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Education and Training on Introduction of Geology for Spatial Planning

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Abstract

In 2015 and 2016, the Education and Training Center of Geology, Mineral, and Coal (*Pusdiklat Geologi, Mineral dan Batubara*) developed training of Introduction to Geology for Spatial Planning based on a new standard curriculum. The objective of this training is to prepare the participants in dealing with basic environmental geology data and its analysis for spatial planning, including data and information management and generation, basic knowledge in the geographic information system (GIS) as well as the data interpretation and obstacles within spatial planning regarding the geological factors. Furthermore, the training is meant to introduce participants to basic methods in spatial planning processes, such as participatory planning, scenario building, and conflict analysis for geologically-induced conflicts in spatial planning. One focus of the training is the issue of disaster prevention via spatial planning. For this topic, the training refers to the Guideline for the Implementation of Geological Hazard Information in Spatial Planning (*Pedoman Penyusunan Informasi Bahaya Geologi untuk Penataan Ruang*) developed by the Geological Agency of Indonesia in 2015, supported by the German Development Cooperation. The approach of the new training differs from the previous standard curriculum which focused on operational and more technical procedures and scoring of geological analysis. One problem of passed training is the effectiveness of the training due to different knowledge levels of the participants, outsourced training parts and the often-passive didactic method implemented during the training. The new training is using a blended learning system, combining between e-learning in the introductory phase of the training to harmonize the participant's background and a highly interactive approach with practical elements to encourage the participants to apply theoretical knowledge directly. Moreover, the training aims to improve the participants' capabilities to implement their knowledge to real case studies, from which they are likely to become more competent to fulfill their office tasks for sure. The new curriculum and training setup is adaptive to the current development process, using methods of gap analysis and SWOT analysis, determined contents, didactical needs, and limitations. These methods help to compare the expected performance of the new curriculum, both internally and externally, with the performance of the previous curriculum. Furthermore, the whole process is accompanied by focus group discussions to acquire feedback, reviews, and considerations for the setup and content of the changes applied to the curriculum.

Keywords: curriculum; education; spatial plan; training

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1. Introduction

Indonesia is prone to many disasters posed by hydro-meteorological (floods and droughts) to geological hazards (volcanoes, earthquakes, and tsunamis) (Nurhayaty, Wimbarti, Triatmadja, & Hastjarjo, 2015). Therefore, it is imperative for Indonesia to improve government capacity to deal with natural hazards. One of the effective tools to reduce the impact of natural hazards is spatial planning (Sutanta, Rajabifard, & Bishop, 2013). Spatial planning has an important role in disaster risk reduction through better management and allocation of land (Sutanta et al., 2013). However, the existing knowledge on spatial planning and its application in the context of geological hazard mitigation is still limited. Not only in disaster field, the connection between geology and spatial planning will also need its application in another field. For example the need for environment interpretation in ecotourism area that needs better quality improvement (Yusnikusumah & Sulistyawati, 2016).

However, these plans, which are supposed to play as an important 'tool' in guiding urban land-use change, are not well implemented and reinforced by the related local governments due to power dispersal at the decentralized levels, causing many problems in reality (Rahmawati, 2015). Thus, harmonious spatial planning is the key to integrating and harmonizing all sectors in an area to reach sustainable development (Dyah, 2015). Therefore, education and training in geology and spatial planning become an important step solve the persisting problems.

Education and training are essential in capacity building part of good human resource management (Akkermans, Brenninkmeijer, Schaufeli, & Blonk, 2014). Carrying out an effective educational course or training workshop will need coordination among the organizers to create skilled and competent human resources that fulfill the needs of their respective institutions. In general, education and training of this caliber aim to improve the performance of government apparatus in delivering services to the public, especially to enhance the livelihood of the marginalized people. There is a challenge to incorporate key issues into planning, such as contemporary social, economic and political issues (Klein, Klug, & Todes, 2012).

The role of human resources in an institution is a key to achieving the objective of the institution (Akkermans et al., 2014). A competent and strategy-minded staff will give added value to the institution. The better and more qualified the human resource an institution has, the more productive that institution will be. The competent and strategy-minded of human resources has become the underlying reason for the activities by the Education and Training Center of Geology, Mineral, and Coal (*Pusdiklat Geologi, Mineral dan Batubara*). The Ministerial Decree No. 18 the Year 2010 stated that the main objective of the *Pusdiklat Geologi, Mineral dan Batubara* is to organize education and training in geology for human resources working in the field of geology can acquire relevant knowledge and skills so that they will be more productive and able to overcome complex problems.

One of the main focuses of the education and training process is on geology-based spatial planning, under the "Introducing Geology for Spatial Planning" program. One of the main problems in Indonesian spatial planning today is that there is a fundamental misuse of the geological aspect of implementing urban and regional plans. The misuse of the geological aspect has caused severe environmental degradation in Indonesian lands and has been a central issue discussed by environmental experts, especially those working with the availability of natural resources and sustainability of their exploitation. Moreover, the demand for and subsequent high-level exploitation of natural resources has been considered as the major cause of climate change which has affected adversely to the environmental degradation. Jakarta, as the capital of Indonesia, has an unconfined aquifer, upper confined aquifer, and bottom confined aquifer that below drinking water quality standard (Matahelumual, 2010) as visible condition need to be noticed. A kind of disasters that creates a frequent constraint to development is a landslide, which inflicts damage to environment or infrastructure (Darmawan, Wahjono, Andiani, & Riyadi, 2011). Inaccuracies in spatial planning can exacerbate natural disasters such as earthquakes, tsunamis, and landslides. Also, global population growth, migration, distribution, and concentration of people within an area will always create new problems, in particular, problems which are related to natural resource management. Growth population will affect housing expansion, such as expanding to volcanoes area including dangerous area. Therefore we need to optimize land resources in volcano area and minimalize negative effect that may come (Firmansyah, 2011).

If land use changes in the area raise doubt in the effectiveness of spatial planning implementation (Rismana & Firmansyah, 2011), then the natural resource management is thus critical within the spatial planning process. The legal basis for this is clear, that is, the Law Number 26 the Year 2007 on the Spatial Planning, Article 5 verse 2 calling for planning the physical environment (Pemerintah Republik Indonesia, 2007a), Government Regulation No. 26 the Year 2008 on the National Spatial Plan (Pemerintah Republik Indonesia, 2008), and the Law Number 24 the Year 2007 on the Disaster Management (Pemerintah Republik Indonesia, 2007b), all stated the importance of planning the physical (geological) environment within spatial planning. Environmental geology is the application of geology to solve environmental problems (Andiani, Darmawan, Badri, & Kurniawan, 2011). This application can be accomplished in some ways such as spatial planning for development and environment management as well as the provision of information on geologic characteristics of an area. These characteristics consist of geological resources and disasters. Geological resources are considered supporting factors for development whereas geological disasters as constraints (Oktariadi & Tarwedi, 2011). As an archipelagic country with lots of carbonate resources, Indonesia must focus on spatial planning process sensitive to geological resources.

Based on the characteristics of, resources potential on coastal areas and carbonate stone in the several islands, therefore it needs specific efforts in developing the area (Darmawan & Lastiadi, 2016).

Regarding this situation, there is a need for education and training on the elementary geology-based spatial planning in Indonesia, so that planners, public servants, and related stakeholders can reduce environmental degradation caused by the irresponsible planning process. In many cases, most planning courses have focused much on the operational and technical aspects of geology within planning, which does have no place in introductory spatial planning. Moreover, basic knowledge of geology that planners and other government agencies have been still less equipped, insofar that there is a need for introducing some aspects of geology to spatial planning.

A course on geology-based spatial planning consists of basic concepts of spatial planning as well as geological elements. This basic knowledge is important because a majority of the course participants (planners and related public servants) have neither a background in geology nor spatial planning, but varies from social sciences to engineering. Therefore, we suggested significant changes in the next curriculum for Education and Training on Introducing Geology for Spatial Planning, which will focus on the basic and important knowledge of analyzing or interpreting geological factors in spatial planning. The new elements in this curriculum include participatory planning. For example, few cases that need participation is a collaboration within the local community in managing the area and potential tourism (Yusnikusumah & Sulistyawati, 2016). Another example is the determination of evacuation route and meeting point which requires local participation during the process (Wiwaha, Mei, & Rachmawati, 2016). The basics of scenario development are one of the most important things to be added on this material because when the public is facing the issue, there will be different opinions among them (Pandia, Rachmawati, & Mei, 2016). The basics of geology conflict analysis within spatial planning related to geology and interpretations in applying spatial planning Indonesia. Expectedly, this course could encourage the participants to become more familiar with factors in the analyses related to environmental geology for spatial planning as well as the interpretation of the geology-related problems within spatial planning.

The rest of this paper will explain the training in the Education and Training Center at the BPSDM. It also will highlight the methods used to carry out the change, such as the gap and SWOT analyses. Furthermore, there will be a discussion on how the changes have taken place and followed by conclusions at the end of the paper.

2. Geology for Spatial Planning

In environmental geology view, the condition of earth can be differentiated by two main factors, that is, supporting and constraint factors. These factors become the primary factor in determining the aspect of environmental geology mainly in connection with spatial planning. The geological supporting factor is geological aspect have a positive impact on spatial planning, such as the potential of land resources, water resources, land, rock and mineral resources. Geological constraint factor is a geological aspect that has a negative impact on spatial planning, such as land subsidence, volcano eruption area, earthquake and tsunami, active fault area.

The result of environmental geology analysis is an environmental geology map which includes a recommendation for spatial planning requirement. As maps play a very important role in spatial planning, their preparation must comply with the certain standard of mapping to ensure the validity of reference. The mapping process includes primary and secondary data collection until analysis and recommendation. Good quality of maps should be an accurate, precise, and good regarding measurement, geography position and variables to avoid overlapping conducts (Hidayat, Rustiadi, & Kartodihardjo, 2015).

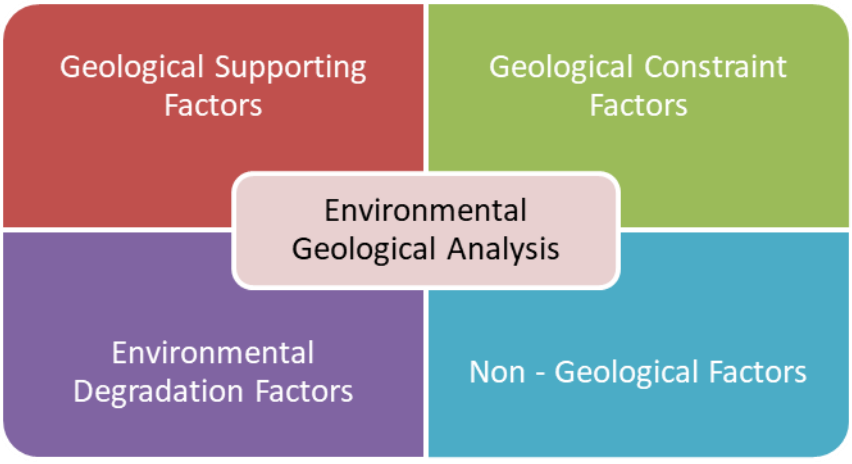

Figure 1. Environmental Geological Analysis Factor
(Source: PPSDM Geominerba, 2017)

3. Training in the Education and Training Center of The Human Resource Development of the Ministry of Energy and Mineral Resources (BPSDM-ESDM)

The Human Resource Development of the Ministry of Energy and Mineral Resources (BPSDM-ESDM) is one of the institutions within the Ministry of Energy and Mineral Resources (ESDM Ministry) whose function is to carry out the development of human resources within the energy and mineral resources. According to Ministerial Decree No. 13 of 2016 on Organization and Work Procedure of the ESDM, the functional task of each working unit within the environment of the BPSDM-ESDM will change. They do not only carry out training and education on government apparatuses but also developing human resources who work in fields related to the Ministry of ESDM. The word 'developing' is the difference between the current function and the previous in which execution of education and training is the only main task. The scope of activities of the BPSDM-ESDM will broaden, since developing human resources is not only done through training but also through non-training activities (internships, seminars, mentoring, etc.). The Center for Human Resource Development for Mineral Geology and Coal (PPSDM Geominerba) has the task of formulating the technical decisions and standardization of human resource development for the *geominerba* (mineral, geology, and coal) fields, carrying out technical training for public sectors within the ESDM sectors, industries, and also the public. PPSDM Geominerba is the institutional amalgamation of the Center for Education and Training on Minerals and Coal (Pusdiklat Minerba) and the Center for Education and Training for Geology (Pusdiklat Geologi) (as of mid-2016), so this new unit operates with a wider scope than the previous ones.

Training activities in Pusdiklat Geologi (before it became PPSDM Geominerba) cover some groups, such as exploration geology, geological disaster mitigation, environmental geology, and geoinformatics. Such classification is to accommodate the wider scope of applied geology and adhere to the official classification by relevant stakeholders. As the only government institution in Indonesia serving for education and training in geology, Pusdiklat Geologi plays an important role in developing human resources within the field of geology. This strategic role is carried out by Pusdiklat Geologi through planning training courses, organizing courses, and evaluating courses, in which all the courses are cyclical and related each other. Also, this institution carries out Internal human resource development and the development of education and training infrastructure as the main concern for ensuring efficient and effective courses.

Since its establishment, Pusdiklat Geologi has carried out many training courses with participants from within the Ministry of ESDM as well as public servants across Indonesia. Training is conducted in the Pusdiklat Geologi campus in Bandung or the field campus in Cisolok, Sukabumi, West Java (or sometimes in other provinces depending on the prior needs analysis).

One of the training courses within the environmental geology group is the Training on Geology-based Spatial Planning, a course that is often carried out in Pusdiklat Geologi by request from stakeholders. The objective of this training is to enable the participants to recommend or suggest the optimal relevant land use based on geology (Standard Curriculum for Geology-based Spatial Planning, 2014). Over the years, this training's participants have come from various backgrounds irrelevant to earth sciences, which is favorable since the decision makers in spatial planning tend to have the various educational background.

4. Methods for Curriculum Changes

Regarding changes to the curriculum for the Geology-based Spatial Planning training course, the new methods applied gap and SWOT analyses which have done in the previous curriculum. These aimed to look at the difference between the actual and potential performance of the previous course and participants internally and externally. Furthermore, the focus group discussion was also conducted to decide the changes within the curriculum to acquire feedback related to the local and specific needs.

4.1 Gap Analysis

Gap analysis is an evaluation tool which emphasizes on the discrepancy between the performance of the current curriculum and the previous targeted performance. Gap analysis also identifies actions required to narrow the gaps and to increase the performance. Also, this analysis can estimate the method of delivery, time allocation, and relevant resources needed for the ideal training course.

The gap analysis conducted twice; the first was to compare the current curriculum/module with relevant literature and guidelines on geology and spatial planning, and the second with the previous module. For the first analysis, the curriculum was reviewed against the relevant literature, legislation (law, spatial plans, etc.), and case studies in other areas. On the second gap analysis, the module was reviewed against evaluation of the previous module. Figure 2 shows the gap analysis within the curriculum for training on spatial planning.

4.2 SWOT Analysis

SWOT analysis is a tool to document the strengths and weaknesses of an institution internally along with the opportunities and threats it faces externally. SWOT analysis helps to assess internal and external problems of the previous curriculum and is used to identify the conditions of the current curriculum. SWOT analysis evaluates the strengths, weaknesses, opportunities, and threats as the basis for evaluation and formulating future curricula. Figure 2 shows the SWOT analysis within the curriculum for training on spatial planning.

The SWOT analysis process starts by matching the conditions of each input elements which are a module, guidelines, curriculum, and discussions to first take a look at the overall strengths, weaknesses, opportunities, and threats. The previous modules reviewed were Module 1-5. The guidelines included as input was the Guidelines for Application of Geological Hazards Information in Spatial Planning and Public Works based on the Ministerial Decree No. 20 the Year 2007 on Analysis Techniques for the Physical and Environmental, Economic, and Socio-cultural Aspects. Other input elements were acquired from modules including the previous curriculum for the Geology-based Spatial Planning Course and the curriculum for GIS in Geology-based Spatial Planning. Focus group discussions and workshops were also conducted between Pusdiklat Geologi and the Geology Department (*Badan Geologi*) facilitated by the Georisk Project. These elements were analyzed to acquire information on the drawbacks of the previous curriculum so that new strategies can be formed to formulate the new curriculum.

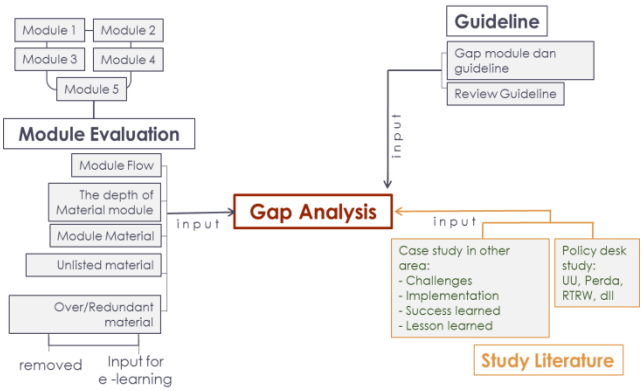

Figure 2. Flow Chart Illustrating Gap Analysis for Changes within the Curriculum for Training on "Introducing Geology for Spatial Planning"
(Source: Authors Analysis, 2016)

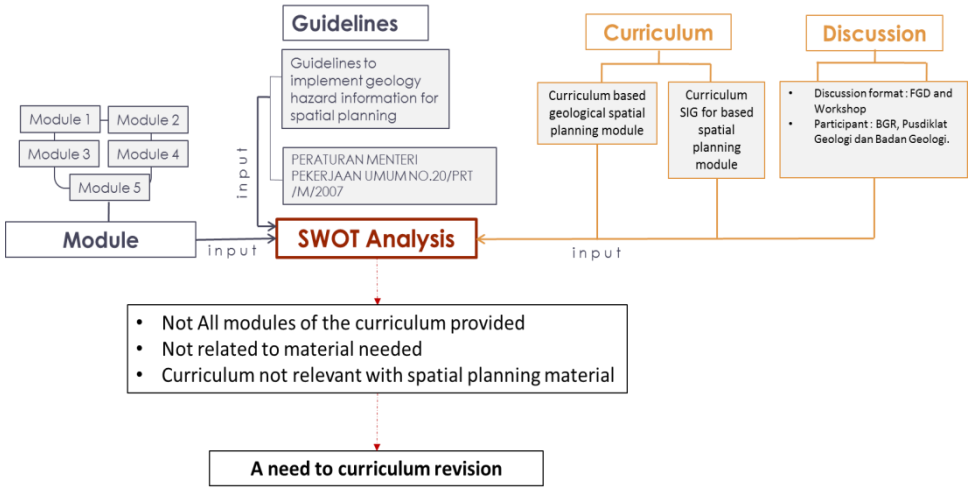

Figure 3. Flow Chart Illustrating SWOT Analysis for Changes within the Curriculum for Training on "Introducing Geology for Spatial Planning"
(Source: Authors Analysis, 2016)

5. Issues Faced

The training for Geology-based Spatial Planning was formulated to enhance the competence of its participants on geology and its aspects within spatial planning. Issues emerged during its implementation were:

1. Participant recruitment:
   - During the period of training, participants may come from varying fields and educational backgrounds. While this does not necessarily pose a problem when the material being delivered are general and basic knowledge, more technical and content-specific materials have hindered the learning process of participants not familiar with geology or spatial planning at the expense of the training schedule.
   - The gap between participants is sometimes too wide where some public servants have different educational background ranging from the high school to the master degrees. This discrepancy has made it difficult for educators to deliver the appropriate materials for the right audience.

- With many participants coming from different institutions and ranks as well as their motivations, some participants looked less enthusiastic, so that inhibited their learning process.

2. Implementing course:
   - The short implementation time of the previous course caused many of the participants do not fully understand the source material.
   - The location of the fieldwork was forced and was not optimal (for training implemented in regions).

Table 1: The Participants of the Training on Geology-based Spatial Planning in 2015

No	Name	Unit	Education	Position
1	Participant 1	Provincial Mining and Energy Agency	Vocational School	Staff
2	Participant 2	Provincial Planning and Development Agency	Vocational School	Spatial Planning Technical Implementation Unit Staff
3	Participant 3	District Mining and Energy Agency	B.Eng in Geology	Mine Inspector
4	Participant 4	Mining and Energy Agency	BA in Management	Staff
5	Participant 5	District Mining Agency	B.Eng in Geology	Survey and Inventory Section Head
6	Participant 6	District Mining and Energy Agency	B.Eng in Mining	Geominerba Staff
7	Participant 7	City Energy and Mineral Resources Agency	B.Eng in Geophysical Engineering	Head of Geology and Mining Division
8	Participant 8	Provincial Mining and Energy Agency	B.Sc in Agriculture	Natural Resources Administration Staff
9	Participant 9	District Energy Mining and Environment Agency	M.Sc in Environment and Natural Resource Management	Head of Geology and Mining Division

Source: Pusdiklat Geologi (2015b)

3. Training material:

The usage of data and information given by the Geological Agency was severely lacking. Only some of the provided materials were adopted to the final course of the training, and the proper explanation on how to utilize them on a larger scale for spatial planning was missing. Geological survey is very expensive, and that is the reason why most local governments do not provide budgets for them (or any independent geological data acquisition). Optimal use of the data provided by the Geological Agency is encouraged to get the most of the training at a reasonable cost.

4. Educators' background:

The numbers of educators who have good skills in environmental geology for spatial planning in Pusdiklat Geologi are not enough compared to their external fellows. Educators in Pusdiklat Geologi have different teaching methods and delivery of the materials compared to the outside trainers, and this impact on the understanding of participants regarding the material sources. For maintaining curriculum updates, more trainers are required to come from Pusdiklat Geologi.

5. Field excursions:

Locations for field excursions have not been selected based on its relevance to current issues of environmental geology and spatial planning. Field excursions should allow participants to understand the geological conditions of the area, land use, and the environmental problems exist.

6. Discussion

Based on the results of the gap and SWOT analyses, the curriculum for Training on Introducing Geology for Spatial Planning needs some change and adjustments in compliance with the standard of Pusdiklat Geologi. The previous curriculum still has irrelevant materials unaligned with the objectives of the training. For example, in Module 1 on Introductory Spatial Planning, it does not even touch geology-based spatial planning. Module 1 is supposed to include elements of spatial planning where scenario building, conflict analysis, and the relationship between geology and spatial planning discussed. The previous modules focused too much on technical aspects of spatial planning and geology whereas the basic concepts and understanding of spatial planning based on geology are more relevant in applying geology to the real-world planning.

The lack of participants' knowledge of the basic spatial planning and geology is a challenge that needs to be improved. This condition relates to the previous point where the participants unfamiliar with the topics so that accelerated teaching of the basic knowledge is necessary.

The need for data in spatial planning is compulsory, especially concerning the geology of areas. Thus, the provision (as well as a collection) of data and information for geology-based spatial planning is important and should be part of the new curriculum. While how to technically use the data in real situations

is important, for the sake of the training it is only the basic methods will be mentioned since the main goal is to make the participants understand the importance of data and how to use them for geology-based spatial planning strategically. Any specific utilization of data using software will be available in the future courses wherever possible.

It is also important for participants to be able to read thematic maps to formulate geology-based spatial plans. Considering the number of skills and knowledge needed to create thematic maps, their preparation should not be part of the new curriculum; rather, it should keep focusing on how to properly read and interpret them to support a well-informed spatial plan decision making. By using the contour maps, land suitability maps, vegetation maps, and rock formation maps, participants should be able to have evidence-based judgments on spatial planning. The availability of several spatial maps will help them to decide strategically in planning situations and not just at the technical level.

Within the new curriculum, theory and practice are still divided into two separate categories of sub-courses. However, the main difference would be that the amount of hours of practice is higher than that of theory. The difference of the number of hours of practices is to help participants to learn by doing through practical activities during the course instead of depending on desk study learning only. Case studies and best practices are also more common to let participants apply the knowledge they have acquired to the specific areas they are working in. Also, field trips and excursions will still be implemented as it is essential to equip the participants with a perspective based on real conditions in the field.

The new curriculum refers to the Guideline for the Implementation of Geological Hazard Information in Spatial Planning (*Pedoman Penyusunan Informasi Bahaya Geologi untuk Penataan Ruang*) (Andiani & Kastl, 2017) produced by the Geological Agency of Indonesia and BGR. The guideline emphasizes the introduction of simple but useful analyses of geological hazards for spatial planning. For example, it shows the interaction between geological hazards and the vulnerable conditions in creating risks. It also considers conflicts between geological hazards and the built environment. Conflicts in spatial planning are also important to be considered (Hersperger, Ioja, Steiner, & Tudor, 2015). In addition to that, the guideline also covers the role of participation in the spatial planning process. This curriculum is later translated into a new course on Introduction to Geology for Spatial Planning.

The new training is using a blended learning system, which uses e-learning in the introductory phase of the training to harmonize the participants' background and also includes a highly interactive approach with practical elements to encourage the participants to apply theoretical knowledge directly. The new training consists of three courses. The first course is on the introduction of geology for spatial planning. The second course is on data and information system while the third one is to interpret maps on geological thematic and spatial planning analyses. In total, the course is expected to have about 70 hours or 7-day course.

In the first part of the training, participants can register and log in to the website of LMS (Learning Management System) to take a basic understanding of spatial planning, geological concepts, conflict analysis and participation. The participants must complete this first training to be able to enroll in the complete training. Moreover, the training aims to improve the participants' capabilities to implement their knowledge to real case studies, and ultimately make them more competent to fulfill their office tasks. This e-learning (LMS) system is provided with videos and animations which assist participants to learn the materials quickly. In this system, there is also a forum where trainers can interact with the participants. Participants can pose questions and also respond to the questions or case studies provided by the trainers.

Figure 4. A Screenshot of Learning Management System on Introduction of Geology for Spatial Planning (Source: Pusdiklat Geologi, 2015a)

7. Conclusion

This paper has presented some issues related to the implementation of education and training on Introduction of Geology for Spatial Planning. As discussed before, the geology factor is very important for spatial planning. So, it should be one of the considerations for a planner to put geological factor as main issues. In fact, this implementation is still problematic in Indonesia; sometimes geology factor is not used properly. In practice, technical approach that has and will be done not comprehensively using environmental geology as the analysis unit, but partially, sectoral, or connected with authorities which reactive to issues and incremental problems (Oktariadi, 2010). The impact of this, there are few spatial planning not friendly with the geological condition in the certain area. Geology as a science facing a little problem when applied to spatial planning. But, nowadays the improvement of science can solve that and is easier to use it for spatial planning. The mandate of the Law No. 26 the Year 2007 on the Spatial Planning instructs that spatial planning should pay attention to the conditions of the region (including the beneath or above the surface), to which all planners are abode with.

One of the methods in geology used for spatial planning, either supporting or limiting, is the weighting method. For example, to determine a location for landfill, there are several factors to be rated and weighted such as the conditions of the water table, an impermeable layer, river, and the potential geological disasters (e.g., landslide, active fault, earthquake, tsunami). Competent skills on rating and weighting these factors belong to a geologist at most or someone with the past relevant experiences. Since the geological information in spatial planning is very important, the institutions responsible for spatial planning should have competent experts in geology. If not, we need a recommendation from credible institutions or professional association to advise the current spatial planning process.

As part of the solutions, the new curriculum containing more practical rather than theoretical approaches is necessary to increase the participants' involvement and competences. The proportion of practical and theoretical approaches in the new curriculum should be 30:70 to facilitate better didactic teaching delivery and to provide the baseline materials for both the internal trainers in Pusdiklat and the external guest trainers. The importance of this baseline materials is to provide the trainers coming from the Pusdiklat and other institutions such as the Geological Agency, universities, and practitioners.

In the future, it is important to promote the training from Pusdiklat to a wider audience. The usefulness of the materials and the blended learning system will help many stakeholders and communities in Indonesia to learn about the introduction of geology for spatial planning.

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