

The Use of Research-based Learning Management in Mathematics Teacher Education: A Work-Integrated Learning Study

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Abstract

The purposes of the study were 1) to investigate the effects of research-based learning management in a work-integrated curriculum on student teachers' learning management abilities and to investigate the effectiveness of research-based learning management in a work-integrated curriculum on students' teachers' research skills. The samples were 30 mathematics student teachers in the faculty of education, Mahasarakham University, Thailand. Purposive sampling was employed in participant selection. The instruments were a research-based learning management plan, a learning management ability evaluation form, and a research skill evaluation form. The study was conducted in a quantitative method. The statistics used in analyzing the effects of the treatment on learning management abilities were percentage, mean score, standard deviation, and Orthogonal Polynomials. Meanwhile, a one-sample t-test with the criterion of 75 was used to analyze the participants' research skills. The results of the studies reveal a linear trend in student teachers' development of learning management abilities. Moreover, an expected outcome was reached in terms of developing the participants' research skills.

Keywords: research-based learning, RBL, work-integrated learning, WIL, teacher education

1. Introduction

Social and educational changes in the 21st century affect a teacher's abilities. With the strong perception of technology's impact on the learning environment, it is crucial for educators to closely monitor their abilities to employ innovation in learning. This includes teachers' learning management ability, a crucial qualification for teachers which is also needed to be upgraded. According to Singha et al. (2020), one of the desirable characteristics of teachers is the ability to design learning experiences that are suitable for their learners to learn in their best conditions. Therefore, teachers starting from their prospective years in teaching colleges should develop the learning management ability to serve teaching situations in the upcoming era (Darling-Hammond & Lieberman, 2012; Darling-Hammond, 2017)

In designing an effective learning management plan, one should be certain that the learning activities and processes employed in the class are selected with a strong rationale to fix class problems and develop students (Davis, 2017). Moreover, to ensure the development of students' expected behaviors, it is necessary to employ systematic assessment methods that could be supported by quantitative and qualitative evidence. At this point, the ability to conduct research is also important for teachers as it helps in the processes of class management design and evaluation (Cordingley, 2015). According to Hargreaves (1996), a teacher with research ability can analyze class problems, employ treatment with strong rationale, systematically access students' abilities, and provide evidence of students' development.

However, both learning management and research ability need years of experience and practice to establish. Especially for student teachers who started their prospected careers and gain experience, handling a learning management design and conducting a research project could be the greatest challenge in their education (Al-Ghattami and Al-Husseini, 2014). According to Labaree (2003), young researchers in teaching college tend to face difficulties in designing research as they lack experience in analyzing gaps in the studies in the area. Since it is likely to be the first time, they encounter research conducting experience, methodology, data collection, and data analysis could trouble their studies. This results in irrational results of the study and failure in search skill development. At a contextual level, Thai student teachers were reported to perceive research as

only a part of their degree (Safkolam et al., 2020). Even though they realized the importance and benefits of research, they reported showing no interest in developing their research skills as it is considered inapplicable for their career in real practice.

Therefore, stakeholders in teacher education must manage the learning experience for prospective teachers to make them realize the importance of research knowledge in their profession. The learning experience should allow them to apply knowledge learned in class in real practice. This would let them comprehend the teaching methods applied to the class and their effects on their students. At this point, the idea of work-integrated learning (WIL) was utilized in teacher education. According to Cooper et al. (2010), WIL is defined as a course's practice-based components where learners learn in class to practice in real situations. Likewise, Patrick, et al. (2008) define WIL as "a range of approaches and strategies that integrate theory and practice in a curriculum". While these definitions differ in learning location, both include learning-and-practice activities.

It's noteworthy that WIL has been recognized to be an alternative solution for higher education in the last decade. Billett (2011) suggested that WIL is designed to broaden the scope of knowledge gained at the university as well as develop the skills necessary to participate in professional practice and do so effectively. Likewise, Students would find a higher education more relevant when it is personalized for them. According to McIlveen (2011), students' awareness of the work link is enhanced when they are encouraged to have personal aspirations. This teaching approach considers university boundaries flexible. Visiting industry experts, participating in simulation activities where students operate virtual enterprises, interacting with virtual patients in health classes, and interactive teaching practicums are becoming more popular in university pedagogies (Ferns & Lilly, 2014). In this case, WIL could be beneficial in teacher education as it provides an opportunity for student teachers to experience the teaching profession in a real context. The method, therefore, could illustrate to them the benefits of research knowledge in learning management designs and develop their abilities as a part of their professional development.

Moreover, it should be noted that research is a complex process both in terms of learning and conducting. Learners of research have to acquire knowledge in various fields such as academic reading and writing, statistics, ethical concerns, data presentation, etc (Guthrie, 2010). On the other hand, research can be a great tool in learning class content as it encouraged learners to put attempt to study a concept thoroughly until they find the results of the study (Healey, 2005). Research-based learning (RBL) has emerged with the idea and is defined as an approach to education that intends to foster and cultivate student competencies concerning research practice and to benefit students through activities linked to research (Lockwood, 2001). According to Yulhendri et al. (2018), research elements in the learning process are a key indicator of research-based learning. This is because research-based learning (RBL) is authentic in its problem formulation, alternative solutions, and how research results can benefit student thinking. Arora et al. (2017) suggested that the benefits of research-based learning on learners include: increasing motivation and class engagement; developing students' skills and capabilities, such as critical and analytical thinking, information retrieval and evaluation, and problem-solving; providing enhanced opportunities for teaching and learning approaches, such as inquiry-based and experiential methods linked to positive learning outcomes for students; increasing their understanding of how the chosen discipline relates to other disciplines group work, time- and resource management, and data handling are transferable skills.

Arora et al. (2017) also suggested strategies for incorporating research-based learning into the curriculum. According to the authors, it could start from drawing on personal research in designing and teaching courses. To illustrate, an RBL class could start by incorporating research directly into the curriculum as the focus of a course and giving an example of how research knowledge is used to deal with real-world problems. Moreover, instructors can encourage students to in departmental research projects. This could be exercised by having students take care of sub-research within a larger project and assigning them as research assistants. Moreover, direct instruction can also be applied in the class. The knowledge of rationale writing, methodology, and data presentation should be instructed before assigning learners to conduct a research study. In addition, learners should be encouraged to be a part of the research culture. Teachers should provide information about seminars and conferences that would benefit their research project. It seems that encouraging learners to expose to theoretical, practical, and attitudinal knowledge of research is the core principle of RBL.

As work-integrated learning (WIL) and research-based learning theoretically show potential in developing learners in higher education including teacher development, empirical evidence has been provided to support both methods in teacher education. For example, WIL was proved to positively affect prospective teachers' skills in several studies (e.g., Aprile & Knight, 2019; Assan, 2014; Msimanga et al., 2021; Thomson et al., 2017; Usher, 2019). To exemplify, the result of a qualitative study on 15 Australian student teachers' perspectives on the impact of work-integrated learning placements on their professional readiness in Aprile & Knight (2019)

indicates the crucial role of WIL in teacher professional development and review challenges in application WIL in the context. Supervisor relationships and performance pressure during the internship are social processes needed to be considered in applying WIL in teacher education. Moreover, Assan (2014) conducted a mixed method study with 50 prospective teachers in South Africa and found that WIL helped participants build confidence, knowledge, and skills in inclusive teaching in terms of human development and curriculum management. Msimanga et al. (2021) conducted a qualitative study on postgraduate certificate in education (PGCE) student teachers examining their perceptions about communities of practice at schools. The results of the study indicate that WIL experiences strengthened their teaching discipline and class management ability as well as enhanced their abilities to handle learning activities while collaborating in co-teaching. Therefore, it could be noted that work-integrated learning (WIL) has become a part of teacher education around the globe.

Likewise, studies (e.g., Agud & Ion, 2019; Alvunger & Wahlström, 2018; Brew & Saunders, 2020; Toom et al., 2010) have also been conducted on research-based learning (RBL) as an approach to improving the quality of teacher education. The results of previous studies illustrate how RBL develops students' teachers' profession. For example, Agud & Ion (2019) applied RBL in a curriculum for 113 student teachers in Catalonia, Spain. A questionnaire was employed to study students' perception of research integration, quality of the course, and beliefs about research integration throughout their higher education. The result of the study indicates that samples were satisfied with RBL as the learning method. Moreover, they precepted research as a crucial skill for their career development. In addition, Alvunger & Wahlström (2018) found that Swedish educators and student teachers believed that prospective teachers could develop the ability to orient themselves to current research issues while they are in the process of receiving their training in the RBL approach. Moreover, Brew & Saunders (2020) suggested that the success in RBL depends on evaluating assumptions about education research's role, how to develop it, and the rationale to conduct it.

What could be noted from the previous studies on both work-integrated learning and research-based learning is that most studies focus on the perception of stakeholders in teachers' education as a whole. However, empirical studies that could prove the benefits of both teaching approaches in a specific teacher's ability are rarely found. Moreover, there is a lack of integration of the two methods in previous studies despite the combining potential and prospective benefits in both research skills and career development. In addition, most related studies focus on assessing the benefits of WIL after learners finished their internship which is the last year of their teacher education (e.g., Assan, 2014; Msimanga et al., 2021). However, the benefits of WIL can be assessed when student teachers observe professional teaching in the first or second year of their studies. Therefore, the current study was designed to fill the gaps in the area by designing a research-based learning management plan and applying it to a teacher profession course. They were expected to conduct a research project while they took part in teaching observation which is a part of the WIL curriculum for teacher education. The study could contribute to the area as it provides empirical evidence to support the integration of WIL and RBL. Moreover, it could also reveal the benefits of WIL in an ongoing stage of teacher education. Lastly, it should show the benefits of WIL and RBL in student teachers' career development as professional teachers and researchers. Therefore, the purposes of the study were 1) to investigate the effects of research-based learning management in a work-integrated curriculum on student teachers' learning management abilities and to investigate the effectiveness of research-based learning management in a work-integrated curriculum on students' teachers' research skills.

2. Methodology

2.1 Samples

The samples were 30 mathematics student teachers in the faculty of education, Mahasarakham University, Thailand. Purposive sampling was employed in participant selection. The samples took the Research in Mathematical Learning course. For the background information of the participants, they were recruited in a 5-year curriculum of teacher education. The curriculum was designed in work-integrated learning (WIL). Students are required to participate in learning activities such as teaching observation, teaching practicum, and internship in the schools with the assessment of professional teachers. The participants were in the third year and asked to participate in a 4-week teaching demonstration in school.

2.2 Instruments

The instruments were a research-based learning management plan, a learning management ability evaluation form, and a research skill evaluation form. The detail of each instrument can be seen below.

2.2.1 Learning Management Plan

The learning management plan was designed using the research-based method and applied in a work-integrated

learning environment. The plan covered 72 hours of teaching and practice in real situations. The class started by providing the knowledge of research and assigning them to research problems in mathematics classes in Thailand and possible solutions. They were then instructed about the research methodology and expected to develop a research proposal as a project assignment. After the processes of research instrument development, the participants took part in a one-month teaching practicum where they employed their research project to teach a concept of mathematics in school with the supervision of professional teachers. In the end, the participants concluded their research and presented it to the class. The development process of the learning management plan involved an evaluation by experts, and it indicates that the plan was appropriate, valid, and feasible.

2.2.2 An Evaluation Form for Learning Management Ability

An evaluation form was developed to assess participants' abilities in learning management design. It involves the aspects of teaching preparation, teaching execution, teaching media, and assessment. It was designed on the 5-Linkert scale. The evaluation by experts indicates the Item-Objective Congruence (IOC) of 1.0 for all the items. The discrimination of the items was 0.34-0.74 while the reliability of the form was 0.93.

2.2.3 An Evaluation form for Research Skill

The research skill evaluation form was designed in a 3-scale rubric scoring. The evaluation aspects cover the topics of research design, research instruments, data analysis, discussion and conclusion of results, and presentation. The discrimination of the items was 0.34-0.74 while the reliability of the form was 0.95.

2.3 Data Collection

The learning management plan was employed throughout the semester. The participants took 4 weeks to participate in a teaching practicum session. As the first week was just an introduction to the class, the participants' learning management abilities were assessed in weeks 2 – 4. After the semester ended the participants' research skills were assessed to complete the purposes of the study.

2.4 Data Analysis

The study was conducted in a quantitative method. The statistics used in analyzing the effects of research-based learning management in a work-integrated curriculum on student teachers' learning management abilities were percentage, mean score, standard deviation, and Orthogonal Polynomials. Meanwhile, a one-sample t-test with the criterion of 75 was used to analyze the effectiveness of the learning management on student teachers' research skills.

3. Results

Table 1. Participants' learning management ability

Learning management abilities	full mark	Week 2			Week 3			Week 4		
		\bar{x}	SD	%	\bar{x}	SD	%	\bar{x}	SD	%
Teaching preparation	25	23.20	1.92	92.80	24.30	1.09	97.20	24.70	0.84	98.80
Teaching execution	40	36.17	3.82	90.42	37.47	2.93	93.67	39.03	1.87	97.58
Teaching media	20	18.20	1.85	91.00	19.07	1.46	95.33	19.53	1.01	97.67
Evaluation and Assessment	20	18.20	2.19	91.00	19.10	1.47	95.50	19.67	0.80	98.33
Total	105	95.77	9.39	91.21	99.93	6.01	95.17	102.93	4.01	98.03

It could be seen that the research-based learning management positively affected the participants' learning management ability. As learners were informed about the procedures for applying research in teaching before taking part in the teaching practicum session, it could be implied that they could show their potential in learning management in all aspects of teaching. In detail, the overall learning management ability of students continuously increased from week 2 ($\bar{x} = 95.77$, S.D = 9.39) to week 3 ($\bar{x} = 99.93$, S.D = 6.01), and to week 4 ($\bar{x} = 102.93$, S.D = 4.01). This accounts for 91.21%, 95.17%, and 98.03% of the full mark respectively. Therefore, it could be interpreted that the research-based learning management helped the participants to gain knowledge of class management and improve their teaching quality.

Table 2. Trend Analysis of Participants' Learning Management Ability

Learning Management Abilities			Sum of Squares	df	Mean Square	F	p	
Teaching preparation	Between Groups	(Combined)	36.20	2.00	18.10	9.76*	0.00	
		Linear Term	Contrast	33.75	1.00	33.75	18.19*	0.00
		Deviation	2.45	1.00	2.45	1.32	0.25	
	Within Groups	Quadratic Term	Contrast	2.45	1.00	2.45	1.32	0.25
		Total		161.40	87.00	1.86		
		Total		197.60	89.00			
Teaching Execution	Between Groups	(Combined)	123.62	2.00	61.81	6.96*	0.00	
		Linear Term	Contrast	123.27	1.00	123.27	13.88*	0.00
		Deviation	0.36	1.00	0.36	0.04	0.84	
	Within Groups	Quadratic Term	Contrast	0.36	1.00	0.36	0.04	0.84
		Total		772.60	87.00	8.88		
		Total		896.22	89.00			
Teaching media	Between Groups	(Combined)	27.47	2.00	13.73	6.28*	0.00	
		Linear Term	Contrast	26.67	1.00	26.67	12.20*	0.00
		Deviation	0.80	1.00	0.80	0.37	0.55	
	Within Groups	Quadratic Term	Contrast	0.80	1.00	0.80	0.37	0.55
		Total		190.13	87.00	2.19		
		Total		217.60	89.00			
Evaluation and Assessment	Between Groups	(Combined)	32.82	2.00	16.41	6.48*	0.00	
		Linear Term	Contrast	32.27	1.00	32.27	12.75*	0.00
		Deviation	0.56	1.00	0.56	0.22	0.64	
	Within Groups	Quadratic Term	Contrast	0.56	1.00	0.56	0.22	0.64
		Total		220.17	87.00	2.53		
		Total		252.99	89.00			
Total	Between Groups	(Combined)	777.22	2.00	388.61	8.31*	0.00	
		Linear Term	Contrast	770.42	1.00	770.42	16.47*	0.00
		Deviation	6.81	1.00	6.81	0.15	0.70	
	Within Groups	Quadratic Term	Contrast	6.81	1.00	6.81	0.15	0.70
		Total		4069.10	87.00	46.77		
		Total		4846.32	89.00			

p < .05

The trend analysis of the participant's learning management ability indicates the F_{linear} of 16.47, 18.19, 13.88, 12.20, and 12.75 respectively which is statistically lower than the prob of .05 ($p < 0.05$). Therefore, the linear trend can be found at a statistical level of .05. In addition, the $F_{\text{Quadratic}}$ was found at 0.15, 1.32, 0.04, 0.37, and 0.22 respectively. The values exceed the prob of .05 ($p > .05$) indicating a non-parabola trend. Therefore, it could be seen that the learning management ability of participants in 3 weeks of teaching practicum was continuously and significantly improved at a statistical level of .05. Therefore, it could be implied that if there had been more weeks to practice, the participant's ability would have been improved.

Table 3. Participants' Research Skills after Learning the Research-Based Course in a Work-Integrated Learning Setting

Research skills	Full-mark	75 % criteria	\bar{x}	SD	t-test	p
Research design	27	20.25	21.57	1.77	4.06*	0.00
Research instruments	12	9.00	9.70	1.53	2.50*	0.02
Data analysis	9	6.75	7.23	1.10	2.40*	0.02
Discussion and conclusion of results	9	6.75	7.27	1.20	2.36*	0.03
Presentation	12	9.00	10.40	1.38	5.56*	0.00
Total	69	51.75	56.17	4.74	5.10*	0.00

p < .05

The results of the study indicate that all participant's research skills were assessed to reach the expected criteria.

In detail, one-group t-tests indicate significant differences between the students' average scores and the determining criteria in the skills of research design ($t=4.06$, $p=0.00$), research instruments ($t=2.50$, $p=0.02$), Data analysis ($t=2.40$, $p=0.02$), discussion and conclusion of results ($t=2.36$, $p=0.03$), and presentation ($t=5.56$, $p=0.00$). Overall, the average score of participants' research skills was significantly high level from the determining criterion of 75% ($t=5.10$, $p=0.00$). It could be interpreted that students learning in learning management is designed using the principle of RBL within a WIL environment could assist their research skills at a certain level of expectation.

4. Discussion

The result of the study indicates that the integration of RBL and WIL benefited both participants' teaching abilities and research skills. This could be a result of activities of research-based learning management that encouraged the participants to see the importance of research as a tool for developing students' knowledge as well as their teachers' skills. Moreover, the participant can apply what they learn in class to conduct a research study in real practice. The participant was provided an opportunity to conduct a research study. They developed research proposals and research instruments with the facilitation of teachers and professional teachers. Even though the data collection took only 4 weeks in a real pedagogical situation, the participants could gain benefit from it in terms of both teaching and research skills development. This could confirm the benefits of the research-based method in teacher education as it utilizes research elements in the learning process. It also helps student teachers to deal with students' problems in real situations which improve their teaching (Arora et al., 2017; Lockwood, 2001; Yulhendri et al., 2018). The results of the study could also provide empirical evidence to support the benefits of research-based learning in teacher education. It joined other studies that also found an improvement in the quality of teacher development widely (e.g., Agud & Ion, 2019; Alvunger & Wahlström, 2018; Brew & Saunders, 2020; Toom et al., 2010).

Moreover, it could be noted that research-based learning could not be completed without the real practice of research development. Therefore, WIL played a great role in the authentic practice of both teaching and doing research. In the study, the participants had a 4-week opportunity to participate in a teaching practicum in school settings. This helped them to familiarize the problems found in class such as students' differences, lack of teaching material, external factors of teaching, etc. Therefore, the participants can learn to manage learning experiences that match the needs of their pupils. Likewise, WIL provided an opportunity to employ research instruments developed in the course in school. This also benefited their research skill development since the participants would have a chance to solve problems occurring during the data collection. They also had an opportunity to observe how learners were affected by the chosen research material in the process. The result is consistent with Aprile & Knight, (2019), Assan (2014), Msimanga et al. (2021), Thomson et al. (2017), and Usher (2019) who also support the benefits of WIL as an important process of teacher education. In the current study, it served as an integrated tool for RBL in developing student teachers' learning management ability and research skills.

Therefore, the results of the study fill the gaps in the area of RBL and WIL. To explain, the previous studies in RBL (e.g., Agud & Ion, 2019; Alvunger & Wahlström, 2018; Brew & Saunders, 2020; Toom et al., 2010) and WIL (e.g., Aprile & Knight, 2019; Assan, 2014; Msimanga et al., 2021; Thomson et al., 2017; Usher, 2019) trend to investigate the perception of prospective teachers or stakeholders in teacher education of RBL and WIL. Meanwhile, the current study provided empirical evidence to support their benefits in student teachers' skill development. Moreover, it also proved that both RBL and WIL can be beneficial during the process of the curriculum considering that participants were in the third year. Lastly, the results of the study could be one of a few that illustrates the benefits of the integrated RBL and WIL on teacher education in terms of both curriculum and learner development aspects.

5. Conclusion

The study was developed to utilize the combination of research-based learning (RBL) and work-integrated learning (WIL) in the improvement of student teachers' learning management abilities and research skills. A learning management plan was developed using the principle of RBL and employed in a WIL teacher education curriculum. The results of the studies reveal a linear trend in student teachers' development of learning management abilities. Moreover, an expected outcome was reached in terms of developing the participants' research skills. The study provided pedagogical contribution as it illustrates how RBL and WIL could be combined and used in developing student teachers' abilities and skills. However, stakeholders in teacher education curriculum development should be aware of both disciplines in designing a curriculum. It should be noted that RBL could not be successfully applied without the opportunity to conduct and utilize a research

project in a real setting. Therefore, work-integrated learning environments are needed to let learners learn with an authentic practicum of theories and advice from professionals.

In terms of academic implications, the study was designed with a methodology that could fill niches in the research area. However, considering a limited number of studies using the integration of the two disciplines, there is room for further studies to develop research based-learning management that could be applied to work-integrated learning environments. Moreover, further studies could be conducted with other teachers' skills such as teaching psychology, class management, teaching material design, etc. Research and authentic practicum should be beneficial in various areas of teacher education.

However, the study still bared limitations that could be solved to improve the quality of data collection. First, the study employed only the quantitative research approach in data collection. Utilizing methods such as surveys, interviews, and observation might provide a deeper understanding of how the method affects learners' ability development. Moreover, the participants were selected only from a single major of student teachers. The diversity of student teachers' disciplines might illustrate the different effects of the methods on teaching different types of teachers' education. Lastly, the employment of the control group should provide clearer empirical evidence to support the integrated RBL and WIL.

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