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Full Length Research Paper

Main factors of teachers' professional well-being

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The purpose of the study was to reveal the main factors of teachers' professional well being. Theoretically constructed model was tested on large scale data belong to 72.190 teachers working at lower secondary level. Theoretical model included teachers' individual, professional and organizational characteristics. Professional well-being was constructed as an index that combines job satisfaction, self-efficacy, aspiration, motivation and authority. Hierarchic regression analysis displayed that organizational factors explained two third of total explained variance. The study concluded that the main factors of teachers' professional well-being were:

1. Cooperation among staff ($\beta=.216$)
2. Fair and helpful assessment and feedback ($\beta=.213$)
3. Positive school climate ($\beta=.212$)
4. Student oriented teaching practices ($\beta=.182$)
5. Classroom climate ($\beta=.146$)
6. Professional development ($\beta=.102$)

Initiatives for developing teachers' professional well-being should focus on the school and classroom climate. To construct positive learning environment, teachers' communicative skills, effective teaching techniques and positive disciplinary techniques should be enhanced.

Key words: Professional well-being; teachers; talis; large scale international data.

INTRODUCTION

Teachers' professional well-being (TPW) as an indicator provides information about statement of teachers in terms of teaching profession. The importance of an indicator comes from its' reasons that generate it. If we know these reasons, the right intervention would be carried out when the problem arises. Professional well-being is accepted as a dimension of general well-being of an employee. Although, there are lots of studies on "general well-being" but there is a scarcity in numbers of researches focused

directly on professional well-being and especially on teachers' professional well-being. Teaching profession as different from other professional groups has naturally some distinctive characteristics. Therefore factors that would effect on it should be different from that of other professions. Identification of factors influencing concept of professional well-being (TPW) might enable administrators, political decision makers and supervisors to undertake actions accordingly to enhance it.

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The concept of professional well-being

Well-being can be defined as physically and psychologically being healthy. It includes people's emotional responses, domain satisfactions and global judgments of life satisfaction (Diener, Suh, Lucas and Smith 1999). The concept is a multidimensional construct and comprehends cognitive, affective, social and behavioural compounds (Horn, Taris, Schaufeli and Schreurs 2004; Ryff and Keyes 1995; Warr 1990). As an outcome it is an affective result and it refers to positive emotions with (Aelterman, Engels, Van Petegem and Verhaeghe 2007).

Warr (1990) examined the concept in a contextual base and specifically focused on how particular work characteristics affect employees' well-being. He described five dimensions (affective wellbeing, aspiration, autonomy, competence and integrated functioning) reflecting the person as a whole. Free from the contextual effect Ryff and Keyes (1995) described a six dimensional model of well-being. Based on positive psychology they used self-acceptance, environmental mastery, autonomy, positive relations with others, personal growth and purpose in life. Unlike Warr they included behavioural dimension. Horn et al. (2004) focused on work-related well-being and combined Warr's model and Ryff's model. They described five dimensions and three of which (affective, social and professional well-being) are taken from Ryff and Warr models. They specifically underlined professional competence, aspiration and autonomy as measures of professional well-being. These measures also include aspects of job-related motivation, ambition, self-efficacy and achievement.

Literature review produced only two studies that are involved in teachers' professional well-being. The first one was carried out by Butt and Retallick (2002), who gathered qualitative data from 29 teachers who worked in Alberta, Canada. They proposed a link between a positive sense of professional wellbeing and feelings of trust, respect, autonomy and efficacy as a teacher. The other study was carried out by Aelterman et al. (2007) who gathered quantitative data from 1.934 Flemish teachers. They highlighted its components as job satisfaction, self efficacy, trust and autonomy. According to them TPW depends on self assessment about his/her professional state which refers to perception about being good in the meaning of teaching profession. Operational description of the concept refers to teachers' perception about the level of possessing the qualities needed for teaching tasks. Both studies are concerned with a particular cultural context. We could not obtain studies that provide common factors of TPW through analysing of different cultural contexts.

Factors of teachers' professional well-being

Bricheno et al. (2009), who carried out a comprehensive review on teachers' well-being, emphasized the need for

research on influences of factors on teachers' well-being. TPW as a result of personal assessment has some causes. According to Hoy and Miskel (2010) various facilitators and obstacles against teaching have potential in affecting a teacher's professional well-being. Multiple systems approach acknowledges that a human is actually a system of interdependent systems. Not only inner system but also outside of the body affect each other. As stated by Bandura (1997), internal personal factors and the external environment mutually influence each other. Many contextual factors including personal and organizational characteristics interacting with each other have potential to shape a teacher's professional well being (Aelterman et al. 2007; Horn et al. 2004; Karakus 2008).

Categorisation of factors is considerable issue in terms of theoretical framework in analysing data. When we consider different dimensions of teaching profession we assume three categories of factors. These are individual, organizational and professional characteristics. Munn et al. (1996) studied specifically on child life specialist's professional well-being and they categorized factors under four titles namely individual factors, workload, role stress and social support. Briones et al. (2010) examined factors under three categories that are personal (age, gender), professional (example, experience) and organizational factors (number of students and cultural variability). Aelterman et al. (2007) used two categories: personal features (gender, age, experience, employment status) and school features (example, support from principal, support for professional development, workload, and size of classes). Review of previous studies demonstrated that individual characteristics (gender, age, education level, and experience), professional characteristics (teaching beliefs, practices, professional development activities) and organizational characteristics (school climate, school resources, school management style, classroom environment, workload, and cooperation among staff) are deduced as being factors affecting TPW.

Basic aim of this study is to determine the main factors of teachers' professional well-being by using large scale international data. In doing this the study draws out a picture that is above to cultural context through analysing large scale international data ($n > 70.000$). Therefore the common factors of TPW would be put forward at international level. Based on the literature review we proposed a hypothetical model that is depicted in figure 1. This study also aims to test this model. Through this model we aim analysing the contribution of individual, professional and organizational (school) characteristics on the TPW.

Dependent variable in the model is TPW and predictors are categorized into individual, professional and organizational characteristics of teachers. The study specifically answers the following questions:

1. Which of the categories of predictor variables (individual, organizational and professional) accounts for the greatest amount of variance in TPW?

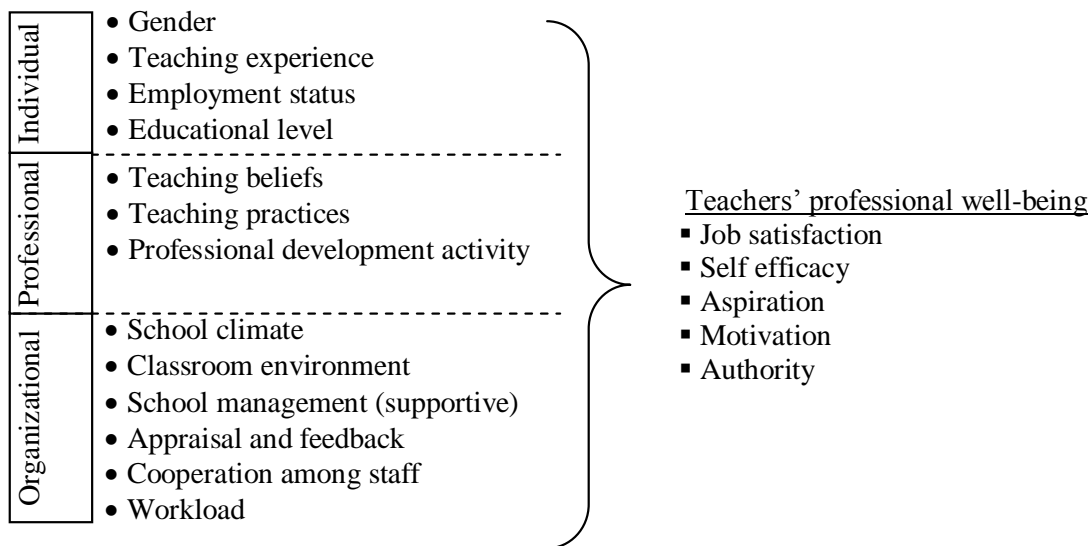


Figure 1. The conceptual model proposing factors of teachers' professional well being.

2. Within each category of predictor variables, which variable(s) is/are the most predictive of TPW?
3. Is the theoretical model verified? If it is not which dimension of the model is problematic?

METHODOLOGY

In searching out whether teachers are good in terms of teaching profession, mainly two different methods can be performed. The first one is related to external evaluation that includes exams, observations, interviews etc. This method is largely expensive, time consuming and very complex task. But the second one depends on teachers' self evaluation that seems more practicable, economical and simple. Disadvantage of this method originates from regarding personal views that are changeable by one. To be able to cope with this problem, researchers obtain the large number of teachers' views.

Data, population and sample

Data used in the current study were gathered from Teaching and Learning International Survey-TALIS. It is the first international survey focused on teachers' working conditions and learning environment in schools. Data were downloaded from the international data base that exists on the web page of TALIS (www.oecd.org/edu/TALIS). It comprehends teaching beliefs and practices, teachers' work and the feedback and recognition, school leadership, management and workplace issues.

23 countries participated in the survey that was carried out in 2008. The target population of the first round of TALIS were teachers who work at lower secondary schools. TALIS had a stratified two-stage probability sampling design. Teachers (second stage units) were randomly selected from the list of in-scope teachers in each of the randomly selected schools (first stage units). Schools were stratified respectively by province (region), type of school (private-public) and school size. In every participant country 200 lower secondary schools or primary schools representing different units were selected then 20 subject teachers

were given questionnaires. Finally 72.190 teachers from 4.401 schools participated and overall corresponded rate was 78% (OECD, 2010).

Teachers' questionnaires consisted of 43 questions and were filled in on paper or on line. Data belong to teachers were subjected to secondary analyses in the meaning of current study's objectives. Using variables existed in original data worksheet, new indexes were constructed too. All variables and indexes can be seen at annex.

Descriptions of the participants

More than two third of the final sample of teachers are female (70.2 %). 15.8% of participants work on a renewable contractual basis, the rest of them had strong job security. 48.4 % of the participants have bachelor degrees and 35 per of them complete a postgraduate degree.

Only 2.8 % of participants are beginners and 37 % of them have experience more than 20 years. In general, teachers' workforce can be defined as female dominant, well educated, and experienced with strong job security.

Measures

Survey instruments of TALIS were developed by expert groups which took responsibility at different phases of the study. TALIS Board of Participating Countries (BPC) approved the questionnaires at each stage of testing and implementation (pilot, field trial and main survey). Items focused on teacher attitudes and beliefs (OECD 2010).

Professional well-being was constructed as an index. This index was represented by five scales. *Job satisfaction* scale consists of only one item ('All in all, I am satisfied with my job', 1 = strongly disagree, 4 = strongly agree). *Self efficacy* scale consists of four items ('I feel that I am making a significant educational difference in the lives of my students', 'If I try really hard, I can make progress with even the most difficult and unmotivated students', 'I am successful with the students in my class', 'I usually know how to get

Table 1 Subscales used in the study

Subscales	Number of items	Min	Max	Mean	Stand. Deviation	Cronbach's α
Teaching beliefs	12	-2.50	3.00	.28	.55	$\alpha=.60$
Teaching practices	19	-4.00	3.20	-1.09	.99	$\alpha=.85$
School climate	4	1.00	4.00	3.13	.43	$\alpha=.77$
School management (leadership style)	11	-3.00	3.00	-.39	.62	$\alpha=.91$
Appraisal and feedback	8	2.00	8.00	5.07	1.02	$\alpha=.92$
Cooperation among staff	9	1.00	4.00	2.53	.58	$\alpha=.75$
Professional development activity	10	1.00	4.00	2.04	.53	$\alpha=.69$
Workload	4	1.00	4.00	2.45	.62	-
Classroom environment	4	1.00	4.00	2.89	.62	$\alpha=.84$
Student ability	2	2.00	10.00	6.26	1.56	$\alpha=.87$
Professional well-being	12	1.00	4.00	2.56	.34	$\alpha=.68$

through to students', 'Teachers in this local community are well respected' 1 = strongly disagree, 4 = strongly agree). *Aspiration* was measured using a three-item scale ('I give different work to the students that have difficulties learning and/or to those who can advance faster', 'I ask my students to suggest or to help plan classroom activities or topics', 'I work with individual students' 1 = never or hardly ever, 4 = in almost every lesson). *Motivation* scale consists of two items ('If I improve the quality of my teaching at this school, I will receive increased monetary or non-monetary rewards', 'If I am more innovative in my teaching at this school, I will receive increased monetary or non-monetary rewards', 1 = strongly disagree, 4 = strongly agree). And *authority* scale was represented by only one item ('Discuss and decide on the selection of instructional media (e.g. textbooks, exercise books)' 1 = never, 4 = weekly). Using these items an artificial continuous variable was produced. The higher score refers to higher degree of teachers' perception about professional well-being.

Table 1 displays the subscales used in the study. Subscales were all represented by indices. Variables used in subscales were measured by using a four point scale. The scale of *age*, *teaching experience* and *assessment/feedback received* variables which had been differed between 5 and 7 scales were all transformed into the four scales. Though reliability scores of 'cooperation among staff', 'professional development activity' and 'workload' are below statistically acceptable level, they are not excluded from the study because of their conceptual contribution.

On the Table 1, higher and positive scores refer better perception about variable. For instance higher positive scores in teaching beliefs mean stronger constructivist beliefs; negative scores represent the belief of direct transmission. For teaching practices, positive scores define student oriented practices and negative scores mean structuring teaching practices. School climate includes four items namely "In this school, teachers and students usually get on well with each other", "Most teachers in this school believe that students' well being is important", "Most teachers in this school are interested in what students have to say" and "If a student from this school needs extra assistance, the school provides it" (1 = strongly disagree, 4 = strongly agree). To be able to measure teachers' professional cooperation frequencies of the collaborative practices were used: example, "Exchange of teaching materials, observing other colleagues in their classroom and discussion on homework", "teach jointly as a team in the same class" (1=Never, 4=Five times and more).

Classroom climate was made up four items namely "When the lesson begins, I have to wait quite a long time for students to quiet down", "Students in this class take care to create a pleasant learning atmosphere", "I lose quite a lot of time because of students

interrupting the lesson" and "There is much noise in this classroom" (1 = strongly disagree, 4 = strongly agree).

Assessment and feedback included; example "public recognition from the principal and/or colleagues", "A development or training plan to improve teaching" (1 = No change, 4 = A large change), "assessment of my work as a teacher was fair" (1 = strongly disagree, 4 = strongly agree). Teachers' workload was measured as the time (hour) consumed for teaching, planning and administrative tasks (Appendix A and B).

Analyse the data

All analysis was carried out at teachers' level. The average score for each subscale and the distribution of scores (at teacher level) were recorded. In analysing phase, descriptive (frequency, mean, standard deviation), correlation, and regression analysis were used. The analysis process had mainly three stages. At the first stage data reduction was made through constructing indices. It was carried out in regard to construct conceptually meaningful variables. At the second stage correlations were examined to determine relation between specific variables to identify multicollinearity. At the last stage hierarchical regressions were conducted with professional well-being as dependent variable. Variables were simultaneously taken into the analysis as three blocks: individual, professional and organizational characteristics. In the regression analysis, the enter method was used because every independent variable has equal opportunity to effect dependent variable. To see picture more generally enter method was selected. It enabled us to assume the situation more realistically.

RESULTS AND DISCUSSION

Correlations

Bivariate correlations for variables in the conceptual model are displayed on Table 2. Since highly correlated measures do the same thing some exclusion would be required (Byrman and Duncan 2005). As can be seen on the table, there are no high correlations. The highest correlation is between assessment and professional well-being (.36). They are sufficiently independent to be considered as separate dimensions. Significant correlation

Table 2. Bivariate correlations among variables used in analysis

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 gender	-	,000	-,020**	-,057**	-,063**	,135**	-,067**	-,028**	-,034**	,016**	-,009*	-,087**	-,035**	,004	-,019**
2 experience		-	,002	,000	-,001	-,022**	-,010**	-,026**	-,019**	-,002	-,021**	-,029**	-,004	-,011**	-,074**
3 emp.status			-	,018**	-,008*	-,006	,000	,022**	-,079**	-,031**	,025**	-,038**	-,108**	-,021**	,002
4 edu.level				-	-,009*	-,056**	,061**	-,041**	,003	-,016**	-,030**	,081**	-,007	,053**	,015**
5 beliefs					-	,039**	,060**	,035**	,039**	,026**	-,074**	,026**	,060**	,006	-,061**
6 practices						-	,031**	,002	,012**	,057**	,084**	,063**	-,039**	,053**	,229**
7 prof.develop							-	,013**	,002	,014**	,083**	,104**	,034**	,025**	,090**
8 sch.climate								-	,165**	-,075**	,183**	,188**	,023**	,123**	,332**
9 class.climate									-	,025**	,074**	,091**	,028**	,328**	,236**
10 man.style										-	,100**	,059**	,009*	,014**	,030**
11 assessment											-	,181**	-,020**	,081**	,357**
12 cooperation												-	,102**	,084**	,313**
13 workload													-	,016**	,004
14 stu.ability														-	,147**
15 prf.wellbeing															-

** . Correlation is significant at the 0.01 level (2-tailed).
 * . Correlation is significant at the 0.05 level (2-tailed).

($r=.31, p<.01$) between cooperation among staff and professional well-being support the findings of Aelterman et al. (2007) and Musanti (2010). Instructional practices have significant correlation with professional well-being ($r=.23, p<.01$) that confirms the findings by Butt and Retallick (2002).

The effect of predictor category/variables

Hierarchical multiple regression analyses were performed to determine which categories (individual, professional, organizational) or variables were most predictive of TPW. The statistical significance was indicated in the $p<.01$.

Table 3 provides the outputs of analysis. For

teachers' individual characteristics the total variance explained by the regression equation was 06 %. For professional features this figure was 12% and for organizational characteristics, it was 21.5 %. The total variance explained by the predictors was 34.2 %. The model moderately fits the data because $0.31 < R^2 < 0.5$ indicates a moderate fit (Muijs 2004: 166). In terms of total explained variance, the result is in accordance with previous researches (Aelterman et al. 2007; Griva and Joekes 2003).

This finding highlights the importance of organizational characteristics. Teacher's individual characteristics are not good at predicting teacher's professional well being. Most striking variables are teaching practices ($\beta = .18$), professional

development ($\beta=.10$), school climate ($\beta=.21$), assessment and feedback ($\beta=.21$), cooperation among staff ($\beta=.21$) and classroom climate ($\beta=.15$). But school management is not a significant variable. On the other hand workload, gender, experience and educational level have very small effect size though they are all statistically meaningful variables.

Teachers' individual characteristics are not powerful predictors of TPW. In terms of explained variance, individual characteristics together explain only 6% of variance in dependent variable. Gender and experience have negative effects on TPW that means female and young teachers have higher score of professional well-being than that of male and more experienced teachers. In the

Table 3. Outputs of regression analyse

Model	Category/Variables	B	SE _B	Beta	t	Sig.
1	(Constant)	2,664	,009		301,906	,000
	Gender	-,013	,003	-,018	-4,811	,000
	Experience	-,032	,002	-,073	-19,283	,000
	Education level	,007	,002	,015	3,996	,000
	Employment status	,000	,002	,001	,188	,851
	R=.077 ^a	R ² =.006	Adj.R ² =.006	R ² change=.006	F (4-70108)=103,342	p ^a =.000
2	(Constant)	2,460	,010		255,321	,000
	Gender	-,032	,003	-,043	-11,927	,000
	Experience	-,028	,002	-,064	-18,026	,000
	Education level	-,001	,002	-,002	-,656	,512
	Employment status	,006	,002	,011	3,016	,003
	Teaching beliefs	-,059	,002	-,096	-26,917	,000
	Teaching practices	,076	,001	,222	62,018	,000
Professional development	,163	,002	,249	69,402	,000	
	R=.355 ^b	R ² =.126	Adj.R ² =.126	R ² change=.120	F (7-70105)=1447,739	p ^b =.000
3	(Constant)	1,139	,013		85,630	,000
	Gender	-,008	,002	-,011	-3,615	,000
	Experience	-,021	,001	-,049	-15,814	,000
	Education level	,006	,001	,015	4,679	,000
	Employment status	,007	,002	,014	4,346	,000
	Teaching beliefs	-,048	,002	-,078	-25,090	,000
	Teaching practices	,063	,001	,182	57,915	,000
	Professional development	,067	,002	,102	30,651	,000
	School climate	,168	,003	,212	65,379	,000
	School management style	-,003	,002	-,005	-1,728	,084
	Assessment and feedback	,071	,001	,213	65,206	,000
	Cooperation among staff	,127	,002	,216	63,621	,000
	Workload	-,016	,002	-,028	-8,719	,000
	Student ability	,004	,001	,021	6,322	,000
Classroom climate	,079	,002	,146	44,241	,000	
	R=.584 ^c	R ² =.342	Adj.R ² =.341	R ² change=.215	F (14-70098)=2597,978	p ^c =.000

a. Dependent Variable: prf.wellbeing

study carried out by Aelterman et al. (2007) individual characteristics explained 20.8% of the variance in teacher well-being. Among the individual characteristics the most controversial topic is gender. Some previous studies found its meaningful effect on the measures of professional well-being (Capri and Celikkaleli 2008; Glenn et al. 1977; Kucuktepe 2007; Mottaz 1987; Okpara 2006). There are also contrary results on gender (Aelterman et al. 2007; Rasku and Kinnunen 2003; Stockard and Lehman 2004). In this study regression analysis indicated negative scores of gender which refers to male teachers (it is coded with 2) have lower scores of

TPW. But we should be cautious in considering this finding because the number of female teachers is more than two times of male teachers. For instance Aelterman et al. (2007) indicated for Flemish elementary teachers that though female teachers had higher levels of wellbeing than men, but the underlying factors was age because the female teachers were significantly younger and more in numbers. Similar results are suggested by Sann (2003) but in her study, experienced teachers had lower sense of professional well-being than their younger counterparts. This finding is in line with the current study's finding because as experience increases, scores of

professional well-being decreases. Similar result was cited by Kinnunen et al. (1994) and Bricheno et al. (2009). But Kucuktepe (2007) found meaningful differences regarding gender, the kind of school and vocational seniority. On the other hand there is an inconsistency between the current study and previous studies in the meaning of teachers' education level. Eginli (2009), Garcia et al. (2005). Vila and Garcia-Mora (2005) indicated the significant and positive association between them.

In terms of explained variance, main factors emerged from classroom and school. It can be suggested that teachers have better perception of professional well-being in a school where (i) assessment and feedback enable teachers to enhance teaching in classroom, (ii) teachers' works are appreciated and (iii) pupils are given importance and their needs are met, (iv) teachers cooperate with each other and they contribute colleagues' professional development and work together on common topics. And in a classroom (v) where activities focus on students' learning, (vi) pupils pay attention to make a positive learning atmosphere.

Principal's management style (bureaucratic or instructional) was intriguingly found as insignificant, whereas positive school climate, teachers' collaborative work, fair and helpful assessments were statistically significant and for all school managerial bodies' have crucial responsibility. Principal's management style seems to be in shadow of school climate, fair and helpful assessment. Previous studies strongly support the importance of relationship between principal and teachers in terms of teachers' professional well-being (Aelterman et al. 2007; Briones et al. 2010; Butt and Retallick 2002; Chong et al. 2010; Munn et al. 1996; Schyns and Croon 2006; Webb et al. 2004). And some previous studies displayed the link between principal's management styles and teachers' attitudes (Bricheno et al. 2009; Eginli 2009; Korkmaz 2007; Solmus 2004; Tasdan and Tiryaki 2008).

This study confirmed the importance of cooperative work, collegial relationship among staff. Cooperation among staff creates opportunities for social and emotional support, exchange of ideas and practical advice. It can thus enhance professionalism (OECD 2009: 101). Cooperation among staff was found as the most powerful factor ($\beta=.216$), which is consistent with previous research results (Aelterman et al. 2007; Butt and Retallick 2002; Munn et al. 1996). It can also be stressed that school-based teachers cooperation should be favoured instead of centrally manipulation as it was resulted by Kougioumtzis and Patriksson (2009). Another significant dimension related with school managerial bodies is assessment and feedback. Munn et al. (1996) indicated the same result. As one of the most effective factors ($\beta=.213$) assessment and feedback explain that if it is fair and helpful, it would positively affect TPW but if it is not, it might threaten teachers' creativeness and authority.

TPW is heavily related with interaction between teachers and students. School climate, which implies positive relationship between teachers and students, was

powerful significant factor ($\beta=.21$). Finding about classroom climate ($\beta=.15$) is in line with school climate. Findings indicate a flow line: If teachers have positive attitudes about students and as a result students feel that it then would reflect on interaction between teachers and students. In this interaction pupils' behaviours are the key point. It is interesting that disciplinary atmosphere positively affect students' learning in classroom. Positive interaction finally affects TPW. A number of quantitative correlation studies have found that pupil behaviour affect aspects of teacher well being (Aelterman et al. 2007; Bricheno et al. 2009; Stockard and Lehman 2004; Van Horn et al. 2001).

The study found that general ability of students has no serious effect ($\beta=.02$) on TPW. At first sight, it seems contradiction with classroom climate. Because its' connection with positive learning atmosphere and achievement level in classroom can be expected to affect TPW. Further analysis showed that its' power is dissolved in classroom climate. When it was alone regressed with dependent variable, its explanation power was higher ($\beta=.15$). With the addition of classroom climate its explanation power decreases ($\beta=.07$). Classroom climate seems to absorb much of its power. Other significant factor related with classroom climate was teaching practices ($\beta=.18$) that need a positive learning atmosphere. Student oriented teaching contribute TPW. This finding is also in line with the finding of teachers' belief on teaching that supports the effect of student oriented teaching. When we consider all important factors together it can be inference that the key element is to be student oriented. This result is in accordance with the result reached by Opdenakker and Van Damme (2006) and Chong et al. (2010) but in contrary with the result by Kucuktepe (2007).

Professional development is significant predictor ($\beta=.10$). Together with the cooperation among staff ($\beta=.21$) they represent of teachers' collaborative active learning. Social support and active learning are already incorporated into the model by means of professional development and collaborative learning, as did by Aelterman et al. (2007). The same result was suggested by Karasek's JDC-S model. Although it was criticized by some studies (Griva and Joeekes 2003; Rasku and Kinnunen 2003; Sann 2003) its' main arguments are supported by this study that social support and active learning are significant factors of TPW.

Workload is another controversial issue which was found as not to be powerful predictor of TPW in this study. While it is in contrast with the results of studies by Stockard and Lehman (2004) and Aelterman et al. (2007) but it is consistent with the study by Rasku and Kinnunen (2003). The result, small but negative effect, can be interpreted in the light of Forrester (2000)'s finding which indicated that intensification of workload had resulted in teachers experiencing a sense of inadequacy and personal dissatisfaction with their own performance. But if teachers went voluntarily under heavy workload this can be no harmful effect on the professional well being. Long

hours devoted teaching can give a teacher feeling of mastering.

CONCLUSION

TPW is mainly shaped by the organizational characteristics. The most effective organizational factors are *school climate, assessment and feedback, cooperation among staff* and *classroom climate*. Teachers' professional characteristics (*teaching practices, professional development*) comparatively have important effect on professional well-being. But, individual characteristics have very small effect.

Factors specified in the study might encourage schools to undertake actions to enhance TPW. Initiatives should focus on the school and classroom climate. Schools' managements, inspectorate and teacher training systems should undertake comprehensive action to enhance effective teaching techniques and positive discipline techniques. To construct positive learning environment, teachers should be trained to create a positive relationship with students, whose misbehaviour could be modified by encouraging good communication and using effective classroom management as indicated by Akin and Kocak, (2007). The time spent at school should be more fruitfully used in promoting the meaning of cooperation between colleagues and activities devoted to professional development.

Implications of the study can be categorized under two main dimensions: First one is related with measuring issue and the second is related with practices in school and in classroom. Conceptualization, as in the previous studies (Aelterman et al. 2007; Butt and Retallick 2002; Dries 2010; Horn et al. 2004), is the core measuring issue in this study, too. However, there was no clear definition of the concept in previous studies. Therefore measures of the professional well-being varied study by study. The current study attempted to suggest a clear definition of the concept and its' measures through getting common points of previous studies and testing them on large scale international data. So this study provides a new basement for further studies on teachers' professional well-being. It is expected that it will give enthusiasm to researchers to develop more comprehensive tools to measure TPW.

This study also indicated politically intervention points at school level for better TPW and for pupil's learning. The most important points are "teaching activities in classroom", "school climate" and "inspection and supervision practices". All these areas are also related with each other so intervention on one of them would also affect others. The quality of teaching practices in classroom has effect on TPW. Implications of this result calls upon both pre-service and in-service training efforts. Effective teaching practices can be executed in real environments, video recording of good examples of teaching activities can be publicised among teachers,

visiting other classrooms and schools can provide opportunity to self assessment for teachers in terms of teaching practices. Common objectives for teachers' teams can be put forward in line with school objectives and teachers can be encouraged to produce projects and expert groups that deal with specific issues can be set off. Since the organizational characteristics have more profound effect on teachers' professional well-being managerial bodies, as responsible of designing process in school, should take steps for better conditions. Specifically school climate and supervision/inspection practices mean that school managerial bodies have crucial roles in developing teachers' professional well-being should be more supportive for teachers' professional development instead of following certain rules be carried out. So in selecting and appointing process it must be considered that if an applicant has skill of creating positive school climate. Teachers expect that their efforts for pupils' learning should be noticed and appreciated by managerial bodies.

LIMITATIONS

Methodological features of the current study should be regarded when the results are generalized. Professional well-being as an index was directly entered into analysis. This way is different from previous studies (Aelterman et al. 2007; Griva and Joekes 2003; Munn et al. 1996) in which measures of dependent variable were analysed one by one. But in these studies, some of the predictors, represented by indexes, were taken into analysis. For instance in the study by Griva and Joekes (2003: 460) total job satisfaction is derived by combining the job satisfaction and turnover intention sub-scales.

As indicated by Bricheno et al. (2007), explanation power of factors fluctuated depending on the sample size ($50 < n < 5000$), the function (primary, secondary, subject teacher), the analysis level (teacher, school) and time (one shot or longitudinal). According to Diener et al. (1999) well-being values may change depending on the type of scales used, the order of items, the time-frame of the questions, and current mood at the time of measurement. In the current study TALIS' large scale data belong to 72.190 teachers from 23 countries were used that was assumed to overcome restrictions. But it also limits the generalizing the results since possible differences of each country were hidden in large scale data. Further studies might focus on countries' differences in this context. Being tested on large scale data, theoretical model of the study proposed main factors of TPW. But the model was not able to include some variables that would be important. In order to enhance the explanatory capacity of the model, future studies should include school resources, relationship between teachers and families, type of school, teachers' function and salary/benefits. Tschannen-Moran and Hoy (2001) informs the need for a valid measure that it requires an analysis of

the task in terms of the resources and constraints in particular teaching contexts. Therefore the model requires to be developed. New initiatives can benefit from this study and focus on factors in combining the qualitative and quantitative perspectives. The study was carried out at a teachers level so the results might be different from studies carried out at a school level.

Please note that the study is a secondary research that used the data from TALIS (Teaching and Learning International Survey) which was carried out by OECD (Organization for Economic Cooperation and Development) therefore the manuscript does not require the inclusion of a statement of ethics.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Appendix A.

Descriptions of variables and indices taken into analysis

A. Independent Variables and their codes	Name	Name index
1. Teachers' individual Characteristics		
Gender btg01	Variable	GENDER ₁
Experience btg09	Variable	EXPERIENCE ₂
Employment status btg06	Variable	EMPLOYMENT ₃
Education level btg07	Variable	EDUCATION ₄
2. Teachers' professional characteristics		
Participation into the professional dev.activities (btg11a ₂ + btg11b ₂ ...+ index btg11g ₂)/7	profdev ₁	
Days attending to the prof.dev.activities btg12	variable profdev ₂	index PROFDEVL ₅
Reading professional literature (btg17a1)	Variable profdev ₃	
Informal dialogue with colleagues (btg17b1)	Variable profdev ₄	
Constructivist teaching beliefs (btg29d+ btg29f+ btg29i+ btg29l)	fac1_4 teach ₁	index BELIEF ₆
Direct transmission teaching beliefs (btg29a+ btg29g+ btg29h+ btg29k)	fac1_5 teach ₂	
Structuring teaching practices (btg42b+btg42h+btg42c+btg42i+btg42m)	fac1_6 teach ₃	index PRACTICES ₇
Student oriented teaching practices (btg42d+btg42n+btg42l+btg42f)	fac1_7 teach ₄	
3. Teachers' organizational characteristics		
Frequency of taking appraisal or feedback (btg21a+ btg21b+ btg21c)	fac1_1 assess ₁	
Implications of the appraisal or feedback (btg23e+ btg23f+ btg23g)	fac1_2 assess ₂	
Results of the appraisal or feedback (btg24a+... btg24h)	fac1_3 assess ₃	index APPRAISAL ₈
Assessment was fair and helpful (btg26a+ btg26b)	index assess ₄	
The effect of assessment on job satisfaction (btg27a)	variable assess ₅	
Cooperation among staff (btg30d+...+btg30l)/9		index COOPERAT ₉
Classroom climate btg43b-(btg43a+ btg43c+ btg43d)	index cls.clim	index CLSCLIMA ₁₀
School climate (btg31g+ btg31h+ btg31i+ btg31j)	index sch.clim	index SCHCLIMA ₁₁
Managerial styles of principal_instructional (btg32d+ btg32f+ btg32c)/3	Index manage1	index MANAGET ₁₂
Managerial styles of principal_bureaucratic (btg32i+ btg32j)/2	index manage2	
Workload (btg08a+ btg08b+ btg08c+ btg08d)/4	index workload	WORKLOAD ₁₃
B. Dependent variable		
Job satisfaction (btg31a)	variable jobsatis	
Self efficacy (btg31b+ btg31c+ btg31d+ btg31e+btg31f)/5	index selfeffi	index PRFWELLB ₁₄
Aspiration (btg42e+ btg42f+ btg42k)/3	index aspirati	
Motivation (btg28g+ btg28h)/2	index motivati	
Authority (btg30c)	index authorit	

Job satisfaction (1: Strongly disagree-4: Strongly agree):

All in all, I am satisfied with my job (btg31a).

Self-efficacy (1: Strongly disagree-4: Strongly agree):

I feel that I am making a significant educational difference in the lives of my students (btg31b).

If I try really hard, I can make progress with even the most difficult and unmotivated students (btg31c).

I am successful with the students in my class (achievement) (btg31d).

I usually know how to get through to students (trust) (btg31e).

Teachers in this local community are well respected (respect) (btg31f).

Aspiration (1: Never or hardly ever-5: In almost every lesson):

I give different work to the students that have difficulties learning and/or to those who can advance faster (btg42e).

I ask my students to suggest or to help plan classroom activities or topics (btg42f).

I work with individual students (btg42k).

Motivation (1: Strongly disagree-4: Strongly agree):

If I improve the quality of my teaching at this school, I will receive increased monetary or non-monetary rewards (btg28g).

If I am more innovative in my teaching at this school, I will receive increased monetary or non-monetary rewards (btg28h).

Authority (1: Never-6: weekly)

Discuss and decide on the selection of instructional media (e.g. textbooks, exercise books) (btg30c)

Appendix B.

Dummies created for nominal variables

Gender	gender_1	1: Female	0: Male
	exp_1	1: first year	0: other
Total teaching experience	exp_2	1: 1-5 year	0: other
	exp_3	1: 6-15 year	0: other
	exp_4	1: More than 16	0: other
Employment status	emp.st_1	1: Permanent	0: Contractual
Education level	edu.le_1	1: ISCED 5A and 6 (masters and doctorate)	0: other

Full Length Research Paper

Effects of lesson study on science teacher candidates' teaching efficacies

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The aim of this study was to investigate the effects of the lesson study process on science teacher candidates' teaching in terms of lesson plan content, pedagogy and classroom management based on expert, peer and self-evaluations. The participants of this case study consisted of 16 teacher candidates in elementary science education in their fourth year of school. Participants conducted a three-phase lesson presentation, and each phase was observed and commented on by experts, peers and the lecturers. All evaluations indicated positive changes in terms of lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning.

Key words: case study, lesson study, science education, teacher education.

INTRODUCTION

Whether they realize it or not, teachers are key agents of change when it comes to educational reform, particularly with regard to teacher professional development (National Council of Teachers of Mathematics, 1991; Guskey, 2000). According to the literature, the principles of a solid, well-rounded curriculum do not always align with current teaching practices, which has prompted a shift encouraging teachers to take control of their own development in order to be successful (Konting, 1997).

The way a teacher teaches is rooted in his or her knowledge and beliefs (Putnam and Borko, 1997). Shulman (1987) addressed this knowledge base by paying special attention to pedagogical content knowledge, which is used by teacher to guide their actions in a contextualized setting. This setting allows a teacher's interpretations of the subject matter while facilitating student learning (Shulman, 1987; Wilson, Shulman and Richert, 1987).

The better a teacher understands a topic, the more likely she or he will be able to enhance conceptual understanding and guide problem solving, as well as improve student performance (Fennema et al., 1996). While teachers could increase this knowledge base independently, Ball and Cohen (1999) have argued that this knowledge can be increased through a collaborative community of teachers working together to design learning tasks. They suggest that a learning environment should be created in which teachers can discuss and analyze students' learning with each other, which parallels Vygotsky's theory of socio-cultural learning. Lesson study is one such practice that increases knowledge while working with peers. Lesson study began in Japan (Fernandez, 2002) and has been practiced in the US since 1999 (Stigler and Hiebert, 1999). This method of professional development allows teacher to examine their

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practices together (Lewis, Perry and Murata, 2006), as they identify a problem and study using lessons and evaluations established with their colleagues (Fernandez and Yoshida, 2004; Lewis et al., 2006). Teachers incorporate their daily work into their development by exploring and improving their pedagogical content knowledge (Fernandez, 2002; Lewis et al., 2006). Lewis, Perry and Hurd (2009) established a theoretical model for lesson study grounded in case studies. In this model, teachers' knowledge and beliefs, professional community and learning resources are developed by (a) determining long-term goals for student development, (b) studying curricula and standards, (c) adapting standards to classroom needs, (d) creating lessons that define a teacher's role and anticipates student thinking, (e) collecting data related to student activities and (f) discussing results with peers to assess goal achievement. Cumulatively, these components cover four stages: investigation, planning, research and reflection.

Literature has shown that science classrooms are one of many areas that can benefit from the lesson study approach, both for teachers and teacher candidates. Lewis and Tsuchida (1998) have explained that lesson study transcends simply improving classroom practices; it encourages teachers to link activities to broader educational goals, as they explore a variety of curricula and perspectives. Lesson study can also improve content knowledge, classroom management and teaching technique. In Japan, educators believe lesson study can even influence educational policy (Lewis and Tsuchida, 1998). Above all, lesson study guides teachers to address what students are doing and thinking during class. While an experienced teacher may be able to predict student responses and adjust teaching to fit, a new teacher may not be prepared to handle unexpected insight, unanticipated misconceptions, or even common errors. Lesson study allows new teachers to consult with veterans about both usual and atypical student responses before facilitating a lesson in the classroom.

Moreover, collaborative discussion of lesson plans and student work can increase content knowledge and the ability to see from another's perspective (Chazan, Ben-Chaim and Gormas, 1998; Jacobs, Franke, Carpenter, Levi and Battey, 2007; Sherin, 2002; Warfield, Wood and Lehman, 2005). More specifically, Dotger (2011) conducted a study in science education graduate students that demonstrated its value in improving discussions and learning about earth sciences. Rearden, Taylor and Hopkins (2005) also found that lesson study led to a greater awareness of relationships between mathematics and science. Maguire, Myerowitz and Sampson (2010) applied lesson study to studying osmosis and diffusion in cells, finding evidence that it improved effective teaching and debunked misconceptions regarding the content.

In addition, lesson study can lead to positive changes by including more hands-on experiments or in-dept discussion, both of which affect student learning (Saito, Harun, Kuboki and Tachibana, 2006). Saito, Hawe,

Hadiprawiroc and Empedhe (2008) found that faculty members who used lesson study transformed their teaching styles from didactic to collaborative, but support was the key in maintaining lesson study as a daily teaching and learning practice. Cerbin and Kopp (2006) further proposed a model of lesson study in the college classroom to investigate how teachers can use it to improve teaching practices.

Drawing from the above literature with a focus on lesson study, the current research aimed to investigate changes in science teacher candidates' teaching processes in terms of content of lesson plans, pedagogy and classroom management based on expert, peer and self evaluations.

METHODOLOGY OF RESEARCH

The methodology adopted was case study, in which a researcher can examine a single setting, subject, depository of documents, or specific event (Meriam, 1988; Stake, 1994). The case being examined was an investigation of the effects of lesson study on teacher candidates' teaching processes.

Sample of Research

The participants of the study consisted of 16 elementary science education teacher candidates in their fourth year at university. All students voluntarily participated in the study. Demographics were collected through a questionnaire developed by the researcher and checked by an expert before administration. According to the results, ages ranged from 21 to 23 with an average of 21.6. Twelve participants were female, while 4 were male. The average grade point (GPA) was 3.07 (4.0 scale). All participants had teaching experience of four hours a week in an elementary school during their third years of college. In general, their experience with science education was limited to the college course Methods of Teaching Sciences; activities in this course mostly consisted of learning and discussing the science teaching program and individual lesson presentations..

Instrument

Four instruments were used to collect data in the current study. First, a demographics questionnaire asked about teacher candidates' age, gender, GPA, teaching experiences (if any), science education activities and coursework. The second instrument was the teaching practices, Skills, and reported satisfaction with performance rubric developed by Marble (2007). This rubric includes four relationship domains: lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. Next, a lesson observation form was developed by the researcher and checked by an external expert. The form included three open-ended questions for teacher candidates who observed lesson presentations:

1. What are your comments about the lesson plan?
2. What are your comments and recommendations about lesson presentation?
3. What are your comments and thoughts about evidences regarding students' learning?

The final instrument was a single question, open-ended survey developed by the researchers and checked by an external expert. It

Table 1. Lesson study procedures

Steps	Duration
Collaboratively planning the lesson plan	3 weeks
Seeing the lesson plan in action	1 week
Discussing the lesson plan	1 week
Revising the lesson plan	1 week
Teaching the second version of the lesson	2 weeks
Sharing reflections about the second version of the lesson	1 week
Teaching in a real classroom	4 weeks
Sharing reflections about the third version of the lesson	1 week

stated, "Please evaluate your own teaching in terms of lesson plan design, your content knowledge, and your pedagogical knowledge."

Procedures

Lewis (2002) described five characteristics of lesson study necessary for success: (a) lessons are planned collaboratively over a period of time, (b) taught lessons are observed by other teachers, (c) lessons intend to bring to life a particular goal or vision of learning, (d) lessons are recorded, and (e) lessons are discussed and shared with others. Consequently, the current study was designed with eight steps (see Table 1).

Step 1: Collaboratively planning the lesson plan. The participants formed their own lesson study (LS) groups of four, making four total groups. Each group chose a topic in Biology from the official elementary science and technology teaching program (MoNE, 2005). Next, each group collaboratively planned a 40-minute lesson for teaching the chosen topic through the 5E learning cycle. Finally, each group planned a schedule for subsequent meetings to complete their lesson plan and activity sheets.

Step 2: Seeing the lesson plan in action. During the fourth and fifth weeks, one participant from each group taught the 40-minute lesson to peers in the teaching room while being observed by experts and remaining group members.

Step 3: Discussing the lesson plan. Following each lesson, peers and three experts provided comments and suggestions to improve the lesson plan, activity sheets and teaching technique.

Step 4: Revising the lesson plan. After discussion, the groups planned a schedule for subsequent meetings to revise their lesson plan and activity sheets based on comments and suggestions.

Step 5: Teaching the second version of the lesson. During weeks 7 and 8, the same participant from each group taught the second version of the lesson. The lesson was observed alongside the revised lesson plan and activity sheets. After the lesson, further comments and suggestions were made.

Step 6: Sharing reflections about the second version of the lesson. During week 9, the groups met to revise their lesson plans and activity sheets for a second time based on feedback before real classroom application.

Step 7: Teaching in a real classroom. During weeks 10 to 13, the same participant from each group taught the third version of the lesson in a real classroom environment. The lesson was recorded by a designated partner and evaluated by the experts and other group members. After the lesson, the peers and researcher provided additional feedback.

Step 8: Sharing reflections about the third version of the lesson. During week 14, the groups met to revise their lesson plans and activity sheets for the final time.

Data Analysis

During each cycle of lesson planning, three experts from the field of science education observed student teachings and work through data collected from the instruments. All experts held doctoral degrees, had publications in the related field, and had teaching experience. The data from the open-ended question were evaluated by the experts through content analysis, while the data obtained from teaching practices, skills and reported satisfaction via the performance rubric were analyzed by means of descriptive statistics.

RESULTS OF RESEARCH

Lectures prepared and led by the teacher candidates were evaluated by experts, peers and the candidates themselves. Results will be presented under related sub-headings.

Expert Evaluation

Table 2 presents the results obtained through the analysis of the satisfaction scale scores (grades by experts) of the groups. The presentation of the Musculoskeletal System group was found to be partly adequate in the first lecture and adequate in the second in terms of creating an integrated science lesson plan connected to the standards and of developing detailed, explicit, and focused lesson plans. On the other hand, the dimensions of providing clear instructions and handouts and managing lesson pacing and transitions were found to be adequate in both lectures; there was a slight improvement from the first lecture to the second. Both lectures were partly adequate in terms of effectively manipulating materials to create a positive learning environment. The lectures were assessed according to the following three dimensions in terms of engaging students in deliberately meaningful content: using effective questioning strategies, providing opportunities for collecting and analyzing data, and structuring discussions to support meaning making. Despite improvement in the second lecture, the teacher candidate improvement in the second lecture, the teacher candidate was only found to be partially adequate in

Table 2. Experts' Evaluations of the Lectures

		Musculoskeletal System		Germ Warfare		Respiratory System		Circulatory System	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Lesson Plan and Design	Creating integrated science lesson plans connected to standards	1.33	2.00	1.33	1.67	0.00	1.33	0.67	2.00
	Developing detailed, explicit, and focused lesson plans	1.33	1.67	0.67	1.67	0.00	1.33	0.67	1.67
Creating a Positive Learning Environment	Providing clear instructions and handouts	1.67	2.00	0.33	1.67	1.00	1.33	0.67	1.67
	Managing lesson pacing and transitions	1.67	2.00	0.67	1.67	0.33	0.67	0.00	1.67
	Effectively manipulating materials	1.00	1.33	0.67	1.33	0.67	1.67	0.00	1.33
Engaging Students in Deliberately Meaningful Content	Using effective questioning strategies	0.67	1.00	0.00	1.33	0.00	1.00	0.00	1.67
	Providing students opportunities to collect and analyze data	0.67	1.33	0.00	1.00	0.00	1.00	0.00	1.00
	Structuring discussions to support meaning making	1.00	1.33	0.00	0.67	0.00	0.67	0.00	2.00
Assessing Student Learning	Creating opportunities for students to demonstrate their understandings	1.00	1.67	0.67	1.67	1.00	1.00	0.00	2.00
	Using student data to assess overall success of instruction	0.67	1.00	0.00	1.33	1.00	1.00	0.00	1.00

Note. 0.00 – 0.66 = Inadequate; 0.67 – 1.33 = Partially Adequate; 1.34 – 2.00 = Adequate

these dimensions. Finally, while the dimension of using student data to measure overall success of instruction was detected to be partly adequate in both lectures, the dimension of creating opportunities for students to demonstrate understanding was only partially adequate in the first lecture but adequate in the second.

The next group covered Germ Warfare from the Systems in Our Body unit. While the dimension of creating integrated science lesson plans connected to standards and developing detailed, explicit and focused lesson plans was found to be partly adequate in the first lecture, it was adequate in the second. Among the sub-dimensions of creating a positive learning environment, providing clear instructions and handouts was found to be inadequate during the first session and adequate during the second. Similarly, managing lesson pacing and transitions improved from partially adequate to adequate across the two presentations. On the other hand, effectively manipulating materials was partially adequate during both. The group was found to be inadequate in the first lecture in terms of using effective questioning strategies, providing students opportunities for collecting and analyzing data, and structuring discussions to support meaning making. Criticism tied to this assessment included, "(Students) should check whether answers are correct or not by themselves," and "Students were not allowed to make an analysis." The second lectures were

partially adequate in terms of the same dimensions. As seen in Table 2, the dimension of assessing student learning was evaluated in two sub-dimensions: (a) creating opportunities for students to demonstrate their understanding and (b) using student data to assess overall success of instruction. For the former, the first lecture was partly adequate and the second lecture was adequate; the latter improved from inadequate during the first teaching to partially adequate during the second.

An analysis was conducted on the satisfaction scale administered for the group lecturing on the Respiratory System within the Systems in Our Body unit. Here, the dimensions of lesson plan and design were determined to be inadequate in the first lecture, based on comments such as, "There was nothing about the acquisition of cognitive process skills," and "It says 'acquisition is to be designed,' but it has already been designed." In the second lecture, these dimensions were partly adequate. The dimension of providing clear instructions and handouts was found to be partly adequate in both lectures. The dimension of managing lesson pacing and transitions was determined to be inadequate in the first lecture but partially adequate in the second. One observer explained, "It was not compatible with the plan. It was the digital story which was used first." The first lecture was partially adequate in terms of creating a positive learning environment in the dimension of

Table 3. Peer Evaluation of the Lectures

	Germ Warfare		Respiratory System		Musculoskeletal System		Circulatory System	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Creating integrated science lesson plans connected to standards	1.14	2	0.5	1.75	1.83	2	1.6	2
Student-Centered Instruction	0.4	1.3	0.9	1	1.44	2	0	1.18
Engage	1.25	2	0.8	1.5	1.66	2	2	2
Exploration	1	1.3	1.2	1.5	1.6	1.5	1.5	2
Being in line with the learning method								
Explanation	2	2	1	2	1.6	2	1	1
Elaboration	1	2	1	1	2	2	1	1
Evaluation	1	2	1	1	1.4	1.5	1	1
Material Adaptation								
Effectively manipulating materials	1	2	1.25	1.25	1.85	2	1.6	2
Its alignment with the content	1	2	-	1	1.75	1.5	1	1
Teaching efficiency								
Content knowledge	1	2	0	1	1.5	2	1	2
Pedagogical knowledge	1.8	1.8	1.3	1.4	1.71	2	1.4	2
Using student data to assess overall success of instruction								
Student examples	-	-	-	-	2	2	-	2
Students' responses to the questions	2	2	-	1	2	2	-	1.5
Students' participation	2	2	1.25	2	-	1.6	-	1.5

Note. 0.00 – 0.66 = Inadequate; 0.67 – 1.33 = Partially Adequate; 1.34 – 2.00 = Adequate

effectively manipulating materials, as explained by the comment, “It might have been so, if the same material had been provided for all students, but it was not.” The second lecture was detected to be adequate in terms of creating a positive learning environment. While the dimensions of using effective questioning strategies, providing students opportunities for collecting and analyzing data, and structuring discussions to support meaning making were inadequate in the first lecture, they were partly adequate in the second. Finally, both sub-dimensions of assessing student learning were found to be partly adequate in both lectures.

The third group lectured on the circulatory system as covered in the systems in our body unit. The first lecture was determined to be partly adequate in terms of creating integrated science lesson plans connected to standards and developing detailed, explicit and focused lesson plans, but the second lecture was adequate. The dimension providing clear instructions and handouts was found to be partly adequate in the first lecture but adequate in the second. While the dimensions of managing lesson pacing and transitions, using effective questioning strategies, effectively manipulating materials, and providing

students opportunities for collecting and analyzing data were determined to be inadequate in the first lecture, the first two of these dimensions were adequate in the second, while the others were partially adequate. The dimensions of structuring discussions to support meaning making and creating opportunities for students to demonstrate their understanding were found to be inadequate in the first lecture but determined adequate in the second. The dimension of using student data to measure overall success of instruction in terms of assessing student learning was detected to be inadequate in the first lecture but partly adequate in the second.

Peer Evaluations

When reviewing peer evaluations, the first and second lectures of each group were analyzed within themselves and tabulated (Table 3).

The first lecture on Germ Warfare was found to be partly adequate in terms of the dimension of creating integrated science lesson plans connected to standards. Student statements support this finding, such as, “Some

of the concepts indicated in acquisitions were conveyed wrongly,” and “Since microbes could not be seen with eye, video method was a good choice, but not enough for acquisition.” The dimension of creating integrated science lesson plans connected to standards became adequate in the second lecture. As one observer indicated, “Content was lectured in such a way that students could understand it.” While the subject of the respiratory system was considered inadequate in the first lecture in terms of creating integrated science lesson plans connected to standards, it was found to be adequate in the second lecture. The statement, “The subject was independent from the acquisition. It could have been better if the lecturer had taken the acquisition as basis more” is an example supporting the inadequacy of the first lecture, while the statement, “Content contained few information deficiencies,” supports the partial adequacy of the second lecture. On the other hand, both the Musculoskeletal System and Circulatory System lessons were determined to be adequate in terms of the dimension of creating integrated science lesson plans connected to standards in both lectures. The statement, “Lesson plan was implemented fluently in accordance with the subject” supports these findings about the musculoskeletal system, while the statement, “It was an acquisition-oriented presentation, but there was information deficiency” which indicates the findings about the circulatory system. In addition, the comment, “Lesson contained fine arrangements in accordance with 5E model.” was made about the second circulatory System lecture, demonstrating its adequacy.

The first lectures on Germ Warfare and the Circulatory System were found to be inadequate in terms of student-centered teaching. As an observer noted, “I think the active participation of students in lesson may provide better conditions.” Further comments are more explicit: “The lecture appeared to be teacher-centered to me somewhat,” “Teacher was in the forefront,” and “Students could have been more active.” However, with regard to the second lectures, an observer stated, “The lecture was teacher-centered in the beginning, but then it became student-centered towards the end.” In this dimension, both second lectures on the musculoskeletal system and respiratory system showed a slight improvement. The comment, “Lesson was made student-centered, which prevented students from getting bored and made the learning process entertaining,” supports this finding.

Another dimension of evaluation was compatibility with the phases of the teaching model used in the presentation. The first phase, or the engage phase, of the first lectures on germ warfare and the respiratory system were considered partly adequate. Regarding germ warfare, one observer stated that the “engage phase appeared to be deficient somewhat.” The second lectures were deemed adequate in terms of the engage phase. The comment, “Engage phase was interesting, but the digital story used was not good enough,” supports this finding.

The engage phase was deemed adequate in both lectures on the circulatory system and musculoskeletal system, which is supported by two statements about the first lecture: “Attention getting was fine in the engage phase,” and “The mind map used in the beginning was nice.” The comment, “It was good that foreknowledge was tested in the beginning,” indicates the above-mentioned finding about the second lecture.

The explore phase was determined to be partly adequate in the first lecture on the subjects of germ warfare and the respiratory system, while it was deemed as partially adequate and adequate, respectively, during the second lectures. The comment, “However, I think more effortful activities should be arranged for the explore phase,” is evidence of the above-mentioned finding for the respiratory system. A supporting comment for the second lecture on germ warfare is as follows: “I think it could have been more effective if some activities had been carried out or students had been used in the explore phase.” On the other hand, both lectures on the circulatory system and musculoskeletal system were found adequate. One observer stated, “It was good that students saw the heart in the explore phase.”

The explain phase was considered adequate in both lectures on germ warfare and the musculoskeletal system. One supporting statement is as follows: “I think the balloon experiment conducted and the game played in the explore phase achieved the goal.” While the first lecture on the subject of the Respiratory System was deemed partly adequate, the second lecture was adequate. The explain phase remained partially adequate in both lectures on the subject of the Circulatory System.

The elaborate phase was found partly adequate in the first lecture on germ warfare, but it was detected to be adequate in the second lecture. Some supporting statements in this matter are as follows: “The examples and the analogy table provided were fine,” and “The digital stories and videos used during lecture were effective for understanding the subject.” On the other hand, that phase was determined to be partly adequate in both lectures on the Respiratory System and Circulatory System. That phase was found to be adequate in both lectures on the subject of the Musculoskeletal System. Some supporting comments for this dimension are as follows: “The examples provided in the elaborate phase were fine,” and “The example given by Hediye about calcification suffered by her grandfather through digital narration provided in the elaborate phase shows that we can face such a problem in our real lives, too.”

The evaluate phase was found to be partly adequate in both lectures on the Respiratory System and Circulatory System. Similar comments were made in this matter. Some examples are, “Evaluate phase could have been extended more,” and “Evaluate phase was deficient.” The comment, “Evaluation ended with question-answer and mind map. Some other things could have been included,” further supports the above-mentioned finding for the

Table 4. Self-Evaluation of the Lecturers for Their Own Teachings

	Germ Warfare			Respiratory System			Circulatory System			Musculoskeletal System		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Creating integrated lesson plans connected to standards	1	2	3		2	3		1		3	3	2
Student-centered instruction					2	3	1	2	2	1	2	1
Engage	1	2	3				2	2	3	2	2	3
Exploration	1	2	3				2	2	3	2	3	3
Being in line with the learning method										2	3	2
Explanation	2	3	3							2	3	2
Elaboration	2	3	3				1	2	3	2	2	2
Evaluation	2	3	3				1	2	3	3	3	3
Overall	1	2	3	1	2	3	1	2	3	1	2	
Teaching efficiency												
Content knowledge				1	1	2				3	3	3
Pedagogical knowledge				1	2	3		2		3	3	2

Note. 1 = inadequate, 2 = partially adequate, 3 = adequate

second lecture on the circulatory system. Both lectures of the musculoskeletal system group were determined adequate. On the other hand, the first lecture for germ warfare was considered partly adequate, while the second was found to be adequate.

While the dimension of effectively manipulating materials was deemed partly adequate in the first lecture on germ warfare, it was determined to be adequate in the second lecture. The same dimension was found to be partly adequate in both lectures on the respiratory system, while it was graded as adequate for the circulatory system and musculoskeletal system groups. The comment, "More materials could have been used to ensure learning," was put forward for the first lecture on the circulatory system, referring to its partial adequacy. "It was good that the heart was brought as a real material," and "Interrelated visual materials provided during the presentation were fine," support the adequacy of the second lecture.

The presentations that were inadequate in terms of content knowledge in the first lectures were partly adequate in the second lectures. In addition, those presentations which were partly adequate in terms of content knowledge in the first lectures were adequate in the second lectures. The comments, "Teacher had imperfect topic knowledge," and "Presentation was good, but teacher did not have much content knowledge" were made for the first lecture on the Circulatory System, while another observer indicated, "I do not think teacher provided imperfect information" for the second lecture on the same subject.

The dimension of pedagogical knowledge was mostly deemed adequate in the first lectures in a way similar to

other dimensions; it became adequate for all groups in the second lectures. A similar tendency was evident in the dimensions of using student data to assess overall success of instruction. Two comments support this finding for germ warfare's first lecture: "Presentation was fine. Teacher had some difficulty in summing up the subject because of excitement," and "Lecturer had some deficiencies because of excitement. The lecturer adjusted his tone of voice perfectly, which enabled him to make a good presentation." About the second lecture, the comment was made, "Teacher had a good command of the lesson during the presentation." The statements, "Students gave unique answers," and "Students dealt with their worksheets by themselves" are indicators of learning from the second lecture on germ warfare.

Self-Evaluations

Table 4 presents the self-evaluation scores of the lecturers. The evaluations made by the lecturer on germ warfare show his opinion that the first lecture did not reflect the 5E model exactly. However, he made the following comment about the second lecture: "I think I reflected the acquisition onto 5E model well."

The lecturer indicated the inadequacy of the engage phase of the first lecture by saying, "The questions asked in the beginning did not cover the entire subject," and "The pictures showed to students contained naming likely to cause misconception." The lecturer felt that these deficiencies were later eliminated: "We corrected them, removed wrong misnaming, and prepared new questions for the second lecture." On the other hand, the lecturer

found himself inadequate in terms of the explore phase of the model. However, he said that all these issues were resolved during the third, internship lecture. The lecturer further stated that the digital story that was considered inadequate in the explain phase of the first lecture was improved in the second lecture. They used video in the elaborate phase during the first lecture but not the second: "In the first lecture, we presented students a video about cleaning materials and hand cleaning for elaborating purposes. However, in the second lecture, the video was replaced by analogy." The lecturer stated that the first lecture was partly adequate, but the second and the third lectures were adequate in terms of evaluation.

The evaluations made by the lecturer on the respiratory system show his opinion that he was inadequate in almost all dimensions in the first lecture. He attributed this rating to the fact that he had not prepared for the lesson sufficiently and that he had experienced some communication gaps with his group. According to the lecturer, there were mistakes in terms of acquisitions, and he had insufficient content knowledge. During the lecture at school, the only problem was about timing, which resulted from communication problems with the teacher. He made the following comment: "I think the lecture at school was better than others."

The student who covered the circulatory system stated that motivation was generated in the engage phase in the first lecture, and he considered this stage partly adequate. The second lecture was also scored as partly adequate because he got excited in the beginning. In brief, the lecturer felt that he had some deficiencies in the phases of learning model in the first two lectures. Otherwise, he explained that he learned how to use time effectively and manage a classroom during the real lecture. He mentioned that students were not active in the first lecture, so an attempt was made to make them more so in others.

The student who lectured on the musculoskeletal system thought that he was adequate in terms of assessment and compatibility with the plan in the first lecture, but he was only partly adequate during the third lecture. During the final lecture, he considered his presentation adequate in terms of many phases; however, he found the lecture partly adequate in the elaborate phase. He attributes the reason to the deficiencies in the digital stories used. The lecturing student indicated that he had some problems during the lecture at school: activities took longer than planned, students sitting in the rear of the classroom could not actively participate, and there was an inconvenience about time management. Some comments of the lecturing student in this matter are as follows: "Students were not able to complete the activity in a short time. I noticed that some students had difficulty. I tried not to ignore the wrong answers given by students to the questions, so I explained the true information to them, which took quite a long time," and "I failed to activate those students who were sitting in the rear section of the

classroom during the lesson."

DISCUSSION AND CONCLUSIONS

The aim of this study was to investigate the effect of the lesson study process on science teacher candidates' teaching in terms of the content of the lesson plan, pedagogical aspects, and classroom management based on the expert, peer, and self-evaluations. The results obtained through this study were limited by the data coming from the 16 teaching candidates and the data collection tools.

Among the results of the study was that the experts' evaluations indicated a positive change in teacher candidates' teaching in terms of lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. Similarly, Marble (2007), who conducted a lesson study model with science teachers, also showed dramatic improvements in lesson design and delivery, management of the learning environment, quality of students' engagements with meaningful content, quality of assessments, and generation of student data. Although it was not evident in this study, Chiew and Lim (2003) also indicated that LS improved the teacher candidates' content knowledge besides their pedagogical content knowledge.

Moreover, peer evaluations of the teacher candidates also indicated improvement in terms of lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. These results were not unexpected, since the literature provides examples showing that lesson study improves the content of lessons and develops teaching skills (Alvine, Judson, Schein and Yoshida, 2007). According to Dotger (2011), among the benefits of the LS approach, the greatest was the regular forum LS provided for teacher candidates to explore their ideas about teaching by defining a context for practice and constructing a structure for new discourse. Lesson study also increases teachers' experience levels by allowing them to learn from the experience of others, which, in turn, improves the content of the lessons.

Finally, the results of the current study highlighted that the teacher candidates own evaluations of their teaching implied improvement in lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. Being in line with the current results, Fernandez and Robinson (2006) found that LS approach helped the prospective teachers to value the opportunity to apply in practice what they were learning in theory. Moreover, peer feedbacks allowed them to think differently about teaching after engaging in LS. Similarly, in a study conducted with mathematics and science teachers, Ono and Ferreira (2010) revealed that the teachers who were involved in lesson study benefited from the approach and

improved their lessons. Moreover, Saito et al. (2006) revealed that the lesson study process improved the academic base of lessons and affected the structure positively by the introduction of experiments or manual activities and discussions.

The results obtained from this study will be beneficial for educational policy makers to consider implementation of the lesson study approach by means of seminars and in-service education applications. Moreover, integrating the lesson study process inside teacher education programs will also contribute to preparing future teachers. Further studies investigating the implementation of the lesson study approach in different education levels and areas of expertise will reinforce the results of the current study. In conclusion, an acknowledgement occurs about limitations in making any generalizations from the results of the current study which was designed as case study and included a limited number of participants who contributed through self-report questionnaires.

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Full Length Research Paper

The Perceptions Of Pre-Service Science Teachers' About Using Vee Diagrams And Electronic Portfolios In Physics Laboratory Course

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The purpose of this study was to identify the perceptions of pre-service science teachers about using vee diagrams and preparing electronic portfolios in physics laboratory course. 103 first grade pre-service science teachers who took general physics laboratory course were the participants of the study. Pre-service teachers constructed vee diagrams for presenting their experiment reports and prepared electronic portfolios about whole laboratory process. This research was based on case study design. Electronic portfolio composed of foreword, diaries and epilogue parts, open-ended questionnaire and semi-structured interviews composed of open-ended questions and holistic rubric prepared for grading vee diagrams of pre-service teachers were used as data sources. 12 pre-service teachers were selected purposefully by considering academic success and voluntariness for semi-structured interviews and document analyses of e-portfolios. Both descriptive and content analyses were used for analyzing data. The results show that pre-service teachers perceived that electronic portfolios and vee diagrams developed science process, metacognitive and social skills and identifying and preventing misconceptions.

Key words: Electronic portfolio, vee diagram, pre-service science teaching.

INTRODUCTION

The philosophy of progressivism and student-centered program approach has become dominant in educational environment at the beginning of the 1990s. This philosophy expects from learners and teachers permanent skills rather than having and transferring knowledge. Science is one of the most important course that provides instructional methodologies and principles for learners to gain scientific literacy, science process skills. Learners can transfer knowledge practically into daily life situations

by the help of these skills Kaptan (1999). Laboratory undertakes the roles of using science process skills and carrying the principles and events of the nature into learning and teaching environments and also fills the gap of the application part of science. Effective instructional designs of laboratory can be done by well-educated science teachers. Pre-service science education has an important role for providing well-designed laboratory courses to pre-service science teachers.

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Operational definitions, visualization, process-based skills and assessments are important terms in laboratory courses. Operational definition defines something (examples. a variable, term, or object) in terms of the operations which are derived from science process and higher order thinking skills or set of validation tests used to determine its presence and quantity. That is, one defines something in terms of the operations that count as measuring it. The term was coined by Percy Williams Bridgman and is a part of the process of operationalization. An example of an operational definition might be defining the weight of an object in terms of the numbers that appear when that object is placed on a weighing scale. The weight then, is whatever results from following *the (weight) measurement procedure*, which should be repeatable by anyone. An operational definition is generally designed to model a theoretical definition. This definition type covers explanations using observable and measurable experiments Emereole (2009). The operational definition is a process for identification of an object by distinguishing it from its background of empirical experience. Application cannot be done without having a theory grounded on strong fundamentals. Concepts are the building blocks of learning. Providing effective skills for using concepts can be done by more visualized and systematic approaches. Concept maps are one of them. A concept map is a visual organizer that can enrich students' understanding of a new concept. Learners think about the concept in several ways by using graphic organizers. Most concept map organizers engage learners in answering questions such as, "What is it? What is it like? What are some examples?" Concept maps deepen understanding and comprehension (Novak, 1998). Concepts maps can be used in every part of the lesson plan and at every level.

Vee diagrams are less structured and systematic than traditional instructional methodologies. A Vee diagram consists of a V-shape separating theoretical part from the practical part of learning. Both sides actively interact with each other through the use of the focus questions that directly relates to concepts and objectives Alvarez et al. (2007). The structure of the vee diagram with its various labels and guide questions provide a systematic manual for students to make reasoning from the problem context in terms of using scientific methodology steps such as indicating hypotheses and variables, conducting experiments Afamasaga-Fuata'i (2014).

A literature review revealed that science education commonly uses vee diagrams, which are effective for review of the literature shows that vee diagram is used commonly in science education and effective for learning and teaching the operational definitions of concepts and recognizing misconceptions Nakiboğlu et al. (2000), Roth et al. (1993) Vee diagrams are preferred to be used for preparing laboratory experiment reports, making a

bridge between theory and practice and providing analytical view, visual and meaningful learning environments for learners (Keleş and Özsoy (2009), Nakiboğlu et al. (2005), Yakişan et al. (2005), Nakiboğlu et al. (2001), Novak (1998), Lebowitz (1998), Novak (1990), Novak et al. (1984). Vee diagrams are useful instructional tools for developing and using learners' reflective, heuristic reading and writing skills and internalizing knowledge about history of science Kamisah Wahidin et al. (2013), Kragten et al. (2013), Chamizo (2012), Nussbaum (2008).

Vee diagram is an instructional methodology and learning material that can be used in every part of the class and at any level of cognitive learning. It is proper for using laboratory classes especially during the preparation process of experiment reports. It is visualized, making concepts more operational and concrete Yakişan et al. (2005) Because vee diagrams provide to find out misconceptions and construct meaningful learning environments, it is important to use in science education for making connections between theory and practice. Effective concept education can be done with concept maps and vee diagrams. Effective implementation of vee diagrams can be done by well-educated science teachers is the starting point of this research study The research questions of this research study were listed as follows;

- 1) What kind of skills of pre-service science teachers are developed by the help of using vee diagrams in general physics laboratory course?
- 2) What are the perceptions of pre-service science teachers about using vee diagrams and electronic portfolios in general Physics Laboratory course?
- 3) What are the future expectations and suggestions of pre-service science teachers about using vee diagrams and electronic portfolios in science education?

MATERIALS AND METHODS

Method of the Study

This was a case study design which covered qualitative methodologies and techniques. Case study is a descriptive, exploratory or explanatory analysis of a specific person, group or event supported with qualitative data collection methodologies and analyzing techniques Yin (2009). This research case was limited to general physics laboratory course process of first grade pre-service science teachers and focusing on the using vee diagrams and e-portfolios.

Study Group

This study was conducted in 2012 to 2013 fall semester at a public university faculty of Education Department of Science Education with 103 first grade preservice science teachers in General Physics Laboratory course. 47 of the participants (46%) do not have labo-

Table 1. Classification of the Focus Group Participants In Terms of Academic Achievement

Pre-service Teachers Who Participate Focus Group Interview	A	B	C	D	E	F	G	H	I	J	K	L
Previous Semester GPA	42	73	89	82	50	91	90	54	69	94	38	45
Type of Classification Levels	Middle	Low	High	Middle	Low	High	High	Low	Middle	High	Low	Middle

laboratory experience in their elementary and secondary education, 32 of them experienced a laboratory process very limited and 31 of them claimed that they had a chance to make experiments and use laboratory equipments during their chemistry education (not biology or physics education). All of the pre-service teachers do not have a physics laboratory experience and do not know what vee diagram is before the General Physics Laboratory course. Both convenience and purposeful sampling strategies were used for this study in terms of using single case study design. 12 of the 103 pre-service teachers were selected purposefully by considering their academic achievement and willingness (the mean of the previous semester courses gpa). The achievement levels were identified as high level from 85 to 100, middle level from 60 to 85 and low level from 0 to 60 by the researcher. The classification of the pre-service teachers who participated the focus group interviews in terms of academic achievement levels was shown in Table 1.

Because of ethical issues, the name of the pre-service teachers were hidden and coded with letters of the alphabet. The pre-service teachers who participated the focus group interviews were identified equally from totally three classification levels. Four of them (C,F,G,J) were belonging to high level, four of them were belonging to middle level (B,D,I,L) and four of them were belonging to low level in terms of Table 1.

Data Sources

“Open-ended questionnaire about the use of vee diagram and e-portfolios”: Five open-ended questions which were adapted and combined from Keleş and Özsoy (2009) about the general characteristics, using process, advantages, disadvantages, contributions of vee diagrams and e-portfolios. These questions were applied to 103 preservice science teachers who were taking General Physics Laboratory Course. Views of two experts from science education and measurement and evaluation field were taken about linguistic issues and measurement characteristics for providing both content validity and reliability issues.

Focus Group Interview Questions: This interview consists of four open-ended questions which cover the special events during using process of vee diagrams, positive and negative sides of vee diagrams and suggestions for future implications and conducted with totally 12 pre-service teachers. Views of two experts from science education and measurement and evaluation field were taken about linguistic issues and measurement characteristics and one sample interview was done with 3 participants as a pilot study for providing both content validity and reliability.

Pre-service Teachers’ Electronic Portfolios: 12 pre-service science teachers’ laboratory portfolios who participated focus group interviews were analyzed by documentation technique principles. Sample quotations derived from foreword, diaries and epilogue parts were analyzed, interpreted in terms of investigating the themes

of literature about vee diagrams and e-portfolios. These findings were used to support and triangulate the findings of open-ended questionnaire and semi-structure interviews. E-portfolios were coded by two researchers for providing inter-rater validity and correlation coefficient between the correlators were found as 0.95.

Rubrics for Grading Vee Diagrams: This is a kind of graded scoring key which was prepared by the researcher and pre-service teachers during the laboratory process. This is a four level holistic rubric covering the issues of statement of purpose, analyzing and interpretation of data, integrating results with daily life situations. This was used for grading vee diagrams of pre-service teachers related to their experiments as they did in the process. Rubrics were both investigated and graded by two researchers for providing reliability and validity issues. Necessary corrections were made in terms of researchers’ views and correlation coefficient between the inter-raters were found as 0.87.

Procedure

General Physics Laboratory course lasted 14 weeks and three hours per week. The topics of nature and importance of laboratory in science education, science process skills, laboratory security symbols and rules, laboratory placement types, properties and using types of laboratory equipments, laboratory experiment report writing styles (traditional style, vee diagrams) were handled during first seven weeks. Pre-service teachers were divided into six groups and each group consists of approximately five or six people. Groups prepared one experiment related to general physics topics such as investigating the difference between mass and weight, using dynamometer, Newton’s law of motion, acceleration, speed, types of motion, the effect of pressure and sound. Groups firstly identified the focus question and hypotheses indicated them on the center of vee diagram, after than they searched the concepts, principles, laws related to their topic and wrote the operational definitions, principles, generalization and laws on the left side of the vee diagram. Groups wrote the necessary equipments below the center of vee diagram. They wrote the application part of the experiment (procedural steps, analysis results, interpretations, connections with daily life situations) on the right side of the vee diagram. Researcher prepared rubrics for assessing their experiment presentations and vee diagrams. Pre-service teachers prepared electronic portfolios and these portfolios are composed of three parts. They wrote down expectations about the course, themselves and the instructor in the prologue part, they underlined their perceptions and feelings and reflections of the course in diaries’ part and they made a general assessment and stated their contributions and suggestions in the epilogue part.

Data Analysis

Both descriptive and content analyses were used as techniques for

Table 2. Rubrics For Vee Diagrams in General Physics Laboratory Course

Level Criteria	1	2	3	4
Identification of main question and hypotheses	They cannot be defined properly	They are defined without examples and incomplete	Well defined but they are not operational and supporting with proper scientific concepts or principles	Well defined, supporting with scientific concepts and principles
Statement of experimental procedures	It is not understood and defined in a right manner	Not clearly stated	Clearly stated but not supported with proper materials and experimental procedures	Clearly stated supported with proper materials and experimental procedures
Operational definitions of concepts related to vee diagrams	Most of concepts are misunderstood and they are identified from the definitions	There are few misconceptions in the definition of the concepts	They are defined correctly and proper to scientific terminology but they are conceptual not application-based	They are defined based on experimental procedures and applications, they are proper to scientific literacy principles
Collecting and analyzing data	Most of the data collection process steps are skipped	Data collection process is defined but some gaps are skipped	Data collection is defined properly but not supported by visualized materials and techniques	Data collection process is defined in a detailed manner, analyzing process is proper and supported by visualized techniques and graphics
Interpreting results and integrating them into daily life situations	Not able to interpret results with proper terminology	Interpreting some of the results with scientific terminology but there are some gaps	Interpreting results with proper scientific definitions and but not give specific examples and relate them into daily life situations	Interpreting results with proper scientific definitions and give specific examples and relate them into daily life situations

data analysis. Researcher identified themes by reviewing the literature and corresponded to the codes which were obtained from open-ended questionnaire, focus group interviews and portfolios. Frequencies and percentages were calculated for open-ended questionnaire codes. Content analysis was used for analyzing focus group interviews and portfolios. Findings coming from open-ended questionnaire, semi-structured interviews and e-portfolios were triangulated for providing reliable results. Vee diagrams were assessed and coded with the help of the rubrics. The rubrics were also prepared in terms of identifying themes related to literature and by taking pre-service teachers' views. This is kind of a holistic rubric which was graded from 1 to 4 and it is not used only for just comparing the student teachers but also learning their comprehension level and developing their science process skills. The rubrics which the pre-service teachers and instructor were prepared cooperatively is shown in Table 2.

This holistic rubric were graded from 1 to 4. The means of the pre-service teachers were calculated for each section of every experimental report. Rubrics were graded by two instructors who guided general physics laboratory courses before besides the researcher for providing inter-rater validity. The correlation coefficient among the inter-raters were calculated as 0.89.

RESULTS

The first research question is "What kind of skills are

developed by the help of using vee diagrams in the general physics laboratory course?" In terms of finding out the answer of this research question, holistic rubrics of pre-service teachers related to vee diagrams of experiment were calculated for criteria identified by researcher and pre-service teachers. Mean scores of holistic rubric were presented in Table 3.

In terms of Table 3 related to mean score of rubrics criteria themes from report 1 to report 7, the mean score rose from 2.6 to 3.8 in the theme of identification of main question and hypotheses, the mean score rose from 2.2 to 3.5 in the theme of statement of experimental procedures, the mean score rose from 2.9 to 3.6 in the theme of operational definitions of concepts related to vee diagrams, the mean score rose from 2 to 3.8 in the theme of collecting and analyzing data, the mean score rose from 1.6 to 2.6 in the theme of interpreting results and integrating them into daily life situations. This finding showed that science process skills of the pre-service teachers (observation, statement of purpose, operational definition, data collection and analysis, interpretation of data, integration of findings into daily life situations) developed during the application process of vee diagrams.

Table 3. The mean scores of the rubrics related to pre-service teachers' vee diagrams

Criteria	Mean Scores	Vee Diagram 1	Vee Diagram 2	Vee Diagram 3	Vee Diagram 4	Vee Diagram 5	Vee Diagram 6	Vee Diagram 7	Mean Score of Whole Vee Diagrams
Identification of main question and hypotheses		2.6	2.7	3	3	3.2	3.4	3.8	3.1
Statement of experimental procedures		2.2	2.4	3.1	3	3.4	3.6	3.5	3
Operational definitions of concepts related to vee diagrams		2.9	3.2	3.3	3.6	3.5	3.3	3.6	3.3
Collecting and analyzing data		2	2.6	2.9	3.1	3.4	3.5	3.8	3
Interpreting results and integrating them into daily life situations		1.6	1.9	2.2	2.5	2.9	3.2	3.8	2.6
Total Score of Repots		2,3	2.6	2.9	3	3.3	3.4	3.7	3

Supporting the results shown in Table 3, the first question of the open-ended questionnaire "What kind of skills do you think that were developed during the application process of vee diagrams and electronic portfolios?" were asked to 103 pre-service science teachers. The codes coming from the pre-service teachers' answers were listed in Table 4.

The most repeated answer was the analyzing (87 people, 84%). Other codes derived from pre-service teachers' answers were making operational definitions (74 people, 72%), interpreting (43 people, 42%), systematic observing (38 people, 39%), making relations with daily life situations (22 people, 21%), classification (7 people, 7%) related to Table 4. The codes coming from the answers show that vee diagramming provide a systematic point of view of pre-service teachers. This finding was parallel with the findings that were coming from the analyzing process of vee diagrams. In terms of answering the second research question of "What are the perceptions of pre-service teachers about using vee diagrams and electronic portfolios in general physics laboratory course?; open-ended questionnaire were applied and focus group interviews were conducted. Second and third questions of the open-ended questionnaire were asked in terms of answering second research question.

The second question of the questionnaire was "What are the advantages of using vee diagrams and electronic portfolios in laboratory courses? The percentages and

frequencies of the pre-service science teachers related to second question were listed in Table 5.

According to Table 5, the most frequent code was "making experiment reports visualized and meaningful" (79 people, 77%), following codes from most repeated to least were "connecting theory with the practice" (66 people, 64%), making concepts and principles concrete (54 people, 52%), providing systematic view to laboratory (32 people, 31%), following procedural steps easily (19 people, 18%) and easy for grading with rubrics (10 people, 10%). This showed that vee diagrams have contributions to visual modelling, conceptual understanding, application and assessment domains. They indicated the advantages of e-portfolios as "taking the responsibility of our own learning" (26 people, 25%) and "thinking more reflective and critical" (21 people, 20%). E-portfolios provided advantages of reflective and creative thinking processes in terms of constructing diaries, foreword and epilogue parts in terms of pre-service teachers' answers.

The third question of the questionnaire was "What are the disadvantages of using vee diagrams and electronic portfolios in laboratory courses? The percentages and frequencies of the pre-service science teachers related to third question were listed in Table 6.

Pre-service teachers indicated the disadvantages of using vee diagrams were "limited area for explaining concepts and principles" (55 people, 53%), "hard to design in

Table 4. Skills developed by the help of using vee diagrams and electronic portfolios

Codes	Frequency	%
Analyzing	87	84
Making operational definitions	74	72
Interpreting	43	42
Systematic observing	39	38
Making relations with daily life situations	22	21
Classification	7	7

Table 5. Advantages of using vee diagrams in laboratory courses

Codes	Frequency	%
Making experiment reports visualized and meaningful	79	77
Connecting theory with the practice	66	64
Making concepts and principles concrete	54	52
Providing systematic view to laboratory	32	31
Taking the responsibility of our own learning (E-portfolios)	26	25
Thinking more reflective and critical (E-portfolios)	21	20
Following procedural steps easily	19	18
Easy for grading with rubrics	10	10

Table 6. Disadvantages of using vee diagrams in laboratory courses

Codes	Frequency	%
Limited area for explaining concepts and principles	55	53
Hard to design in a computer environment	23	22
Difficult to construct diaries and foreword parts	18	17

a computer environment” and “difficult to construct diaries and foreword parts” (18 people, 17%) in terms of Table 6. These findings could arise because of student teachers’ lack of experience about using vee diagram at any time. The third research question was “What are the future expectations and suggestions of of pre-service science teachers about using vee diagrams and electronic portfolios in science education?” The fourth and fifth questions of the open-ended questionnaire were asked in terms of answering this research question. The fourth question of the questionnaire was “What are the con-tributions of vee diagrams and electronic portfolios into science education?” The percentages and frequencies of the pre-service science teachers related to fourth question were listed in Table 6.

Pre-service teachers emphasized the contributions of vee diagrams into science education from the most to least were “developing science process skills, such as making

operational definitions, analyzing, interpreting” (78 people, 76%), “providing learning environment for using scientific literacy skills” (45 people, 44%), “identifying misconceptions related to critical science concepts such as mass and weight” (28 people, 27%), “observing and assessing skills holistically in a long term period” (22 people, 21%) and promoting meaningful learning (16 people, 16%) in terms of Table 7. Codes coming from the answers indicated that vee diagrams were effective instructional tools which provide benefits for the critical building stones of science education such as meaningful learning, misconceptions, scientific literacy and science process skills. E-portfolios are process-based assessment approaches which provide choices to follow and assess skills in a long term period with frequent and reflective feedbacks.

The fifth question of the questionnaire was “What are your suggestions that can be used to improve using vee

Table 7. Contributions of vee diagrams and electronic portfolios into science education

Codes	Frequency	%
Developing science process skills, such as making operational definitions, analyzing, interpreting	78	76
Providing learning environment for using scientific literacy skills.	45	44
identifying misconceptions related to critical science concepts such as mass and weight	28	27
Observing and assessing skills holistically in a long term period	22	21
Promoting meaningful learning	16	16

Table 8. Suggestions about using vee diagrams and electronic portfolios in science education

Codes	Frequency	%
Using vee diagrams and e-portfolios in the other courses	68	66
Having theoretical information and making practical applications about vee diagrams and electronic portfolios in the content of a specific course	59	57
Having a deep information about preparing vee diagram and portfolio in electronic environment	41	40
Periodical and practical feedback during the preparation of vee diagram and e-portfolios	22	21

diagrams and electronic portfolios in science education? The percentages and frequencies of the pre-service science teachers related to third question were listed in Table 8.

Pre-service teachers indicated the suggestions about using vee diagrams and electronic portfolios in science education from the most to least were, “using vee diagrams and e-portfolios in the other courses” (68 people, 66%), “having theoretical information and making practical applications about vee diagrams and electronic portfolios in the content of a specific course” (59 people, 57%), “having a deep information about preparing vee diagram and portfolio in electronic environment” (41 people, 40%) and “periodical and practical feedback during the preparation of vee diagram and e-portfolios” (22 people, 21%) in terms of Table 8. This finding showed that pre-service science teachers didn't have enough information and have experiences about vee diagrams and e-portfolios, so providing a specific course and periodical feedback with rubrics would be useful for organizing the process. Focus group interview results were parallel with the open-ended questionnaire results. The first question of the semi-structured focus group interview was “How do you feel and what you have learned during the preparation process of vee diagrams and e-portfolios?” The sample quotations from pre-service teachers' answers were listed below;

Pre-Service Teacher B (Middle-level): *“It looks like complicated at first and I don't know how to prepare but when I start to write diaries and organize vee diagrams, I recognize what we have done in lab course and comprehend what we did in the experiments and what we*

wrote practically related to concepts, everything become meaningful for me at the end of the process...”

This participant underlined that e-portfolios provide opportunities about making reflections about the course and vee diagrams give a chance to make connections between the theory and practice of the scientific concepts and principles.

Pre-service Teacher A (Low-level): *“Using rubrics show us where we concentrate on and provide to complete our gaps related to topics in lab course...”*

This answer indicated the importance of identifying criteria with the learners provide a learning environment which learners can take their own responsibilities and fill their incomplete parts.

The second question of the semi-structured interview was “Are there any times that you feel this process (using vee diagrams and e-portfolios) is not useful and necessary in lab course? Have you experienced any difficulties during the preparation process of vee diagrams?” The sample quotations from pre-service teachers' answers were listed below;

Pre-service Teacher C (High-Level): *“Vee diagramming and electronic portfolios are new concepts for us. Most of us don't have laboratory experience. It is difficult to make an adaptation to this process. Teachers gave grades to us and evaluated us but you asked us to identify our criteria about experiment and lab process, it is good but hard for me...”*

This pre-service teacher emphasized the importance of

experience and making practice during the construction processes of vee diagrams and e-portfolios. Preparation of diaries and criteria for rubrics can be done effectively after long-term theoretical and practical learning environments.

Pre-service Teacher D (Middle-Level): *“Cooperation is very problematic because we cannot come together so much after the lab course and we cannot reflect our common views to the vee diagrams. If I have a chance to see more examples related to rubrics and e-portfolios, it will be more useful for me”*

This pre-service teacher told that she and also her classmates needed to have support about constructing cooperative learning environments. She indicated her comments in terms of her construction process of vee diagrams. They made a group work during the preparation of experiments and vee diagrams. Researcher kept away from giving lots of examples because the probability of pre-service teachers' tendency of making imitations but she insisted on emphasizing her inexperience about vee diagramming and preparing e-portfolio and rubrics.

The third question was “What can be done in laboratory environments for improving the application process of e-portfolios and vee diagrams? The quotations coming from student teachers' answers are indicated as follows;

Pre-service Teacher E (Low level): *“If we see this process before, it is easier to organize and manage the process. There should be theoretical and practical sessions about vee diagramming and e-portfolio in a specific course.”*

This pre-service teacher emphasized the need of longitudinal and professional educational environment before application process of e-portfolios and vee diagrams.

Pre-service Teacher F (High Level): *“Computer applications and periodical feedback can be increased during vee diagramming and e-portfolio process in laboratory course, especially identifying criteria and preparing experiment reports, vee diagrams need collaborative environment...”*

This pre-service teacher indicated that process-based assessment methodologies need frequent feedback and practical applications. Student teachers emphasized the importance of experience in this process. The fourth question was “Will you plan to use vee diagrams and e-portfolios in your future science courses, if your answer is yes in what way will you plan to use?”

Pre-service Teacher G (High level): *“I really decide to*

use vee diagrams in my class because it is concrete and easy to understand. I divide class into groups and give some information about collaborative studying principles and vee diagrams...”

This pre-service teacher underlined the importance of collaborative working and the development of social skills during the application process of vee diagrams in terms of his experience with his group.

Pre-service Teacher H (Low level): *“Both e-portfolios and vee diagrams are very beneficial materials and if my classes are not crowded I can use this, I will identify criteria with my students and this needs small groups...”*

This pre-service teacher emphasized the need of small groups for the effective application of vee diagrams and electronic portfolios because they need periodical feedback and strong guidance. In terms of pre-service teachers' portfolios, 96 of the 103 (93%) preservice science teacher stated that electronic portfolio and vee diagram applications met their expectations in general physics laboratory course in the epilogue parts. Most of them (70 of the 103, 70%) stressed that electronic portfolios and vee diagrams were effective and necessary for developing science process skills, scientific literacy and reflective writing skills in science education in the diaries part of e-portfolios. Pre-service teachers indicated their expectancies in their foreword parts of the e-portfolios. All e-portfolios were investigated during this research process and portfolios of pre-service teachers who participated focus group interviews were selected and quotations of them were listed in this part for indicating the parallelism among the variety of data sources. Sample quotation of a pre-service teacher was given from foreword part of an e-portfolio below;

Pre-service Teacher D (Middle Level): *“I want to learn how we conduct experiments and how our teacher evaluates us. I wish I have a chance to gain the skills of using lab materials, making observations and relating them with nature....”*

This pre-service teacher indicated to have an expectation of gaining both specific laboratory and science process skills. Pre-service teachers indicated their feelings about the application process of vee diagrams and e-portfolios in the diary parts of e-portfolios. Sample quotation derived from a diaries of an e-portfolio was given as follows;

Pre-service teacher C (High Level): *“Preparing vee diagrams and thinking about criteria in terms of rubrics rise my concentration on what I am doing. When I start to write diaries, I focus on my applications and deeply thinking about my own learning experience...”*

This pre-service teacher emphasized the facility of developing reflective thinking skills during the application process of vee diagrams and e-portfolios. This finding was also parallel with semi-structure interview and open-ended questionnaire findings.

Pre-service teachers stated their judges about the whole process of general physics laboratory course in epilogue parts of e-portfolios. Sample quotation derived from an epilogue part of an e-portfolio was given below;

Pre-service teacher A (Low-level): *“This was an amazing learning experience for me. I learnt how our teachers evaluated us and organize the concepts of my observations and applications in a meaningful manner. I feel that the skills I gain will be permanent...”*

This pre-service teacher implicated that both vee diagrams and e-portfolios are materials which serve meaningful learning environments and help to make knowledge and skills permanent. This finding comes from the strong organization characteristics of vee diagrams and e-portfolios.

DISCUSSION

In terms of pre-service science teachers' perceptions regarded to questionnaire, interview and portfolios; vee diagram was an effective instructional technique and a material which helps to develop science process skills, scientific literacy, metacognitive, creative, critical thinking and social skills of learners. This tool helped to identify misconceptions, help learners to make operational definitions. It provided a bridge between theory and practice in science education. It was visualized, make concepts concrete and provide environments for supporting meaningful learning. Those findings are similar with the research studies of Keleş and Özsoy (2009), Nakiboğlu et al. (2005), Nakiboğlu et al. (2001), Novak (1990), Novak (1998), Lebowitz (1998), Tatar et al. (2007), Otto et al. (2013). These findings coming from data are also parallel with literature review. Most of the student teachers wanted to use vee diagrams in their future science classes. Student teachers identified the problems of class size, internalizing collaborative learning principles and duty oriented project rules and also experience. This finding is parallel with Demirci et al. (2009), Lebowitz (1998), Keleş and Özsoy (2009) and Afamasaga-Fuata'i (2014). E-portfolios provided longitudinal process-based assessment ways which learners can take their own responsibilities about their learning process and have a chance to participate grading process in terms of this research study results. This assessment approach and tool offered choices to develop and follow learners' higher order thinking skills

such as interpreting, integrating concepts into daily life situations, reflective thinking. This was inferred from the pre-service teachers' answers coming from their diaries, open-ended questionnaire and interviews and parallel with Maher et al. (2009), Wang et al. (2012), Chang et al. (2013);.

Construction of grading system is the part that should be improved as pre-service teachers indicated in their reflections. Relationship between application process of vee diagrams and class size, classroom setting, number of the students can be organized for making group projects. This mainly depends on socio-economical status and background of the country. Pre-service teachers' background can be different in terms of the secondary schools that they graduated from. Individual differences and the need areas of the pre-service science teachers should be identified clearly and considered during the preparation process of pre-service teacher education programs. Although general physics laboratory course has a definition and instructors prepared syllabuses in terms of the course definition, it does not have any particular curriculum like the other pre-service teacher education courses. Effective instructional designs and assessment systems, objective feedbacks come from well-organized curricula. Needs assessment is the first and the most important part of curriculum development process. This process should be longitudinal supported with both product and process-based assessment tools for getting indepth and objective information from the pre-service teachers' need areas. Social skills are one of the most important issues that vee diagrams and e-portfolios have contributions to. These skills are necessary for pre-service teachers for constructing meaningful and interactive learning environments. Pre-service teachers can have information and application about collaborative and group working principles with supportive courses or workshops that the universities can organize. Taking a responsibility and participating assessment systems are critical elements of metacognitive learning and both e-portfolios and vee diagrams have a positive contribution to these issues. Development process of megacognitive skills should start from early ages. In terms of this, students, teachers and parents can come together in pre-school and elementary level focusing on grading principles and provide environments for learning how they learn and take their responsibility of their learning. They can actively participate on other projects depending on this philosophy. Ministry of National Education, universities and secondary-elementary schools can make collaborative projects focusing on constructivist learning principles. Both preservice and inservice teacher training programs can be organized in an application-based manner. This research theme can be investigated for different levels and different disciplines such as mathematics education, geography education...etc and find the

effect of inter-related disciplines and their philosophies and properties on vee diagramming and process-based assessment methodologies Longitudinal studies in different levels such as in elementary, secondary and college can be done for investigating the time and age group effects of vee diagramming and using e-portfolios in teaching and learning environments. Standardized misconception tests will be used for indicating the effects of vee diagrams during the applications which help to minimize or remove misconceptions in science education. Standardized systems for grading vee diagrams will be useful for taking vee diagrams into assessment techniques. Relationship between vee diagrams and variables such as science process skills, scientific literacy, metacognition, motivation, self efficacy with standardized tests will be calculated for suggesting observable and measurable clues for the organization of effective instructional designs and meaningful learning environments for learners.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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