The development of diffusion and osmosis practicum activities based on the practical work domain along with curriculum progresses in Indonesia

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Abstract. Some developments going on biology learning as long as curriculum progresses such as practical activities on diffusion and osmosis. The research aims to describe the characteristics of diffusion and osmosis practical design based on the student’s worksheet along with the development of the curriculum. The research method was descriptive. The samples used include eight student worksheets from different curriculums. Analysis indicators include the content, practical activities, and the construction of knowledge. Curriculum that used in the study began from the 2004 Standard-based Curriculum until 2013 Curriculum. Data analysis was conducted by scoring aspects of concepts, practices, and knowledge construction in student worksheets using the assessment rubric. The results show that the content of diffusion practicum and osmosis activities do not increase the percentage in line with the development of the curriculum (75.00%; 75.00%; 75.00%). The percentage was increase in practices (71.43%; 80.95%; 90.48%) and knowledge construction aspects (83.33%; 91.67%; 95.83%). Thus, it can be concluded that as the curriculum progresses, diffusion and osmosis activities do not develop in the essence of the content but on practical activities and knowledge constructions.

1. Introduction
The current education has entered the second decade of the 21st-century. With the development of time, education also developed with some changes in it. A fundamental difference in 21st-century education is interconnection (connectedness) between disciplines. Students do not study the knowledge separately, but knowledge learned as a whole from the perspective of various disciplines [1]. The advancement of technology has also influenced the development of science. The emergence of the revolution technology makes biologists realize a drastic change in tools and the process used to scientific research [2], [3], through the use of the technology embedded practices of science and engineering. Experience through science and engineering practices contribute to the college career as well as the readiness of the students to work in the future. Also, the students can have a basic knowledge of life enclosing science, technology, engineering, and mathematics [4]. The education system should give higher and competence for all students thinking skills [5]. The current science education should put more emphasis on understanding students about ideas and scientific knowledge as well as the process of inquiry. The process is based on the theory of constructivist. Learning biology is to do with scientific investigations to encourage the ability to think, work, be scientific, and communicate. It is useful as an important aspect of life skills [6].
This 21st-century education direction is very relevant to the goal of education in Indonesia as stated by National Education System section 3 chapter 1 Law No. 69 years 2013 that “2013 curriculum aims to prepare Indonesian people to have the ability to live as a person and a citizen who are faithful, productive, creative, innovative, and affective and capable of contribute to people's lives, national, state, and world civilization [7]. Learning directed at the creation of an active atmosphere, critical, analysis, and creative in solving through the development of thinking ability [8]. Learning science since 1975 had emphasized understanding and relationship among concepts in curriculum, as well as the use of the scientific method. In the 1984 and 1994 curriculum, the BCO (Basic Course Outline) curriculum aimed to develop science process skills at the level of primary education and use the process skills at the level of secondary education. The 2004 Standard-based curriculum and 2006 School based curriculum strongly emphasized the development and the ability (competence) in teaching at various levels [9]. The scientific approach in the 2013 curriculum is a process of learning designed in such a way that students can actively construct concepts and principles through the stages of observing, coordinating, collecting information, associating, and communicating which recognized as scientific skills [10].

Practical work plays an important role in the process of science learning [11]. Learning science with the practical work is not just learning about the content but also is a process giving learning experience so that building skills to acquire knowledge [12]. Learning science with the practice is not just learning about the content but also is a process giving learning experience so that building skills to acquire knowledge [13].

The concept of diffusion and osmosis is an example of functional basic concepts of cells that are transported to the membranes. Some research has been conducted to analyze the concept of diffusion and osmosis like analysis pre-service teacher in understanding the diffusion material and understanding the ability osmosis that is affected by the old teaching and their experience [14]. Practical activity analysis has also been carried out on photosynthesis [15] and environmental material change [16]. The development of the curriculum in Indonesia from the Standard-based curriculum in 2004 to the 2013 curriculum has been examined [17]. Thus, analyzing practical activities as the development curriculum that applies research in particular on the concept of diffusion and osmosis has not been conducted.

2. Method
The method used in this study is descriptive. The sample is eight student worksheets on the concept of diffusion and osmosis with different curricula. Eight student worksheets including one student worksheet from the 2004 Standard-based curriculum, four worksheets students of the 2006 School based curriculum, and three students’ worksheets of the 2013 curriculum. The instruments used in the form of sheet analysis and assessment rubric. On the sheet analysis, there is a conceptual indicator, practical activities, and knowledge construction based on the domain of practical work (Figure 1). Data analysis was conducted by scoring in student worksheets using the assessment rubric that adapted from the vee diagram rubric and curriculum components. The results of the analysis in the form of design development activities that practical activities view descriptions characteristics in terms of content (conceptual), practical activities, and knowledge construction.

3. Result and Discussion
The results of the analysis of activities in the form of data about the analysis of the essence of content (conceptual), practical activities analysis, and knowledge of construction analysis.

3.1. Essence of Content
The essence of the content or conceptual is idea that needs to be studied or subject matter which are listed in the curriculum and became the basis to achieve knowledge appropriate educational goal. Content analysis is based on curriculum components such as basic competence and subject matter, also component of the activity such as practical titles, goals, sequence of activity, and the conclusion of activity. This section aims to analyses the suitability of the laboratory activities with the prevailing curriculum. Table 1 shows the development of the essence of content on diffusion and osmosis activities from the 2004 Standard-based curriculum to the 2013 curriculum. The results of the development of the
analysis of the essential content on a diffusion and osmosis student worksheet show average earnings the same percentage as the development of curriculum with a percentage of 75.00%.

Table 1. The development of the essence of content on diffusion and osmosis practice as the development of curriculum

| Curriculum       | Percentage (%) |
|------------------|----------------|
| 2004 Standard-based | 75.00          |
| 2006 School-based          | 75.00          |
| 2013 Curriculum            | 75.00          |

On a diffusion and osmosis worksheet of the 2004 Standard-based curriculum and the 2006 School-based curriculum, the average percentage is 75.00%. The acquisition of an average percentage because there one aspect that has an appropriate category according to the aspects of the purpose of the suitability activities and sequence of activity. Also, there are three other aspects with less appropriate categories that aspect of the alignment of practical content with basic competence, aspects of the suitability of the competence as measured during practical with the demands of basic competence, and aspects of alignment of the title activities and the purpose of activities.

While on a diffusion and osmosis worksheet of 2013 curriculum, the acquisition of the percentage average due to there are two aspects that have an appropriate category according to that aspect of the suitability of the title activities and the purpose of activities and aspects of the purpose of the suitability of activities and sequence of activity. While aspects by category less appropriate aspects of the suitability of practical content with basic competence. While the aspects of the suitability of the competence as measured during practical and basic competence demands are on the category is not appropriate.

Alignment of the essence of practical content with basic competence on any curriculum role in the conceptual development of students. Curriculum and the quality of education are the two components that affect each other, contributing and can't even separate [18]. The 2004 Standard-based curriculum and 2006 School-based curriculum strongly emphasized the development and the ability (competence) in teaching at various levels [9]. The 2013 curriculum is said to be as adding from the previous curriculum designed to anticipate the competence needed for the 21st-century [19].

3.2. Practical Activities
Practical activities include activities to understand the content through the object/phenomenon by using the tools/ingredients accordingly. Table 2 shows the development of practical activities aspects of diffusion and osmosis activities from the 2004 Standard-based curriculum to the 2013 curriculum. The results of the development of practical activities aspects analysis show the acquisition of an average percentage increase over the development of the curriculum from 71.43% to 90.48%

Table 2. The development of practical activities on diffusion and osmosis practice as the development of curriculum

| Curriculum       | Percentage (%) |
|------------------|----------------|
| 2004 Standard-based | 71.43          |
| 2006 School-based          | 80.95          |
| 2013 Curriculum            | 90.48          |

In this section there are descriptions of practical activities through the trials without change tools, materials, and procedures contained in student worksheets. This process aims to test activities laboratory in the present object/phenomenon. Based on the diffusion and osmosis worksheet of the 2004 Standard-based curriculum, the average percentage of practical activities aspects is 71.43%. The acquisition of an
average percentage, because there are three aspects by appropriate category are the tools, materials, data recording. Besides, two aspects have a less appropriate category that is in sequence of activity and the appearance of the object/phenomenon. Then two aspects with categories do not appropriate include time for activities and laboratory safety instructions.

On a diffusion and osmosis worksheet from the 2006 School-based curriculum, the average percentage of practical activities aspects is 80.95%. The acquisition of the percentage average, because there are four aspects are on the category appropriate that tools, materials, data recording, and the time of activity. Also, there are two aspects with less appropriate categories that phases in sequence of activity and the emergence of the object/phenomenon. Then one aspect by inappropriate category is an aspect of the lab safety instructions.

On a diffusion and osmosis worksheet of the 2013 curriculum, the average percentage of practical activities aspects is 90.48%. The acquisition of the percentage average of five aspects has a category which is due to appropriate tools, materials, data recording, time activities, and laboratory safety instructions. Besides, two aspects have a category that is less appropriate stages in sequence of activity and the appearance of the object/phenomenon.

The practical work on the lab is active learning process that requires students’ involvement in observing or manipulate the materials and real objects [20]. Some scientists agree that the quality of good practical work that can involve students to develop skills, understand the process of scientific investigations, and develop their concept of understanding [21].

### 3.3. Knowledge Construction

The construction of the knowledge involves the process of building concepts based on the process of observing objects/phenomenon, recording and doing transformation data based on objects/phenomenon, as well as linking the theory and observations. This analysis ideally set up based on objects/phenomenon that appears, recorded, and used to construct knowledge. In this section, there is the process of checking between the contents of the activities and theory formed during the activities. Table 3 shows the development of knowledge construction on the diffusion and osmosis activities from the 2004 Standard-based curriculum to the 2013 curriculum. The results of the analysis in the development of knowledge construction show the acquisition of an average percentage is increasing as the development of the curriculum from 83.33% to 95.83%.

| Curriculum        | Percentage (%) |
|-------------------|----------------|
| 2004 Standard-based | 83.33          |
| 2006 School-based  | 91.67          |
| 2013 Curriculum    | 95.83          |

On a diffusion and osmosis worksheet of the 2004 Standard-based curriculum, the average percentage is 83.33%. The acquisition of an average percentage because four aspects have an appropriate category according to the process of answering the question, guiding the character of the fact, the principle, and the process of analyses in guiding questions. Also, the four other aspects are on the less appropriate category that the fact to construct the concept, the process of data interpretation, the making conclusion, and alignment of the conclusion with the title/objective of the activity.

On a diffusion and osmosis worksheet of the 2006 School-based curriculum, the average percentage is 91.67%. The acquisition of the percentage average because there are six aspects with appropriate categories such as the process of answering the question guide, has the character of the fact, the process of data interpretation, the principle, the process of analyses in the guiding questions, and the making conclusion. Two other aspects are less appropriate categories like facts for construct concepts and alignment from the conclusion with the title/objective of the activity.
On a diffusion and osmosis worksheet of the 2013 curriculum, the average percentage is 95.83%. The acquisition of an average percentage because seven aspects have an appropriate category according to the character of fact, the fact to construct the concept, the process of interpretation, data the principle, the process of analyses in the guiding questions, the making conclusion, and compliance between the conclusion with the title/objective of the activity. An aspect that less appropriate category is the process of guiding answering the question.

Learning science with the practice is not just learning about the content but also is a process giving learning experience so that building skills to acquire knowledge [12]. To make meaningful learning, students must build a relationship between the theory and practice in the experience of daily life and change it from not real to be real [22].

The graph of the development of the essence of content, practical activities, and construction of knowledge on the different curriculum can be seen in Figure 1. The picture shows the development of each indicator is in line with the development of the curriculum. Based on the chart, it can be seen as the tendency of the full development of practice activities design.

![Figure 1](image1.png)

**Figure 1.** The development of the essence of content, practical activities, and knowledge construction as the development of curriculum

At the 2004 Standard-based curriculum, the lowest value found in the practical activities aspects and the highest value contained in the knowledge construction. In the 2006 School-based curriculum and 2013 curriculum, the lowest value found in the essence of the content and the highest value contained in the construction of knowledge. Practical work play a role in helping students connect between objects/phenomena that observed and the ideas [23]. These interrelated of three aspects in the practical work domain as indicated in Figure 2.

![Figure 2](image2.png)

**Figure 2.** The role of practical work

4. Conclusion

Based on the research results, it can be concluded that there are some differences in the development of the essence of content (conceptual), practical activities, and knowledge construction on diffusion and osmosis practicum. The essence of the content / conceptual are not subjected to the development along with the development curriculum that looks from the same percentage value (75.00%-75.00%) of the 2004 Standard-based curriculum until 2013 curriculum. The increase in percentage was contained on the practical activities (from 71.43% to 90.48%) and knowledge construction (from 83.33% to 95.83%) as long as the curriculum progresses.
5. References

[1] Mintzes J J Wandersee J H and Novak J D, 2001 Assessing understanding in biology, Journal of Biological Education. 35, 3 p. 118-124

[2] Diaz C E Drew M L and Maeve L M, 2020 21st Century Reform Efforts in Undergraduate Quantitative Biology Education: Conversations, Initiatives, and Curriculum Change in the United States of America An Int. J. Lett. Biomath. 7, 1 p. 55–66

[3] National Research Council Of The National Academies T, 2009 A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution (Washington DC: The National Academies Press)

[4] Bybee R, 2015 Translating the NGSS for Classroom Instruction (Arlington: National Science Teacher Association)

[5] Anagin Ş S, 2018 Teachers’ perceptions about the relationship between 21st century skills and managing constructivist learning environments Int. J. Instr. 11, 4 p. 825-840

[6] Muskita M Subali B and Djukri, 2020 Effects of worksheets base the levels of inquiry in improving critical and creative thinking Int. J. Instr. 13, 2 p. 519-532

[7] Permendikbud no 69, 2013 Kerangka Dasar dan Struktur Kurikulum Sekolah Menengah Atas atau Madrasah Aliyah (Jakarta)

[8] BSNP, 2006 Panduan Penyusunan Kurikulum Tingkat Satuan Pendidikan Jenjang Pendidikan Dasar dan Menengah (Jakarta)

[9] Rustaman N Y, 2011 Pendidikan dan Penelitian Sains dalam Mengembangkan Keterampilan Berpikir Tinggi untuk Pembangunan Karakter Prosp. Semin. Biol. 8, 1 p. 15-34

[10] Kemendikbud, 2014 Materi Pelatihan Implementasi Kurikulum 2013 (Jakarta)

[11] Supriatno B, 2018 Praktikum untuk Membangun Kompetensi Proceeding Biol. Educ. Conf. 15, 1 p. 1–18

[12] Ramadhyanti R Soesilawaty S A and Nuraeni E, 2020 Analisis kualitas struktur dan keberadaan literasi kuantitatif pada lembar kerja peserta didik biologi SMA Assim. Indones. J. Biol. Educ. 3, 1 p. 25-33

[13] Hasni A Roy P and Dumais N, 2016 The teaching and learning of diffusion and osmosis: What can we learn from analysis of classroom practices? A case study Eurasia J. Math. Sci. Technol. Educ. 12, 6 p. 1507-1531

[14] Wahidah N S Supriatno B and Kusumastuti M N, 2018 Analisis Struktur dan Kemunculan Tingkat Kognitif pada Desain Kegiatan Laboratorium Materi Fotosintesis Assim. Indones. J. Biol. Educ. 1, 2 p. 72-76

[15] Shawmi nur ayu, 2016 Analisis Pembelajaran Sains Madrasah Ibtidaiyah Mi Dalam Kurikulum 2013 J. Ilm. Didakt. 16, 2 p. 216-229

[16] Millar R and Abrahams I, 2009 Practical work: making it more effective Sch. Sci. Rev. 91, 334 p. 59-64.

[17] Millar R, 2004 The Role of Practical Work in the Teaching and Learning of Science (Washington DC: National Academy of Sciences)