searched the following six databases: PubMed, Scopus, ProQuest, PsychINFO, EBSCOhost and Medline. In keeping with the intention of scoping reviews as outlined by Arksey and O'Malley (2005) and Levac, Colquhoun & O'Brien (2010), these databases were selected to give comprehensive coverage and concerned with medical education or higher education, because research in medical education is not necessarily published in medical education journals.

To encircle the specific topic of our scoping review, we employed a number of criteria for inclusion as well as exclusion of studies derived from the research question. Studies were included for further review if:

- Problem based learning/problem-based learning was mentioned in either the title, abstract or keywords
- Identity was mentioned in either the title, abstract or keywords
- The study was conducted in the context of undergraduate medical education

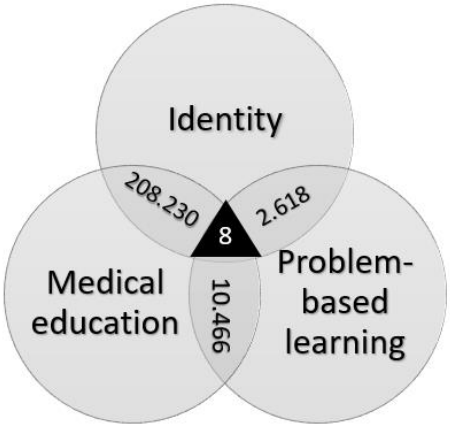

Figure 1. Volume of identified papers in six databases used in the scoping review concerned with PBL, Medical education and professional identity.

In addition to the scoping review, a preliminary search was conducted to strengthen the relevance of our scoping review. As shown in Figure 1, research in identity and medical education is well represented with 208,230 identified papers and 10.466 papers were identified relating to research in PBL and medical education. 2.618 papers were identified relating to PBL and identity and only 8 papers met the inclusion criteria derived from the research question.

In order to limit our search, studies were excluded if they were not available in English. Books, book chapters, conference abstracts and non-reviewed publications were also excluded. Having performed the initial literature search using the specific search string outlined above, we continued to sort the articles by employing the criteria for inclusion and exclusion in the following three steps: First we identified and removed the duplicates from the first search, we used the reference manager Mendeley. Second, the abstracts of the remaining articles were sorted manually, in the sense that titles, abstracts and keywords were manually screened.

In this step, only the articles conducted in a medical education context with a primary focus on undergraduate medical students' and mentioning problem based learning/ problem-based learning and identity in the title, abstract or keywords were included. Third, the full-text version of the remaining articles was retrieved and included for in-depth analysis. To ensure the eligibility of the selection of articles guided by the research question, the inclusion and exclusion process, was assessed jointly by three researchers.

The search and identification process of the literature search is presented in Figure 2.

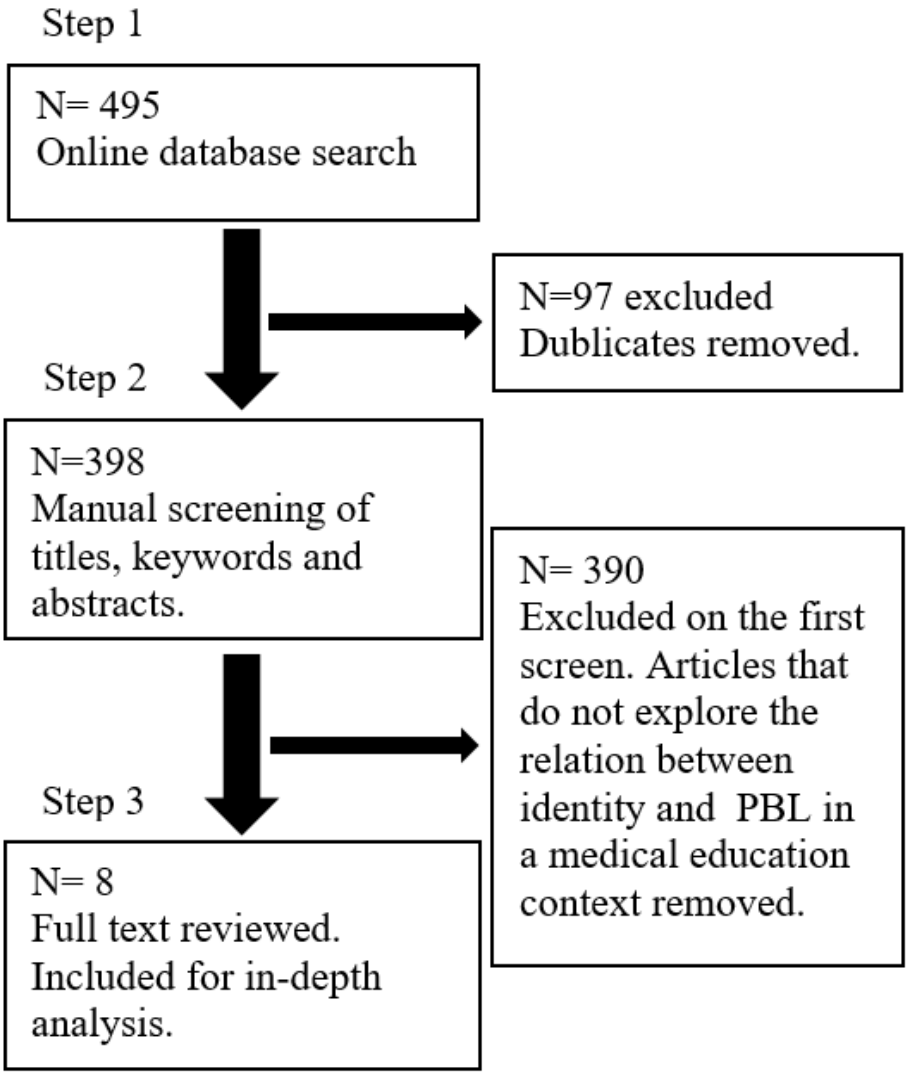

Figure 2. Search and identification flowchart.

The principal strength of this scoping review was the detailed search strategy designed to cover all the research that studies relations between PBL and undergraduate medical students' professional identity development.

RESULTS

The search was conducted on October 10, 2018 and included six databases PubMed (23), Scopus (35), ProQuest (377), PsychINFO (21), EBSCOhost (17) and Medline (22), which yielded in total 398 articles, which were potentially relevant, when duplicates were removed. After further screening of the 398 titles, keywords and abstracts, in accordance with inclusion and exclusion criteria, 8 full text articles were retrieved for detailed review, as shown in table 1 below. The very limited number of articles for review testifies Fig. 1 to the lack of studies which explicitly examine the relation between professional identity development and PBL.

Ref. nr.	Database	Authors	Year	Title	Journal
[1]	Scopus	Bell, K., Boshuizen, H. P. A., Scherpbier, A., & Dornan, T.	2009	When only the real thing will do: Junior medical students' learning from real patients.	*Medical Education*, *43*(11), 1036–1043
[2]	MEDline	Berkhout, J. J., Helmich, E., Teunissen, P. W., van der Vleuten, C. P. M., & Jaarsma, A. D. C.	2018	Context matters when striving to promote active and lifelong learning in medical education.	*Medical Education*, *52*(1), 34–44.
[3]	Scopus	Evensen, D. H., Glenn, J., & Salisbury-Glennon, J. D.	2001	A qualitative study of six medical students in a problem-based curriculum: Toward a situated model of self-regulation.	*Journal of Educational Psychology*, *93*(4), 659–676.
[4]	Scopus	Badenhorst, E., & Kapp, R.	2013	Negotiation of learning and identity among first-year medical students.	*Teaching in Higher Education*, *18*(5), 465–476
[5]	PsycINFO	Imafuku, R., Kataoka, R., Mayahara, M., Suzuki, H., & Saiki, T.	2014	Students' Experiences in Interdisciplinary Problembased Learning: A Discourse Analysis of Group Interaction.	*Interdisciplinary Journal of Problem-Based Learning*, *8*(2), 1–18.
[6]	EBSCOhost	Imafuku, R., Kataoka, R., Ogura, H., Suzuki, H., Enokida, M., & Osakabe, K.	2018	What did first-year students experience during their interprofessional education? A qualitative analysis of e-portfolios.	*Journal of Interprofessional Care*, *32*(3), 358–366.
[7]	ERIC	MacLeod, A.	2011	Caring, competence and professional identities in medical education.	*Advances in Health Sciences Education*, *16*(3), 375–394.
[8]	ProQuest	Reddy, S., & McKenna, S.	2016	The Guinea pigs of a problem-based learning curriculum.	*Innovations in Education & Teaching International*, *53*(1), 16–24.

Table 1. Articles included for full text review (in-dept analysis).

During the analysis of the 8 included articles, three main themes appeared relevant to discuss in relation to the research question. Firstly; the methodology used in the articles, secondly; how professional identity is conceptualized and finally how the relation between PBL and professional identity in medical education is visible. Themes that in one way or another can be regarded as a framework for the later discussion of the consequences or impact that a PBL curriculum has on undergraduate medical students´ professional identity development.

Nature of research

Of the 8 articles (see Table 2) for full text review, 7 contained empirical content utilizing qualitative approaches to data collection such as interviews, observations, self-reported statements and learning portfolio interviews, to investigate the relation between PBL and professional identity development in a medical education context [1,3-8]. The observations in the articles [4,5,7] were all conducted during PBL group sessions, group meetings or tutorials and the interviews in these articles were performed after or during the observation period. The articles using retrospective data as interviews [1,4,7,8], e-portfolios [6] and self-reported statements [1] were analyzing or interpreting the learner's own experiences with PBL. The last article [2] was identified as conceptual, since it is contained conceptual principles about current knowledge on enhancing active learning in PBL, and furthermore introduced some theoretical frameworks that may foster the understanding of the relation between active and self-regulated learning and professional identity development.

Ref. nr.	Research participants	Type of research
[1]	Third year medical students	Empirical (*self-reported statements*)
[2]	Conceptual article	Theory
[3]	First year medical students	Empirical (*observations and interviews*)
[4]	First year medical students	Empirical (*interviews*)
[5]	Third year medical students	Empirical (*video-recorded data*)
[6]	First year medical students	Empirical (*written e-portfolios*)
[7]	Undergraduate medical students	Empirical (*observations and interviews*)
[8]	Undergraduate medical students	Empirical (*interviews*)

Table 2. Learning context, research participants and type of research.

Conceptualization of professional identity

Professional identity in the included articles often refers to what a physician is, described as a representation of a position or a self, achieved in stages over time during which the characteristics, values, and norms of the profession are internalized through social interaction, agency, learning, reflection, acting, and feeling like a physician [1-8]. The authors of the 8

papers argue that professional identity is an adaptive developmental process that occurs both at the individual level of the medical student and as a result of socialization into a clinical role and professional community. Contained within these analytical descriptions from the articles, some principles of professional identity are brought forward: Professional identity development is a dynamic and developmental process that occurs in all medical students; professional identity is the result of social interaction and active participation in clinical practice; and professional identity develops from a series of identity transformations that occur primarily during periods of transition [1-8]. Each of the included articles contributes to various ways of examining the concept professional identity and thereby emphasises the challenge of doing research on professional identity development.

Relation between PBL and professional identity development in medical education

Below in table 3 the identified themes are listed to give an overview of the PBL concepts that are identified in the articles as influencing the professional identity development.

Themes in articles	References
Social interaction	[1-8]
Self-reflection	[1,2,3,5,7,8]
Proffesional community	[1,2,3,5,6,7,8]
Problem solving	[5,6,7,8]
Self-directed learning	[2,3, 5,8]
Cultural enviroment	[2,3,4,5,7,8]
Learning	[1,3,4,5,6,8]
Real patient learning	[1,2,5,6,7,8]
Active participation (agency)	[1-8]
Communication/ Language	[1,2,4,5,6,7,8]
Negotiating subject positions	[4,5,6,7,8]
Opportunities for learners	[2,3,4,7,8]
Rolemodel	[2,6,7]

Table 3. PBL Themes that are represented in the included articles.

The results indicates that professional community, real patient learning, cultural environment, social interaction, agency and communication are important PBL competencies that affect professional identity development. Of the 8 articles 6 recommend PBL as pedagogical approach to enhance professional identity development in undergraduate medical students' [1-3,5-7]. Thus 2 of the 8 articles problematized PBL in regards to the need for active participation, communication skills, opportunities for learners and learners as equal participants in the group sessions to generate learning [4,8]. These articles claim that PBL is best suited for capable students [4,8].

The three identified themes 1) nature of research, 2) conceptualization of professional identity and 3) relation between PBL and professional identity development in medical education deliver different perspectives on the connection between PBL and professional identity development, which will be discussed below.

DISCUSSION

Educational focus on professional identity development serves the need of preparing the medical graduates for the work as physician (Cruess, 2006; Hafferty, Michalec, Martimianakis, & Tilburt, 2016). Competencies as critical thinking, self-reflection, self-directed learning, communication and problem-solving skills have been emphasized as important goals of medical education, which also affect the developmental process through which medical students' form his or her professional identity (Niemi, 1997). However, little is known about how PBL curricula affect the professional identity development and the learning context and environment through which the personal experiences of the undergraduate medical students are elaborated. Thus, to our knowledge, this is the first scoping review conducted with the aim to explore and identify the existing literature concerned with the relation between PBL and professional identity development in a medical education context.

As presented in the results section the volume of research examining the relation between PBL and professional identity development is very limited despite the importance of professional identity development in medical education. In order to reduce the identified research gap, the purpose of this discussion is to inspire and contribute for further research, by discussing different theoretical approaches to professional identity development and alternative research methodologies to explore the relation between PBL and professional identity development in medical education.

New methodological approaches can apply important knowledge to medical education

As our results show, none of the included articles used ethnographic material to explore the relation between PBL and professional identity development in medical education. Thus, various social researchers have previously suggested that professional identity is primarily acquired through active participation in a professional practice, by observing how others behave and how they embody the values and behaviors of the profession (O'Brien & Irby, 2013). This argument suggests that social research in medical education can profitably take advantage of ethnography or methodological triangulation to better understand the complexities of the medical students' professional identity development in relation to PBL. Conducting ethnographic studies or methodological triangulation the researcher will gain a thorough insight into the process in which the medical students develop their professional identity. To produce knowledge that can explain this dynamic and complex development process, Leung (2002) suggest that one has to employ methods such as participant observation and unstructured

interviewing and put emphasis on the influence of the curriculum. Moreover, the formal, as well as the informal PBL curriculum, contains important knowledge to the research field of professional identity development. To go beneath the surface of the existing research and produce new knowledge, ethnography or method triangulation will allow us to untangle this research field and give a deeper understanding of how a PBL curriculum transforms the students (Leung, 2002). While other types of qualitative methods such as interview, self-reported statements and portfolios may be used to investigate students' perceptions, they cannot uncover the influence of prior socialization or learning on their perceptions.

Professional identity development in medical education

As the results shows in this scoping review the individual level is more or less absent. Thus, these new theoretical lenses could put forward new and interesting perspectives on the relation between PBL and professional identity development and thereby contribute to a unique approach to the delivery of undergraduate medical PBL curriculum.

The reviewed articles affiliate with a certain perspective that points out the need of the undergraduate medical students' to engage in a professional community to develop a professional identity. The theoretical perspective, can be closely tied to the concepts of community of practice (CoP) presented by Lave and Wenger. They suggest that social interaction between individuals enhance learning, and that CoPs emerge when those who wish to share a set of common approaches and shared knowledge and standards that create the basis for action, communication, problem solving, performance, and accountability (Wenger, 2001). CoP as a concept and PBL is often seen as a particularly helpful relation because they appear to reflect the reality of both medical education and practice (Dolmans & Schmidt, 1996; Lave & Wenger, 1998). A perspective that seems to capture the description of the practice of medical education that is presented in the included articles [1-3,5-8] and the idea that becoming a member of a community of practice is one of the major ways in which students begin to form their professional identities, often through as a dynamic process of legitimate peripheral participation (Lave & Wenger, 1998). It should be kept in mind that CoPs illustrate only one way of expressing the development of professional identity. Therefore, the research field demands attention towards the role of the individual and new theoretical approaches in a varied manner to explore and support the PBL curriculum improvement.

Social identity theory can subject the positions available to the medical students to a critical examination and support the preferred theoretical lens on CoP and turn the research focus towards the importance of the environment and context in which the PBL is practiced.

Tajfel & Turner (2004) and Jenkins (2014) propose that social identity theory refer to the way in which we understand ourselves to be a member of a group, along with an emotional connection to our group membership(s). As such, group membership is a very central aspect within all our identities. In the context of real patient learning, case work, group work and the

learning environment in which the medical students work and learn contributes to their social identity in different ways: through their developing sense of self as a member of the group of students or physicians, and as a member of the department in which they work. Furthermore, the engagement within the work as a physician and the level to which they are included, also contribute to their professional identity (Turner, 1987). Another theoretical perspective presented by Jarvis-Selinger, Pratt & Regehr (2012) claims that professional identity development is an adaptive process occurring at two levels: the individual level of psychological development, which occurs primarily within the individual; and the collective level, whereby the individual learns through interaction in the social context (Jarvis-Selinger, Pratt & Regehr, 2012). Students' learn and make meaning of their environment through the mental structures or schemata they develop. As students learn and develop, these schemata become increasingly complex and form the basis for self-reflection, self-directed learning, problem-solving and communication skills (Dolmans & Schmidt, 1996; Tajfel & Turner, 2004).

PBL as a catalysis for developing professional identity in medical education

PBL is often a debated medical education pedagogy and has been widely recognized as a progressive student-centered active learning approach and currently underpins the philosophy of the entire medical education curriculum (Barrows, 1990; O'Brien & Irby, 2013; Quirk, 2006). Even though there is no universal definition of what constitutes PBL and a conceptual uncertainty lingers in the literature both in terms of its underlying philosophy and in how it is executed. Thus, PBL advocating an experience-based learning environment that encourages collaboration to identify what to learn and how to solve a problem and they apply their new knowledge to the problem and reflect on what they learned of the strategies used (Barrows, 1996; Hmelo-Silver, 2004; O'Brien & Irby, 2013; Schmidt & Rikers, 2007).

Medical education appears enraptured with the intention of developing professional identity in medical students to prepare them and make them "fit in" to the work life (Hafferty, Michalec, Martimianakis, & Tilburt, 2016). PBL as defined by Barrows (1996) intend to prepare the students in the transition from medical school to working life by putting the students in real life learning environments. Cruess & Cruess (2014) argue that students should be supported in the transition to becoming a physician and that medical schools ought to devote more attention to the development of professional identity. In this respect, we would like to add on this perspective of Cruess & Cruess (2014), even though training in professional identity development at medical school most certainly will help medical students adjust in their career. We believe that an extended focus on the relation between PBL and professional identity development is needed during the transitions in the whole education program. With a perspective on medical education as a site of occupational socialisation and a site where the PBL curriculum sets the agenda for learning, then Hafferty (2016) argue that socialisation theory could contribute to an insight into identities that medical students assume. Furthermore, Hafferty addresses socialisation theory as a theory we can draw upon in exploring topics such

as behaviour, attitudes, self-image, self-reflection, occupational culture, values, norms and emotions (2016).

The development of professional identity in undergraduate PBL medical education serves an important purpose (Barrows, 1990; Murray & Savin-Baden, 2000) and to our knowledge, this is the first scoping review conducted to summarise the existing research currently available on this topic and to that end we encourage to further research to bridge the knowledge gap identified.

CONCLUDING REMARKS

In this paper, we have presented a scoping review of a sample of the research literature about the relation between PBL and professional identify development. More specifically, we have tried to answer the following question: How is the relation between problem-based learning and professional identity development represented in the field of medical education research? As it turned out, there was not much evidence in the sample of included articles on PBL we reviewed that could be used to clarify the specific relation between PBL and professional identity development in medical education. We found that none of the 8 included articles explicitly conceptualized professional identity or PBL, but used the concepts as common terms. However, we could identify a pattern of the use of professional community, that could be used to provide an adequate unifying picture of what affects professional identity development in medical students.

The most important conclusion that can be drawn based on the findings we have been able to produce, is that even though the topic of professional identity development in medical education has been studied quite extensively, there is a lack of knowledge about how new types of pedagogical approaches such as a PBL curriculum influences medical students' professional identity development. Thus, it is impossible to draw any final conclusions on how PBL affect the professional identity development in medical students and therefore more and varied research is needed.

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Theoretical and Operational Reflections on the Interdisciplinary PBL Simulation for Conflict Negotiation and Communication at the University of Helsinki

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ABSTRACT

An interdisciplinary approach has been adopted for undergraduate Law and Social Science students attending separate seven-week intensive language communication courses run at the University of Helsinki. The challenge has been to anchor this pedagogical development within theoretical frames of reference that contextualise the interdisciplinary PBL simulation. Focus is placed on one of the simulations - Bradford Simulation, based on the 1995 riots involving the Pakistani immigrant community in the English city of Bradford. Conflict encompasses multidimensional problems and synthesising interdisciplinarity with the PBL simulation attempts to create a learning environment in which students can gain an insight into the intricacies of conflict analysis, management and resolution. Considerations of student identity and learning factors are recognised. Key operational management factors requiring advanced organisational and communication skills by the teacher are also broached. Whilst positive outcomes have accrued there are limitations that have compromised the activity.

INSTITUTIONALISATION AND INTERDISCIPLINARITY

In January 2020 the transdisciplinary Helsinki Institute of Social Science and Humanities was established to disseminate research results. This evolution of Helsinki University highlights the intellectual trajectory the university is following in developing the philosophical underpinnings of the search for interdisciplinarity within a policy-oriented framework (Mäki, 2016). Since 1989, I have utilised an interdisciplinary approach in my courses involving Law and Social Science students at the university.

Clearly there is interdisciplinary synergy between the Law and Social Sciences (Sumner, 1973; Weinstein, 1999; Coleman, 2001; Kozakiewicz, 2008; Anders, 2015). Research has shown that

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behind traditional discipline-based departments, interdisciplinarity has been an active component of many courses (Pharo & Bridle, 2012). Neil Smelser observes that "the boundaries of most disciplines have become so permeable and indistinct, and so much exportation and importation has occurred that if one ranges widely in his or her discipline, one is being in effect interdisciplinary" (2003, p. 653).

Obstacles are confronted when embarking on the interdisciplinary path (Berger, 1972; Frodeman, Klein & Pacheco, 2010). Yet research and pedagogical developments at Aalborg University identifies the potential for and pitfalls in integrating Problem-Based Learning (PBL) within an interdisciplinarity framework (Jensen, Stentoft & Ravn, 2019). The challenge facing the teacher who wants to enhance PBL as the constructivist answer to traditional and learning paradigms is to ensure that the 'problem' is carefully chosen (Maurer & Mawdsley, 2014, p. 37).

CONSCIENTIZATION AND THE 'GOOD' CONFLICT PROBLEM

Winne and Nesbit (2010) expanding upon the work of Piaget, see that problems in the guise of contradictions, obstacles, anomalies and conflict, stimulates cognitive disequilibrium that positively impacts on reasoning and learning. The level of complexity in identification, analysis and resolution of conflicts transcends disciplinary boundaries, involving many fields of knowledge requiring "both disciplinary and interdisciplinary specialists to work together, hand in hand" (Weidner, 1973, p. 207).

However, as Petrie (1992) notes, many societal problems do not follow the contours laid down by traditional disciplines. Whilst 'conflict and violence' are intrinsic to the basic DNA of both disciplines it is remarkable how little is understood when it comes to comprehending the dynamic processes and drivers of violence for instance (Kilby & Ray, 2014). Even more damaging is the critique that the study of conflict has been subsumed beneath disciplinary paradigms and has become "specialised and balkanised" (Jackman, 2002, p. 387).

The utility of PBL is linked to the quality of the problem confronting the students because different problems exert different demands on the cognitive scaffolding required by students (Jonassen & Hung, 2008; Walker & Leary, 2009). This linkage may be enhanced if the process of conscientization is assured so that the learner is empowered to become critically aware of the different constituents, dynamics and power relationships within society on all levels of abstraction (inter-individual, inter-group and inter-national). The numerous works of Paulo Freire have resonance here, although the article by Andrew Armitage incisively draws attention to the value of conscientization underpinning the implementation of PBL in a Higher Education Setting (Armitage, 2013). Any student of Law or the Social Sciences should be equipped with multiple tools of analysis for identifying, evaluating and resolving conflict because it is the *sine qua non* of their existence. It is within the classroom that the simulation has the tradition of being the platform where conflict has been scrutinised (Sabin, 2012).

Simulation and Conflict PBL

Savin-Baden & Major, (2004) recognises the diversity of practice that has unfolded in different institutions. Robert Sternberg (2008) emphasises that PBL and simulations may find a natural fit with interdisciplinarity because he sees them as essential platforms for evaluating the major problems facing society, such as instances of collective violence.

Anderson and Lawton observed that simulations "can effectively serve as the 'problem' in a PBL designed course" (Anderson & Lawton, 2004, p. 28), and in divergent fields there have been attempts to integrate PBL and simulation. Research by Roh and Kim (2015) indicates that simulation combined with PBL enables increased intrinsic goal orientation, efficiency of learning and performance, task value, problem solving and autonomous learning. Murphy et al., (2011) merged simulation and PBL in their research concluding that:

> although PBL and simulation in isolation have educational merit, merging these pedagogies has the scope to link aspects of learning that further enhance and transform knowledge. Together with the necessary resources, merging PBL and simulation is feasible within a variety of curriculum models. (p. 146)

If a simulation centres on an outbreak of public disorder, then it is important to be sensitive to the dynamic shifts between conflict and violence and the perspective one takes. To some, the act may be glorious, to others it may be depraved (Scheper-Hughes. & Bourgois, 2004) This multiplicity of frames links to the hybridity value of the simulation (Sjoberg, 2014). Herein different levels of comprehension and understanding are accessed by simulation participants who are engaging with differing interpretations of processes and outcomes observed and experienced in the conflict simulation.

In the Bradford simulation, the 'problem(s)'ensue when the legal codes of public order are contravened. This legalistic perspective (Gurr, Grabosky & Hula, 1977) is imbued with notions of 'injustice,' whereby those in the crowd confront this perspective because the police are perceived as the architects of violence (Munkler & Llanque, 2003). It is this tension in the problem conceptualisation that is the centripetal force of the simulation.

The simulation is primarily human-to-human interactions, with computer assisted elements employed to open and maintain channels of communication between the different teams during non face-to-face interactions (Asal & Blake, 2006). The simulation

> is an interactive representation of the system to be studied, based on a model of the system…a model is a simplified representation of a real or imagined system, and a system is a collection of different elements whose combination yields results that are unobtainable by the elements alone (Landriscina, 2013, p. 6).

The Bradford simulation system is the problem-based environment of conflict observed during the riots. The model is a simplified representation of possible conflict resolution scenarios involving different stakeholders in the system interaction. The students represent key

stakeholder groups and interact using professional communication skills to analyse and resolve the conflict scenarios.

A successful simulation should encourage student interest and align with the learning concepts and objectives laid down in the course so that the participants can analyse and resolve the problem(s) they are faced with (Borstad, Forchhammer & Gabrielsen, 2017). Research has shown enhanced comprehension of processes and increased utility in terms of enjoyment when simulations have been employed, and they have also been seen to increase collaborative learning (Schick, 2008). Meanwhile, Harper (1985) asserts that there are "far-reaching and longer-term social and psychological benefits that can be attributed to the use of simulations" (p. 219).

The simulation also confronts many of the frustrations seen by teachers using traditional methodologies when "students were simply repeating the information taught in lectures without any critical consideration of the material, thus they were not engaging in deep learning and considered thought, the intrinsic level of motivation that educators strive for when designing programmes" (Clough & Shorter, 2015, p. 278). This introduces the challenge of being sensitive to the target group to whom the simulation is directed.

Identity Considerations

There has been definitional confusion over whether role play is ether a form of simulation or an activity distinct from simulation. Some authors integrate the two platforms (Waters, 2016) while others espouse the relative virtues of role play in promoting higher levels of learning (Fliter, 2009).

The extent to which a student takes on the persona of another party obviously decreases the sense of realism associated with the activity, but it does allow for the student to 'hide' behind the persona adopted. They see their role as a theoretical participant rather than as a student and may lure them out of their restrictive learner identity (Crookall, 1978). Conversely, if they apply their own persona to the simulation then the degree of artificiality is reduced. This allows the student to access their own repertoire of perceptions and here the simulation is exploiting the reality intrinsic to the classroom itself. But this also exposes them to counter arguments that they may feel uncomfortable with, a criticism that Claire Fox (2016) lays at the door of present-day academia.

It is important to realise that the communicative interactions of the negotiation do not mean "how faithfully the situation created reflects the relevant factors in a 'real world' situation, but rather on how realistically and credibly from the students' point of view it does so" (Crookall 1984: 262). This is determined by the learners themselves and research shows distinctive characteristics in the Finnish environment where:

- Active participation may mean delayed attempts at turn-taking, clumsy gambits, disfluency, slow speech and silent observations of ongoing discourse,
- Silent participation is often utilised,
- Entire withdrawal from the discussion is adopted (Lehtonen and Sajavaara 1985).

Within the Finnish context, the introduction of the simulation may be compromised by such patterns. This is not to denigrate such traits as they may be an important component of the socio-cultural profile of the students, but an awareness of learner types is essential in simulation design. Kolb identifies personality types having preference for certain learning styles that are often predisposed towards specific disciplines (Kolb, 1984). But the teacher needs to be sensitive to the possibility that simulations may induce higher levels of stress and anxiety (Yockey, 2015).

If the traits seen by Lehtonen and Sajavaara are encountered, then this may deter the teacher from using simulations. However, the benefits accruing from the use of simulations should be considered because they may extend beyond the confines of the classroom itself and seep into the cultural and professional fabric of the different communities.

Previous attempts in my courses at introducing role play into simulations with students allocated specific detailed roles were met with frustration. They could not engage with the role allocated and the suspension of disbelief necessary was unattainable by many students. This was compounded when the simulation was run with students interacting with each other from the same course because "if participants think that the simulation is comprised of like-minded individuals then they do not challenge each other's positions, thus reducing the need to defend their own position and so appreciate the logic behind it" (Usherwood, 2014, p. 56).

Group association and identity is important when working in teams and the cultivation of the 'in group' based upon course participants and their bonds of friendship are an important reflection of reality. But when placed in conflictual interactions then such attributes may be a hinderance to the inculcation of realism into the interaction because as friends they could not envisage taking on the mantle of adversaries in conflict scenarios. By introducing 'interdisciplinarity' into the classroom, this allowed me to devise a creative learning platform to address these demands.

LEARNING FACTORS

Drawing upon Stephen Krashen's (1982) monitor model, Taylor believes language acquisition and communicative competence requires the learner to be exposed to "real, comprehensible input provided in communicative settings that actively engage the learner" (1982, p. 35). This acknowledges the simulation fidelity continuum scale developed in the Health Sciences ranging

from 'low fidelity' where there is artificiality to 'high fidelity' invoking actual real-life situations (Doolen et al. 2016).

The primary objective of interdisciplinarity is moving the learning paradigm to higher levels of creativity as formulated in Bloom's Taxonomy of Learning Objectives (Bloom et al. 1956). Because "given the increasing complexity of modern society, the number of complex problems is likely to increase in the future so that interdisciplinary approaches will be required to an ever greater extent" (Mudroch, 1992, p. 46).

To get to these higher levels of creativity necessitates raising awareness of the value of the use of interrogatives in inter and intra-group encounters. The use of questions gives control over the interaction and they give information which allows the individual or group to have a competitive advantage if so desired. They perform essential social functions in easing the flow of communication. And, according to philosopher Jaakko Hintikka at a 2011 Helsinki Collegium for Advanced Studies presentation they lie at the heart of philosophical genius (personal communication).

Interdisciplinary platforms require what Lana Ivanitskaya et al. (2002) terms a "more personal construction of knowledge," by developing connections among ideas and the "interpretation and application of knowledge across several contexts" (p. 98). This crossing of contexts means students need to come to terms with higher levels of complexity (Spelt et al., 2009). This immersion of the student into unfamiliar surroundings echoes the words of John Stuart Mill:

> It is hardly possible to overrate the value… of placing human beings with persons dissimilar to themselves, and with modes of thought and action unlike those with which they are familiar…Such communication has always been, and is particularly in the present age, one of the primary sources of progress (1870, ch. 17-14).

Zygmunt Bauman calls for positive learning outcomes that accord with wider societal needs that go beyond the remit of university education and proposes the concept of liquid modernity (Bauman, 2000, 2004). This perhaps underpins Kek and Huijser's (2017) call for an 'agile PBL ecology' for learning. Yet research has identified that Finnish language centres for example, have placed more emphasis on academic language skills than professional communication skills (Lehtonen & Karjalainen, 2008). Subsequent research in a survey of Finnish Law graduates showed a deficiency gap between the skills taught at university and those needed at work (Lehtonen, 2017).

If the graduates of Social Sciences and Law are to be professionally engaged in their chosen career, then constructive alignment between what is taught and learnt at university should be in accord with the professional obligations after graduation (Biggs, 1996). However, the degree of complexity and the management of change that students face upon graduation may not have been given sufficient attention during their studies if constrained within a traditional disciplinary background (Bratt, 1977).

Yang Wong called for the harnessing of PBL in legal education because of the shortcomings of the traditional focus on disciplines (Wong, 2003). Stephen Nathanson stresses that problem analysis is central to the legal profession (Nathanson, 1997) whilst Stephanie Boys et al. (2015) was recognising this synergy of purpose in the interdisciplinary law and social work course she was running.

Taking these factors into consideration has influenced the rationale and design of the simulation.

OPERATIONAL MANAGEMENT

The simulation objectives are: to enhance student professional communication and negotiation skills, especially the use of interrogatives, to ensure that students have at least B2 level according to the Common European Framework of Reference for Languages and refine student competence in conflict analysis and resolution.

Recent insights look at integrated learning platforms (Fisher & Fisher-Yoshida, 2017). Petranek, Corey and Black (1992) subdivide the simulation into 'preparation,' 'interaction' and 'debriefing' phases. The preparation stage of the Bradford simulation in weeks 1-3 focuses on the use of interrogatives in interactions and the self-realisation by students that the power of the 'question' is infinite in conflict management. Micro activities raising awareness of communication and negotiation strategies are used, with lexical and conceptual awareness tasks being introduced. Lockstep teaching strategies are replaced by student-centred tasks to sensitise and empower them to take responsibility for their own learning. Tasks are introduced reflecting Levels 1 – 3 (Recognising, Understanding and Applying) of Anderson and Krathwohl's taxonomy (2001). This is the start of the 'marketing' of the simulation that prepares them for the full simulation commencing in week 4. During weeks 1-3, the Law and Social Science students are taught separately, it is only until the simulation is introduced when they engage with students from the other faculty.

Over the weekend of the 9-11th June 1995, riots broke out in Bradford resulting from police intervention during a street football game involving local Asian youths. In week 4 of the simulation, students are introduced to the Bradford simulation subject matter and stakeholder perspectives they represent. The students of Law represent the police and the Social Science students are community leaders representing the rioters from the Pakistani Kashmiri community. No specific roles are allocated, only that they represent either the authorities or the community and they can decide themselves if they want to make this more specific. However, to assist the students, general team objectives are provided but these are for guidance only and can be amended by the teams although this must be confirmed with the teacher. For example, the police want adherence to legal procedure whilst community representatives want legal procedure to be suspended. The objectives highlight mutually exclusive positions and rigid adoption of these positions exacerbates the conflict. It is the realisation of this outcome and the

shift away from these 'positions' towards an understanding of 'interests' (the motivations behind the stated positions) that empowers the students to realise the basic principles of integrative bargaining (Fisher and Ury1983).

In some simulations I have reversed these representations to give students an insight into differing perspectives. This reversal enhances the interdisciplinary fusion of the groups requiring higher levels of creativity and more exacting analytical skills. However, the sense of realism in the simulation was diluted with this additional layer of complexity and some students simply could not embrace the change in perspective.

The riots broke out on Friday evening and negotiations between the police and community representatives took place during and afterwards. On Saturday there was a lull in the riots whilst negotiations took place. Riots then broke out in a second successive evening only to recede on the third day when further negotiations were proposed. The topography of the real events is reflected in the simulation, only the simulation negotiations take place over a period of weeks and allow for negotiations to take place on three different occasions.

I try to make the start as interesting as possible, utilising audio-visual input (Renninger, Hidi & Krapp, 1992). Newspaper articles are a vital reference point, as is the testimony from those involved in the event itself and observers. These are accessible by students via a cloud-based system - Google Drive. This reflects the differing learning styles that students employ (Honey & Mumford, 1992) and is an explicit recognition of a blended learning approach (Bersin, 2004).

In the faculty within the two groups of twenty, students are allocated to teams of four. They stay within their teams and interact only with a designated team from the other discipline. Chinese walls are established so that teams do not engage with other teams from their own discipline to garner information. Allocation to teams is not done randomly (Work & Mauffette, 2018), but is based on their assessed performance during the first three weeks identifying their content knowledge and communicative competence. Sensitivity to the challenges and opportunities of mixed ability and background groups is recognised (Engen et al., 2018).

After the precipitating event of the riots is presented via video format in week 4, the Social Science students compose a letter expressing their concerns at the arrests of the youths who are placed in police detention. This is sent to their counterparts in the Law team and the latter respond via Google Drive as the first point of contact. The session is taken up with teams processing the information input, drafting the correspondence and deciding appropriate communication and negotiation strategies.

Once the Law students have replied, in the intervening week between weeks 4 and 5, materials input shows an escalation in the conflict with youths congregating outside the police station. This provides the context for the first negotiations to take place in week 5 that represent the negotiations that took place on the Friday evening. The teams are allocated 90 minutes per

negotiation during that week and arranged with the teacher who observes each negotiation. These negotiations centre on the call by the community to free those who have been arrested and the reluctance of the police to comply with this demand. The inherent tension then feeds into the systemic distrust of the community towards the police and the latter's rigid adherence to protocol and security considerations. Towards the end of the time allocated for the team negotiations, irrespective of what has been agreed in the negotiation, new input from the teacher shows that rioting has broken out, as it did on the first night of the disturbances and that the negotiations be suspended.

In the intervening period between weeks 5 and 6, the students are in further correspondence with each other with the aim of meeting for more negotiations in week 6. During week 6 the second negotiations take place; 120 minutes being allocated for each team negotiation and this represents the negotiations that took place on the Saturday afternoon during the riots. The negotiations evolve from a focus on the flashpoint the previous evening to questions of community grievances swirling around a sense of injustice where the community experiences high levels of multiple deprivation. In contrast is the police resorting to security issues and frustration at the unwarranted demands of the community. Towards the end of the negotiation, information input shows riots have broken out again and negotiations are suspended. The point at which the riots emerge and bring an end to the negotiations are carefully orchestrated by the teacher so that it fits in with the negotiation dynamic taking place. The negotiations are staggered throughout the week so that the teacher can observe and the interactions are recorded and transcribed focussing on salient issues and used as the basis for feedback to the students in the debrief session. Video extracts from the recordings are not shown for teaching purposes as some students are sensitive to their portrayal in public.

The last part of the simulation is in week 7 and this concentrates on feedback to the students. The riots culminated on the Saturday night and the next day, Sunday, the two parties were waiting in abeyance for the other to make the first move. Negotiations were expected to continue, and the students are expecting to further engage with the other team. In the disturbances, the confrontation was defused when a group of women from the Interfaith Women for Peace group intercede and the attention is taken off the rioters. In the simulation, the teams are awaiting the appearance of the other team, instead the teacher takes control and meets the teams separately for debriefing. Previous attempts at joint debriefing sessions with the teams from the two faculties were very successful in most instances, however, there were some sessions that became acrimonious and this approach was terminated.

During weeks 4-7, teams complete a reflection journal showing their strategy and their impressions of the other team. This is written into a formal memorandum by each team and forms part of the students' assessment which is a simple pass/fail categorisation. Part of the memorandum, where the students give their impression of the other team is used to give feedback to the opposing teams.

Teacher feedback to the students concentrates on the objectives set for the simulation and this alignment is central to the simulation experience (Duffy & Savery, 1994). The type of feedback transforms throughout the simulation. During weeks 5 and 6 when the face-to-face negotiations are being enacted, feedback to the students is given in the form of reflective interrogatives compiled by the teacher and not statements of performance to help students realise the potential strengths / weaknesses of their performance and strategies. This allows the student to take more responsibility for their learning experience and incorporates some of the basic tenets of autonomous learning (Clifford, 2006).

Because the students are often interacting online, teams are required to sign up the teacher to their respective groups and I have access to the dialogues between and within the different teams. The students have the flexibility to decide the learning environments within their own teams to more closely meet their learning needs (Craig & Hale, 2008, p.172). In previous courses where an institutional VLE platform (Moodle) was available it was not used by students for inter/intra team interactions. The favoured *modus operendi* by students is setting up a social media group team for interactions which is a natural exploitation of the learning environment (Lieberman, 2014). When the teacher has real time access to the student interactions between the negotiations, then feedback and innovative assessment mechanisms can be put in place to assist the student learning experience (Clegg & Bryan, 2006).

TEACHING AND LEARNING IMPLICATIONS

Course feedback from students consistently placed the interdisciplinary element of the course as the most engaging and motivational part of the course, although they found it demanding. 90% of all student feedback found the interdisciplinary experience to be the most positive. They reported having to invoke skills and strategies that they would not normally utilise in more traditional learning environments. They felt that interdisciplinary practice exposed them to creative thinking and breaking the disciplinary paradigms. One team couched it in less academic discourse: “the other team were idiots, but they had good points and to understand the problems and the solution we had to consider their point of view.” This highlights some of the key principles espoused in negotiation theory requiring them to defuse the emotional capital and to think of creative options (Ury, 1991).

There are limitations when following an interdisciplinary path within a PBL context (Bursztyn & Drummond, 2014). Despite the overwhelming positive feedback there were still some students who found the experience stressful and reacted by looking inward and limited their interaction. These students took advantage of the 20% absence policy which allows them to be absent from the course. This constrained some teams and raises questions on students’ intrinsic and extrinsic motivation, it also highlights the ‘producer-scrounger’ spectrum of student application (Vickery, 2013). Sometimes this resulted in complaints being made by other team

members forcing the teacher to set up a 'grievance policy framework' in later simulations. Conversely there were occasions when emotions took precedence within the negotiations and then overflowed into the team discussions. The teacher had to then be the mediator and raise individual student awareness of their responsibilities of being a team member. This again required more time investment by the teacher.

Despite these reservations, the introduction of the interdisciplinary perspective negated the oft-quoted criticism of simulations that students do not take them seriously (DiCamillo & Gradwell, 2013). The majority embraced the interdisciplinary feature and student feedback confirmed research observations that simulations enhance student learning and increase interest in abstract theories and concepts (Shellman & Turan, 2006).

Students reacted positively to feedback from the teacher, many often remarking that they receive no personalised feedback in other courses. Sensitivity to differing student personality types is important and because feedback may be misconstrued by students, the form and type of feedback given to students should be carefully considered (Gibbs, 2006). There is a triangulation of feedback approaches involving participant-led feedback in terms of student self-reflection, observations of interactions by the teacher and documentary evidence such as the memorandum.

Based on student feedback, the Bradford simulation accords with the following PBL outcomes:
- Development of decision-making skills,
- Problem-solving contextualises learning,
- Development of student autonomy,
- Development of collaborative learning skills (Martin 2003).

In addition, there was an increased awareness of conflict resolution and enhancement of professional communication skills. This was an implicit recognition that the interdisciplinary component facilitated the advance towards higher levels of learning (Biggs & Tang, 2009). For instance, students often remark that their strategy and actions in the second negotiation were influenced by their experience in the first negotiation. The 'realism' of the interdisciplinary simulation exposes the students to a key success factor in negotiations and this is separating the 'people' from the 'problem.' The focus of undergraduate Law study in Helsinki University is on refining skills to adapt to an adversarial environment in court and the students often transfer this outlook into the simulation. Engagement with the Social Science students reveals the possible consequences and limitations of such an approach within the framework of negotiations.

This is also revealed in the increased use of interrogatives by the students during the simulation. The activity engendered an atmosphere in which the use of questions was an absolute requirement. Students are often faced with lectures and seminars in which lockstep pedagogy prevails and do not often have the opportunity to refine their questioning skills. In contrast, the

simulation necessitated the active use of interrogatives in all encounters. Herein lies the paradox for the Finnish learner- if they realised there is a compromise between being silent and being garrulous and that lies in the use of questions, then their recourse to reduced participation in interactions might be mitigated.

Moreover, whilst there are increased moves to autonomous learning in Helsinki University, it is unclear how this addresses some of the stereotypical communication attributes of Finns. The interdisciplinary PBL simulation counters this trend and whilst encouraging some degree of student autonomy, this is synergised with active teacher and peer-group input in all stages of the learning experience.

Teacher investment, especially in outside classroom operational matters is high and resource intensive. Workload increases dramatically and requires teachers to have skill sets that transcend the traditional classroom environment. Institutional deficiencies are encountered, notably the lack of rooms as highlighted by Usherwood (2014) because the simulations are often placed into constrained temporal and physical slots that compromise their utility.

CONCLUSION

The interdisciplinary PBL simulation requires students to invoke a portfolio of skills processing differing levels of information and interactional communicative input/output. The simulation allows for the hybrid nature of multi-layered tasks to be employed so that participants have to initiate and react to different learning environments. This is juxtaposed with the elevation of the conflict problem as the conduit between the learning platform and an insight into the complexity of real-world critical scenarios. In this respect the interdisciplinary PBL simulation allows for the fusion of hybridity and conscientization that may suitably equip students for their future roles in society.

The ‘conflict’ problem has attendant risks, not least because students are placed in environments where their world view may be questioned. But surely the essence of intellectual development is not found in the answers discovered but the questions asked. The simulation platform has the potential for encouraging safe emotional responses and invoking different communication strategies. It promotes a collective view in which ‘we’ and not ‘I’ become the norms of learning. Where using questions become a natural part of communication and the students evolve professional skills that they can transfer to the workplace.

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Implementing the Introduction, Methods, Results and Discussion Article Structure in Engineering Education based on Problem-Based Learning

Vincenzo Liso *

ABSTRACT

The organization of knowledge influences how effectively students learn, so that if the information is well structured and the knowledge acquisition process is carried out in a systemic way, one can more effectively retrieve pieces of knowledge. To tackle this problem a common document format used in academia, IMRaD (Introduction, Method, Results, and Discussion), can help students in natural science and engineering education to approach the problem of knowledge organization in a systemic way from the beginning of the learning process.

In this study, we explore the use of the IMRaD format for students pursuing undergraduate and master's degrees as a tool for learning whilst making the project report more comprehensible for readers. The predefined document structure cannot be considered the solution to all learning issues and it should not limit the unpredictability, which is necessary during the creative thinking typical of the research environment.

Keywords: IMRaD report format; knowledge management; project learning; problem based learning; problem solving

INTRODUCTION

Universities around the world have started adopting research-based methods for education from undergraduate curricula with the motivation to increase critical and innovative thinking among students and promote research findings outside the university walls (Oriokot, Buwembo, Munabi, & Kijjambu, 2011). Students therefore face

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challenges when approaching the research methods that at the first instance may seem unstructured and characterized by many tacit rules.

Project- and Problem-Based Learning (PBL) have also become distinctive methods in students' education (Mills & Treagust, 2003). This approach is motivated by the need to train students in a working method, which is close to the real world (Graaff & Kolmos, 2003). In this context, the project is selected, scoped and framed to serve as the ecosystem for learning the course contents through practice and implementation of the theory. However, it has been demonstrated through numerous cases that there is a need to increase student support and coaching in acquiring a reporting style that conforms to academic standards. This is supported, for instance, by Oriokot et al. (2011) where it was found that student teams with less support from faculty members were less likely to follow the IMRaD format while drafting their reports. This led to the conclusion that actively supporting undergraduate research could yield beneficial results in acquiring fundamental academic writing skills.

Academic articles written in a recognizable format such as IMRaD, can also help readers who will be able to readily find information in the report. Wu (2011) mentions several studies in which readers deem papers with a well-organized abstract to be superior to the ones that do not show a clear structure.

Wittek, Askeland and Aamotsbakken (2015) analysed how students approach the writing process and revealed that novices tend to approach writing as mere "reporting": they write to present data and facts. Writing plays an important role in students' learning because it puts them in an active position to clarify the world as it appears to them. In Wolfe, Britt, and Alexander (2011), authors report a decline in the teaching of good technical writing in education, and as a consequence teachers have increasingly relied on "reactive teaching methods". This means that writing instruction occurs only when the student's problem arise and the instructor deems it appropriate to comment. The authors show evidence that students who were explicitly taught technics for scientific writing performed better then who were not taught any specific strategy. Kirschner, Sweller and Clark (2006 pointed out that, in an education context, approaches with minimal guiding instructions are found less effective and efficient than educative approaches with an emphasis on extensive guidance, because of incompatibility between the human cognitive architecture and the teaching methods of minimal guiding instructions. The importance of the writing process in emphasized in Petersen (2018), where it is suggested that thoughts are organized verbally in our mind, and therefore learning to think through writing helps develop an organized and efficient mind.

Writing requires that the student organizes knowledge as a hierarchy. Reif (1987) emphasizes that organizing knowledge is a complex exercise; generally, it is more

difficult to create such a structure than use it. To explain the point, the analogy of a geographical map was used. Most people can use a map, but to create a map is a much more complex task which requires systematic organization of information.

In all, PBL is becoming a growing trend in education and is posing a need to develop new strategies for teaching students. In this context, the aim of this paper is to analyze why the systematic and well-structured framework provided by the IMRaD format can facilitate student learning by explicitly indicating the contents in each section of the report. The analysis is to be considered in the context of a problem-based education where students are requested to solve a problem during the project time. Additionally, we assume that the IMRaD format is implemented in the context of engineering education, where the problem formulation both reflects the nature of the engineering project and enables students to expand on one another's work.

In this paper, we first discuss the challenges that students face when organizing a large amount of knowledge in a project report. This effort is associated with the definition and the solution of a project's main questions; then, we analyze the phases and challenges during the problem-solving process. After that, we describe the main phases of the project and the main sections of the IMRaD report format. Finally, we discuss how teaching the IMRaD report format can contribute to student learning.

MATERIAL AND METHODS

The scientific literature on the relevant topics constitutes the knowledge base for this study. In order to understand the impact of the IMRaD format on the student learning process, three main subjects were investigated: (1) the organization of knowledge in the learning process, (2) the major phases involved in the problem solving, and (3) the project life cycle phases.

As criteria to select the relevant literature in the different subjects, we aim to find well-established models in project management and problem solving in the field of cognitive science and education. We analyze how the learning process occurs when students have to organize the knowledge to solve the project problem over a framed period, with the intent to show how the IMRaD format can promote the student objectives.

In particular, we start documenting the implications of organizing knowledge during the learning process. We then describe the main phases of problem solving identified in the literature. In doing so, we gain a better understanding of the cognitive process in learning.

Since the problem solving occurs throughout the project period, we investigate what the main project phases are and their correlation with the problem-solving phases. For

instance, it will become evident that the problem definition will be performed in the early stage of the project, while the problem conclusion will be towards the end of the project.

The identified problem-solving phases and project phases are useful to debate later in the Discussion section, which outlines how the IMRaD format can promote student learning and knowledge organization and how this paper structure resembles both the identified main project and problem phases.

RESULTS

The results section is organized in four parts, where the first three parts are meant to justify the importance of the IMRaD format in the context of education. Thus, the four parts are the organization of knowledge, the problem-solving and project phases, and finally the IMRaD format description.

Organizing knowledge in educational context

Interpreting and organizing scientific concepts is a complex exercise, which differs from common everyday tasks (Reif 1987). Knowledge can be organized in different ways; however, a systematic organization can increase the performance of students. Reif (1987) found that inexperienced students tend to remember bits of knowledge without a coherent knowledge structure. This can be attributed to the tendency to memorize facts and formulas. In many cases, they are unaware of ways to effectively organize knowledge during their learning process. On the other hand, experts have coherently organized knowledge such that it is easy for them to infer detailed information. If well organized, information can be easily retrieved; this is particularly true in the case of large amounts of knowledge. Moreover, in science there is a need to make good connections among different pieces of information.

In hierarchical knowledge organization, the most important piece of knowledge is intended to be the one that helps the most in the attainment of the overall goal. Subordinate knowledge is less important and is useful for solving specific goals. In Eylon and Reif (1984), evidence was shown that knowledge, when organized according to clear principles and tasks, is easier to apply and consequently increases student performance.

In science, we use unifying principles, which provide a general understanding of a physical phenomenon. These principles provide the building blocks to solve problems. Inexperienced learners can have a fragmented and poorly organized knowledge, which leads to poor application of the concepts that can be easily forgotten after a short period. Even instructors can come with some poor organization of lectures, if there is little effort to arrange the knowledge globally across the course lectures. In this way, the task of

organizing knowledge is left to the responsibility of students, with the consequence that students' knowledge remains poor.

Problem solving phases

Problem solving is a process, which is motivated by the necessity to accomplish a goal. Its difficulty depends on the complexity of the problem in itself and the ability of the solver. A problem can be solved using different strategies; however, some major phases can be highlighted. Different authors have investigated the cognitive process involved in the problem-solving process. Among others, Reif (1995, 2010) defines basic problem solving in the four following phases:

"(i) describing the problem; (ii) analysing the problem; (iii) constructing the solution; (iv) assessing the solution."

In the initial phase, a description of the problem with all the needed information is created. The second phase involves the problem analysis in which relevant theoretical concepts and principles are recalled to develop a more analytic description of the problem. Consequently, a solution is constructed. A problem may be divided in multiple sub problems, and lacking information must be covered by the solver existing knowledge. If this initial phase is not correctly done, the subsequent work can produce wrong results. In the third and last phase, the solution is checked. It is essential to evaluate if the solution is correct and in order to do so some standard checks must be carried out (i.e. consistency of units of measurement, validation of results against previous results). An additional phase can involve exploiting the solution to solve other similar problems.

A similar definition was provided by Carlson and Bloom (2005), where the authors define what they call a "Multidimensional Problem-Solving Framework". In this case the problem-solving process was studied for the discipline of mathematics, and it is constituted of four phases:

"(i) orientation, (ii) planning, (iii) executing, and (iv) checking"

During the orientation phase, the problem solvers puts their effort into making sense of the provided problem information and constructing a logical representation of the problem. In this phase, goals are defined. In the planning phase, the focus is on accessing previous knowledge, algorithms, and schemata that can help solve the problem and construct a solution approach. During the execution phase, the solution approach is implemented. During the checking phase, the proposed solution is verified for reasonableness and correctness. A decision is made regarding the validity of the solution.

These four problem-solving phases closely resemble the ones previously defined by Reif (1995). Both the presented frameworks are characterized by being cyclical, meaning that

during phase four, if the solution is not satisfactory, a new cycle starting from phase two is engaged; the problem is re-analyzed and a new solution approach is constructed. This cycle occurs multiple times when attempting to solve a problem and therefore the process is far from being considered linear. In this regard, Olsen and Pedersen (2005), chapter 2, says that the problem formulation requires most of the work at the beginning of the project, but it can be reformulated several times during the project and is closely connected to the conclusions. When the students' group finds a solution for a sub-problem, the original problem formulation can be re-assessed and further clarified. At the end of the project, both the problem's formulation and conclusion are reassessed to make the project coherent.

Reif (2010) emphasizes that, in the science domain, problem solving requires a substantial amount of well-connected conceptual knowledge and a systematic approach so that mere cleverness will not be sufficient to construct a correct problem solution. Good problem solvers tends to spend more time in the first phases, namely describing and analyzing the problem, while inexperienced students tend to focus on the construction of the solution, and sometimes they are not aware of all the knowledge required to solve a problem. Similarly, good students tend to reason around a few important principles and concepts rather than use knowledge from a previous similar problem. Based on these considerations, instructors should focus on explicitly teaching the decision process needed to solve a specific case, with all the potential options, and making sensible choices rather than describing one example. In this regard, Sweller and Cooper (1985) found that abstraction of general rules requires an exposure to different schemata for constructing a solution.

Emotions and good attitude can also play an important role during the problem solving. With regard to this, Carlson and Bloom (2005) found that making correct decisions during problem solving depends not only on the ability to draw from well-connected conceptual knowledge, facts, and schemes, but also on the ability to manage emotional response during the process. Experienced problem solvers tend to be more self-aware and therefore control their emotional response better. The less experienced may not notice when their effort is following an unproductive direction, and therefore this can lead to frustration.

Problem-based learning is a good environment to develop a new mental model that values connecting theory and practice, develops collaboration, and acquires a better control of the learning practice (Askell-Williams, Murray-Harvey, and Lawson 2007). On the same line, Hmelo-Silver (2004) found that, through the experience of solving a problem collaboratively, students construct a knowledge base, become more independent and motivated to find the learning direction, and learn to effectively collaborate with their peers and other stakeholders. By becoming an autonomous learner, the student will be

able to apply these important lifelong learning skills and metacognitive strategies in his future professional life.

Project life cycle phases

In a project-based learning context, the problem solving occurs over an extended period of time, generally a few months, which coincides with the beginning and the end of the project. A project task simulates an experience that is close enough to the professional world where the team and different stakeholders are involved at a different time. According to HBR (2016), in the life cycle of every project, we can identify the four phases listed below.

Planning. The real problem that needs to be solved is identified and defined. The project stakeholders are identified and the success criteria are defined. The project objectives are planned.

Build-up. After the planning phase, the estimates previously conducted become commitments in terms of resources. In this phase, precise resources for solving the project are put together.

Implementation. During the implementation phase, the plan is put into action. In this phase, it is important to control the time and report progress to the stakeholders in frequent meetings.

Closeout. During the final phase, the focus is on delivering the results to the relevant stakeholder and assessing the quality of the output.

These phases are so broadly specified that similar stages are found during a project in the educational context.

IMRaD report format description

Several comprehensive guidelines were developed for helping students to write a report according to the IMRaD format (Cuschieri, Grech, & Savona-Ventura, 2018; Gastel & Gastel, 2013; Manterola, Pineda, Vial, & Grande, 2007; Mateu Arrom, Huguet, Errando, Breda, & Palou, 2018). The guidelines in Morley (2018) provide the phrasal elements commonly used in each section of the IMRaD report. The author suggests that there are recurrent phraseological patterns that are used in academic language that are worth acquiring, especially for non-native English speakers. The benefits of teaching students recurrent language patterns were analyzed by Wolfe et al. (2011). Moreover, course material and handouts for academic writing including the IMRaD format have been produced by many universities.

In Meadows (1985), the reasons for the popularity of the IMRaD format in the scientific community are outlined. In the study, it is suggested that this construction is the consequence of an evolutionary process aimed at simplifying the complexity of a scientific report so that authors can address the typical common questions of a scientific study. There are also advantages for the editor and reviewers, who will find it easier and more time-efficient to evaluate the manuscript and find specific pieces of information in the structure blocks without reading the entire document. Considering the large number of rules in scientific writing, Luby and Southern (2011) wished that editors could permit more lenient requirements in academic writing standards from young researchers.

Szklo (2006) examined how different reader types approach science articles written in the IMRaD format. The results of a survey showed that the reading strategy depends on the specific reader role: scientist, editor, and reviewer. For instance, scientists tend to read strategically; they jump to the section that can provide the needed information. Second-language readers require more cognitive effort during reading; therefore, they may be more interested only in the sections rich in information, such as the results and discussion. On the other hand, reviewers and editors look at the paper as a "raw product". Reviewers for instance start focusing on the soundness of the methodology description. Editors scan the paper from beginning to end to make sure that it adheres to academic standards.

Below we list and briefly describe the main content of each IMRaD report section. As often suggested, each section responds to a precise question (Manterola et al. 2007; Mateu Arrom et al. 2018; Wu 2011). The names of the sections in some articles can be slightly different. In some cases, these sections can be merged into one for convenience (e.g. "Results and discussion"). Even with these slight variations, the structure remains the same.

Introduction. (Why the study was done?) The introduction serves to put the work into context. It starts with the background of the study from higher level down to the specific problem addressed in the study. The section should contain the general context that motivated the study, a review of the relevant literature on the subject, a clear definition of addressed problems with hypothesis and research questions. The final paragraph is generally used to outline the structure of the report.

Methods. (How was the study done?) In this section, we describe in details the research procedure. We generally start with the problem theoretical assumptions, after we present the procedures and techniques used to solve the case. In quantitative research, data is collected through modelling or experimental testing. If the study involves modelling, the physical equation should be accurately reported. If an experimental study is done, the test procedures and the data analysis should be described in details. The information provided should allow other researchers to reproduce the study.

Results. (What did the study find?) The main findings are reported and commented in a systematic and detailed way. In an engineering study, we usually report quantitative results in plots and tables. Each of listed results should be described with the interpretation of the physical phenomena. In the results' presentation, it is important to link and comment them to the methods previously described and relate them to respond the research questions.

Discussion. (What is the relevance of the study?) This section is a further elaboration of the results previously described. Differently from the results section, here we present the results connecting them with each other and with the results in open literature. The section begins with a brief summary of the results explaining how they link to the initial objectives. We then describe the main conclusion that can be draw from the results. We explain how the conclusions fit in the global scientific understanding. Finally, we propose how the conclusions can be practically implemented and what are the major limitations.

Conclusion. (What are the major findings?) This section summarize the purpose and motivation of the study. The results are then briefly reformulated with the most general arguments and future work is outlined. The results should be clearly connected to the research questions outlined in the introduction. This section should be written so that a reader should be able to understand the key messages in the paper without going through the details in the results and discussion sections.

Reference. This section provides the list of articles, books and webpages cited in the text. Mack (2016) emphasizes that, in scientific papers, citations serve to provide sufficient context and background to the reader, to establish credibility, to validate and compare the presented 'facts and figure' and finally to acknowledge other people ideas. In general, citations should be carefully chosen to help the reader navigate in the large amount of information provided in a paper.

To conclude, it is obvious that in the writing process, we will not write the IMRaD sections sequentially, however this format will help us to organize portions of knowledge with the additional advantage that the readers will be able to find the information. The phases of the writing process were reported in Olsen & Pedersen (2005), Chap. 4. The author identified four overlapping phases i.e. "ideas, contents, form, text retirement and evaluation".

When comparing the IMRaD format with other report formats for students in PBL education, the project report sections list defined in Olsen and Pedersen (2005), Chap. 14, may come useful. The author suggest the following sections list: "(1) The preliminaries; (2) Introduction; (3) Analysis; (4) Conclusion; (5) Final touches". The structure presented here is very similar to the IMRaD structure. In fact, the third block,

"Analysis", includes the method, results and discussion sections of the IMRaD format. The main difference between the two formats is that the IMRaD format has a clear distinction between the information that should be included in the method, results and discussion sections, while the other format leaves more freedom to students in the way they want to arrange the information in the main body of text.

DISCUSSION

IMRaD structure contribution to student learning

In the previous sections, we have seen how learners organize knowledge in an educational context based on project- and problem- learning. In engineering, a project report addresses different goals connecting the needs to acquire and organize a large amount of knowledge and describe the problem solving during the project period. Figure 1 attempts to depict the process of writing a report in the IMRaD format in the context of project and problem based learning. The report sections shown in the bottom layer and the project phases shown in the top layer are related to the problem phases shown in the middle layer.

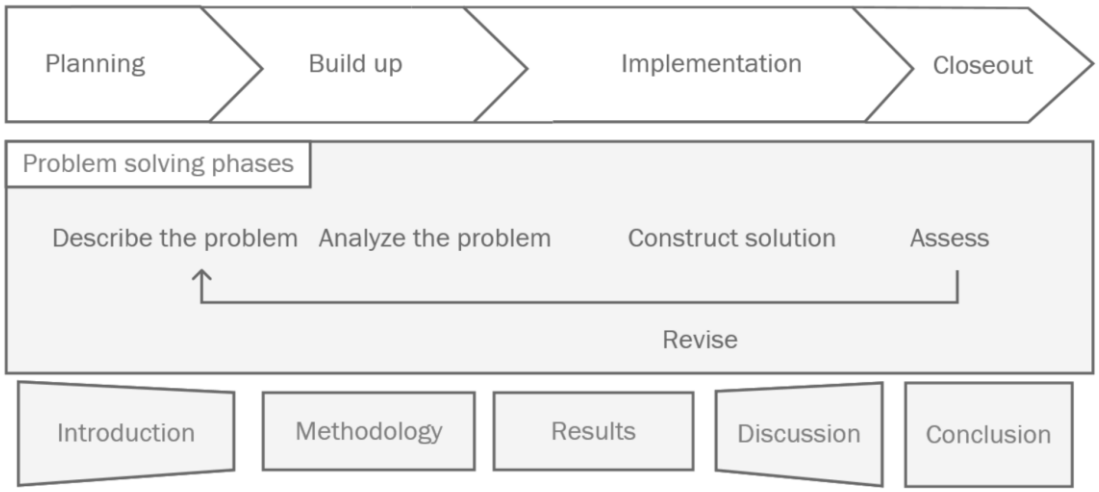

Figure 1. IMRaD format in the context of project- and problem-based learning; Project phases (HBR, 2016); Problem solving phases (Reif, 1995, 2010).

In the top of the figure, we can see the previously described project phases. These phases have different durations, with the implementation phase taking generally a longer time. In the first part of the project, namely "planning" and "building up", the student is focusing on describing and analysing the problem. At this regard Dahl (2018) points out that in the educational context the problem formulation is not originated by observations but rather by a practical or empirical problem which is edited by the teacher to fit the learning goals.

The initial project phases will be reported in the introduction and methodology chapter of the report. The students' team investigate the state of the art of the technology, review the scientific literature and discuss with supervisor and other project stakeholders what are the initial information and the best methods to address the problem. In these phases, they should also formulate some compelling and detailed research questions and a list of assumptions.

During the implementation, the results are produced and discussed. The students will be in this case involved in constructing a solution and assessing it. This phase is usually labour intensive as it can require, for instance, to set-up an experimental campaign or to develop a software model simulation and perform some data analysis. Some inexperienced students may dive straight in the implementation phase without carefully planning and analysing the problem solution with the intent to accelerate the process. In this case, the risk is that they may later find themselves following an unproductive direction.

In the project closeout, the students will be involved in the testing and validation the solution and describing the concluding remarks in the final section of the report. The report is entirely revised and the research questions are readjusted to fit the results that were actually achieved. Additional simplifying assumptions, which were necessary during the problem solving, can be added at this stage.

We have previously emphasized that both the problem solving and the writing process are cyclical rather than linear. This means that the sections in the report are not written sequentially but they are refined over the time once the problem analysis becomes clearer, similarly paragraphs that becomes irrelevant are omitted, arguments that are not convincing enough can be improved. The writing process is helpful also for the students to discuss and validate their knowledge with their peers and supervisors once is put down on paper.

During the project, students have to work at different levels. This can include, for example, learning a new software, mastering new concepts and developing the ability of teamwork. Acquiring good reporting skills in a specific academic format is an additional level of complexity that students will have to deal with. Due to the overlapping of different learning objectives, new students may experience "cognitive loading". This will reflects in the quality of the report. Beginner students will focus more, for instance, on descripting of the methodology and results rather than connecting and discussing the different results and making sound conclusions. This can be explained with the fact that problem-solving process requires already a large effort so that there is no room for more general abstractions. Sweller (1988) argued that developing a good curricula structure

and providing good explicit instruction can reduce the cognitive load especially in the early stages of learning.

CONCLUSION

Effective communication of academic results is an integral part of education. Teaching the value of having strong knowledge organization can be very helpful to students. In this paper, we discussed how the learning process occurs and how students organize knowledge. In published works, we found that knowledge organization is fundamental in science, as areas of knowledge are closely connected and arranged by importance. Moreover, we have seen that problem solving occurs during four major phases. This process is cyclical rather than linear, meaning that if the problem's solution is considered unsatisfactory, a new analysis of the problem must be performed.

Writing a report in the IMRaD format can help students reorganize their knowledge in a systematic way. This is relevant especially for students pursuing undergraduate and master's degrees, which are not necessarily exposed to a research environment. It will be useful in their future careers when they will need, as members of the scientific community, to read (and in some cases write) scientific papers.

By comparing another format for students in PBL education, we have seen that the IMRaD format has a clearer format in terms of how information should be included in the method, results, and discussion sections, while the other format may allow more freedom for students to choose how to distribute the information. This suggests that the IMRaD format provides a more constrained framework and clearer organization, which may be helpful to students who are learning the craft of writing. Furthermore, from a literature point of view, it appears that providing explicit guidelines on how the contents of each report section should be presented can be advantageous for students.

The sequence of information in the report roughly resembles the problem-solving process. We emphasized that the predefined IMRaD sections should not limit the variable creative elements that are typical of the research process.

This study raised many questions that will need further empirical analysis. It would be particularly interesting to complete a survey of students to understand what impact learning to write using the IMRaD format has on them. The ultimate goal would be to find out what the best strategies are for teachers to use to promote both effective learning and good academic standards in the context of problem- and project-based learning. Moreover, the findings could be used to develop an IMRaD report template with guidelines that better fit the needs of students.

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Use of Project-Based Learning in Preparation of Education Managers: Case of Post-Soviet Azerbaijan

Lala Mammadova *

ABSTRACT

This study explores the implementation of Project-Based Learning (PBL) in Master of Education Management Programs in two Azerbaijani universities. The aim was to find out if the sample universities integrate projects into their programs using a systematic PBL model. Interviews with the faculty and administration were conducted and the curricula of programs were scrutinized to assess the level of the consistency in the subjects on offer. Although the courses in both programs are quite suitable for PBL integration, only in one of the sample universities was there evidence of extensive use of projects, albeit mainly in a single assignment level. The results show that Azerbaijani universities need to develop a well-structured PBL model adapted to the local context. The results of the interviews emphasize the crucial role of PBL in the acquisition of employable skills and competences in education management. Major limitations in the process of PBL implementation include a lack of awareness about PBL, inadequate organizational support in the form of staff trainings, the provision of facilities and negotiations with stakeholders.

Keywords: *Project-based learning, higher education in Azerbaijan, Master of Education Management, teaching approach, teacher perspectives.*

INTRODUCTION

Today, changing higher education towards a more student-oriented paradigm is an important focus of worldwide educational reform. The reason for this transformation is that universities are becoming more accountable to meet societal demands and expectations than in the past. Their mission is to achieve excellence in teaching and learning. However, to achieve quality in learning, universities must employ different

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effective pedagogical approaches. Mere lectures, it is often argued, can no longer serve the purpose of innovative pedagogical aims. Traditional lectures stem principally from the theory of knowledge transfer from lecturer to student. As a result, students do not focus on knowledge *per se* but often accept the lecturer's words uncritically as truth (Surif, Ibrahim & Mokhtar, 2013). This approach cannot cultivate graduates with critical thinking, teamwork, interpersonal communication, evaluation and other soft skills. This lack of skill development also does not satisfy the demands of the contemporary labor market. Thus, taking into consideration the needs of the labor market in education can improve the employability of graduates (Stehling & Munzert, 2018). This does not necessarily imply that additional activities must be used to supplement lectures. Rather, students' projects and initiatives should be supplemented by traditional teaching methods (Henriksen, 2011). Currently, best practice involves teachers doing their best to make their classes more student-centered by engaging their students in different projects (Ngo Cao, 2018).

Many pedagogical changes are involved in this process. Among them, Project-Based Learning (PBL) is an effective approach in Western countries. Although PBL is often referred to as an innovative teaching approach, its history dates back to the end of 19th century when John Dewey and his student William Kilpatrick, representatives of pragmatic pedagogy, underlined the importance of the connection between the real life and practice on the one hand, and education and theory on the other (Bilgin, Karakuyu & Ay, 2015; Kwietniewski, 2015; Mansur, Fernando & Alves, 2018; Rousova, 2008). This idea is still up to date. PBL changes the role of students from passive recipients to generators of knowledge (Araz, 2007; Chin, 2014; Evensen, Salisbury-Glennon & Glenn, 2001; Ngo Cao, 2018;). This educational methodology is seen as one of the most effective methods of instruction capable of contributing to the development of soft skills and competencies and creating a clear bond between academic and professional life (Musa, Mufti, Latiff, & Amin, 2011; Kondratyuk, 2019; Rios, Cazorla, Diaz-Puente & Yagüe, 2010). As a pioneer, McMaster University at Hamilton in Canada initiated and widely used PBL in its medical school (Borhan & Yassin, 2013; Krishnan, 2009). As a result of this change, students demonstrated increased motivation, problem-solving and independent learning skills. Soon after McMaster, medical schools in the Netherlands and Australia also shifted to PBL.

The positive influence of PBL eventually resulted in its move beyond medical education. Today, it is practiced in various disciplines and at various levels (Strobel & Barneveld, 2009). Aalborg University in Denmark started to use PBL as its main teaching method in engineering degrees. Following this, Central Queensland University and the University of Technology, Sydney identified gaps in the competencies of their engineering students as well as in their curriculum and began changing their approach to PBL accordingly (Krishnan, 2009). Back in the 1990s, PBL started to be implemented in general and liberal

education curriculum in Samford University, Birmingham, Alabama. As this method gained success, the university started promoting it across the curricula of its five schools: arts and sciences, business, education, nursing and pharmacy (Savin-Baden & Major, 2004). However, research shows that curriculum reform in higher education towards the project-oriented teaching has met with resistance, since the aim of the reform was to change all the elements of the curricula, such as syllabi, traditional lectures, and formal examinations (Krishnan, 2009).

In the literature, there is a common view about the four main types of relationship that is important for PBL: those between subject and problem, teacher and student, individual and the social, and single discipline and the interdisciplinary (Li, Du & Stojcevski, 2009). PBL focuses on four main principles - collaborative learning, critical thinking, self-directed learning and reflection, which are also related to each other. As the studies state, collaborative learning eventually develops critical thinking. While working in teams, students learn to give each other feedback and to evaluate the ideas of others. At the same time, critical thinking is important for self-directed learning. Through assessing their own performance, students become responsible for their learning and for shaping their learner personality. Taking turns to reflect also happens throughout the whole process and links to each principle significantly. Thus, PBL focuses squarely on lifelong learning skills and "understands knowledge as changing and context dependent." (Doig & Werner, 2000; Nunez, Jonasen, Skov & Thomas, 2016, p. 19).

While extensive research has been conducted regarding, amongst others, the design, application, and assessment aspects of PBL in disciplines as diverse as engineering, medicine, computer science, and business administration, research concerning the use of PBL as a pedagogical approach in Education Management programs, especially at Master's level, is limited. Education Management is a field of study which must meet the needs of a changing society. Competent education managers are no longer just those who simply manage educational institutions. They are expected to have the skills and competencies of leaders who can address contemporary educational issues which, in turn, concern education not in isolation, but in close connection with many global, social, political, economic, environmental, and cultural factors. The education offered to future managers should therefore equip them with knowledge and skills, which will in turn help them to make sensible decisions, foresee problems, solve them in collaboration with colleagues, and foster resilience.

Thus, the purpose of this study is to examine if Master of Education Management Programs in two sample universities of Azerbaijan display these elements of PBL in their curricula, and to ask if PBL is implemented as a stand-alone mode of instruction, or as a curriculum-based approach. One of the universities is Azerbaijan State Pedagogical University (ASPU) and the other one is ADA University, which previously was

Azerbaijan Diplomatic Academy (ADA). At ASPU, graduates of the program must have a broad understanding and knowledge about theory and research methods and must be competent at solving unpredictable and complex problems in the field. They must acquire skills in interpersonal communication, independent work, decision-making, leadership, planning, analysis, adaptation etc. (State Standard of Higher Education, 2012). Students are expected to accumulate 120 ECTS upon graduation. The subjects taught within the program can be seen in Table 1 (See Appendix 1). At ADA University**,** the MA in Education Management is a two-year full-time program focused on developing policy and management in the education sector. Graduates of the program are trained to become educational leaders, who provide smart solutions to problems and manage educational institutions focused on shared governance and ethics. Students must accumulate 90 ECTS to graduate from the program. The program consists of Major Core and Technical Elective subjects (See Table 2, Appendix 1).

The study tries to contribute to the research related to PBL in higher education by scrutinizing the following research questions:

> To what extend does Project-Based Learning exist as a systematic pedagogical approach in Educational Administration master's programs in two sample Azerbaijani universities?
> If it exists, how is it implemented within the programs?

THE SIGNIFICANCE OF THE STUDY

Since gaining independence in 1991, Azerbaijan has undertaken numerous actions to enhance its education system. Due to the Soviet education structure, the country had been left with faculty and researchers trained in the old system. The predominant teaching approach in HEIs was lecturing with the teacher at the center of the process. Unsurprisingly, little attention was given to the extent of learning achieved during the classes. However, since Azerbaijan joined the Bologna Reform Process in 2005, the country's higher education system has undergone significant transformations, particularly regarding teaching and learning. Entering into the European Higher Education Area (EHEA) required Azerbaijan to bring its higher education system close to a European model, which meant promoting pedagogical approaches that foster in students the skills required for the internal and external labor market. To meet such requirements, PBL can be considered an effective teaching and learning approach, supported by a large body of international research demonstrating its effectiveness in developing students' skills and competences.

Azerbaijan is a country for whom the post-Soviet transformation period has been quite painful. Crucial moves in the economic and political life of the country demand significant changes in the education system as well. Hence, Azerbaijan has no option other than to develop high-quality graduates capable of contributing to the progress of the country and being highly valued by the modern labor market, particularly in the field of education. It is a necessity to explore how Azerbaijani universities have tackled the challenge of a paradigm change in instruction and learning, specifically, by making education more student-oriented and outcome-based. The sample program of study is the master's degree in Education Management. In keeping with other disciplines, Education Management now needs to be understood within a larger social context, thereby creating a question as to how far it prepares graduates who can add value and leadership capacity. Thus it is vital to know if professors in the Master's in Education Management program in Azerbaijani universities employ PBL methods to prepare education leaders who can apply educational theories in practice, identify and solve problems that their institutions encounter, make collaborative decisions, evaluate changing a political and social context, and create an environment which encourages lifelong learning.

LITERATURE REVIEW

What is PBL?

PBL is a student-centered approach through which students identify a gap in their knowledge and study to fill that gap. Teachers' role in PBL is mainly seen as that of a facilitator. Students are more responsible for their learning in PBL when compared to the traditional approach (Borhan & Yassin, 2013). The study identifies that since students must find solutions to problems with the help of projects, it enhances their self-directed learning. Other studies reveal that generally, there exist six core characteristics of the PBL approach: learning is totally student-centered; students learn in small group tutorials; teachers are facilitators; problems (projects) are the main elements of learning; problems lead to the development of problem-solving skills; new knowledge is acquired with the help of self-directed learning (Barrows, 1996; Borhan & Yassin, 2013; Ribeiro & Muzikami, 2005; Rousova, 2008; Stolk & Harari, 2014).

PBL is considered an effective approach which puts students at the center of the learning process, making the learning outcome-oriented, and equipping learners with real-world skills to fit them into a technologically advanced and rapidly changing environment (Borhan & Yassin, 2013; Ngo Cao, 2018; Rios, Cazorla, Diaz- Puente & Yagüe, 2010; Strobel & Barneveld, 2009). Choosing authentic problems and collaborating with specific industries gives students opportunities to solve realistic issues, actively practice employment experiences, and develop teamwork and communication skills through the learning process (Nielsen, 2009). As a result, PBL students perform better in knowledge application. Also, PBL helps students to construct flexible knowledge as well as to

become lifelong learners. This is explained by the fact that PBL emphasizes self-directed learning, which includes the planning and developing of learning as well as the use of specific strategies, including resources, for the learning process (Hmelo-Silver, 2004; Sukerti & Yuliantini, 2018). The study also shows that in contrast to traditional students, PBL students develop their own strategies during learning and are more likely to use new information in different situations. Hmelo-Silver (2004) states that PBL students use more self-chosen learning resources, whereas traditional students mainly rely on the choice of their teachers. The results of other qualitative studies show that PBL students are significantly more competent and skilled than traditional learners because they retain knowledge for the long term and gain more life skills through the successful facilitation of PBL strategies and scaffolding. These skills include communication, critical thinking and problem-solving, team-work, and lifelong learning. The studies conclude that thanks to PBL, students develop their employability skills (Baharom & Palaniandy, 2013; Strobel & Barneveld, 2009). Regarding academic achievements, the findings from a quantitative study conducted by Barak and Dori (2004) reveal that PBL students from the Department of Chemistry at the Israel Institute of Technology received higher scores on their exams compared to their peers who studied in a traditional way.

As for the development of soft skills, the studies reveal the positive role of PBL in students' development. Students involved in the studies claim that their communication skills were enhanced considerably with the help of group activities and interaction between group members (Barrows & Tamblyn, 1980; Surif, Ibrahim & Mokhtar, 2013). Research also highlights that students' critical and creative thinking skills were boosted as a result of analyzing and solving problems, which is the core of the PBL approach (Siti Norbaizura, 2006). Research on social studies curricula shows that PBL instruction students outperformed their traditional curriculum peers (Summers & Dickinson, 2012).

Although the positive impacts of PBL are acknowledged by many educators, the implementation process is not always smooth and properly conducted. Best practice involves developing a full model of PBL which enhances success by including lecturers in a systematic and professional development process (Lasauskiene & Rauduvaite, 2015). Research suggests that if any educational institution wants to implement PBL effectively, it needs to change its curriculum and organizational structure, develop its resources and infrastructure and, of course, change its organizational culture (Li, Du & Stojcevski, 2009). Aalborg University started using PBL in 1974, something that has become an established model. Yet, their practice shows that it is not enough merely to move from a traditional approach to a new one labelled as PBL. Studies done on the Aalborg model of PBL demonstrate that although it may be crucial to make fundamental changes to the curriculum, this must be done with caution. To achieve a successful change, it is vital that academic staff, regardless of their years of experience, receive training in innovative teaching methods, as well as different forms of formative and summative assessments.

The researchers also emphasize the importance of aligning elements of the PBL curriculum model to the local context (Kolmos, Holgaard & Dahl, 2013).

Several studies identify a number of disadvantages related to PBL implementation. The main concern articulated by students is about the time constraint. As they state, the period provided for the PBL activities are insufficient for developing the skills needed. Moreover, inadequate scaffolding of PBL skills creates barriers for its application at curriculum level. As for limitations regarding academic staff, the study identifies a lack of communication and coordination among professors as a problem, something which impedes the process of implementation (Kolmos, 2017).

Thus, analyzing various PBL models is crucial for identifying the most practical and appropriate ways of designing curricula and adapting them to different disciplines and contexts. Generally, studies emphasize eight models of PBL practice implemented today. Some implement a PBL approach at a module level, whilst others structure the whole curriculum according to PBL. Overall, research shows that designing the program curriculum based on content and then shifting to PBL synthetically results in failure. Thus, consideration of the culture and context where PBL is going to be implemented is very important since this differs across countries, groups, disciplines, and institutions (Coffin, 2013; Savin-Baden & Howell Major, 2004).

PBL Across Disciplines

Considerable research has been conducted regarding the use of PBL in engineering education, a professional field which makes extensive use of PBL as its predominant pedagogical approach. Today, graduates from engineering faculties are not expected only to solve engineering problems and possess only disciplinary knowledge and skills. Rather, today's industry requires them to have leadership skills, an ability to collaborate, and to generate ideas and solutions that will meet the demands of our modern and technologically advanced society (Krishnan, 2009). Similar ideas were stated by Carmenado, Lopez, and Garcia (2015). The authors refer to the American Society for Engineering Education (ASEE) to claim that engineering discipline must go beyond theory and experimentation and must prepare students for continuous learning. The authors emphasize the importance of graduate employability which is an issue central to the European Higher Education Area (EHEA). The research concludes that modern engineers should be taught skills derived from three interconnected dimensions. The first is technical skills, which is important for engineers to be able to design and produce. The second is the contextual aspect, which helps engineers adapt to, amongst others, political, legal, and financial factors. The last is the ethical and social dimension of the required skills is about the development of character and behavior. The researchers believe that the PBL approach enables the development of these competences (Carmenado, Lopez & Garcia, 2015).

Research on PBL in medical education is also very rich and robust. This is not surprising, since the systematic use of this pedagogical approach started in the field of medicine. Studies reveal that although PBL students in medicine perform less successfully in standardized tests, they have better self-directed learning, problem-solving, and information gathering skills (Strobel & Barneveld, 2009). Research conducted to examine the effectiveness of PBL has identified how significant its impact can be on students' clinical reasoning and diagnostic abilities, psychological knowledge, and professional capabilities such as planning and ability to work under pressure (Alexander, Tedman, Wallace & Pountney, 2011).

Since a significant number of studies reveal that PBL boosts students' problem-solving ability, teamwork, communication, and leadership skills, the usefulness of its implementation in business administration education may seem obvious. Criticism about the quality of business management education has made educators think about how to transform curricula. Some critics claim that many MBA students lack practical knowledge, and teachers mainly teach what they know best in their disciplines. As a result, students mainly develop their analysis and calculating skills which in future puts them in an awkward situation when faced with different problems. PBL responds to the main requirements of modern business management education in the sense that it prepares managers for action, equips students with leadership and management skills, teaches them to control their emotions and integrate technology into their daily practice (Hallinger & Bridges, 2007). Another research analyzed the effectiveness of PBL in business education in terms of knowledge acquisition and knowledge application. Quasi-experimental research reveals that both PBL and conventional groups scored low at the pre-test stage of knowledge acquisition. However, at the end of the first year, PBL students showed better results. Although conventional students were stronger at the end of the second year, they were outscored by PBL learners over the course of their whole study period. Overall, the results coincide with those of many other studies, which proves that PBL has a positive effect on students' knowledge. The study also confirms the hypothesis that PBL learners apply the knowledge better than traditional curriculum students (Dochy, Segers, Bossche & Gijbels, 2002). However, for the successful implementation of PBL, an appropriate level and form of guidance should be chosen by teachers and advisors, students must be willing to take part in classes, university management should support the PBL implementation process, and active collaboration with stakeholders should be priorities.

The introduction of PBL as an innovative pedagogical method in different fields, such as engineering, business, and medicine has created a question as to why it cannot be extensively employed in teacher education. Thus, the use of PBL in educating educators was adopted and implemented with the purpose of developing teachers' skills and

competences. The first PBL cohort in teacher education dates back to 1999, when the University of British Columbia (UBC) used it among elementary and secondary teachers in small group tutorials to supplement lectures. The purpose of this change was to demonstrate the importance of practice in the learning process. The results of the study show that PBL is a highly effective model for cultivating teachers and helping them to become "constructive solution seekers" (Filipenko and Naslund, 2016). Another research done among 32 Masters of Education students claims that there must be clear alignment between the elements of a PBL curriculum. The study supports the idea that, above all, seven elements in the PBL curriculum must be aligned before starting the implementation process. They are: 1) objective and knowledge, 2) types of problem and project, 3) progression and size, 4) students' learning, 5) teachers and facilitation, 6) space and organization, and 7) assessment and evaluation (Borhan & Yassin, 2013; Coffin, 2011; Du, Graaf & Kolmos, 2009). This qualitative research examines the problems and benefits of the implementation of PBL from the master's students' perspective. The analysis shows that anxiety, struggle, and lack of time impede the process. The students mainly emphasize insufficient time for discussions, group meetings, and understanding the PBL tasks. Regarding the positive sides of PBL, study participants emphasized the crucial role of PBL in developing their skills, expanding their ideas and enhancing group formation (Borhan & Yassin, 2013). Another study conducted among pre-service teachers, introduced results consistent with the aforementioned research. This supports the idea that students taught with the PBL model are successful in problem-solving, logical reasoning, and communication (Wilhelm, Sherrod & Walters, 2008). Similarly, a quantitative analysis carried out among students regarding the use of PBL in pre-service teacher education explain the reasons for supporting it as a methodology. The participants emphasize the positive role of PBL in their development, motivation, interest, and comfort in the learning process (Nikolayeva, 2012).

Fundamental changes happening in the economy, politics, information technology and other aspects of life, have changed the way organizations are managed. This is particularly true for Education Management. Research emphasizes important aspects that must be taken into account while designing an education management course. Management graduates must learn to "manage for action", think globally, and apply their knowledge in the local context, manage and lead by considering values, emotions, and ethical norms, and incorporate technology into practice (Hallinger & Bridges, 2007). Currently, the need to cultivate educational leaders capable of dealing with unpredictable problems, adapting to change, collaborating with internal and external stakeholders, and possessing not only rich theoretical knowledge but also many soft skills, is among the key problems facing the educational sector. Although the literature emphasizing the role of PBL in management education is valuable, its focus is mainly on the business sphere. Research regarding the implementation of the project-based approach in preparing leaders for educational institutions is either outdated or limited. The current research aims to help

address this gap by examining the potential of the PBL approach in education, a discipline outside those traditionally discussed in this context – namely, medicine, engineering and business. It achieves this by examining how far PBL is integrated into the curricula of two education management programs in Azerbaijan.

METHODOLOGY

This study employed semi-structured interviews. This was because interviews create more opportunity to probe the perspectives of respondents, including through follow-up questions. Document analysis too is an effective way of eliciting meaning and acquiring empirical knowledge (Corbin & Strauss, 2008). Thus, an analysis of the programs' curricula was also undertaken.

The interviews were conducted at two universities in Baku. The reason for this is that Education Management Program exist only at those universities. The first sample university was ASPU, established in 1921. The second was ADA University, established in 2006 under the Ministry of Foreign Affairs of the Republic of Azerbaijan as Azerbaijan Diplomatic Academy and transformed into a full-fledged university in 2014.

Interviews were conducted with the five academic staff and two program administrators. The study used purposeful sampling, since the number of the faculty teaching in the education management program is limited. We contacted with the maximum available faculty and administrators. All the participant professors are the holders of a PhD degree whose teaching experience in HEIs ranges between 10 – 30 years. Data collection lasted for a three-week period from the end of October to the middle of November 2019. The interviews took place at the venues the respondents had chosen and ranged in length from 45-60 minutes. There was a total of 27 questions. The open-ended questions were designed to learn about the respondents' background and the description of the Master of Education Management Program, to study the learning and teaching process within the program, and to identify if PBL exists at a systematic level in the program. An informed Consent Form was sent to each respondent prior to the interviews. Upon the participants' approval, the interviews were tape-recorded. All recorded interviews were transcribed. Topics and sub-topics were identified based on the literature review. The data was coded using a lean coding approach. Categories and themes were identified.

Additionally, the curricula of the Education Management Programs of the universities were analyzed and compared. The purpose of the analysis of these documents was to gain insights about the taught subjects within the programs and to identify similarities and differences between the two universities of Azerbaijan. Thus, descriptive comparative analysis was used aa a methodological tool.

Participants	Gender	Academic degree	Position	Years of teaching experience in HEIs	Years of teaching experience in master's level
Interviewee 1	Female	MA	Administrator	-	-
Interviewee 2	Male	PhD	Administrator	-	-
Interviewee 3	Male	PhD	Professor	10 years	8 years
Interviewee 4	Male	PhD	Professor	14 years	10 years
Interviewee 5	Female	PhD	Professor	8 years	3 years
Interviewee 6	Female	PhD	Professor	30 years	10 years
Interviewee 7	Female	PhD	Professor	20 years	10 years

Table 1. Participant Demographics.

LIMITATIONS OF THE STUDY

We recognize that the study is not free of limitations. First of all, the number of the participants may limit the generalizability of the findings. This was beyond the control of the researcher, since the number of professors teaching in the education management programs is not high. In each university, there were approximately 6-7 full time instructors available for the interview. Secondly, the collected data could not be supported with observations and surveys among students. A more extended study would supplement our findings with these data sources.

RESULTS

The aim of this study was to examine the use of PBL in two universities of Azerbaijan offering a master's degree in Education Management. The analysis of the documents reveals that both universities offer courses covering important aspects of education management. They deal with leadership and management, instruction and learning, research and public policy, finance and budgeting and other major issues in the education field. Almost all the courses could in theory incorporate PBL into their course structures.

Interviews with administrators and teachers reveal their insights into the following aspects of PBL:

PBL in the Teaching and Learning Process

The interview results from the Azerbaijan State Pedagogical University show that more emphasis is put on theoretical and disciplinary learning predominantly by means of lecturing. The topics of the courses are based on pre-determined objectives and are approved by the academic staff. Normally, the learning process in the university is teacher

oriented. The lessons are conducted in the form of lectures and seminars. The teacher is the main source of information, and the students are primarily assessed by exams. To graduate, the students must write an individual master's thesis and successfully defend it. Although there exist some group activities within the subjects, they are of a fragmented nature. One of the professors describing the group project specified:

> We have some group work during the semester. The students choose their group members themselves. Some of them, however, prefer to work alone. We provide them with the topics, which are pre-determined and approved by the relevant department. We can make minor alterations in the topics. The task of the students is to prepare a presentation on the given topic.

The results from ADA University are considerably different in terms of the teaching and learning happening within the program. According to the professors, virtually all the courses include some kind of project-oriented learning elements. As a graduation requirement, the students have an opportunity to choose either a master's thesis, which is written individually, or a Capstone project, which is carried out through group work. The students are encouraged to research and find a problem in the field of education and work on the analysis of that problem in their groups. Groups are formed randomly or by students themselves depending on the professor. The students play a central role in this process. They are responsible for their own learning. They conduct a real small-scale piece of research to find a problem and present their findings and propose solutions. The Capstone project, which lasts for one semester, requires students to identify a problem in the education field, negotiate with external stakeholders, and present their results to committee members to defend their proposals. As stated by the Capstone supervisor:

> Professors and supervisors introduce only the broad area for the research, and the students must find the problems themselves.

As we can see, the professors encourage learners to find their own path and direct their learning through enquiry.

PBL and the Role of a Teacher

In terms of the teacher's role in Education Management, the interview results show differences between the programs at the sample universities. The outcomes of the research show that the professor's role in the universities differs considerably depending on the approach used during the teaching process. Azerbaijan State Pedagogical University, which tends to stick to a more conventional pedagogical approach, focuses on a content delivered predominantly by a teacher. The teacher is the main decision-maker regarding the topics of any assignments, the structure of the lesson, and the students' role in the process of learning. Also, the teacher is considered the main source of information.

Mostly, the professor presents the topic in a lecture format, and the students are passive receivers. In the case of group presentations, the professor's main responsibility is to assess the end product. One of the professors describes the situation as following:

> The students are provided with the list of topics, and they choose one to work on, yet under the supervision of the teacher. We try to suggest up-to-date topics. To identify the portion of the work done by each individual, I check their written reports. My main role in the process is grading.

By contrast, teachers at ADA University have multiple roles in the teaching process, according to the results. They also deliver lectures within the courses, which mainly have an interactive format. Regarding project-based assignments, ADA professors see their role as that of a facilitator. They leave it to the students to decide on the topic for inquiry, analysis, and data collection. As a rule, they meet with the project groups once a week or every two weeks with the purpose of guiding them in narrowing down the topic, gathering data, or simply answering any of their concerns. Professors state that they are more satisfied with their role in projects than in traditional assignments.

> I enjoy teaching with projects. They make the learning more alive and engaging.

> Projects are more interesting, interactive, and applicable than traditional lectures. But there are also many difficulties because the students do not always understand what is expected from them in the project. Teaching with projects is less stressful but requires more creativity from a teacher. It requires a more individual approach.

Assessment Procedures and PBL

It is crucial to highlight the importance of assessment methods in teaching both in traditional and contemporary teaching environment. As can be seen from the results of the interviews in Pedagogical University, the main assessment is summative. The students are predominantly graded based on the midterm and final exams. As for the group activities, one of the professors says that:

> The students mainly prepare presentations on given topics and are assessed according to their performance during the presentations. Sometimes, the whole group gets one grade, sometimes they are graded individually. It is based on their speech and answers to questions.

Thus, summative assessment is the dominant way of evaluating the students' oral or written performance.

The experience at ADA University is different, however. The professors in this university use diverse assessment methods. The students have midterm and final exams as well.

However, the exam is not the only, or even predominant, assessment tool. Regarding group project assignments, although the professors mainly grade the end product, they state that the students receive feedback along the way, which eventually helps them to learn from mistakes.

> Usually we assess the end product. Although we may assess the first or second draft. But we use formative assessment during the process.

The results of all the interviews conducted reveal that anonymous peer evaluation and individual performance of each student contribute to the final grade of the project. Nevertheless, they state that they do not know any effective ways of monitoring and ensuring equal contribution to the group projects.

Perceived Problems and Benefits of Teaching with Projects

Some questions in the semi-structured interviews were related to the concerns of teachers while using projects within their courses. Virtually all the respondents articulated the same problems while teaching with projects. Primarily, the lack of organizational support at various levels was highlighted by the participants. While the representatives of the Azerbaijan State Pedagogical University see the main obstacle for project-based teaching in the insufficiency of technology and facilities, ADA University professors emphasize other problems, namely awareness among some students, teachers and administrators alike about project-based teaching and learning. Weak negotiation with the external stakeholders, a shortage of ideas related to authentic problems, and time constraints were also highlighted among the perceived difficulties.

> They don't negotiate with stakeholders. They may involve stakeholders who have no clue about the problem. Some of them don't even understand why they are invited.

> Main complaints are related to stakeholders. Not all of them want to see students. In our country, it is almost impossible. We are mostly too optimistic about it. Even when we invite, they do not understand what we want. We need partners.

The professors also think that in order to teach successfully with the projects, there is a need for professional trainings related, especially related to teaching methodology and assessment.

As for the beneficial aspects of using projects within courses, the respondents emphasized the enhanced motivation of students. Their engagement in the learning process increased even more if the students were dealing with authentic problems, something stated by most of the participants. Nearly all the respondents stressed that project-oriented lessons help

students to develop their soft skills (See Table 2).

Perceived Problems	Perceived Benefits
Insufficient organizational support	High motivation to learn
Inadequate infrastructure	Developed research skills
No awareness about teaching with projects	Ability to work in teams
Weak negotiation with stakeholders	Independent learning
Shortage of ideas for projects	Self-discipline
Time constraint for completing the tasks	Creativity
Lack of knowledge about monitoring equal contribution	Problem solution skills

Table 2. Problems and benefits of teaching and learning with projects.

DISCUSSION

By analyzing the data, we were able to generate a list of principal issues relating to PBL in the Azerbaijani university context. These issues were as follows: the overall teaching and learning process within the programs; the role of the professor within the process; the method of assessments used; perceived difficulties and benefits of using project-oriented assignments. The comparison of two universities shows that ASPU tends to use more traditional approach whereas ADA University has more combined approach in terms of implementation of PBL.

In general, at universities where the projects are integrated vigorously into the program, students take a more active role in the learning process than they do in classrooms with traditional teacher dominance. The literature emphasizes that students' participation and involvement in the activities is paramount for achieving deep learning which should be the main goal of higher education institutions. Universities today are spaces which require innovative approaches in teaching. As seen from these results, although project-based learning does not happen as a curriculum-based and systematic approach in the sample universities, the observable elements of it are nonetheless contributing to the development of learner-centered pedagogical practices. Fluck (2010) describes those practices as opportunities for students to carry out collaborative work on complex and real-world problems, and to going beyond classrooms to communicate with different people.

The analysis of the teaching approach within the education management program allows us to divide the sample universities into various types. Jamison et al. (2014) identify three university types, two of which might be considered consistent with the results of our study. Thus, ASPU can be considered as a mode one academic university, which emphasizes "theoretical learning and the process of knowing." Jamison et al. (2014) calls

this type a "traditional" university i.e. one which offers mandatory and elective courses based on the purpose of theoretical knowledge acquisition. According to this division, ADA University, by contrast, can be considered a mode three university, i.e. one which focuses on hybrid learning and has a combined approach (Jamison et al., 2014). Our results obtained from the ASPU are consistent with the idea that in a mode one university, problems are usually designed by staff to fit learning objectives, and projects are very short-term (Kolmos, 2017). Hence, this type of teaching approach cannot be called a systematic PBL approach. One positive side of it, however, is that an attempt to stimulate active learning and encourage team work to prepare a project does occur, yet within very narrow and discipline-specific confines. We should emphasize that in a mode one university, skills and competencies are not the focal points during the learning process. Our outcomes from ADA University are also consistent with how the literature describes a mode three university. Specifically, mode three universities focus on the development of skills and competencies. Nevertheless, PBL is integrated into the curriculum across the existing courses.

It is obvious that students in Azerbaijani universities are not experienced in learning through projects, since the approach itself is new to these universities. Thus, undoubtedly, to be able to learn in a team setting, the learners need the appropriate and adequate instruction and assistance of a professor. The results of the study display that in these two universities, the role of a teacher differs in terms of both teaching and assessment approaches. There exists a considerable body of research concerning the role of a professor in PBL classrooms. Our findings are mainly consistent with the idea that in institutions which emphasize the outcomes and the process of learning as equally important as the content knowledge, teachers see their responsibilities as primarily facilitative. In contrast, in universities where the focus is primarily on content, the main role of teachers is to promote memorization of the material and to grade performance accordingly (Savin- Baden & Wilkie, 2004).

Although the professors at ADA University with a more student-centered approach see their responsibilities as a guide or a facilitator, all of them perform their roles based on the experience as former students in universities abroad or based on discussions and collaborations with their international counterparts. Therefore, they echoed the ideas stated in the research done by Graaf (2013), who claims there is a profound need for staff training, particularly when a new pedagogical approach is introduced at the institution. In a similar way, our participants emphasize the importance of teacher training in methodology and assessment while using projects within the courses. Thus, there is no doubt that teacher training in PBL teaching can first of all raise awareness about PBL, change the perception of teachers about their role in the teaching and learning process and, most importantly, develop their facilitation skills (Graaf, 2013).

Overall, all the participants stated that by integrating projects into the courses, teachers help students to become responsible for their learning and to acquire the practical skills now highly sought by employers. This finding is consistent with numerous studies which claim that PBL is an effective teaching approach which cultivates marketable graduates (Baharom & Palaniandy, 2013; Strobel & Barneveld, 2009). Additionally, as stated in the literature, learner motivation is enhanced through the authenticity of tasks, through finding solutions to problems, as well as through teamwork and self-evaluation (Hmelo-Silver, 2004).

CONCLUSION

Considering that PBL is seen as a robust method of teaching capable of educating skillful graduates for the labor market, the current research attempted to answer the question if PBL exists in the preparation of education managers at master's level in Azerbaijani universities. Two universities offering this program were chosen as a sample. The goal was to talk to the program administrators and professors in order to identify any signs of PBL integration into the program. The results show that in both universities, there is no indication of a well-developed systematic curriculum based PBL model. Nevertheless, different kinds of project are included into the courses. Yet at ASPU it appears to exist in a more fragmented and task-based form. Overall, the results show the dominance of a teacher-centered approach. Moreover, a lack of awareness among teachers about PBL makes the current situation in the program less promising. In contrast, the findings from ADA University display a more aligned approach in the use of PBL. The professors are conscious about PBL and use projects either at the assignment level or in a semester-long final project. As a result of this study, we can claim that for preparing education managers with the required practical and soft skills, both universities need to create structured PBL models by scrutinizing international experience and considering the local context and the available organizational culture and capacity.

The research was conducted only through interviews with teachers and administrators. Thus, to be able to support the findings, further quantitative research among students of this program would need to be done. Furthermore, there is a need to research the reasons for the difference in terms of the PBL elements in two universities. A preliminary hypothesis might be the differences in the financial conditions, organizational structures, and infrastructures of the two universities, was well as the human capacity and motivation present at each. Although this research can contribute to the body of knowledge about PBL in Education Management Programs at Azerbaijani universities, future studies with the aim of uncovering hidden aspects behind the fragmented and surface level of project-oriented teaching and learning might shed more light on the issue.

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Interdisciplinary PBL Course Development in Higher Education

Cheryl Marie Bowen *

ABSTRACT

This case study explores how a problem-based learning (PBL), graduate education course could be organized in ways that utilize the current knowledge of how people learn within diverse, real world community settings. Students were asked to identify an educational enterprise and a social problem within a culturally diverse, high-need community. Throughout the course, they designed a service-learning experience, which was linked to the mission and vision of the enterprise while providing a meaningful, sustainable service to the community. At the end of the course, students viewed themselves as potential agents of social change through project presentations and reflections.

The element of discovery has always been a vital part of the learning process. It is a key component of how people learn. Yet studies indicate that although a large percentage of faculty in higher education regularly use problem-based learning (PBL), most either use it very little of the time (Wurdinger, 2016), or as a superficial way to acquire predetermined knowledge (Hüttel & Gnaur, 2016), focusing on the irrelevant acquisition of knowledge rather than the active production of knowledge (Szulevicz & Jensen, 2013). Current studies indicate that there is a specific need for research studying the effective pedagogical design of interdisciplinary PBL learning that applies knowledge in real world contexts (Franks et al., 2007; Stentoft, 2017).

PURPOSE AND PBL MODEL OF INQUIRY

The course examined in this case study utilized an interdisciplinary PBL learning approach that was anchored in constructivism (Crotty, 1998). The purpose of the study was to understand how a PBL graduate education course could be organized in ways that

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utilize the current knowledge of how people learn within diverse, real world community settings.

Problem-based learning approaches date back to John Dewey's (1938) work on the relationship between experience and the learner. They are also strongly influenced by educational theorists such as Piaget, Lewin, Negt, Vygotsky, Kolb, etc. (Kolmos et al., 2004) who believe that learning is an active process rooted in experience. For this study, the instructor utilized a pedagogy framework in her PBL course development that was guided by the cyclical elements of learning found in the Stripling (2003, 2010) Model of Inquiry. The model incorporates six phases in which the students connect, wonder, investigate, construct, express and reflect on their learning (see Figure 1). In this constructivist model, students do not passively receive knowledge through a transmission-oriented model of instruction (Castronova, 2002). Rather they actively process information with teacher guidance and feedback from peers.

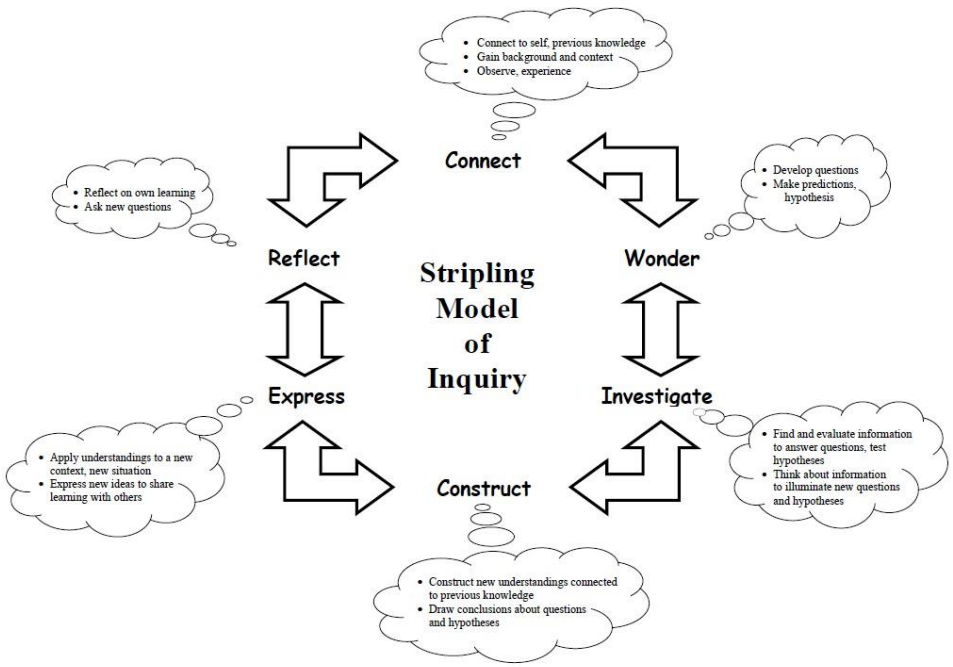

Figure 1. Stripling Model of Inquiry.

HOW PEOPLE LEARN FRAMEWORK

The research supporting the *How People Learn* (National Research Council, 2000) framework suggests that skills and knowledge must transcend the narrow contexts of initial learning. The framework explains that transfer occurs when learners know and understand the underlying principles that can be applied to problems in new contexts.

Additionally, learners are most successful if they are able to use metacognitive skills to see themselves as thinking learners.

The *How People Learn* framework is rooted in the belief that humans are predisposed to be both problem solvers and problem generators. However, designing effective PBL learning environments can be complex. It requires the application of four instructional perspectives that integrate a) learner-centered environments, b) knowledge-centered environments, c) assessments that support future learning, and d) community-centered environments.

In effective learner-centered environments, learners use current knowledge to construct new knowledge. Such environments make connections between previous and new knowledge, thus increasing learning relevance and the motivation to learn. In the construction of a successful PBL course, the *How People Learn* framework emphasizes that the instructor must consider formative assessments that effectively support these connections. Such assessments provide learners with opportunities to revise and improve the quality of their thinking and understanding through learning environments that promote a sense of community.

When these instructional perspectives are integrated into the design of a PBL course, an emphasis on understanding becomes the primary characteristic that defines learning. Focused on the process of knowing (Piaget, 1978; Vygotsky, 1978), learners are viewed as goal-directed agents who actively engage the co-construction of knowledge. They utilize prior knowledge, skills, beliefs, and concepts to organize and interpret new learning thus improving their ability to problem solve and acquire new knowledge.

SETTING AND PARTICIPANTS

This case study observed the PBL design of a blended, interdisciplinary, 5-week PBL course developed for a Jesuit graduate education program in northern California. Eight part-time candidates were enrolled in the course, six females and two males. Candidates brought to the course a wide variety of expertise in curriculum and instruction, technology education, and international education.

COURSE DESIGN

The competency-based, PBL course was developed as a blended learning experience through JesuitNET. The “e-Learning” platform included all elements of Competency Assessment in Distributed Education (CADE) instruction, shifting the focus from what students know, to what students can do with what they know. Philosophically, the course

was designed to follow the Ignatian Pedagogical Paradigm, which helps teachers and learners in a manner that is academically sound and at the same time is formative, "a person for others". E-learning assignments included five modules which asked students to read chapters from the assigned text *Building School Community Partnerships* (Sanders, 2006) and discuss their thoughts through an online discussion forum.

The interdisciplinary nature of the course provided candidates with opportunities to develop their understandings of the interactions among biological, psychological, and social dynamics in diverse families and communities. It also encouraged them to identify and build on the funds of knowledge in families and communities, and to establish connections with support systems for vulnerable youth within diverse communities. These understanding were developed through in-class literature circle discussions (see Figure 2) that were based on weekly readings from the text *Empowering family-teacher partnerships: Building connections within diverse communities* (Coleman, 2013).

Meeting	**Concepts**	**Chapter Readings**
#1	Setting Up Literature Circles	* Assign roles and reading for each week
#2	Exploring Family Units **ROLE SHEET #1**	* Chapter 1-*Contemporary Family Lives and Early Childhood Learning Environments* * Chapter 2 –*Developing a Guiding Philosophy*
#3	Exploring Family Involvement **ROLE SHEET #2**	* Chapter 3-*Benefits of Family Involvement for Children* * Chapter 4 –*Benefits of Family Involvement for Families and Teachers*
#4	Exploring Diverse Partnerships **ROLE SHEET #3**	* Chapter 5-*Normed Families: Single Parent Families, Stepfamilies, and Grandparents as Caregivers* * Chapter 6 –*Emerging and Vulnerable Families: Gay and Lesbian Families and Families Living in Poverty* * Chapter 7 –*Families of Children with Disabilities*
#5	Exploring Cultural Responsiveness **ROLE SHEET #4**	* Chapter 8-*Immigrant Families and Families from Nondominant Cultures: Understanding the Adaptation Process* * Chapter 9 –*Adopting a Culturally Responsive Approach to Family Involvement*
#6	Exploring Family Involvement **ROLE SHEET #5**	* Chapter 10 – *Responding to the Challenges of Family Involvement* * Chapter 11 – *Empowering Families Through Family Involvement*
#7	Exploring Family Collaboration **ROLE SHEET #6**	* Chapter 12 – *Creating a Welcoming Environment for Families* * Chapter 13 – *Communicating with Families*
#8	Developing a Family Involvement Program Model	* Use Chapter 14 to Organize Your Family Involvement Model
#9	Program Model Presentations	* Present Your Family Involvement Model to the Class

Figure 2. Literature Circle Major Concepts and Chapter Readings.

During literature circle meetings #8 and #9 each group completed a culminating project directing candidates to design a *Family Involvement Program Model* incorporating strategies discussed throughout the quarter and suggesting ways to build on or improve

family-teacher interactions existent within their school or social enterprise. This project was constructivist in nature and embedded the following two perspectives from the *How People Learn* framework – learner-centered environments and knowledge-centered environments.

The signature assignment chosen for the course was a service-learning project, which at its core was project-based. Service-learning is a research-based, best-practice teaching strategy in which classroom learning is deepened through service to others. Researchers have found that combining PBL with service-learning increases (a) student motivation, (b) the connection between professional knowledge and social responsibility, and (c) a sensitivity to the sociocultural environmental consequences of professional decision making (Duffy et al., 2008; Swan, Rachell, & Sakaguchi, 2000; Vanasupa et al., 2008). The structured process involved student decision-making in preparation for and implementation of meaningful experiences; reflection time before, during, and after the service action; and respectful communication- understanding and valuing the diverse backgrounds and perspectives of those offering and receiving the service.

The project asked candidates to identify an educational enterprise and a social problem within a diverse, high-need community. As candidates connected their enterprise to a current social problem, they designed a service-learning experience, which was linked to the mission and vision of the enterprise while providing a meaningful service to the community. Utilizing the perspectives from the *How People Learn* framework, the instructor formatively evaluated the projects on a weekly basis using the *K-12 Service-Learning Standards for Quality Practice* (National Youth Leadership Council, 2008). To aide in project development, candidates used the *Service-Learning Project Planning Toolkit* created by the RMC Research Corporation for Learn and Serve America's National Service Learning Clearinghouse (2009) to design five core project components: a) investigation, b) planning and preparation, c) action, d) reflection, and e) demonstration of results. Each project component correlated with all phases of Stripling's (2003) Model of Inquiry.

The activities within the *Service-Learning Project Planning Toolkit* gave candidates opportunities to dive deep into practices characterized by the fourth perspective in the *How People Learn* framework. Candidates developed experiences which engaged their enterprise in the a) identification of a potential social problem, b) establishment of a meaningful partnership between enterprise participants and community recipients c) research of possible service solutions, d) development of project goals, learning objectives, and formative benchmark assessments, e) integration of reflection, civic knowledge, skills, and f) public celebration.

PROJECT PRESENTATIONS AND REFLECTIONS

On the last day of class, candidates presented their service-learning project designs to the entire class. Students interacted by asking questions and giving constructive feedback to each other. Project titles and partnership affiliations included: a) *Google's BOLD Teens Project* – A Google - Local High School Partnership, b) *The Huff Elementary School Fresh Food Exchange* - A Neighborhood - Local School Partnership, c) *The Building Bridges Between the Cashion Cultural Legacy (CCL) and the Community Project* – A School, Community, and Cultural Organization Partnership, d) *Partners in Arms: The CAMP College Program Buddy System Project* – A College Assistance Migrant Program and Local School District Partnership, e) *Recycling Your Success: Alumni Mentoring Program* – A LEAD Scholarship Program and University Alumni Partnership, f) *Building Water Consumption Literacy: Effective Ways to Reduce Your Water Use Footprint* – A Local Christian School and Community Partnership, and g) *Developing Community Relationships to Inspire the Innovator in Everyone* – A Tech Museum of Innovation and Local Community Partnership. At a later date, three of the students publicly presented their project designs at the 2018PBL International Conference (Bowen, 2018).

As candidates reflected on their service-learning project development, a majority expressed profound connections between service-learning and PBL in diverse community contexts. One woman wrote, "Helping others is a powerful tool that makes one feel valued, while at the same time benefitting the recipient."

Another wrote, "My school is launching a PBL initiative next year. Service-learning and PBL align perfectly, and there may be a particular grade level that wants to take this on initially as a PBL unit, and then carry on with it throughout the year, showcasing their learning in public forum along the way."

A third wrote,

> I hope to help build the bridge between the CCL and the school systems in our area. I want the local students to take advantage of the activities the CCL has to offer and I really want the CCL to thrive in our community. I believe that there is no way around not acknowledging the great Latino presence in our community and I think the CCL is a great way to present the richness of our culture in a positive light to the outside world.

One young first generation migrant candidate wrote,

> Being a first-generation migrant student my whole life, I was very fortunate to be able to qualify for the services that the migrant education program provided me from middle school to my first year in college. In a like manner, I would like to propose a plan where we can strengthen migrant programs. I would love for

the College Assistance Migrant Program (CAMP), a program that guides the transition of first-generation migrant freshmen and mentors them throughout their first year in college, to create a partnership with local school districts that also offer a component or Migrant education services in middle schools. My vision for this partnership is for College Freshmen, or CAMPers, to do their required service-learning at one of these schools and be a mentor to a migrant middle schooler - something like a buddy system for one whole semester.

CONCLUSION

Students do not learn in silos of isolation behind closed doors. The future of learning for university graduate students intersect and surpass boundaries of disciplines. It invades spaces of reality where people work together to solve critical social problems within diverse community contexts.

The future of learning for university graduate students views learners as agents of social change as they bring to each new learning experience the relationships they have forged within their own families, friends, and community contacts, the personal struggles they have overcome, and the relevance of what matters most.

The future of learning for university graduate students is personal, and problem based. It bridges the gap that exists between the micro-interactions that exist both inside and outside of school. People connecting with people on a personal basis creating networks of resources necessary for building thriving communities of hope.

The creation of this interdisciplinary PBL course has taught me that real school exists outside the walls of an institution. The intersection of discovery and learner/knowledge centered environments create democratic community learning spaces that advocate for equality and justice that are currently under explored in higher education. It is my hope that the future of learning for university graduate students advocate for inclusive community collaborations that embrace diversity, and a sense of connectedness to the human spirit.

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The Problems that Impact the Quality of Project Management Courses Developed Following a Project-Based Learning Approach with the Support of Community Partners

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ABSTRACT

This case study presents findings regarding the problems that impact the quality of a Project Elaboration and Management course, developed following a project-based learning approach. From 2014 to 2019, the course was taught 27 times, involving 596 undergraduate students from Federal University of Sao Paolo, Campus Osasco, Brazil. The research objective is to reveal the main problems encountered both in setting up and delivering the course, and to analyze their impacts on the quality of the course. Data was collected from the professor's notes, from correspondence between the professor, students, and other stakeholders, minutes of meetings between the professor and stakeholders, and from the students´ reports about the projects. The data was analyzed following a qualitative systemic analysis, revealing the impacts of the identified problems on the course. The article concludes by presenting possible ways of reducing such problems.

DESCRIPTION OF THE CONTEXT

The Project Elaboration and Management course is taught to undergraduate students from the Federal University of Sao Paolo (thereafter UNIFESP), Campus Osasco, Brazil. From 2014 to 2019, the course was taught 27 times, involving 596 undergraduate students. Each course is developed in fifteen weeks, following a project-based learning approach with the participation of community partners (organizations that help people in need). The course was designed to provide hands-on experience for students: the students learn project management concepts while working on real-life projects. Groups of students (on

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average 5 in number), plan and execute projects that create products and services on behalf of the community partners (thereafter CPs).

The CPs provide the professor with the needs of the organizations, referred to here as *project themes*. The project themes vary: sometimes the project objective could be the acquisition or the development of a product while at others it might be the accomplishment of a service. The professor then selects the projects he thinks have the most chance of succeeding within the context and lets each team of students chose the one they want to work on. The course follows a project-based learning approach: the students are challenged to reflect on their use of the project management tools to accomplish real-life project. The students are also challenged to reflect on their learning process. The courses take place in regular UNIFESP classrooms.

The UNIFESP occupies a rented building located in the city of Osasco. The building lacks good infrastructure: classrooms have no air conditioning and acoustic conditions are poor. There is only one restaurant and a very small canteen to serve the approximately 1,750 students.

The campus was created in 2011. It has 106 professors allocated in five Departments (Multidisciplinary, Economics, Accounting, International Relationships and Administration). The Project Elaboration and Management course is taught by one professor of the Multidisciplinary Department to students coming from all other departments. In spite of the importance of the course, it is obligatory only to the students in the Departments of Economics and Accounting. The organizational climate is far from ideal. There are conflicts among professors springing from academic rivalry.

THEORETICAL FRAMEWORK

Several researchers have followed a project-based learning approach to teach project management (De los Ríos-Carmenado, Lopez, & Garcia, 2015; Arantes do Amaral, Gonçalves, & Hess, 2015). Scholars point out the benefits of challenging the students to accomplish real-life projects on behalf of real-world clients, including the development of critical reasoning (Barron et al., 1998; Boss & Krauss, 2014) and of problem solving and communication skills (Arantes do Amaral, 2018; Jacoby, 2014). This approach also fosters knowledge sharing among the students, and between the students and the real-world clients (Arantes do Amaral, 2019). Researchers have also pointed others benefits such as the development of sense of concern over social issues (Yusop, 2013). Although there is substantial literature about the benefits of teaching project management following a PBL approach with the support of community partners, it seems that there is still a lack of information regarding the problems that may occur in the development of courses with

these characteristics. This case study aims to address this gap. Our research questions follow:

1. What are the problems that may occur in setting up and delivering an Elaboration and Project Management course following a PBL approach that has the support of CPs?
2. What are the impacts of these problems on the quality of the course?

CONCRETE IMPLEMENTATION

Each course had clearly defined milestones and deliverables. The students were required to create project plans and put them into practice. The students had to develop fundraising strategies, manage risks, assure the project' quality and revise their plans if and when they encountered setbacks. The courses led to the development of 138 projects on behalf of 23 CPs. Throughout the courses, the professor collected data about the problems that impacted the course quality. The data was collected from notes of observation, from the correspondence between the professor and other stakeholders, and from minutes of meetings between the professor and the Standing Committee for Promotion and Tenure and between the professor and the Committee on the Undergraduate Program.

RESULTS AND REFLECTIONS

Analyzing the problems that emerged from the data collected about the courses, we identified six main categories of problems (Table 1).

Problem categories	Type of problems	Percentage of the courses where the problem occurred	Impact on course
Problems created by other professors vis a vis the course	• Barriers to enrollment	95%	High
	• Devaluation of course	95%	Medium
Problems created by students vis a vis each other	• Dropouts	100%	Low
	• Conflicts between students	10%	Medium
	• Lack of commitment	12%	High
Problems created by the professor vis a vis the students	• Difficult project theme	10%	Medium
	• Choice of unsuitable community partner	5%	High

Problems created by the university vis a vis the course	• Lack of inter-department planning	100%	High
	• Inadequate classroom facilities	100%	Low
	• Inadequate food facilities	100%	Low
	• Inadequate public transport to campus	100%	Low
Problems created by the university vis a vis the professor	• Class cancelations	100%	Medium
	• Administrative burden	25%	Medium
Problems created by community partners vis a vis students	• Lack of participation in classroom activities	95%	Low
	• Communication issues	25%	High
	• Change of project´s scope	10%	High

Table 1. Problems' categories.

Category 1: Problems created by other professors vis a vis the course

Academic rivalry, unfortunately, is a problem we have faced here. Sometimes a department blocks the course itself, based on non-academic criteria (personal bias against the professor who teaches the course). Even when the course is approved, it is approved in a time window that allows very few students to attend. Another problem occurs when professors from other departments deliberately devalue the course to their students with the goal of discouraging them to enroll.

Category 2: Problems created by the students vis a vis each other

In all course taught there were dropouts. This problem led to change in the structures of the teams. Eventually the team members had conflicts and disagreements that impacted development of the project. Lack of commitment of some students was also a problem that occurred. In addition, sometimes the students made inefficient use of project management tools.

Category 3: Problems created by the professor vis a vis the students

Sometimes the professor did not select appropriate project themes from themes offered by the community partners. For example, sometimes he allows a theme that was too easy to deal with. On other occasions, the professor selected an inadequate CP, a partner that didn´t give the students the information they needed to accomplish the projects.

Category 4: Problems created by the university vis a vis the students
The students' workload sometimes was too high. This occurred when the departments didn´t plan adequately which courses´ should be offered to the students at a specific semester. The other courses were sometimes too demanding; therefore, the students had very limited time to work on the projects.

Moreover, as we said previously, the UNIFESP campus lack adequate food facilities: the campus has only one restaurant and one canteen. Sometimes the students had to stand in line for several minutes in order to get their meals. This made them arrive late for class, missing some classroom activities.

The classrooms themselves were not suitable: they lacked adequate noise and thermal insulation. Therefore, the classrooms were hot in the summer, cold in the winter and noisy all year.

Finally, the lack of adequate public transport forced the students to leave the classroom early, in order to catch the last train to their homes.

Category 5: Problems created by the university vis a vis the professor
In UNIFESP the professors are also evaluated by their participation in administrative work. In other words, the professors must to serve on committees, perform departmental or university-wide tasks in order to be promoted. However, there are a large amount of committees that demand several meetings, reducing the amount of time the professors have to improve their courses.

In addition, there are academic events such as "Accounting Department Week," where the department offers a series of activities and workshops whose scheduling conflicts with the course and forces class cancellations.

Category 6: Problems created by the community partners vis a vis the students
Sometimes the community partner changed the scope of the project during the project's execution. These changes forced the students to revise their goals and/or rework project activities. On other occasions, the community partners failed to provide the students with the information they needed to perform their tasks in a timely manner. When this happened, projects were delayed and became more difficult to accomplish.

Finally, the UNIFESP campus is located in a region that is not easily accessible by public transport and unfortunately not very safe. Several assaults occurred in the region of the campus, which discouraged community partners from participating in the first class (when the project begins) and the final class (when the project ends). The participation of the community partners in these classes is very important for two reasons: in the first class the community partners explain their work and their needs to the students. Their presence

motivates the students to choose the appropriate organization and project theme. Community partner participation at end of the project helps the students grasp the consequences of their work and the impact of their projects. The absence of the community partner in these classroom activities therefore impacted course quality negatively.

REFLECTIONS

In this section we perform an analysis, following a systemic perspective. We analyze the impacts of the problems on the quality of the course. We do so by using a system dynamics tool, a causal loop diagram (Figure 1).

The quality of the course impacts on students' enthusiasm, thus influencing whether information about the course is spread by word of mouth in a way that sparks the interest of potential new students. (Figure 1, feedback loop "Course quality"). Others researchers have reached to similar finding (Arantes do Amaral & Gonçalves, 2015; Moens, 2006).

However, the course quality is impacted negatively by the stress felt by the students, which in turn is created by the problems encountered dealing with the community partners, with the university itself, with the professor and with each other. (These causal relationships are shown at the top of the figure 1). This finding is in accordance of the findings of other scholars (Arantes do Amaral, 2019; Blumenfeld et al., 1991).

The quality of the course is also impacted negatively by the stress felt by the professor. Administrative burdens, class cancelations and the negative influence of other professors all contribute to the problem. (These causal relationships are shown at the bottom left of the figure 1). Academic rivalry leads to the creation of barriers to the students' enrollment, which increases stress on both students and the professor and takes time to counter (Figure 1, feedback loop 'Escalation').

Similar findings have been reported by other scholars (Fogg, 2008; Frazier, 2011; Raineri, Frear, & Edmonds, 2011).

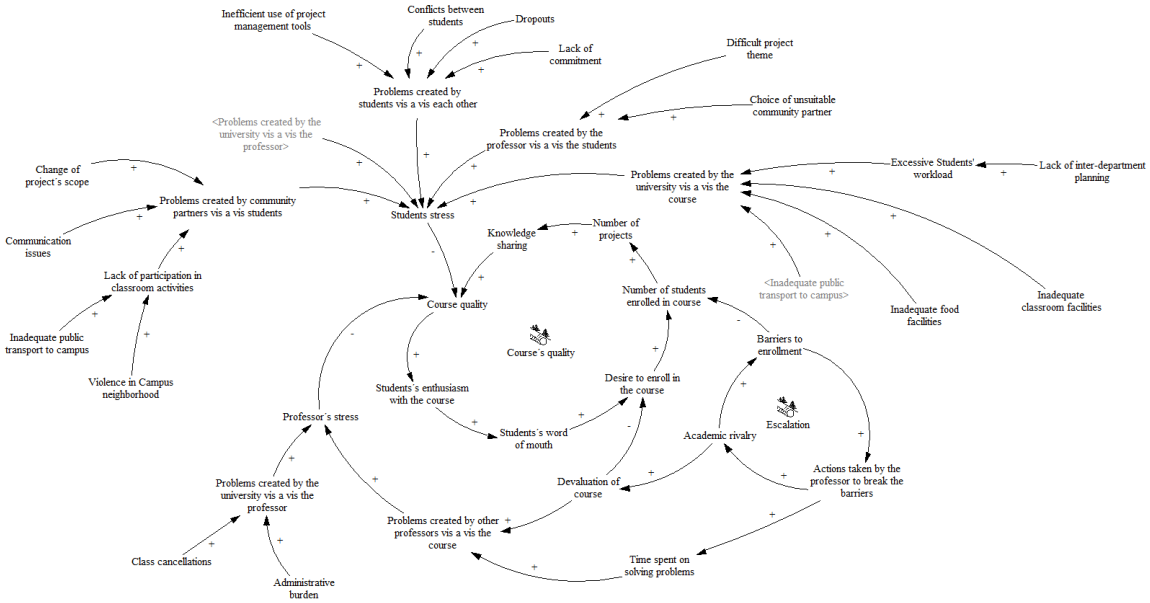

Figure 1. The systemic impacts of the problems.

SO WHAT DID WE LEARN FROM THIS CASE STUDY?

We were able to identify the six major problem areas that can influence the success of the projects. Some variables are under the professor's control, such as choosing adequate community partner, selecting adequate project themes, and managing the conflicts between the students.

However, exogenous variables such as the violence in the campus neighborhood, the inadequate classroom and food facilities, and the lack of public transportation to the campus are those that the professor can do very little about, except by reporting them to the university and asking for help. We do understand that these problems are very difficult to solve. However, UNIFESP is building a new campus in a safer area with better public transportation. Therefore, we are hopeful that some of these problems may begin to resolve themselves.

There are also variables that make the course less attractive than that should be (such as the lack of the presence of the community partner in classroom activities) that may be addressed with the supportive actions from the university to the community partners (such as providing taxi or shuttle bus to bring the community partners to the campus). Nowadays there is a movement in UNIFESP going on, in order to create a service-learning center that would help on these issues.

Other variables that impact the course negatively such as those created by academic rivalry are currently being addressed by officials of the school. Actions are also being taken by academic boards to improve collaboration and coordination between departments, with the aim of reducing the students' workload and the professor´s stress.

We speculate that similar problems may be occurring in other universities where PBL centered courses are being conducted. Thus, we hope that our study may be helpful to other scholars that are dealing with similar problems.

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Incorporating Problem-Based Learning Skills into Graduate and Professional Student Classes: The University of Michigan Law School's Problem Solving Initiative

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ABSTRACT

This paper provides insights into an initiative that offers graduate and professional students from across the University of Michigan the opportunity to participate in multi-disciplinary, problem-based classes that foster creative thinking, teamwork, and development of transferrable skills. The paper describes how, in order to improve student learning outcomes and play to the strengths of instructors with, each, subject matter and problem solving expertise, we have modified the initiative's structure.

INTRODUCTION

The University of Michigan Law School's Problem Solving Initiative (PSI) offers graduate and professional students the opportunity to learn creative problem solving and collaboration skills in a classroom setting. Under the guidance of the Associate Dean for Strategic Initiatives and the PSI Program Manager, this initiative incorporates instructional approaches and techniques from several sources, including problem-based learning and small group collaboration approaches.

The current structure of the PSI divides each PSI course into two distinct modules with two sets of instructors to cover, each, (1) substantive instruction on the specific class topic, and (2) the problem solving skills component. Students in each PSI course are required to take both the substantive module and the skills module as part of a single PSI course, where those two modules are taught concurrently.

Experiences with the University of Michigan Law School's Problem Solving Initiative offer insights into challenges and opportunities associated with creating and

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administering problem-based classes for graduate and professional students. I focus on one particular feature of these classes: the fact that they combine substantive instruction and skills instruction. I highlight pros and cons that this two-pronged approach creates, and I discuss how the PSI has been reconfigured to address some of those challenges. I first provide a brief overview of the Problem Solving Initiative's creation and the structure of PSI classes.

BACKGROUND

The University of Michigan Law School launched the Problem Solving Initiative (PSI) in 2017 with two classes. Since then, the PSI has offered an additional sixteen classes, and it will offer another six to eight classes each academic year for the foreseeable future. Graduate and professional students from any unit (school or college) at the University of Michigan have the option to take a PSI class, where each PSI class is offered for a full semester for three academic credits.

With respect to offering students from several disciplines the chance to collaboratively tackle real-world problems, the PSI's structure parallels that of several programs at other colleges and universities, which provide opportunities for students and faculty from different units or departments on campus to work together. These include, for example, Yale University's Multidisciplinary Academic Programs, which offer undergraduates opportunities to examine "pressing social challenges from a variety of disciplinary perspectives among a community of students and faculty who have shared interests" and "Big Problems" courses offered at the University of Chicago, where each class focuses on a different, complex challenge using "interdisciplinary team teaching...cross[ing] disciplines and divisions" and "transcend[ing] familiar models of content, organization, and instruction." (Yale University Catalog, 2019; University of Chicago College Catalog, 2019).

The substantive component of PSI classes is taught by one faculty member from the Law School and a second faculty member from another (non-Law) University of Michigan unit. By contrast, the skills component of PSI classes is taught by instructors with expertise in team-based teaching, creative problem solving skills, design thinking, and community engagement. Faculty teams teaching the substantive modules typically change because new topics or challenges — ranging from identifying human trafficking victims in health care settings to tackling algorithmic discrimination by automated vehicles — are prepared and offered to a new set of students each term. Each PSI class is limited in size to approximately twenty students, and because each PSI class focuses on a different, real-world challenge or problem, students learn about that topic in depth while also absorbing and applying transferrable problem solving skills.

INSTRUCTOR EXPERTISE: THE CRITICAL COMPONENT TO PSI SUCCESS

The first six semesters that PSI classes were offered provided us with key insights into the challenges associated with administering this initiative, the most important of which was that instructors who were responsible for introducing and teaching problem solving skills had to have a thorough understanding of the relevant pedagogical underpinnings and hands-on experience teaching those skills to students. Based on that information, we re-tooled the PSI accordingly.

As a result, for the past two semesters, instructors who teach problem solving skills modules have expertise in (1) small group facilitation, (2) community engagement, (3) iterative design processes that generate innovative ideas, (4) team conflict management, (5) creative problem solving, and (6) scoping solutions developed in the classroom to fit real world problems. The PSI selected and focused on this instructor skill set based on student and faculty feedback about PSI classes, discussions with teaching consultants and creative problem solving workshop designers, and extensive research on relevant scholarly literature and parallel programs offered at other academic institutions. Based on this foundational work and a clear understanding of our programmatic needs, we identified skills instructors who had been trained in creative problem solving and had experience teaching small groups and guiding student teams in cross-disciplinary and collaborative university initiatives.

APPROACHES AND IDEAS THAT INSPIRED THE PSI

As noted, PSI classes allow students to learn about and engage with real-world problems. The nature of the challenges that students consider in each particular PSI class differ from class to class and from one semester to another. At the same time, all PSI classes foster acquisition and application of skills.

More specifically, skills taught in PSI classes incorporate underlying tools and techniques associated with creative problem solving. Throughout the term, and as part of the skills module, PSI students learn:

- how to work effectively as part of a team comprised of people from different disciplines
- how to innovate, develop prototypes, learn from failure, and scope potential solutions
- how to define real-world problems and engage in solving those problems
- how to apply creative problem solving strategies and tools throughout the term
- how to communicate ideas to stakeholders, faculty members, and fellow students

- how to view a problem through their own disciplinary lens and the lenses of other disciplines

As this list suggests, PSI classes are meant to benefit students in a number of ways. These classes provide students with skills that they will be able to continue to develop and apply in other classes and in settings where they will work as members of a team or group. In addition, students acquire skills in PSI classes that will be useful to them at a time when many future employers are likely to value "right-brain" aptitudes in their new hires (Pink, 2005). Law firms, corporations, government agencies, non-profit organizations, and other entities benefit from employees who can develop innovative solutions that reflect collaborative effort. PSI students also benefit from the experience of developing ties across campus and working with people from a range of backgrounds and disciplines.

Further, PSI classes offer a participatory learning opportunity that requires students to conduct research, assess what they know, prototype, work with stakeholders, and incorporate feedback and failures. Scholarly literature shows that problem-centered learning has several benefits, including improving active, self-directed learning, developing cross-disciplinary knowledge, and fostering student responsibility for their own learning, and students who learn and apply related techniques improve "process competencies" like project management, collaboration, conflict resolution, and communication skills (Biggs, 2003; De Graaff & Kolmos, 2003; Hmelo & Evensen, 2000; Kolmos, 1996; Savin-Baden, 2003). According to Servant et al. (2015), there may also be a link between problem based learning and "creative output." (p. 48). For these reasons, PSI classes are meant to complement, and add another dimension to, existing opportunities at both the University of Michigan Law School and at the University of Michigan more broadly (Stanford University, Legal Design Lab, 2019).

Although the PSI does not represent an example of problem-based learning (PBL), the PSI's format is partly inspired by approaches to PBL in academic environments. According to Yadav et al., (2011), PBL was developed in the 1950s in response to critiques that instruction based solely on lectures failed to prepare medical school students to solve problems in clinical settings (p. 255). Yadav et al. summarize PBL as a participatory, student-based approach to tackling problems (2011, p. 255). For their part, Stevens and Tieman (2017) write that PBL originated in the 1960s at McMaster University as an approach that allowed teachers to act as facilitators, where classes were limited in size, and students focused on particular challenges or problems even as they developed a distinct, problem-solving skillset that they would continue to refine.

PBL's origins are a topic in their own right; however, as Gijbels et al., (2005) note, disparate variants or offshoots of PBL emphasize tools and approaches that are distinct from PBL as it was initially developed (p. 29). In some cases, small group work and skill development are prioritized; in other settings, engagement with real-world problems and

knowledge acquisition — more than skill acquisition — are prioritized (Gijbels, et al., 2005, p. 29).

PSI classes are not an example of PBL; instead, PBL components offered a useful starting point and highlighted the need for us to clarify which goals we wanted to pursue as part of the Initiative. For example, we did not set out to replicate PBL as described by Barrows and Tamblyn, which was developed specifically with the needs of medical students in mind, nor did we use a model similar to the one described by Cowden and Santiago, where students learned to locate scholarly sources to support research with minimal instructor involvement. (Barrows and Tamblyn, 1980; Cowden and Santiago, 2016, p. 466). Rather, PBL provided one of the many precursors we considered in developing and modifying the PSI to suit the particular needs of our students and faculty. PSI students work in small groups and they work on developing solutions to problems. At the same time, PSI classes rely heavily on instructor experience and knowledge, and students receive guidance from faculty throughout the term when it comes to stakeholders they should interview, resources they may need to review, and understanding why different disciplines offer alternative insights into the problems they are interested in solving. In addition, PSI classes don't focus on hypothetical organization-level or workplace challenges; each class focuses on pressing and current challenges, such as firearm violence, toxic airborne emissions, or homelessness.

In this respect, PSI administrators focused extensively on the fact that PBL has been adapted, transformed, and applied in settings beyond medical education to include architecture, business administration, engineering, law, social work, and other disciplines (Gijbels et al., 2005, p. 28, Brescia, 2016). Cornell University's teaching resources define PBL as "a student-centered approach in which students learn about a subject by working in groups to solve an open-ended problem." (Cornell University Center for Teaching Innovation, n.d.) At UC Berkeley, the School of Public Health covers foundational sciences classes using PBL through a combination of patient case studies, information gathering, concept maps, and group participation and collaboration. At the University of Delaware, a number of courses have been taught using a PBL format, including Introductory Biology, Introduction to Biochemistry, and Honors Introductory Physics (PBL@UD, n.d.). PBL has also been adapted to Law Schools, with instructors using a variety of different PBL components, such as small-group work, to address a specific, well-defined problem (Flagg, 2002; Grimes, 2015; Wijnen et al., 2017). Based on a host of examples, we modified and repurposed components of team-based student learning approaches for the Problem Solving Initiative.

PSI CLASSES: SUBSTANCE, STRUCTURE AND SKILLS

PSI classes incorporate a number of features: PSI classes focus on pressing real-world problems, and instructors provide essential information, guidance, and resources to further student learning. PSI classes also cover a broad range of topics that warrant input from people from a range of different disciplines. Past PSI classes have focused on disparate topics, including concussions in youth football, heritage preservation, and "fake news." Faculty members who teach PSI substantive modules are subject matter experts who guide student learning. At the same time, PSI students play a central role in directing their own learning, as they engage in small-group work, report out to fellow classmates, and apply the problem solving skills that they are learning to their class challenges.

Even though the substantive material that PSI students learn in each PSI course is unique to that class, since each class focuses on a different challenge, the skills that students absorb and develop throughout the term as part of the skills module are part of the fabric of the entire PSI program and of *all* PSI classes. These problem solving skills, broadly defined, allow students to gather and assess information, work well as part of a team, collaborate with people from academic disciplines outside their home units, incorporate human-centered design thinking, learn how to identify and scope a problem, and develop one or more potential solutions to that problem. PSI students learn that they can master tools applicable to an indefinite number of challenges, large and small. Students in PSI classes grasp and apply a set of transferable skills throughout the course of a semester, but one goal of the PSI is for students to continue to develop and hone those skills and apply them to other classes, jobs, group work, and challenges that they will tackle in the future, long after they have completed a particular PSI class.

Unlike in some flipped classrooms, where students "are required to engage in or complete some form of preliminary learning online" to prepare for a coordinated learning activity that subsequently takes place on campus with fellow students and faculty, in-person work is prioritized in PSI classes. (Reidsema et al., 2017, p. 6). For example, it is the case that PSI students complete group tasks during their skills sessions — during a typical skills module session, a student team might complete a group exercise, discuss alternative plans to address their class challenge, or present information about findings from their research. In addition, although PSI students play a role in directing their own learning, instructors in both the skills and the substance modules are critically important. Instructor guidance is essential, not only given the range of material covered in each PSI class, but also because the format is unfamiliar to students. Instructors present information, they observe student teams and offer feedback, they oversee in-class exercises, and they demonstrate and discuss how tools learned in the skills module are applicable to the class challenge. As such, PSI faculty members play several different roles in PSI classes throughout the

semester, and students spend most of their class time engaging in person with fellow students and instructors.

As noted, students are taught PSI skills by one set of instructors, and they learn substantive information about their class challenge from another set of instructors. Instructors who teach the substantive module use a variety of methods to assess student work, including a final capstone project. Instructors who teach the skills module use several methods to assess student progress and mastery of materials. First, skills instructors observe student participation, answer student questions, and review student work in class. Next, the quality of student work and student learning in the skills modules are assessed in other ways, including:

- written reflections on how to address the class challenge and approaches to problem solving
- ecosystem maps identifying components of the class challenge, designated stakeholders, impacted groups, and other relevant parties
- visualization, prototyping, and community engagement exercises
- lists of potential, alternative solutions to the class challenge
- written plans of action that demonstrate understanding and application of concepts discussed and applied throughout the term

FLAWS WITH EARLY APPROACHES TO TEACHING THE SKILLS COMPONENT

Over the course of six semesters of PSI classes, it became clear to PSI administrators that teaching problem solving skills to students in PSI classes presented several challenges. Before we developed the new structure that split the skills module and the substantive module into two parts, the three primary challenges that we faced in the PSI specifically linked to skills instruction were:

1) Most faculty members who taught in the PSI did not have formal problem solving expertise that they could seamlessly integrate and apply to their PSI class. Only a few units on campus are likely to have faculty members familiar with relevant teaching skills, such as those in Information Schools, Design Schools, Libraries, Business, and certain other fields that regularly and consistently incorporate problem solving in their classes.

2) Most instructors do not teach PSI classes repeatedly; rather, they usually teach only one PSI class, so there was little incentive for them to invest in the training or preparation to teach the skills portion of the class. Further, the skills component of PSI classes essentially required preparation for what amounted to a second class, since faculty had to select readings, develop class assignments, prepare lectures, and develop in-class

exercises on problem solving, in addition to the work that they committed to the substantive component of their PSI class.

3) Even when a faculty member who taught in the PSI did have experience teaching creative problem solving or had a comparable set of skills, it was still the case that the framework that the faculty member presented, the assignments and exercises he or she used, and the skills that the faculty member prioritized differed from those that the PSI had adapted or that other faculty members in the PSI used. Having myriad approaches to teaching problem solving skills ran counter to a key PSI goal; namely, offering a uniform problem solving approach that all PSI students could learn over the course of a semester.

With respect to the first challenge described above, faculty members are usually experts on key issues, research, and scholarship in a particular field or fields, and they are used to training graduate and professional students to approach writing, research, class assignments, and in-class discussions in a way that reflects their own training, scholarly interests, experiences in the field or professional life, and intellectual priorities. Faculty members training graduate students and professional students are, in general, preparing those students to pursue a career in a specific discipline – environmental studies, law, business, engineering, etc. – so it is reasonable for faculty members to help their students hone skills that will be useful to them as subject matter experts. Part of what appeals to faculty members who teach in the PSI is the opportunity to tackle a pressing, contemporary problem with which they are deeply familiar. At the same time, however, the PSI is a program rather than a single class, and its programmatic goals are broader and more complex than the goals pursued by an individual faculty member. The PSI enrolls between 160-180 students each academic year, and a central objective of the PSI is for students to learn about, adapt, and apply a set of problem solving skills, in addition to ensuring that students learn about and engage in advancing solutions to important problems.

With respect to the fact that PSI instructors typically only teach one PSI class, even when faculty members were comfortable incorporating small group work, self-assessment assignments, student-directed learning, and other similar exercises and tools into their classrooms, their priority was still to help students learn the substantive material presented over the course of the term rather than for students to acquire problem-solving, design thinking, or teamwork skills for their own sake.

The PSI does not have its own cohort of instructors. Instead, PSI instructors are drawn from all over the University of Michigan campus to teach a PSI class for one term based on their research interests. Some instructors have taught more than one PSI class; however, even in those cases, each class topic was new, requiring class preparation. In contrast to the goals of individual PSI faculty, the aim of PSI classes is to ensure that students acquire a range of skills that are broadly applicable, where those skills or tools

have a distinct value of their own. Faculty members who teach PSI classes bring their expertise to bear as students learn about and weigh solutions to complicated problems, but expecting these same faculty members to also be experts in teaching problem solving techniques was unrealistic.

Along similar lines, because each PSI course is taught only once and because the faculty teams are different each time, individual faculty members had no incentive to invest the time to learn how to teach creative problem solving, human-centered design thinking, stakeholder engagement, or collaboration skills to students from a range of different disciplines. PSI instructors were already tasked with prepping a new class, navigating the complexities of working with a co-instructor, and providing students with guidance on a capstone project. Requiring faculty members to also familiarize themselves with another set of skills, to the point where they could comfortably teach those skills to students, was not an effective use of their time.

Some faculty members are familiar with and do have an interest in applying problem solving methods in their PSI classes. In addition, some faculty members come to PSI classes with past experience teaching problem-based classes, engaging with stakeholders, and incorporating a number of skills into classroom work. Nevertheless, faculty members' backgrounds, priorities, and methods vary from one person to another. In addition, the faculty members who have adapted relevant techniques to their classes have often worked only with students from their home unit, and they have incorporated exercises and assignments that harness problem solving tools for use in a particular discipline. To ensure that all PSI students gain the same set of tools over the course of semester, relying on individual instructors was not viable.

In combination, the fact that faculty members who teach in the PSI lack formal problem solving expertise, PSI faculty members only teach one PSI class, and a key PSI goal is ensuring that students in PSI classes all learn the same set of skills, meant that the PSI had to separate the substantive module and the skills module into two distinct components. As noted, this means that two sets of instructors now work with each PSI class — a set of skills instructors and a second set of instructors, who cover substantive material. This allows instructors to focus on their areas of expertise, which simplifies things for the instructors and improves the classroom experience for students.

STUDENT FEEDBACK

As part of our assessment of the PSI, PSI classes, and features of the PSI program, we collected and reviewed anonymous student feedback about the skills component of PSI classes for each term that PSI classes have been offered using Qualtrics, which stores completed (anonymized) survey responses for each term and offers a number of analysis

and reporting tools. Sample PSI survey questions are provided in Appendix A. Survey questions were developed with the input of, each, teaching and research consultants on campus, research faculty, and PSI administrators. The PSI surveyed students from four PSI classes offered in the first term of 2019 from eleven different graduate and professional programs at the University of Michigan: Law, Social Work, Public Health, Architecture and Urban Planning, Business, Environment and Sustainability, Public Policy, Engineering, Information, Literature, Science and the Arts, Music, Theater, and Dance, with at least one student from each of those units responding to the PSI's Qualtrics survey. Using Qualtrics, we determined that of the combined sixty-four students who took the four PSI classes, forty of them (62.5%) responded to the survey that the PSI administered at the end of the term. Along with what we had learned from faculty members and observed during class sessions, student comments lent further support to the idea that restructuring the PSI to develop a distinct skills component would be beneficial.

Students from all four (first term) 2019 PSI classes were given the opportunity to respond anonymously to an open-ended Qualtrics question about how to improve their class. One subset of those student responses focused on learning and skill acquisition. Specifically, students made it clear that they wanted to learn how to work as part of a team, how to navigate conflicts within a team, how to make the most of working with people from different disciplines, and how to incorporate different perspectives to understand the class challenge and define the ultimate goal for the class capstone. Another set of student responses focused on a desire to practice working through the problem solving process and understand the value of distinct stages of problem solving, including how to generate ideas and how to withhold judgment. Students also requested more instructor assistance connecting the skills component of the class to the substantive components of the class.

In short, students in all four 2019 PSI classes expressed a desire to learn from instructors who were deeply familiar with structured problem solving techniques, human-centered design thinking, and tools to foster innovation, collaboration, and assessment. Students made it clear that they wanted to learn relevant problem solving skills and methods throughout the term with the aid of instructors who were well-versed in teaching those skills and navigating challenges to learning and applying problem solving skills. For example, before we created distinct skills and substance modules in the PSI, one PSI student noted that "[t]here was very little content in this class on collaboration strategies, how to effective[ly] frame a problem, or interdisciplinary work." Another student recommended that the PSI incorporate experts who could "…speak about problem-solving and working on interdisciplinary teams…" Another student noted " I would have appreciated the introduction of a tool/process for interdisciplinary collaboration; [little] was presented to advance our interdisciplinary work."

Prior to the new format that separated the skills module and the substantive module, PSI students also noted that PSI instructors had subject matter expertise, but that they did not have had the expertise to help students address the class challenge with an eye to the more abstract, step-by-step process of solving problems, leading them to request that PSI classes "[d]evelop a more thorough…informed perspective [about how to scope the challenge]." Another student wrote: "[The faculty members are content area experts, but] PSI course instructors need to receive advanced training in facilitation." Similarly, another student wrote, "I would love for there to be training for faculty to obtain facilitation skills. While they are content area experts, they did not have the tools to facilitate the course in an efficient fashion." In addition, some students commented on needing guidance in order to collaborate effectively with people from other schools and colleges, as PSI faculty members did not provide sufficient help to students when they faced challenges specific to working as part of a multi-disciplinary team.

Based on this feedback, students in all four PSI classes made it clear that they wanted to learn how to work in teams, scope problems, interact effectively with people from other disciplines, and develop a skillset that they could develop throughout the term and use well after their PSI class ended. This input supported what students in other PSI classes in prior terms had communicated about their experiences, and it was part of the impetus for making program-wide changes to the PSI, whereby skills and substance modules were offered as distinct components taught by different sets of instructors.

SUMMARY: INCORPORATING FEEDBACK AND ASSESSMENTS TO IMPROVE SKILLS ACQUISITION

Student feedback echoed what we had heard from PSI instructors and observed as part of our own assessments administering the PSI. We also benefitted from assessments offered by a number of partners and consultants who had experience teaching problem-based approaches to university students. Based on those assessments, discussions with PSI faculty, student feedback, and evaluations from eighteen different PSI classes over the course of two years, we restructured PSI classes.

As noted above, key features of the restructured framework are: 1) a distinct, program-wide PSI skills component, 2) skills instruction by individuals who are trained in creative problem solving and separate instruction on the class challenge by subject matter experts, and 3) an extended timeline to teach, and ensure absorption of, PSI skills over the course of the entire term. By modifying the way that skills are taught, we aim to improve the learning experience for students, clarify our expectations for faculty, and refine our goals as a program.

Beginning with the second 2019 term, the skills portion of PSI classes will be taught as a separate, semester-long module in tandem with the substantive module on the class challenge. Instructors of the skills module will focus only on problem solving skills, rather than the class challenge. Skills instructors will identify, explain, and apply the components of a creative problem solving approach, as they facilitate the learning process and handle challenges that arise within student teams, cover solution assessments and feedback, and incorporate exercises that develop students' problem solving skills (De Graaff, 2016, p. 398). As a result, PSI students will cover topics like working in teams, communicating across disciplines, scoping a problem, learning about alternative problem solving styles, incorporating stakeholder needs, and more, throughout the term.

According to Salinitri et al. (2015), although "numerous facets" are associated with the use of PBL, "skilled facilitators are central" to the success of PBL pedagogy given its many moving parts (p. 73). Drawing on that logic, and for the purposes of the PSI, in order to ensure that students can develop problem solving skills in a step-by-step manner and build on those skills all semester long, the PSI's new skills module is taught by experienced instructors, who focus only on teaching problem solving skills. Two other faculty members separately cover substantive material for each class challenge. As noted, instructors who run the skills module have participated in training programs to facilitate small group work and develop problem solving skills and multi-disciplinary collaboration, and they have studied general principles of creative problem solving, incorporating classroom shadowing and feedback from more experienced instructors. (Kukkamalla and Lakshminarayana, 2011, p. 1152). Our expectation is that students will benefit from this new arrangement much in the same way that McLoone et al. (2016) found that facilitators with problem solving experience were better at teaching students relevant skills and addressing challenges than instructors without those qualifications (pp. 72-79).

The new, updated PSI configuration will allow students to both learn problem solving skills and focus on the substance of their class throughout the term. This two-pronged approach will ideally ensure that students absorb information, and it will provide a longer timeline for them to practice problem solving skills and apply them to the class challenges. In addition, by enlisting experienced instructors and teaching problem solving skills as a distinct module, we hope students will be equipped to continue applying problem solving tools in other settings.

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Solar Car Chassis Design and Optimization Using PBL and Design of Experiment

*Mehdi Moayyedian, Ameenah Alateeqi, Dalal Alzuabi, Reem Burhama, Shouq Alathari**

ABSTRACT

A beneficial project is defined and implemented for the senior project of bachelor students of mechanical engineering program in the school of engineering at American University of The Middle East (AUM). Students need to design, analysis, and optimize a solar car chassis using Design of Experiment (DOE). It is required that the design process and DOE implementation are conducted in 14 weeks based on Problem Based Learning (PBL) method. The main elements of PBL for this project are the ability to understand the project, analyze and resolve problems, and have a teamwork and leadership ability in addition to independent responsibility. The design of the chassis and an analysis of the stress loads are conducted using SolidWorks. Four designs are proposed to obtain an optimum design using DOE and PBL. By optimizing the chassis design, students determined the factor of safety of 10.8 and the weight of 56.4 kg.

Keywords: Solar car, chassis, design of experiment, problem-based learning.

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INTRODUCTION

Although the main concept of problem-based learning was initiated in medical education at McMaster University (Neville, 2009 and Perrenet et al., 2000), there are several research activities and case studies of PBL in education which increase student ability to have an acceptable communication skill and develop their self-learning (Savery, 2015 and Preeti et al., 2013). The outcome of PBL was knowledge, higher-order thinking, problem-solving, and effective team skills. The Key PBL steps were to identify the key information of the selected case study, generate different hypothesis and mechanisms for the case, and evaluate the learning issues in education (Murray et al., 2005). In different fields of education, by applying PBL, students will learn both content and thinking strategies. In PBL, students will learn how to solve a complex problem that does not have a single solution. They will work as a team to determine what they need to learn to solve the problem (Hmelo-Silver, 2004).In chemical engineering, PBL was very significant for the course *process control and dynamics* and the outcome of the pilot was very successful so that was an encouragement for other faculties to implement PBL for mechanical engineering courses (Yousef et al., 2005). There are different deliverables for the senior project at AUM and PBL guide was developed based on different generic skills. The first skill is to define the aim of the project, project scope, and the expected outcome which covers the knowledge and higher-order thinking of the selected case study for students. The second is to analyze and resolve a complex problem that does not have only a single solution via the design of experiment (DOE). Finally, the third skill is to have teamwork and leadership ability and independent responsibility for shared learning.

The senior project of bachelor degree in the department of mechanical engineering at AUM makes an opportunity for students to learn the following objectives:

1. How to define the aim of the project, scope and the expected outcome.
2. How to conduct the benchmarking for the current design and also the new designs
3. How to work as an individual and as a team.
4. How to apply different rules and regulations of a competition.
5. How to optimize their design via DOE and PBL.

PROJECT DETAILS

The details of the project are explained for all group members in the department of mechanical engineering at AUM. The objective of this project is to design and optimize a solar car chassis for one of the car challenges – Australian word solar car challenge- and the design has to be as light as possible in order to reach the highest efficiency. Based

on the number of parameters and their levels, it is not durable to implement the design via conventional method. Hence, the optimization process is conducted via DOE to reduce the number of simulations for the selected design.

There is a number of restrictions for the project as follow:

- Students need to consider different criteria as restrictions for the chassis design in different categories such as manufacturability, material selection, seat location, weight, safety and sustainability based on the literature review.
- Based on the regulations of the competition, the chassis design must be solar powered, must be a single seated solar car, must not be in a straight line, the dimension must not surpass a width of 2 meters and a length of 5 meters.

The final report must be submitted on week 14 which includes the following details:

- Defining the aim of the project, project scope, the expected outcome and the initial work plan.
- Understanding the current problem of the project
- Conducting the literature review and benchmarking
- Generating the alternative solutions and all required engineering standards
- Analyzing each potential solution and selecting the best solution.
- Optimizing the final model via DOE

PROJECT METHODOLOGY

Different steps need to be conducted based on the proposed methodology as shown in Figure 1. Students need to define their project, scope, problem as the first step and after implementing the detailed literature survey, they will propose different alternative solutions. Based on the selected parameters for their decision matrix, students will choose one of the designs as their best design. Finally, by applying Taguchi method, they will optimize the selected design.

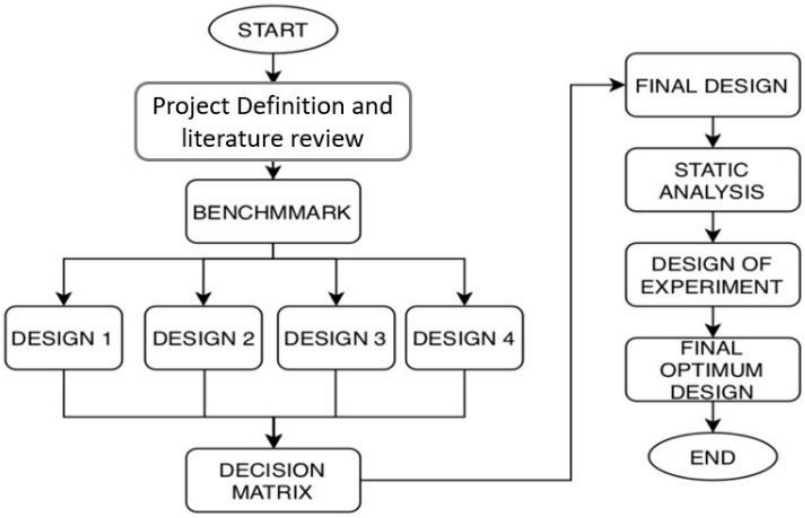


Figure 1. Methodology flowchart.

Different steps of the proposed methodology are as follow:

1. A thorough literature review and an acceptable understanding of the project must be conducted by week 4; followed by benchmarking to get a clearer image of what the best features are for a winning car.
2. Different designs (4 designs) are generated and then a decision matrix is applied to form one cohesive design by week 7.
3. Static analysis is done using SolidWorks by week 10; the results are analyzed and DOE (Taguchi Method) is implemented to obtain the optimum level of the selected parameters.
4. After obtaining the results, the stress analysis is conducted to ensure the optimum design meet all necessary requirements by week 14.

Figure 1 demonstrates the methodology discussed. For having a deep understanding of their project, students need to follow the flowchart as shown in Figure 2. There are 2 meetings of 1 hour per week between the supervisor and students. Also, students need to have 2 meetings per week with all members to list any self-contribution and team activities and at the end of their meeting, they need to have a minute of the meeting.

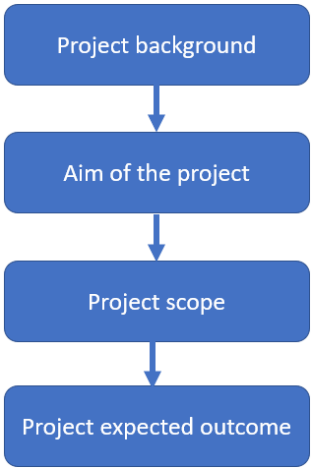


Figure 2. Project definition.

RESULT AND DISCUSSION

The aim of this research is to find the optimum chassis design for a solar race car. Hence, different steps of the proposed methodology need to be conducted to determine the optimum design as follows.

Project definition

Students need to define different project elements such as project background, the aim of the project, project scope, and the expected outcome to have an acceptable understanding of the project. For this section, students need to write a paragraph for each part of the project definition so that they have a clear understanding of what the problem is and finally how to evaluate any potential solutions.

Literature review and benchmarking

After they defined the project, the next step is to do the literature review and benchmarking to understand the current ideas and designs. Then, students are able to do brainstorm to have their own design features in the following step. In this section, students need to find at least 20 relevant references for the literature review and finally do the benchmarking based on current designs.

Concept generation and a decision matrix

The next step is to create a concept generation by proposing different designs. Hence, the design process for this project started by creating four preliminary designs simultaneously. Different design concepts have been proposed as shown in Figure 3. All designs have different features; a decision matrix is employed in order to obtain one design that can then be optimized. The criteria for the decision matrix are; manufacturability, material, seat location, weight, center of gravity, safety, and

sustainability (Sarifudin, 2012). Based on the results from the decision matrix, the best feature from each design is taken to create one new design.

Design of Experiment and static analysis

Design of experiments is a method applied in order to reach the optimum design and also reduce the number of experiments or simulations (Moayyedian, 2018). Although Taguchi method is a practical method for a single objective, it is durable to apply if there is more than one objective (Moayyedian and Mamedov, 2019). The main objectives of this project are to have high factor of safety and less stress level. Hence, based on the literature review and benchmarking, the selected parameters for DOE calculation are listed in Table 1. L9 orthogonal array of Taguchi is selected based on the number of parameters and their levels.

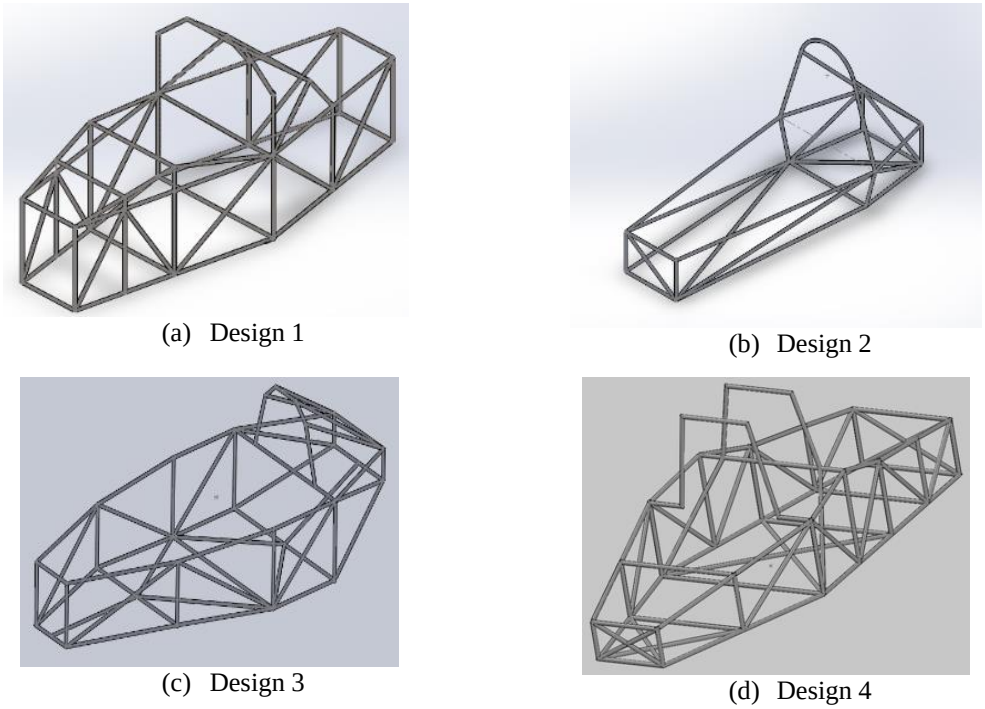
Parameters	Level 1	Level 2	Level 3
Length of front vertical members (mm)	200	250	300
Pipe Outer diameter (mm)	26.67	33.4	48.26
Length of dip (mm)	350	400	450
Number of members	86	87	88

Table 1. Parameters in three levels.

Table 2 represents the L9 orthogonal array. The letters; A, B, C, and D symbolize the parameters chosen. The levels chosen of each parameter for each experiment is set based on the selected orthogonal array.

Experiment number	Length of front vertical members (mm) A	Pipe Outer diameter (mm) B	Length of dip (mm) C	Number of members D
1	200	26.67	350	86
2	200	33.4	400	87
3	200	48.26	450	88
4	250	26.67	400	88
5	250	33.4	450	86
6	250	48.26	350	87
7	300	26.67	450	87
8	300	33.4	350	88
9	300	48.26	400	86

Table 2. L9 orthogonal array with the parameter's values.



(a) Design 1 (b) Design 2

(c) Design 3 (d) Design 4

Figure 3. Different designs of Chassis for solar car.

A SolidWorks static study is generated for all 9 experiments to find the factor of safety and the overall stress across the chassis. Static analysis is done because it is extremely vital to have a chassis that is stable and safe in its static position.

Since the chassis has to be as light as possible, the weight for each experiment had to be noted. Even though having low stress on the chassis is essential, though the factor of safety was the dominant objective to consider. When considering the maximum stress as the dominant objective, the factor of safety will have a high value. Having a high value for the factor of safety results in a safe and durable design with low stress. However, having a very high value for the factor of safety increases production costs. As shown in Table 3, the factor of safety values that were obtained for all experiments were relatively high. This is because other forces that may be encountered through the dynamic analysis will lower the factor of safety further by increasing the stress. Another calculation of Taguchi is to find the Signal to Noise (S/N) ratio -the smaller the better- for the factor of safety using Equation 1 (Moayyedian et al., 2018) since the factor of safety must be as low as possible for the optimum design.

$$\frac{S}{N} = -10\log\left(\frac{1}{n}\sum_{i=0}^{n} {y_i}^2\right) \quad (1)$$

where n is the number of iterations conducted for each experiment and y_i is the objective of the project. Since each experiment will only be conducted once therefore *n* will be equal to 1. Moreover, y_i is supposed to be the outcome raised to the power of 2. In this

case, the outcome was considered to be the factor of safety, which formulated Equation 2.

$$\frac{S}{N} = -10Log(Factor\ of\ safety)^2 \quad (2)$$

Experiment number	Maximum stress (MPa)	Factor of safety	S/N	Weight (Kg)
1	**20**	**11**	-20.83	55.153
2	9.082	24	-27.60	81.623
3	5.06	**54**	-34.65	131.845
4	11.5	19	-25.58	57.865
5	12.52	18	-25.11	84.413
6	**4.776**	46	-33.26	129.69
7	14.94	15	-23.52	58.625
8	6.816	32	-30.10	85.749
9	5.096	43	-32.67	134.214

Table 3. Results of maximum stress, FOS, S/N and weight.

The next step is to create the response table of Taguchi as shown in Table 4. For example, for parameter A, level 1 is as follow:
(S/N value from Table 5)/3 so (-20.83-27.6-34.655)/3=-27.69.

The highest values in Table 4 represent the optimum level of each parameter to minimize the factor of safety as much as possible. The optimum design is determined as shown in Table 5. It is clear that the optimum design does not existed in Table 3 which is the main idea of the Taguchi method. Hence, in DOE, there is no need to conduct all simulations to determine the optimum one. By having only 9 simulations out of 81 possibilities, you are able to find the best response. The optimum design is modeled using SolidWorks as shown in Figure 4.

	Length of front vertical members (mm) A	Pipe Outer diameter (mm) B	Length of dip (mm) C	Number of members D
Level 1	**-27.69**	**-26.55**	-28.06	**-26.20**
Level 2	-27.98	-27.60	-28.62	-28.13
Level 3	-28.76	-33.52	**-27.76**	-30.11
Difference	-1.07	-6.97	-0.30	-3.91

Table 4. Average values of S/N for each level.

Optimum design	
Weight (Kg)	56.47
Maximum stress (MPa)	20.28
Factor of safety	10.8
A1, B1, C3, D1	

Table 5. Optimum design.

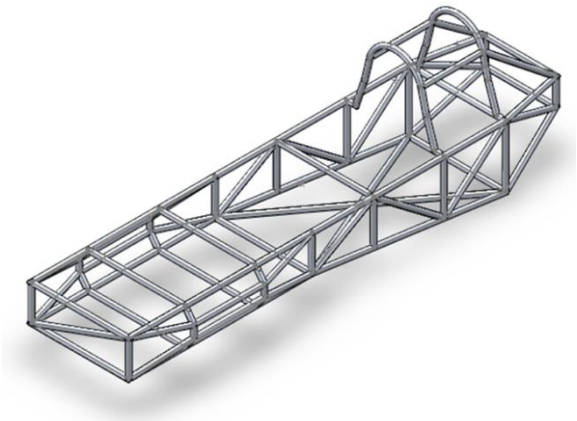


Figure 4. Optimum design of chassis.

DISCUSSION

One of the generic skills of PBL is to understand the project, analyze and resolve the problems. One of the main challenging parts for students as the first step was to define an algorithm that they can understand and analyze the project. By applying the flow chart as shown in Figure 1, students were able to understand and analyze the problem before they propose any solutions. Also, for chassis design and simulation, there are a number of parameters in different levels that increase the number of simulations. Based on the number of parameters and levels they had to run 81 simulations to determine the best solution but the Taguchi method as a solution was selected to resolve the problem efficiently by running only 9 experiments to find the best solution.

After the literature survey, four selected parameters in designing of solar car chassis were evaluated which are: Length of front vertical members, Pipe Outer diameter, length of dip, and a number of members. Then, different alternative solutions for the chassis design were modeled in SolidWorks, and the Taguchi method and L9 orthogonal array were applied for analyzing different objectives namely, the Weight, Maximum stress, and factor of safety. Based on the result in Table 4, the highest value for each parameter represents the optimum level for the optimum chassis design. The optimum levels are *Length of front*

vertical members at level 1, Pipe Outer diameter at level 1, length of dip at level 3, and Number of members at level 1. By applying the optimum level for the chassis design, the weight of the chassis is 56.47kg, Maximum stress is 20.28 MPa with a factor of safety of 10.8. it is clear that the Taguchi method is an acceptable tool to determine the optimum design and reduce the number of experiments. Also, the Taguchi method would be a useful tool for solving any complex problem that does not have only a single solution.

INDIVIDUAL AND TEAM WORK ASSESSMENT

Another generic skill of PBL is to have a teamwork and leadership ability in addition to independent responsibility. Finally, two different forms as peer assessment forms and self-contribution forms were proposed for students to assess their self-contribution and peer activities. That was an encouragement for students to evaluate their individual and teamwork activities during their senior project program based on the selected assessment criteria. For the self-contribution form, students need to list any individual contributions every week based on their weekly meetings. Contributions include any individual activities such as literature review, writing, calculation, and simulation. For the peer assessment form, students need to list all members of the group and assess them based on attendance and participation at group meetings, willingness to work and share with the group, and contribution made to the assessment component. Finally, the supervisor will evaluate two different forms for individual students based on different assessment criteria for the final evaluation.

CONCLUSION

AUM proposed a plan to apply PBL for bachelor students of mechanical engineering programs in the school of engineering for student's senior projects. The proposed plan includes different tools such as the design of experiments with problem-based learning to understand the project, analyze and resolve complex problems, and also their teamwork as well as their independent responsibility for shared learning. To understand the project in designing the chassis for a solar car, students applied a flowchart to understand the different concepts of their project deeply using PBL. To analyze and resolve a complex problem, students were able to develop their own ideas in design and reduce the number of simulations from 81 simulations to 9 experiments to find the optimum chassis design using DOE and PBL. By optimizing the chassis design, students determined the optimum stress of 20.28 MPa, the factor of safety of 10.8, and the weight of 56.4 kg. Finally, students were able to assess their self-contribution and peer activities via related forms with different assessment criteria based on Problem based learning skills. It is clear that

the combination of DOE and PBL is a practical technique to simplify a complex problem and determine the optimum design of different case studies in mechanical engineering.

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