Developing A Learning Continuum on Ecological Aspect from Elementary to Senior High School Based on The Opinions of Biology Education Experts

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Abstract. This research uses survey method aiming to investigate the opinions of biology education experts toward the teaching and the assessment of ecological aspects previewed from the level of competency and characteristic of specific pedagogical materials in order to develop the learning continuum of ecological aspects from elementary to senior high schools was conducted in 2018-2019. The population used in this research was hypothetical population which consisted of the all experts of biology education who taught in public and private universities in Indonesia. The sample used in this research was convenience sample consisted of 85 experts of biology education who taught at 18 public and private universities in Yogyakarta, Central Java, East Java, West Java, and Jakarta determined by using purposive technique. The instrument used was confirmatory assessment questionnaire learning continuum based on mastery of ecological aspects which has been arranged by Subali et al. (2016) and the validity was well examined through the focus group discussion activity by 3 lecturers of UNY and 5 lecturers of UNS. The result of this research showed that learning continuum of ecological aspects according to the biology education experts’ opinion, start be taught and assessed in the fourth and fifth grade of elementary school with the competency level C1 and C2. Then, it will be continued to the higher level in seventh grade of junior high school with the competency level C2 and tenth grade of senior high school with the competency level C3.

1. Introduction

Learning continuum (LC) is a logical order which shows the continuity between the competency level and characteristics of specific pedagogical materials vertically in every level of education [1]. The basic concept of LC is implemented by doing some mappings toward some competencies which have correlation in each level starting from the simples to the most complex and also composing the characteristic of pedagogical material from the easiest one until the most difficult one and from the most concrete until the most abstract thing [2]. Therefore, the learning process follows the rules of LC so it can give some descriptions toward the developmental phase of students and makes the learning process becoming more directed, efficient, and effective[3]. The most important thing to be considered is that the mental and cognitive development of students in every level of education are different[4].

LC has many benefits in the learning process, some of those benefits are LC can be made as the basic in selecting the learning materials and learning sources which are appropriate with the variety level of students, LC can be utilized by teachers to develop individuals’ learning and the further lesson plans, as the basic to compose, to develop, and to fix the curriculum[5],[6].
LC can be implemented in various aspects of knowledge fields, one of them is in ecological aspect. Ecological aspect has the various scopes of learning material from the level of organism until biosphere, having correlation with the other aspects of Biology, and when studying about curriculum in Indonesia the material about ecology has been taught to students from the early level of education in elementary school until in the level of high school[7],[8],[9]. Therefore, the order which shows the appropriate gradation with LC so students can easily learn and understand the materials is urgently needed.

Unfortunately, the fundamental problem faced until now is the serving of competency level and characteristics of pedagogical materials of ecological aspect in the curriculum which is still overlapping, whether in elementary or high school[10]. Besides that, the result of the previous research taken from the opinion of practitioners still shows the grouping of opinion and tends to follow the serving in curriculum. Based on the description explained above, the further research about this topic is highly recommended by asking the opinions from the experts of biology education about LC of ecological aspects from elementary to senior high school. The modus of practitioners’ opinion from the previous research is served in the research questionnaire which is purposed to become considerations from the experts when giving opinions.

2. Method
This research uses survey method aiming to investigate the opinions of some experts of biology education toward the teaching and the assessment of ecological aspects previewed by the level of competency and characteristic of specific pedagogical materials in order to develop the LC of ecological aspects from elementary to senior high schools was conducted in 2018-2019. The population used in this research was hypothetic population which consisted of the all experts of biology education who taught in public and private universities in Indonesia. The sample used in this research was convenience sample consisted of 85 experts of biology education who taught at 18 public and private universities in Yogyakarta, Central Java, East Java, West Java, and Jakarta that become the respondents in this research determined by using purposive technique. The instrument used was confirmatory assessment questionnaire LC based on mastery of ecological aspects which has been arranged by Subali et al. (2016) and the validity was well examined through the Focus Group Discussion (FGD) activity by 3 lecturers of Universitas Negeri Yogyakarta (UNY) and 5 lecturers of Universitas Sebelas Maret (UNS). These aspects are presented in the questionnaire that contain of 10 sub-aspects that are characteristics of biome, characteristics of ecosystem, characteristics of ecosystem community, characteristics of the arrangement population of the ecosystem community, characteristics of the functions happened in the ecosystem, interaction interspecific inter population, interaction interspecific inter individual in a population, functions of the biotic components in the ecosystem, functions of abiotic components in the ecosystem, and interaction between biotic components and abiotic components in the ecosystem. Thus, the competency level in this research is the competency level of cognitive area in taxonomy Bloom by Anderson and Krathwohl that contain of six levels that are remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6).

The data analysis in this research used descriptive statistic which served the modus data of respondents’ opinion through the use of questionnaire. The serving of modus aims to find the agreement of opinion among respondents. It means that, the respondents who have same opinion will be on the one group of modus. The modus of respondents previewed furthermore by the group of biology education expert through the activity of FGD to decide whether the opinion of respondents is logic or not. Its decision follows the basic concepts of the LC arrangement that are competency level and the pedagogic materials, and they are arranged from the abstraction of the concepts (concrete to abstract), the easiness of the concepts (easy to difficult), and the complexity of the concepts (simple to complex). Besides, they also consider about the appropriateness with the students’ cognitive development step in every level of education starting from the elementary school to senior high school.
3. Result and Discussion
The result of this research shows the modus of respondents’ opinions then it is analyzed further by the group of experts of biology education through FGD activity that can be seen in Table 1 to 10. The analysis result can become a reference to arrange the grid LC of ecological aspects in elementary to senior high school (from the first grade to the twelfth grade) that will be shown in Table 11. The description of the research result further can be seen in the table below:

**Table 1. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 1**

| Ecology Aspects | Modus | % | G/CL | FGD |
|-----------------|-------|---|------|-----|
| Sub-aspect 1: Biome characteristics with the indicators, as follows: |       |   |      |     |
| a. The characteristics of land biome based on its structure (its arranging components) | 36    | VII/C2 | L  |
| b. The characteristics of water biome based on its structure (its arranging components) | 34    | VII/C2 | L  |
| c. The growth of land biome and the factors that influence it | 31    | VII/C2 | L  |
| d. The growth of water biome and the factors that influence it | 31    | VII/C2 | L  |
| e. The evolution of land biome and the factors that influence it | 31    | VII/C2 | L  |
| f. The evolution of water biome and the factors that influence it | 31    | VII/C2 | L  |

Note: %= Percentage, G= Class, CL= Level of competency, L= Logic

Table 1 shows that between the modus of respondents’ opinions and the analysis result of FGD have the similarity. It means that the sub-aspect 1 in ecology materials that is biome characteristics shows that all indicators from indicator a to f are logically started to be taught in the seventh grade of junior high school with the competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 2 can be seen in Table 2, as follows:

**Table 2. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 2**

| Ecology Aspects | Modus | % | G/CL | FGD |
|-----------------|-------|---|------|-----|
| Sub-aspect 2: The characteristics of ecosystem with the indicators, as follow: |       |   |      |     |
| a. The characteristics of natural ecosystem and artificial ecosystem | 26    | VII/C2 | TL, V/C1 |
| b. The characteristics of land ecosystem based on its structure (its arranging components) | 22    | VII/C2 | TL, V/C1 |
| c. The characteristics of water ecosystem based on its structure (its arranging components) | 25    | VII/C2 | TL, V/C1 |
| d. The growth of land ecosystem and the factors that influence it | 25    | VII/C2 | L  |
| e. The growth of water ecosystem and the factors that influence it | 25    | VII/C2 | L  |
| f. The evolution of land ecosystem and the factors that influence it | 25    | VII/C2 | L  |
| g. The evolution of water ecosystem and the factors that influence it | 25    | VII/C2 | L  |

Note: %= Percentage, G= Class, CL= Level of competency, L= Logic, TL= illogical

Table 2 shows that the indicator a, b, and c based on the FGD result are illogical if they are started to be taught in the seventh grade of junior high school because the three indicators have the characteristics and the scope of materials that are easy and simple. So that, the FGD result suggests to teach them in the fifth grade of elementary school with the competency level C1 whereas the indicator d, e, f, and g between the modus of respondents’ opinions and the analysis result of FGD agree if these indicators start to be taught in the seventh grade of junior high school with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 3 can be seen in Table 3, as follows:
Table 3. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 3

| Ecology Aspects | Modus | FGD |
|-----------------|-------|-----|
| Sub-aspect 3: The characteristics of ecosystem community with the indicators, as follows: |       |     |
| a. The characteristics of land ecosystem community based on its structure (its arranging components) | 28 VII/C2 | TL, V/C1 |
| b. The characteristics of water ecosystem community based on its structure | 28 VII/C2 | TL, V/C1 |
| c. The growth of land ecosystem community and the factors that influence it | 24 VII/C2 | L |
| d. The growth of water ecosystem community and the factors that influence it | 24 VII/C2 | L |
| e. The evolution of land ecosystem community and the factors that influence it | 24 VII/C2 | L |
| f. The evolution of water ecosystem community and the factors that influence it | 24 VII/C2 | L |

Note: %= Percentage, G= Class, CL= Level of competency, L= Logic, TL= illogical

Table 3 shows that the indicator a and b based on the FGD result are illogical if they are started to be taught in the seventh grade of junior high school because the three indicators have the characteristics and the scope of materials that are easy and simple. So that, the FGD result suggests to teach them in the fifth grade of elementary school with competency level C1 whereas the indicator c, d, e, and f between the modus of respondents’ opinions and the analysis result of FGD agree if these indicators start to be taught in the seventh grade of junior high school with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 4 can be seen in Table 4, as follows:

Table 4. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 4

| Ecology Aspects | Modus | FGD |
|-----------------|-------|-----|
| Sub-aspect 4: The characteristics of the arrangement population of the ecosystem community with the indicators, as follows: |       |     |
| a. The characteristics of the arrangement population of the land ecosystem community | 34 VII/C2 | TL, V/C1 |
| b. The characteristics of the arrangement population of the water ecosystem community | 34 VII/C2 | TL, V/C1 |
| c. The growth of the arrangement population of the land ecosystem community and the factors that influence it | 33 VII/C2 | L |
| d. The growth of the arrangement population of the water ecosystem community and the factors that influence it | 33 VII/C2 | L |
| e. The evolution of the arrangement population of the land ecosystem community and the factors that influence it | 34 VII/C2 | L |
| f. The evolution of the arrangement population of the water ecosystem community and the factors that influence it | 35 VII/C2 | L |

Note: %= Percentage, G= Class, CL= Level of competency, L= Logic, TL= illogical

Table 4 shows that the indicator a and b based on the FGD result are illogical if they are started to be taught in the seventh grade of junior high school because the three indicators have the characteristics and the scope of materials that are easy and simple. So that, the FGD result suggests to teach them in the fifth grade of elementary school with competency level C1 whereas the indicator c, d, e, and f between the modus of respondents’ opinions and the analysis result of FGD agree if these
indicators start to be taught in the seventh grade of junior high school with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 5 can be seen in Table 5, as follows:

| Sub-aspect 5: The characteristics of the functions happened in the ecosystem with the indicators, as follows: |
|---|
| a. Food chain | 26 | IV/C2 | TL, IV/C1 |
| b. Food webs | 26 | IV/C2 | TL, IV/C1 |
| c. Energy flow | 29 | IV/C2 | TL, IV/C1 |
| d. Pyramid ecology (total number, biomass, and energy) | 41 | VII/C2 | L |
| e. Biogeochemical cycle (carbon, nitrogen, phosphor, sulfur, and other mineral) | 34 | X/C3 | L |

Note: % = Percentage, G = Class, CL = Level of competency, L = Logic, TL = illogical

Table 5 shows that the indicators a, b, and c according to the FGD results are illogical when they have to be taught in the fourth grade of elementary school with competency level C2. It caused by the three indicators that are taught in elementary school only in introducing level, so the FGD results suggest to teach them in the fourth grade of elementary school with competency level C1. Thus, the indicator d starts to be taught in the seventh grade of junior high school with competency level C2 whereas the indicator e starts to be taught in the tenth grade of senior high school with C3 competency level. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 6 can be seen in Table 6, as follows:

| Sub-aspect 6: The interaction interspecific inter population with the indicators, as follows: |
|---|
| a. Symbiosis (mutualism, parasitism, and commensalism) | 27 | IV/C2 | TL, VII/C2 |
| b. Neutralism | 28 | VII/C2 | L |
| c. Predation | 27 | VII/C2 | L |
| d. Competition | 26 | VII/C2 | L |
| e. Cooperation | 26 | VII/C2 | L |

Note: % = Percentage, G = Class, CL = Level of competency, L = Logic, TL = illogical

Table 6 shows that the indicator a according to the FGD result is illogical if it is taught in the fourth grade of elementary school with competency level C2. The indicator has the characteristics and scope of the materials that are difficult, abstract, and complex. So that, the FGD results suggest the indicator of symbiosis logically to be taught in the seventh grade of junior high school with competency level C2. Otherwise, the indicators b, c, d, and e based on the respondents’ opinions and discussion results that agree will be taught in the seventh grade of junior high school with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 7 can be seen in Table 7, as follows:

| Sub-aspect 7: The interaction interspecific inter individual in a population with the indicators, as follows: |
|---|
| a. | | | |
follows:

- **Neutralism**
  
- **Predation**
  
- **Competition**
  
- **Cooperation**

Note: % = Percentage, G = Class, CL = Level of competency, TL = illogical

Table 7 shows that the indicators a, b, c, and d based on the FGD results are illogical if these indicators are taught in the tenth grade of senior high school with competency level C2 since the characteristics and the scope of the materials are easy and simple. So that, the FGD results suggest these indicators logically to be taught in the seventh grade of junior high school with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 8 can be seen in Table 8, as follows:

### Table 8. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 8

| Ecology Aspects | Modus | % | G/CL | FGD |
|-----------------|-------|---|------|-----|
| Sub-aspect 8: The functions of the biotic components in the ecosystem with the indicators, as follows: |       |   |      |     |
| a. Functional status (*nisia*) in the food chain and food webs (producer, consumer, garbage eater, and decoder) |       | 26 | IV/C2 | L   |
| b. Functional status in the food sources (autotroph, heterotroph, and saprotrophic) |       | 38 | VII/C2 | L   |

Note: % = Percentage, G = Class, CL = Level of competency, L = Logic

Table 8 shows that between the respondents’ opinions and the FGD results have the similarities. It means that the indicator a is logically started to be taught in the fourth grade of Elementary school with competency level C2. Thus, the indicator b is logically started to be taught in the seventh grade of Junior High School with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 9 can be seen in Table 9, as follows:

### Table 9. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 9

| Ecology Aspects | Modus | % | G/CL | FGD |
|-----------------|-------|---|------|-----|
| Sub-aspect 9: The functions of abiotic components in the ecosystem with the indicators, as follows: |       |   |      |     |
| a. The functions of land in the ecosystem based on the physical characteristics |       | 31 | X/C2 | TL, V/C2 |
| b. The functions of land in the ecosystem based on the chemical characteristics |       | 32 | X/C2 | TL, V/C2 |
| c. The functions of atmospheric components in the ecosystem based on the physical characteristics |       | 32 | X/C2 | TL, V/C2 |
| d. The functions of atmospheric components in the ecosystem based on the chemical characteristics |       | 32 | X/C2 | TL, V/C2 |
| e. The functions of hydraulic in the ecosystem |       | 25 | X/C2 | TL, V/C2 |

Note: % = Percentage, G = Class, CL = Level of competency, TL = illogical

Table 9 shows that all indicators are illogical to be taught in the tenth grade of senior high school with competency level C2 because the characteristics and the scope of the materials are still easy and simple. So that, the FGD suggests these indicators logically to be taught in the seventh grade of
Elementary School with competency level C2. The description of the respondents’ modus with the analysis result of FGD in the sub-aspect 10 can be seen in Table 10, as follows:

| Table 10. The Opinion of Biology Education Experts on LC Ecological Aspects of Sub-aspect 10 |
|-----------------------------------------|---------|---------|
| Ecology Aspects | Modus | FGD |
|-----------------|-------|------|
| Sub-aspect 10: The interaction between biotic components and abiotic components in the ecosystem with the indicators, as follows: | | |
| a. The interaction between biotic components and land/edaphic components | 26 | X/C2 TL, V/C2 |
| b. The interaction between biotic components and air/ atmospheric components | 25 | X/C2 TL, V/C2 |
| c. The interaction between biotic components and hydraulic components | 25 | X/C2 TL, V/C2 |

Note: %= Percentage, G= Class, CL= Level of competency, TL= illogical

Table 10 shows that all indicators are illogical to be taught in the tenth grade of Senior high school with the competency level C2 because the characteristics and the scope of the materials are still easy and simple. So that, the FGD suggests these indicators logically to be taught in the seventh grade of Elementary School with the competency level C2. From Table 1 to Table 10 that are explained previously can be concluded in the grid LC of ecological aspects in elementary and senior high school, as follows:

| Table 11. The Grid LC of Ecological Aspects in Elementary and Senior High School |
|---------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Ecology Aspect | Education level/ Competency level (C1-C6) |
|----------------|---------------------------------|
| Characteristics of biome | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| Characteristics of ecosystem | - | - | - | - | - | C2 | - | - | - | - | - | - |
| Characteristics of ecosystem community | - | - | - | C1 | - | C2 | - | - | - | - | - | - |
| Characteristics of the arrangement population of the ecosystem community | - | - | - | C1 | - | C2 | - | - | - | - | - | - |
| Characteristics of the functions happened in the ecosystem | - | - | C1 | - | - | C2 | - | - | - | C3 | - | - |
| Interaction interspecific inter population | - | - | - | - | - | - | C2 | - | - | - | - | - |
| Interaction interspecific inter individual in a population | - | - | - | - | - | - | C2 | - | - | - | - | - |
| Functions of the biotic components in the ecosystem | - | - | C2 | - | - | C2 | - | - | - | - | - | - |
| Functions of abiotic components in the ecosystem | - | - | - | C2 | - | - | - | - | - | - | - | - |
| Interaction between biotic components and abiotic components in the ecosystem | - | - | - | C2 | - | - | - | - | - | - | - | - |

Note: C= Competency level, I-VI= Elementary school level, VII-XII= Junior and Senior high school

Table 11 shows that, according to the biology education experts’ opinions, the ecological aspects start to be taught and assessed in the fourth grade of elementary school with C1 and C2 competency.
level and in the fifth grade with the competency level C1 and C2. Then, it will be continued to the higher level in the seventh grade of junior high school with the competency level C2 and in senior high school with the competency level C3.

Based on the result explained previously, there are some sub-aspects from the modus of respondents’ opinions (the biology education experts that are given the questionnaire) which are illogical according to the FGD results. In this case, it can be happened because they are not suitable with the basic concepts of the LC arrangement that are competency level and the characteristics of pedagogical materials. These things are not arranged continually from the simple to complex, easy to difficult, and concrete to abstract in every level of education and the development stage of the students[2],[10],[11]. For example, the modulus from the respondents’ opinions stated that there are several indicators that have the characteristics and the scope of the materials which are easy and simple. Besides, they become the basic materials and are still taught in the higher level of education. It can be seen in the Table 2 (indicator a, b, and c), 3 (indicator a dan b), 4 (indicators a and b), 5 (indicator a, b, and c), 7 (indicator a to d), 9 (indicator a to e), dan 10 (indicator a to c). Otherwise, in the Table 6, indicator a has the characteristics which is more difficult, complex, and abstract, so it is illogically taught in the elementary school.

According to the competency level in the cognitive area of taxonomy Bloom by Anderson and Krathwohl that contains of six levels [12]. If they will be arranged from the simple one to the complex, so that the competency level of remembering (C1) is more simple that the competency level of C2 understanding (C2), then, the competency level of applying (C3), analyzing (C4), evaluating (C5), and creating (C6) [13]. Besides, the essential thing in the LC arrangement especially for developing the curriculum is the continuity of the pedagogic materials specifically in every level of education. The materials in the elementary school as the basic level must learn the basic materials to build the concepts of the next materials [14],[15], for example in Table 5 that shows the sub-aspects of the functional characteristics that happen in the ecosystem that consist of the food chain, food webs, and the energy flow are taught in the elementary school as the reference to learn the pyramid of ecology and biogeochemical cycle in the Junior High School.

The development stages of the students by Piaget theory consists of four stages that are sensorimotor (age 0-2 years), pre-operational (age 2-7 years), concrete operational age 7-11 years), and formal operational (age 11 to upward) [16],[17]. If they are connected with the students’ age in every level of education, the students will be in elementary school at the age from 7 to 11 years old. It means that they are in the formal operational stage where, in this stage, they must be able to think logically and be able to apply their way of thinking to the concrete and specific example with remembering (C1) and understanding (C2) competency level[18],[19].

The students that are in the junior and senior high school are about 12 to 17 years old. It means that they are in the formal operational stage where, in this stage, they must be able to think abstractly, ideally, and logically [20], [21]. If they are linked with the competency level, the students of junior and senior high school are in the level of understanding (C2), applying (C3), and analysing (C4) [11]. Ideally, the materials that are presented in the curriculum between the competency level and the pedagogic materials taught by the teachers must be suitable with the sub-aspects or the learning materials and the students’ development [22], [23], [24].

4. Conclusion

By considering the result of the research, it can be concluded that LC of ecological aspects according to the opinions from some experts of biology education should be taught earlier in the fourth grade of elementary school in sub-aspect characteristic of function happened in the the ecosystem (indicator a, b, and c) with the competency level C1 and sub-aspect of the function of biotic components in the ecosystem (indicator a) with the competency level C2. The fifth Grade of elementary school in sub-aspect characteristics of ecosystem (indicator a, b, and c), sub-aspect characteristics of ecosystem community (indicator a and b), sub-aspect characteristics of the arrangement population of the ecosystem community (indicator a and b) with competency level C1 and sub-aspect functions of
abiotic components in the ecosystem (a, b, c, d, and e), sub-aspect interaction between biotic components and abiotic components in the ecosystem (indicator a, b, and c) with competency level C2. Furthermore, in the level of junior high school in seventh grade sub-aspect characteristics of the biome (indicator a, b, c, d, e, and f), sub-aspect characteristics of ecosystem (indicator d, e, f, and g), sub-aspect characteristics of ecosystem community (indicator c, d, e, and f), sub-aspect interaction of interspecific among populations (indicator a, b, c, d, and e), and sub-aspect interaction of intraspecific among individuals in a population (indicator a, b, c, and d). Sub-aspect functions of biotic components in the ecosystem (indicator c) with competency level C2 and in the level of senior high school tenth grade sub-aspect characteristic of the functions happened in the ecosystem with the competency level C3.

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