Preservice Chemistry Teachers’ Preconception on the Topic of Sustainable Development Oriented Plant Pigments Separation

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Abstract. One of the important principles in the success of learning activities is that educators need to pay attention to students’ preconceptions before designing learning designs, because this will provide direction in compiling learning materials and strategies to achieve learning goals. This study aims to identify the preconceptions of preservice chemistry teachers’ as a basis for developing a didactic design on the topic of plant pigments separation which is one of the materials discussed in analytical chemistry II lectures. This research uses descriptive methods with participants were 36 pre-service chemistry teachers at one of the state universities in Pekanbaru City. This descriptive study used a diagnostic test in the form of an essay which totaled 19 questions. Based on the results of preconception analysis, it was identified that most of the students experienced learning barriers mostly in the following sub-discussions: (1) types of green solvents; (2) benefits of eutectic solvents; (3) the relationship of eutectic solvent with principles of green chemistry; (4) the process of making eutectic solvents; (5) experimental stages of plant pigment extraction; (6) processes that occur during extraction; and (7) extraction techniques. So it can be concluded that students do not yet have sufficient basic knowledge because students are not yet able to answer questions in most contexts on the topic of separating plant pigments.

Keywords: Pre-service chemistry teachers, preconception, separation of plant pigments

Introduction

Chemistry is a scientific study that studies matter and its changes which are obtained and developed based on experiments (Chang, 2010). There are three things that we cannot separate in studying chemistry, namely chemistry as a process (scientific performance), attitudes, and knowledge (concepts, facts, laws, principles and theories). Chemical concepts basically use/involve three study aspects that cannot be separated, namely macroscopic (properties that can be observed), submicroscopic (particles that make up
substances), and symbolic (chemical formulas and other chemical symbols) study aspects. In understanding this aspect of the study, it is necessary to have a good understanding of chemical concepts because chemistry also studies a lot of abstract things and this abstractness makes understanding the concepts difficult.

Analytical chemistry is a mandatory course that studies the separation and measurement of chemical elements or compounds which includes qualitative and quantitative analytical chemistry. Qualitative analysis states the presence of an element or compound in the sample, while quantitative analysis states the amount of an element or compound in the sample. According to Adam et al. (2008) analytical chemistry is a branch of chemistry that studies the separation and measurement of chemical elements or compounds. In the context of analytical chemistry, separation is a method or effort made to separate or purify a compound or group of compounds that have a related chemical composition, both on a laboratory and industrial scale. One of the topics in analytical chemistry that is widely discussed and applied in various fields is extraction.

Solvent extraction is a sub-material of the chemical separation course which aims to provide students with an understanding of the concept of separating chemical compounds. Extraction is a chemical separation technique to separate or withdraw one or more components or compounds (analytes) from a sample using an appropriate solvent (Aloisia, 2017). Currently, various researchers in the field of analytical chemistry are developing designs for extraction processes that are more environmentally friendly or what are known as green extraction. New trends in chemistry and environmental law have demanded the use of so-called green extraction processes. The European Union's environmental policy and legislation for the period 2010-2050 calls for reducing the use of petrochemical solvents and volatile organic compounds, as most of them are flammable and highly toxic (Ivanović et al., 2020). Volatile organic solvents (VOS) are estimated to account for 60% of all industrial emissions and 30% of all volatile organic compounds emitted worldwide (Lewis et al., 2020). Based on the character of green extraction, namely a process design that will eliminate or drastically reduce the consumption of organic solvents from analytical procedures, the use of green solvents is the solution.

It is very important to provide an understanding of sustainable chemistry to preservice chemistry teacher students to increase their knowledge and competence. All levels of education are tasked with contributing to sustainable development, especially chemistry education in higher education (Burmeister et al., 2012). Chemistry is considered to have a central role in sustainable development, because many products in everyday life are based on chemistry. As agents of change, prospective chemistry teacher students must understand their role before entering the world of practical work, so it is necessary to introduce and develop sustainable values (Jegstad & Sinnes, 2015). Based on an article review conducted by Murti & Hernani (2023), it is explained that learning that contains elements of sustainable development can develop communication skills, collaboration, creative thinking, problem solving, systems thinking, critical thinking, and also scientific literacy skills. By introducing sustainable chemistry to student teachers, we can grow their scientific literacy and increase their understanding of chemistry studies in sustainability (Pernaa et al., 2022).

Based on the results of the needs analysis conducted by Cahyani et al. (2021) found that in studying chemical separation, especially the solvent extraction sub-material, as many as 75% of students stated that they experienced difficulties in studying the solvent extraction sub-material from the learning resources they used. Therefore, a learning innovation is needed that can accommodate students' needs in studying extraction material. However, before designing a learning design, it would be good for educators to know the initial abilities of their students.

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In planning a good learning plan, prior knowledge or preconception students must be one of the considerations. Hailikari (2009) defines prior knowledge as a combination of knowledge and skills. Prior knowledge is a collection of knowledge and experience that a person has obtained from various sources and has an important influence on learning (Trianto, 2007). Purwana (2012) states that initial knowledge comes from previous lesson material, other lesson material and students' knowledge in the family and community environment.

Pashler et al. (2009) stated that every individual is born with extraordinary learning abilities and potential. So from here it can be said that the task of educators is to condition the abilities and potential of students through maximum learning. Because students are individuals who have extraordinary potential, this does not mean they do not have problems in learning. Often educators have carried out learning optimally using various methods and innovations, but it is not uncommon for students to still face difficulties in learning and learning objectives are not achieved. According to Maulidya & Saputri (2016), one of the causes is that students do not have sufficient abilities or prior knowledge so that when faced with new experiences or knowledge received, students experience difficulties in understanding or applying new knowledge.

A student's initial abilities are the abilities or understanding that students already have which can be obtained from previous learning results before undertaking learning activities at university. Students' initial abilities are students' initial provisions for studying the same concepts but in more depth or other related concepts. One way of knowing a student's initial abilities is by carrying out an initial test before learning. Based on the results of the initial understanding test, it can be seen about the concepts that have been embedded in the student's memory and to detect any conceptual errors. By knowing students' initial abilities, an appropriate learning strategy can be designed to teach concepts, correct conceptual errors or to strengthen existing concepts.

According to Hasanuddin (2020), preconceptions are important in learning because they are one of the bases for designing learning designs. Educators often focus on the content of the material to be taught. However, it would be better to first obtain information about students' preconceptions to find out whether they are active, appropriate, sufficient, and accurate. Sumarto (2013) states that one of the important principles in the success of learning activities is that educators need to pay attention to students' preconceptions before they carry out learning activities. Preconceptions provide direction in compiling learning materials, strategies and designs so that they are able to provide efficient use of learning resources and achieve learning objectives (Hasanuddin, 2020). Based on this explanation, it is very important to identify students' prior knowledge to design learning designs that are innovative and in accordance with the set learning objectives so that learning activities can provide good results (Suryadi, 2011).

Analysis of students' preconceptions about the topic of plant pigment separation is needed to produce learning designs that can develop students' more comprehensive understanding of concepts. Therefore, it is important to analyze students' preconceptions in interpreting various concepts on the topic of plant pigment separation. Based on this, this research aims to determine students' initial abilities in explaining the concept of separating plant pigments regarding sustainable development.

**Methods**

This research uses descriptive methods. This research was conducted using participants, namely 36 students who took the analytical chemistry II course. The sampling technique in this research is convenience sampling. This research uses a test instrument.
in the form of an essay to determine the preconceptions of prospective chemistry teacher students. The essay test is prepared based on an analysis of learning objectives on the topic of separating plant pigments with sustainable development which is limited to the extraction chapter using 4 discourses with 19 questions. Questions are arranged based on the learning objectives to be achieved and accommodate the scientific literacy skills of prospective chemistry teacher students. The questions given included knowledge of plant pigments, sustainable development goals (SDGs), the process of separating plant pigments, understanding and principles green chemistry, green solvents, eutectic solvents, and the relationship between the context of eutectic solvents as solvents in the separation of anthocyanin pigments. To guarantee the test instrument used, a suitability test is carried out by asking for advice from experts in the field being measured. After receiving suggestions and input from experts, revisions are then carried out to improve the essay test that will be used.

Data analysis is carried out by assessing student test results using an assessment rubric, so that data will be obtained in the form of scores/percentage values of student preconception test results for each question which are grouped into 3 categories, namely: high, medium and low. This research was carried out at one of the state universities in Pekanbaru City.

Results and Discussion

The results of research into the preconceptions of prospective chemistry teacher students regarding the topic of separating plant pigments are presented in table 2. Analysis of the data obtained begins by scoring each prospective teacher student's answer according to the answer key that has been developed. Scores are grouped for each question developed with the information 0= No answer/wrong answer (-); 1= Answered correctly but incomplete (+); 2= Answered correctly and completely (++). Then the scores obtained are converted into percentage data. This grouping was carried out to make it easier to analyze the results of preservice chemistry teachers preconceptions on the topic of plant pigments separation regarding sustainable development.

Table 1. The results of preservice teachers preconception

<table>
<thead>
<tr>
<th>No</th>
<th>Questions</th>
<th>Preconception (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>Explain the meaning of pigment and the basic types of pigments that exist in plants!</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Regarding the SDGs mentioned earlier, what do you know about SDGs?</td>
<td>31</td>
</tr>
<tr>
<td>3</td>
<td>Why is the context of utilizing mangosteen peel a movement that supports the SDGs?</td>
<td>42</td>
</tr>
<tr>
<td>4</td>
<td>Describe what you know about the extraction separation method!</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>What are the stages of the plant pigment extraction experiment?</td>
<td>56</td>
</tr>
<tr>
<td>6</td>
<td>Explain the basic principles of the extraction process!</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>What is the process that occurs in the extraction of plant pigments?</td>
<td>100</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>64</th>
<th>19</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Have you ever heard of these extraction techniques? Or have you ever done one of these extraction techniques? If you have tried, explain.</td>
<td>36</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>9</td>
<td>Explain the components of the tool and the working principle of reflux extraction from what you know by looking at the picture above!</td>
<td>36</td>
<td>39</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>Explain the basic considerations in the selection of extraction techniques and solvents used!</td>
<td>25</td>
<td>17</td>
<td>58</td>
</tr>
<tr>
<td>11</td>
<td>Explain your knowledge about green chemistry!</td>
<td>33</td>
<td>53</td>
<td>14</td>
</tr>
<tr>
<td>12</td>
<td>Why is green chemistry a trend that is being promoted in many studies and industries?</td>
<td>58</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>13</td>
<td>Explain what you know about green solvents!</td>
<td>86</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>Explain the types of green solvent that already exist!</td>
<td>42</td>
<td>36</td>
<td>22</td>
</tr>
<tr>
<td>15</td>
<td>Are eutectic solvents suitable for use as solvents for the extraction of natural materials to replace organic solvents? Give the reason.</td>
<td>61</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Are eutectic solvents sustainable and in accordance with the principles of green chemistry? Give the reason.</td>
<td>81</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>How do you make eutectic solvents?</td>
<td>72</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>Why can eutectic solvents be used to extract anthocyanin pigments? Explain what affects it</td>
<td>69</td>
<td>0</td>
<td>31</td>
</tr>
</tbody>
</table>

After the scores are converted into percentages, the total percentages for each category are obtained. If sorted by the largest percentage, based on table 1, overall it is identified that 50% of students have mastery of preconceptions in the low category, 26% of students have mastery of preconceptions in the medium category, and another 24% of students have mastery of preconceptions in the high category (Figure 1). Next, the results of the student's preconception test are analyzed for each question item. Analysis of these results is to find out what learning obstacles students experience when understanding the material on separating plant pigments regarding sustainable development.

![Figure 1. Graph of Preservice Teachers Preconception](image)

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Through the analysis that has been carried out, very varied student answers can be identified. This supports the view of Piaget, a constructivist, that students should not be considered as blank white paper who do not have any knowledge before learning new material is provided in the classroom, but rather as individuals who already prior knowledge or preconception, and this can be seen from the varying answers of each student (Campbell & Thompson, 2008). In line with the results of Langitasari (2016) research, chemistry education students at Sultan Ageng Tirtayasa University who took the Basic Chemistry I course already had initial knowledge of the concept of redox reactions, although it was still relatively low. Once learning obstacles have been identified, they are then described further to obtain an overview for designing didactic situations and didactical anticipation which can be used to develop good learning designs that take into account students' prior knowledge, as well as a solution to overcome learning obstacles that occur.

In question number 1 regarding the meaning of pigments and the basic types of plant pigments, it was found that none of the preservice chemistry teachers were in the low category, meaning that students already had most of the understanding of the meaning of pigments and the basic types of pigments in plants. However, from the answers of students in the medium and high categories, they could not explain the types of plant pigments comprehensively, and could only mention 2-3 types of pigments. Based on a review of articles by Azmin et al. (2022), that pigments are chemical compounds that absorb light in the visible wavelength range. Pigments are substances found in animal or plant tissue that can be produced naturally and synthetically, and provide a distinctive color. Basic plant pigments include chlorophyll which is responsible for the green color, β-carotene for the red-orange color, lycopene for the red color, and so on.

In questions number 2 and 3 related about SDGS, it was found that the majority of students already had basic knowledge about SDGs. Through these findings it can be concluded that students in the high category have good general knowledge about current issues as a source of their initial knowledge. Students usually get current issues by reading lots of articles and news. This is in accordance with what Purwana (2012) stated that initial knowledge comes from previous lesson material, other lesson material and students' knowledge in the family and community environment. Meanwhile, students in the low category do not yet have basic knowledge about SDGs. One of the reasons is that students usually don’t really care about current issues related to education and the environment. According to Paristiwati et al. (2022) Knowledge of ESD is an important element in 21st century learning, therefore, it is very important for prospective teachers to understand how to apply it in schools during the learning process. The contribution of chemistry education to supporting ESD includes developing prospective chemistry teachers' understanding and ability to apply appropriate pedagogy. Personal, social, and professional competencies are necessary for a paradigm shift, where knowledge of ESD is integrated and reflected in prospective teachers' approaches to chemistry education in a way that instills the value of sustainability in their students as early as possible.

In question number 4 regarding the meaning of extraction, it was found that students in the low category did not know the meaning of extraction. Solvent extraction is a sub-material of the chemical separation course which aims to provide students with an understanding of the concept of separating chemical compounds. Extraction is a chemical separation technique to separate or withdraw one or more components or compounds (analytes) from a sample using an appropriate solvent (Aloisia, 2017).

In question number 5 regarding the stages of the extraction experiment, it was found that the majority of students were in the low category. This indicates that students do not have initial knowledge about plant pigment extraction experiments. Based on the research article by Azmin et al. (2022) the extraction stages of plant pigments are divided into 3,
namely, first, drying as a preventive measure to protect the samples from any microbial activity, thereby increasing the shelf life of the samples. Second extraction, where the dry sample will be mixed with a solvent and usually treatments such as heating and stirring are added to reduce extraction time and get higher extraction yields. Third, filtering and evaporation, where this stage is necessary to separate the solid residual biomass and liquid plant pigments with a solvent and continue with evaporation using rotary evaporator.

In questions number 6 and 7 regarding the basic principles of the extraction process and the processes that occur when the sample is extracted, it was found that the majority of students already have sufficient basic knowledge regarding the basic principles of the extraction process, but regarding the processes that occur when the sample begins to be extracted, students do not know yet. The basic principle of the extraction process is the process of withdrawing the target compound using an appropriate solvent based on the principle of close polarity of the compound and solvent. The extraction process begins immediately after the plant part is immersed in the solvent with the help of heating and stirring, then continues with 3 processes, namely the first is that the solvent penetrates into the plant cells because the solvent concentration is different between the cells and the solvent medium. The second is that solvents quickly diffuse into plant cells to replace lost water. Third, plant pigments dissolve in solvents before diffusing out of the cells into the solvent medium (Nurgroho, 2017).

In question number 8 regarding extraction techniques, it was found that most students did not know about extraction techniques. Meanwhile, other students who know one or two of the extraction techniques are students who have graduated from Vocational High Schools (SMK). This is in line with what was stated by Trianto (2007) that initial knowledge is a collection of knowledge and experience that a person already has which is obtained from various sources and has an important influence on learning. Bioactive compounds from plants can be extracted using various extraction techniques. Existing techniques include maceration, Soxhlet extraction, microwave assisted extraction, ultrasound assisted extraction, and reflux extraction (Nurgroho, 2017).

In question number 9 regarding the reflux extraction technique, it was found that the majority of students had never tried the reflux extraction method. However, through the picture of the tool in the question, most students were able to explain the tool components of reflux extraction. This is in line with what was stated by Campbell & Thompson (2008) that students’ initial knowledge must be activated through various activities such as reading, writing, discussing, thinking, providing visual cues and organizing. The reflux extraction method is an extraction method with the help of heating. The working principle is hot extraction which is carried out by evaporating the solvent and cooling it (condensation) again to be repeated continuously so that the volume of solvent in the system is maintained (reflux). During the heating process, the solvent will boil and evaporate. In this phase, the hot solvent will damage the tissue and cell walls which then penetrate the inside of the cell and dissolve the metabolite compounds which are then dissolved with the solvent (Nurgroho, 2017).

In question number 10 regarding the basic considerations in selecting the extraction technique and solvent used, it was found that students in the low category did not know about the basic considerations in selecting the extraction technique and solvent used. According to Nurgroho (2017), several things that must be considered in choosing the extraction technique to be used are efficiency, producing high yields with maintained quality, and shorter extraction times. Meanwhile, the main considerations in choosing the type of solvent are polarity, viscosity, according to the physical and chemical properties of the material and secondary metabolites to be extracted, non-corrosive, non-toxic, easy to
obtain, cheap, does not cause residue problems, and does not damage/ bad for the main elements in the product and the environment.

There were questions number 11 and 12 related to green chemistry. It was found that some students were in the low category and did not know about green chemistry. Chemistry education has a central role in education for sustainable development (Burmeister et al., 2012). Sustainable development in the field of chemical education is called sustainable chemistry. Sustainable chemistry can be realized one way by applying the principles of green chemistry. Green chemistry is a chemical thinking concept developed in education to participate in the sustainable development process. Green chemistry, also called sustainable chemistry, is the utilization of a set of principles that reduce or eliminate the use or generation of hazardous substances in the design, manufacture and application of chemical products (Anastas, 2001). The principles of green chemistry are needed in all processes related to chemical substances, such as experimental processes in the laboratory. The use of chemicals has the potential to produce waste that is dangerous for the environment. Schools as laboratory users can apply green chemistry principles (Aubrecht et al., 2015), and the application of green chemistry is starting to be developed in the chemistry curriculum (Karpudewan et al., 2015). The process of integrating principles of green chemistry in education is called green chemistry education.

In question number 13 related green solvents, it was found that the majority of students did not have basic knowledge about green solvents. Most students are still not familiar with the term green solvents because they have never had knowledge about it before. Green solvents or green solvent is an environmentally friendly solvent which has characteristics namely degradable, cheap, safe, stable, renewable, and atom economical. The solvent that is generally considered safe, non-toxic and environmentally friendly is water. However, for extracting polar bioactive compounds, the extractability of water is in many cases significantly lower than that of organic solvents. So to minimize the use of organic solvents, the researchers designed green solvents (Schuur et al., 2019).

In question number 15 related to the definition of eutectic solvents, It was found that most students did not have basic knowledge about eutectic solvents. DES is a new generation solvent formed by mixing hydrogen bond acceptor (HBA) and hydrogen bond donor (HBD) components at different ratios. The resulting mixture has a melting point that is lower than the melting temperature of each component (Dai et al., 2013).

In question number 16 regarding eutectic solvents suitable for use as solvents for the extraction of natural materials to replace organic solvents, it was found that most students did not know about eutectic solvents. This is because the topic of eutectic solvents still sounds new to them. Based on the research article by Dai et al. (2013) explained that eutectic solvents have the same solvent properties and are even better than solvents that are usually used for the extraction process of natural materials such as organic solvents. One important property is polarity, because it affects the dissolving capacity during the extraction process. Organic acid based eutectic solvents are the most polar with a polarity value of 44.81 kcal/mol, followed by amino acids and a pure sugar-based eutectic solvent with a polarity similar to water with a polarity value of 48.21 kcal/mol. Eutectic solvents based on sugar and polyalcohols are the least polar, with a polarity close to that of MeOH, namely 51.89 kcal/mol.

In question number 17 regarding eutectic solvents sustainable and in accordance with the principles of green chemistry, It was found that most students did not know the properties of eutectic solvents. Based on research by Mišan et al. (2020), eutectic solvents have properties that provide many advantages, including: biodegradable or easily decomposed so that it is environmentally friendly, non-toxic, cheap, liquid state even below 0 °C, adjustable viscosity, safe and cheaper because many eutectic solvents are composed.
of components that are abundant in our daily food. Apart from that, several eutectic solvents also show very high solubilization capabilities for both polar and nonpolar compounds, as well as the simple, easy preparation of eutectic solvents with high purity and no waste generation, making eutectic solvents a solvent that meets the 12 principles of green chemistry (Anastas, 2001).

In question number 18 regarding how to make eutectic solvents, it was found that most students did not know how to make eutectic solvents. The eutectic solvent is obtained by heating the HBA and HBD components at a certain molar ratio simultaneously to a temperature of 80°C and while stirring using a magnetic stirrer for 1 hour, then after the heating process is complete, a clear liquid is obtained which is called a eutectic solvent (Gu et al., 2015). For example, the eutectic solvent lactic acid-glucose is made by mixing lactic acid, glucose and water in a certain ratio, heated together to a temperature of 80°C and while stirring using a magnetic stirrer for 1 hour until a homogeneous clear solution is formed.

In question number 19 regarding the reasons why eutectic solvents can be used to extract anthocyanin pigments, it was found that most students did not know the reasons because they had never read about this topic before. The extraction of bioactive components is influenced by one factor, namely polarity. In line with the explanation of (Bosiljkov et al. (2017) that anthocyanin is a polar compound that can dissolve better in polar solvents than non-polar solvents, so that when a polar eutectic solvent is mixed, the eutectic solvent will be able to attract more anthocyanin.

Based on the results of data analysis of student preconceptions, from the 19 questions given, it appears that the majority of students experience the most learning obstacles in the following sub-discussions: (1) types of green solvents; (2) benefits of eutectic solvents; (3) the relationship of eutectic solvent with principles of green chemistry; (4) the process of making eutectic solvents; (5) experimental stages of plant pigment extraction; (6) processes that occur during extraction; and (7) extraction techniques. Based on these findings, the learning obstacles that have been identified are described further in order to obtain an overview for designing didactic situations and didactical anticipation that can be used to develop good learning designs that take into account students' prior knowledge, as well as solutions to overcome learning obstacles that occur.

The reason why many students do not know the basic concepts regarding the topic of separating plant pigments regarding sustainable development is because they have never received or read about this topic before, so this affects their mastery in explaining several concepts in this topic. This is in line with the statement put forward by Susilo (2016) that there is a relationship between initial knowledge and the ability to complete and investigate concepts. The higher the level of students' initial knowledge, the higher the students ability to understand concepts. So, in this relationship, students who have high initial knowledge have greater ability to discover and investigate concepts. From this research, it was found that prior knowledge helps students train their thinking skills and learn independently.

Some research on prior knowledge (prior knowledge) shows that students who have high initial knowledge have greater ability to discover and investigate concepts, so that initial knowledge also helps students practice thinking skills and learning independence (Susilo, 2016). Other research shows that student learning outcomes are influenced by prior knowledge positively and significantly (Hikmah, 2018). Astuti (2015) reseach shows that interest in learning and prior knowledge together have an influence on students' learning outcomes and achievements.
Preconception data of pre-service chemistry teachers regarding the topic of separation plant pigments can be a diagnosis of learning barriers to serve as a basis for designing innovative learning designs and facilitating the achievement of learning objectives. The identified dominant learning obstacles are epistemological learning obstacles, which means that student learning difficulties arise because students’ understanding of concepts is incomplete, only seen from their origins (Sulistiaawati et al., 2015). Specific learning barriers can be seen in Table 2.

Table 2. Learning obstacles on the topic of plant pigments separation oriented towards sustainable development

<table>
<thead>
<tr>
<th>No</th>
<th>Concept</th>
<th>Learning Obstacles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Definition and types of plant pigments</td>
<td>Most students do not understand the types of basic plant pigments comprehensively (types, colors, and sources of pigments).</td>
</tr>
<tr>
<td>2</td>
<td>SDGs</td>
<td>Most students do not understand SDGs well and the relationship between SDGs and the given context</td>
</tr>
<tr>
<td>3</td>
<td>Extraction of plant pigments</td>
<td>Most of the students did not know about the experimental stages of extracting plant pigments and the processes that occurred in the samples when they were extracted</td>
</tr>
<tr>
<td>4</td>
<td>Extraction techniques</td>
<td>Most students do not know because they have never seen it</td>
</tr>
<tr>
<td>5</td>
<td>Basic considerations in the selection of extraction techniques and solvents used</td>
<td>Most students do not know the concept in depth</td>
</tr>
<tr>
<td>6</td>
<td>Green Chemistry</td>
<td>Most students do not have broad basic knowledge about green chemistry, so the explanations given are incomplete because they rely on the given discourse</td>
</tr>
<tr>
<td>7</td>
<td>Green Solvents</td>
<td>Most of the students only gave a few general answers, not covering the existing keywords</td>
</tr>
<tr>
<td>8</td>
<td>Eutectic Solvents</td>
<td>Most students do not understand broadly about eutectic solvents</td>
</tr>
</tbody>
</table>

Based on the results of the preconception test for preservice chemistry teacher, it was found that the most common learning obstacle that emerged was that students did not yet have basic knowledge in several sub-materials. This is in line with the research by Wijaya et al. (2020) that students have difficulty in answering the questions given because they did not have sufficient basic understanding possibly due to conventional teaching using memorization methods without any emphasis on constructivist approaches. In addition, pre-service teachers also have difficulty in relating the chemical concepts they have with new concepts. The results of the preconception analysis obtained can be used as material for consideration in developing learning designs. According to Hasanuddin (2020) prior knowledge becomes important in learning. This is because learning becomes easier for pre-service teachers so that learning objectives can be achieved. In addition, for teachers, prior knowledge provides direction in compiling materials, strategies and learning designs so that they are able to provide efficient use of resources in the implementation of learning. Therefore, as an implication in learning, a teacher needs to understand the importance of students’ prior knowledge and how students’ prior knowledge is
accommodated in appropriate learning forms and designs. But before that, the teacher must make efforts to identify, activate students' prior knowledge so that this can be used as an entry point in learning design.

**Conclusion**

Based on the results of the research and the description of the discussion above, it can be concluded that only a small proportion of students understand all the concepts contained in separation of plant pigments topic. Overall, based on student preconception data, students were identified as having the most low understanding of concepts in the following discussion: (1) types of green solvents; (2) benefits of eutectic solvents; (3) the relationship of eutectic solvent with principles of green chemistry; (4) the process of making eutectic solvents; (5) experimental stages of plant pigment extraction; (6) processes that occur during extraction; and (7) extraction techniques. This shows that most students do not have sufficient basic knowledge on the topic of separation plant pigments. These results indicate the need to create innovative didactic designs so that students can have a more comprehensive understanding of concepts.

**References**


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