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Profiling the Preservice Biology Teachers' Teaching Orientations: Challenges of 21st Century Learning

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abstract

Teacher's teaching orientations represent teachers' preference in selecting teaching methods that are part of their thinking process and decision-making. Because of the variety of classroom situations, the condition of the students, and the topics to be taught, different teachers might have different preferences for teaching their classrooms. As novice teachers still learn and acquire information regarding the actual classroom setting, this research aims to determine their preference for teaching instructions. Forty-six preservice biology teachers participated in this study. The data was collected using the online version of Indo-POSTT (Pedagogy of Science Teaching Test) was used to understand the preservice teachers' teaching orientations. This formative instrument has been implemented to assess pre- and in-service science teachers' teaching orientations but has never been done widely in Indonesia. Statistically, the study results show that our respondents preferred the more teacher-centered approaches instead of student-centered ones. Active Direct instruction is the most preferred teaching method, while inquiry instruction is the least preferred. This information is especially essential for teacher training institutions to prepare preservice teachers best qualified by understanding the teaching approaches they selected for teaching in the classroom.

1. Introduction

Teaching is a complex process that involves various knowledge, such as pedagogy, subject matter, assessment, knowledge of the learner, curriculum, and other knowledge related to classroom management that is integrated and is called Pedagogical Content Knowledge (PCK). According to Shulman (1987), pedagogical content knowledge is special knowledge formed by the interaction between content and pedagogy that forms an understanding of how particular topics or content knowledge are organized and presented to be understandable for learners. This pedagogical content knowledge results from contextually acquiring and implementing all the associated knowledge, which is called a transformation process, that influences classroom practice (Carlson et al., 2020; Gess-Newsome, 1999). One of the components of PCK is the orientation toward science teaching, which is important for preservice teachers and should develop appropriately (Schiering, Sorge, Keller, & Neumann, 2022).

Pedagogical content knowledge is a blended knowledge of subject matter and knowledge of pedagogy, in which every knowledge is important to support one and another, so they cannot be separated (Copur-Gencturk & Tolar, 2022). PCK is personal knowledge so that every teacher should develop different PCK (Tuithof, Van Drie, Bronkhorst, Dorsman, & Van Tartwijk, 2021). However, some studies showed that Indonesian science teachers had a lack of PCK because they have a problem in understanding the subject matters (Astuti, Wijayatiningsih, Azis, Sumarti, & Barati, 2017; Fananta, Umbara, & Hastuti, 2018). Meanwhile, other studies found that Indonesian science teachers should be guided in implementing their pedagogical knowledge appropriately regarding supporting the development of their PCK (Biru, Prasetyaningsih, Vitasari, Resti, & Suryani, 2018; Hartadiyati, Wiyanto, Rusilowati, & Prasetyo, 2020). On the other hand, it is also noted that the role of mentors or instructors in the teacher training program for developing the preservice and in-service teachers' PCK is important. Jufri, Ramdani, Jamaluddin, and Azizah (2019) found that during the teacher training program, preservice science teachers experience difficulties in exploring their thinking and reasoning in designing a lesson. Intensive interaction and guidance from their mentors help them improve the quality of the lesson that should be designed. This also contributes to the improvement of preservice science teachers PCK. Thus, various factors should be considered in improving teachers PCK.

As part of PCK, the development of orientation toward science teaching influences the ability of determining appropriate ways of the instruction (Gözüm, Papadakis, & Kalogiannakis, 2022; Magnusson, Krajcik, & Borko, 1999). Orientation toward science teaching is related to the knowledge of instructional strategies, specifically in terms of the goals to teach science and the nature of instructions Associated with Different Orientations to teaching Science (Magnusson et al., 1999; Mientus, Hume, Wulff, Meiners, & Borowski, 2022). By integrating the goals and the nature of orientations to teaching science and considering conceptual understanding of science content, Cobern et al. (2014) suggested the science teaching orientation spectrum. This spectrum is basically based on teacher choices, in which whether they will teach science implicitly or explicitly. Within these choices, the teacher's teaching orientations could be didactic or inquiry based.

The teaching orientation spectrum proposed by Cobern et al. (2014) was rooted in Ausubel's meaningful learning theory, in which either direct or discovery learning potentially brings students to learn meaningfully or ends up with rote learning. Although in this orientation spectrum, the teaching instructions are depicted as a range from didactic to inquiry; this does not mean that inquiry base learning represents meaningful learning while direct instruction represents rote learning. This spectrum of orientation consists of four instructions, Didactic Direct (DD), Active Direct (AD), Guided Inquiry (GI), and Open Inquiry (OI), which was based on the orientations proposed by Magnusson et al. (1999) and by simplifying Friedrichsen, Driel, and Abell (2011) definition of orientation. However, the main purpose of this orientation is to picture the predisposition of teachers' instruction. Therefore, teachers should not be judged as merely having direct teaching instruction or inquiry instruction but on how far their direct instruction or inquiry instruction is. Moreover, by considering the skills teachers should possess to face the 21st century, classroom activities should facilitate students to learn comprehensively and integrate into other subjects and knowledge (Hiong & Osman, 2013; Juanda, Maulida, Gloria, Nasrudin, 2021).

Since teachers might tend to select their preferred teaching instructions, Cobern et al. (2014) developed an instrument to picture the teacher's teaching orientations. This instrument is named the Pedagogy of Science Teaching Test (POSTT) (https://wmich.edu/science/inquiry-items) and consists of items that were developed based on the concepts of Problem-Based Learning (PBL) instruction, in which the item vignettes were designed as mini case classroom teaching

situations. These vignettes provide realistic classroom situations and specific instructional goals, consisting of a particular facet of science and phase of the lesson, and then followed by four alternative options of teaching approaches. Although the options in POSTT items consist of four teaching instructions, this instrument was not designed to label the teachers based on these orientation categories but rather elicit the tendencies along the dimension in the teaching approach. The teaching instructions in POSTT were not presented as discrete orientations; instead, the degree of how far the instruction represents inquiry-based learning. Thus, the POSTT scale was constructed as an 'ordinal interval hybrid scale,' in which the calculation through descriptive statistics, such as mean and standard deviation, can be meaningful for describing the central tendency and dispersion of the item from the perspective of instruments, individuals, or groups.

Implementing the POSTT instrument to assess teachers' teaching orientation formatively has been wide. This instrument also has been translated into several languages, such as Turkish (Şahingöz & Cobern, 2018), Korean, Indonesia (Listiani, Cobern, & Pleasants, 2019; Listiani, Cobern, Pleasants, & Adams, 2020; Listiani, Cobern, & Skjold, 2014), and Thailand (Ladachart, 2019, 2020a, 2020b). Because of time constrain problem during teacher education programs, this instrument provides a new way for exposing various classroom situations presented on each item that requires teachers to think about the most appropriate teaching instruction to implement, as well as learn how to make decisions or making evaluations on a particular instructional approach without asking teachers to go to the classroom.

Some scholars have conducted research in teaching orientations for both preservice and in-service teachers using this instrument and found various preferences related to teaching instructions (Bansal, Ramnarain, & Schuster, 2019; Ladachart, 2019, 2020a, 2020b; Ramnarain, Nampota, & Schuster, 2016; Ramnarain & Schuster, 2014; Sondlo & Ramnarain, 2019). Since it has been noted that orientation is part of PCK and has been identified as a critical component of science teaching, some researchers study the relationship between orientation and PCK (Demirdöğen, 2016; Ekiz-Kiran & Boz, 2020; Park & Chen, 2012) and note that orientation contributes to the development of teachers' PCK. Because of its importance, taking closer to teacher orientation becomes an interesting research topic during teacher training programs. However, research in teaching orientation in Indonesia, especially using the POSTT instruments and conducted in teacher training institutions, is still limited. It is important to understand how preservice teachers orient their teaching method preference according to the Indonesian curriculum that requires them to implement inquiry in the classroom because inquiry could improve students' understanding and knowledge about how scientists learn about nature (Fananta et al., 2018). Given the background of the study, we know that teaching orientation is important for preservice teachers as they develop their knowledge for teaching during the teacher training program. Thus, this research addresses the preference of preservice biology teachers in selecting teaching instructions.

2. Method

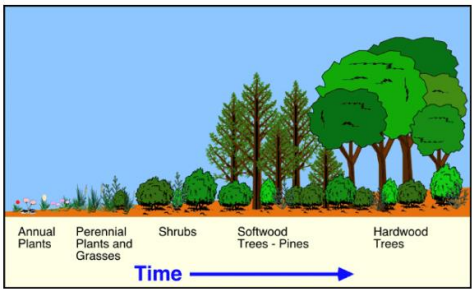
This is a quantitative study and used survey to collect data (Creswell, 2014) related to preservice teachers' teaching orientation. The survey was distributed to the respondents electronically through an e-learning platform. All students who took the interaction and learning strategy course could access the survey easily. The participants were selected using convenience sampling (Creswell, 2012). Thus, 46 preservice biology teachers in one of the public universities in North Borneo who took the Interaction and teaching strategies course agreed to participate in this study. These second-year preservice biology teachers had yet to learn about teaching instructions previously. However, they had taken some pedagogical courses such as the

Introduction to Education course, teaching plan course, and Psychology of Learners course. The participants were asked to respond to an online survey that had been posted on the electronic learning platform.

The data was collected using the Indonesian version of the Indo-POSTT (Pedagogy of Science Teaching Test) that has been translated, adapted, and validated for Indonesian respondents (Listiani et al., 2019; Listiani et al., 2020). This instrument consists of eight items in the form of vignette. Each vignette is followed by four options depicting teaching preference arranged randomly: Didactic Direct (DD), Active Direct (AD), Guided Inquiry (GI), and Open Inquiry (OI) (Cobern et al., 2014). See Figure 1 for the example of the original POSTT item presented in its original language.

Succession

Ms. Tutt's 6th grade class has just finished an introductory lesson on plant succession. The students now understand that succession can be initiated either by the formation of a new, unoccupied habitat (*primary succession*) or by some form of disturbance of an existing community (*secondary succession*). She is now considering the use of a follow up activity at a green space near campus and has several options.



Thinking about how you would teach, of the following, which is most similar to what you would do?

A. Provide the students with a map of the green space demarcating succession. I would then walk the students through the succession areas pointing out the plant life specific to each area.

B. Provide the students with a map of the green space demarcating succession. The students' task would be to identify the types of plant life in each succession area.

C. Ask the students if they thought they could identify succession and how they would do it. Then we would go to the green space, and the students' task would be to map out succession at the green space, developing and documenting their own maps.

D. Take the students to the green space and ask them to observe as much as they could corresponding to our recent studies on succession. I would leave it to the students' own imaginations on how best to use their observations of a real succession environment, and how to document those observations.

Figure 1. An example of the POSTT survey

The data were analyzed descriptively using SPSS software 26.0 for Windows to create histograms depicting the profile of the preservice biology teachers' teaching method preference. The results are also presented in the form of tables. Since the options are arranged randomly, before the data was analyzed, it should be recorded so all the responses would have similar order, which was Didactic Direct (DD), Active Direct (AD), Guided Inquiry (GI), and Open Inquiry (OI). The profile of the preservice teachers' teaching orientations was analyzed based on each item in the questionnaire, and the overall responses. See Figure 2 below for the overall process in this study.

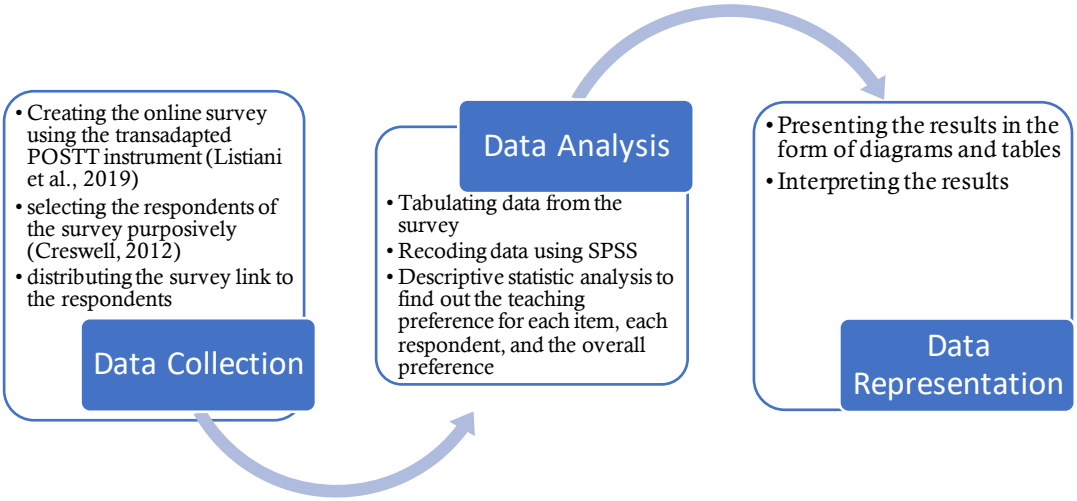


Figure 2. The overall research method with detailed information on each stage

3. Result and Discussion

Teaching orientation is one of the research topics in education that is rarely being conducted in Indonesia, especially for teacher training programs. Teaching orientation is a fundamental aspect of teacher identity (Bunker, 2012), as it reflects how pre-service teachers conceptualize their roles in the classroom and their views on the nature of learning and knowledge (Kind, 2016; Sizer et al., 2021). Teacher training programs play an important role in preparing preservice teachers to be qualified teachers. A qualified teacher is knowledgeable in both pedagogy and content knowledge. Indeed, being a qualified teacher is a long journey, starting with the training program (Stavridis & Papadopoulou, 2022). Therefore, one important aspect that should be the consideration in teacher training programs is the curriculum so that it can greatly facilitate the preservice teachers to have experiences in learning how to be a good teacher, such as having opportunities to practice the knowledge that they have acquired (Mufidah, 2019). During this program, preservice teachers have started to acquire and develop knowledge and skills related to teaching and learning, such as Pedagogical Content Knowledge (PCK), pedagogical reasoning, and teaching orientation (Cobern et al., 2014) as well as how to implement this knowledge in real classroom situations.

The preservice teachers' teaching orientation varied among the eight items, ranging from the more teacher-centered to a student-centered approach. Table 1 shows that over 50% of the survey questions (six items) received more teacher-centered approach responses than student-centered approach responses. In contrast, the rest of the items received more student-centered approach responses. The difference between the teacher-centered and student-centered approaches is insignificant except for two questions, items four and eight. In these two items, the teacher-centered approaches almost dominated the responses. As we can see that, student-centered approaches are not the most preferred teaching orientations, and open-inquiry instruction is the least preferred among the four approaches, which can be seen in most items. Contextual factors may influence preservice teachers' perception of inquiry instruction, such as difficulty to implement, which drives them not to choose the more inquiry-based instructions (Şahingöz & Cobern, 2018). However, further studies should be conducted on the reason behind the orientation.

The scenario in item number one concern teaching the "Food chain" topic using a computer simulation game. The preservice biology teachers preferred to teach this topic with inquiry instructions, either guided or open inquiry. Over fifty percent of respondents selected inquiry

instructions to respond to this item. Another item that represents the preference of inquiry instruction is item number three. This item provides a vignette related to the "Succession" topic. Half of the respondents prefer the Open Inquiry (OI) instruction to teach the Succession topic. This causes item number 3 to be the only item with the highest percentage of inquiry instruction responses. Meanwhile, in the other items, Open Inquiry (OI) seems as the least preferred teaching instruction.

Although teacher-centered instructions are the most preferred instruction among preservice biology teachers, there are also some interesting findings from the results. We have found that the respondents preferred Active Direct (AD) to teach in the scenario in item number four. This makes Item number four the only item that Active Direct (AD) is the most preferred instruction among preservice teachers, which covers almost 80% of the respondent's preference. The item that has Active Direct as the most preferred method is related to teaching the concept of Photosynthesis for eight grade students, and teacher-centered instruction is preferred to more student-centered instruction. Similarly, preservice biology teachers also preferred to teach the topic of "Photosynthesis pigments" on item number eight using Active direct instruction (AD). When the preservice biology teachers preferred the more teacher-centered instruction for teaching, it can be influenced by their learning experiences during secondary education, in which they were exposed to direct instructions since they were required to memorize the content to pass the standardized test (Güven, Muğaloğlu, Doğança-Küçük, & Cobern, 2019).

Table 1. The summary of preservice biology teachers' preferred methods for teaching

Questionnaire items	Percentage				Total
	DD	AD	GI	OI	
Item 1	15.22	32.61	26.09	26.09	100
Item 2	32.61	26.09	26.09	15.22	100
Item 3	13.04	13.04	23.91	50.00	100
Item 4	4.35	76.09	15.22	4.35	100
Item 5	32.61	30.43	30.43	6.52	100
Item 6	26.09	30.43	32.61	10.87	100
Item 7	43.48	13.04	10.87	32.61	100
Item 8	17.39	52.17	10.87	19.57	100

DD : Didactic Direct
AD : Active Direct
GI : Guided Inquiry
OI : Open Inquiry

As one of the knowledge that preservice teachers acquire during the training program, assessing preservice science teachers' teaching knowledge is important. It can be done in various ways (Cobern et al., 2014), for example, continuous surveys from the first semester of the training program until the end of the program to monitor the progress of the preservice teachers in general or the development of their specific skills. This is because teaching orientation is one of the knowledge and skills that the preservice teachers should develop during the training program as a longitudinal process of being a professional teacher (Güven et al., 2019). Thus, evaluating preservice teachers' teaching orientation becomes crucial for teacher preparation programs. Their theoretical or practical experiences may influence the preservice biology teachers' orientation toward science teaching development during the preparation program, such as conceptual development about teaching and learning or experiences during apprenticeship programs (Ladachart, 2019). Because of the importance of teaching orientation, novice biology teachers

should be directed to appropriately develop their orientation toward science teaching, which can lead to achieving scientific literacy. This means the preservice teachers can select the most proper teaching method.

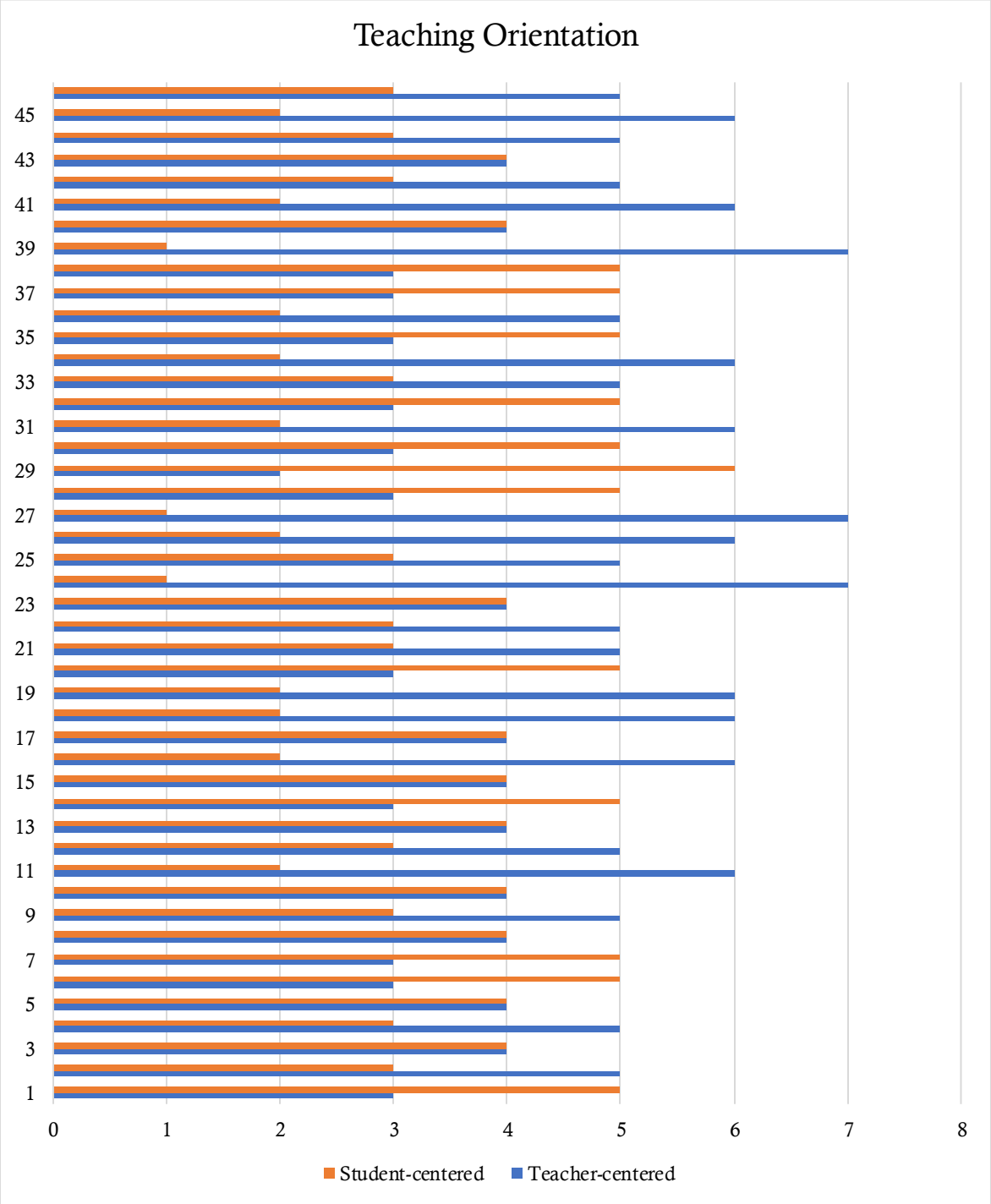
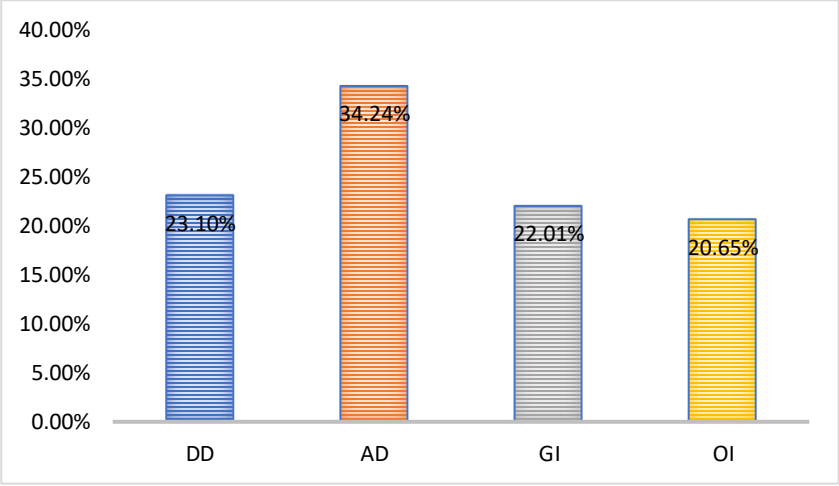


Figure 3. Teaching orientation of each respondent

This study examined 46 preservice biology teachers in the second year of the training program. We had yet to complete all the required pedagogical courses or do the apprenticeship program. This study's results show that preservice biology teachers' orientation toward science teaching varied from teacher–centered to student–centered orientations. In this case, a more

teacher-centered-oriented preservice teacher selects Didactic Direct or Active Direct instruction. In contrast, preservice teachers who prefer Guided Inquiry or Guided Inquiry instruction are categorized as student-centered oriented teachers (Cobern et al., 2014). Generally, there was an obvious finding that overall, the preservice biology teachers' teaching orientation laid on the teacher–centered orientation. This result aligns with research conducted by Ladachart (2020b) and Bansal et al. (2019), which also showed that the teaching orientation of preservice science teachers preferred teacher-centered approaches over student-centered approaches. However, a student-centered approach such as inquiry is another way to teach science. This shows that teachers' teaching orientation can be varied that is influenced by several factors, such as their previous educational background (Avraamidou, 2013), environmental factors such as time constraint and class size (Sondlo & Ramnarain, 2021) or their understanding of the classroom context (Friedrichsen et al., 2011; Güven et al., 2019).

Furthermore, among the respondents, the teaching approaches are also varied. Figure 3 shows the variety of preservice biology teachers teaching preferences. Some preservice science teachers prefer teacher-centered instructions, while others prefer to implement teaching instructions that are more student-centered. From Figure 3, we also see that three respondents are very teacher-centered in selecting teaching instructions. They responded to seven out of eight vignettes with options categorized as teacher-centered instructions. Conversely, only one respondent responded to six of eight items with options categorized as student-centered instructions. Overall, preservice science teachers in teaching lean toward teacher-centered approaches (Figure 4). Although (Cobern et al., 2014) proposed a spectrum of orientation that is consisted of Didactic Direct, Active Direct, Guided Inquiry, and Open Inquiry, because of their characteristic, both Didactic Direct and Active Direct can be categorized as teacher-centered instructions, while Guided Inquiry and Open Inquiry represent student-centered instructions. Thus, the total percentage of teacher-centered instruction responses is higher than student-centered instruction responses.



DD: Didactic Direct; AD: Active Direct; GI: Guided Inquiry; OI: Open Inquiry

Figure 4. The overall teaching orientation profiles of preservice biology teachers

Figure 4 displays the percentage of the overall responses from the respondents for eight POSTT items. Active Direct (AD), which is more teacher-centered, is the most preferred teaching instruction with the highest percentage among other options. On the contrary, Open Inquiry (OI), categorized as student-centered instruction, is the least preferred approach for preservice biology teachers, which can be seen from its lowest percentage compared to other instructions. This is

because the preservice teachers tend to have their own epistemological believe related to teaching instruction preferences (Ladachart, 2020b). The preservice teachers are novices in teaching experience, but their personal experience as students may affect their beliefs related to teaching and learning (Güven et al., 2019). It is possible that in the previous education level, the preservice teachers had been exposed to didactic instruction, which influenced their preference for teaching instruction.

Since orientation toward science teaching is part of PCK (Magnusson et al., 1999), teacher training programs should concern how preservice teachers develop this knowledge. The orientation of preservice teachers toward science teaching is the representation of their thinking and decision-making process related to teaching approaches (Avraamidou, 2013; Friedrichsen et al., 2011). The training program is a crucial time for preservice teachers in shaping their knowledge for teaching and positively impacting their teaching orientations. Identifying preservice teachers' teaching orientation since the early stage of training will be useful in understanding the point of view of preservice teachers in orienting their instruction preferences. For instance, in this study, we found that teacher-centered instructions are preferable to student-centered instructions, which the preservice teachers' perspective can cause that knowledge transmission from teachers to the students to be more important than encouraging students to explore and share their perspectives (Kind, 2016). By the time the preservice teachers learn more about pedagogy and teaching practices, this perspective may shift. Pedagogical orientation is one of teacher's skills that are influenced by internal and external constraints (Bansal et al., 2019). As the preservice teachers continue learning, it will impact the way they orient their teaching approaches to meet what students need and what the curriculum has required.

4. Conclusion

The training program is a crucial time for preservice teachers in shaping their knowledge for teaching and positively impacting their teaching orientations. Identifying preservice teachers' teaching orientation since the early stage of training will be useful in understanding the point of view of preservice teachers in orienting their instruction preferences. This preference is useful to understand whether the preservice biology teachers are ready to face the 21st century competition. In this study, we found that teacher-centered instructions are preferable to student-centered instructions, while more student-centered instructions are the least preferred. Among eight vignettes presented in the questionnaire, only in one classroom case were the preservice biology teachers preferred to teach using a student-centered approach. The respondents selected the more teacher-centered instructions for the rest of the items. Although the preservice biology teacher's teaching orientation is directed to teacher-centered approaches, the exact reasons behind this preference need to be investigated. Thus, further investigation related to preservice teachers' reasons for an orientation toward science teaching is important. Since orientation toward science teaching is part of PCK, teacher training programs should concern how preservice teachers develop this knowledge. The orientation of preservice teachers toward science teaching is the representation of their thinking and decision-making process related to teaching approaches.

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