World Journal of Educational Research
ISSN 2375-9771 (Print) ISSN 2333-5998 (Online)
Vol. 7, No. 1, 2020
www.scholink.org/ojs/index.php/wjer

Original Paper

Active or Passive-What Do Pre-Service Science Teachers Prefer in Their Professional Training?

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Received: January 2, 2019 Accepted: January 20, 2020 Online Published: January 26, 2020

doi:10.22158/wjer.v7n1p81 URL: http://dx.doi.org/10.22158/wjer.v7n1p81

Abstract

The integration of PCK into CK courses base on diverse learning environments and student-centered approach has enabled the development of a Knowledge-Pedagogy-Student-Centered—KPSC teaching approach. This approach has made experiential, interesting and challenging learning accessible to in-depth learning. Moreover, it raises the self-efficacy to adopt this approach in the future. Consistent with the positive feelings of the pre-service teachers when using KPSC, the science lessons in the schools may look different and thus increase the potential to motivate people into becoming science teachers. In summary, this approach has enabled the development of a teaching model based on food web. 1) Similar to the open system of the food web, the effect of implementing KPSC does not end with the boundaries of the classroom. Family, friends and spouses are affected by in-depth learning; 2) There is no single central figure in KPSC and the teacher and students make a great contribution to the learning process; 3) Similar to the relationship within and between the trophic levels, there is an extensive relationship between the lecturer and the students and the students themselves; 4) Similar to the biodiversity in the food web, there is a personal development of the students that creates a variety of learners.

Keywords

content knowledge, content pedagogical knowledge, teaching environment, pre-service science teachers, science teaching

1. Introduction

Pre-service science-teacher training moves on two main axes. On the one axis lies the debate between the need for Content Knowledge (CK) and the need for Pedagogical Content Knowledge (PCK). On the

second, is a debate between teachers in the center (Teacher-Centered Approach) and students in the center (Student-Centered Approach). The combination of providing content knowledge along with teacher-centered approach characterizes teaching in most academic institutions since the 19th century (Shulman, 1986) until today (Le et al., 2018). In most cases, this combination leads to the direct and frontal transfer of knowledge from the teachers to students (Forzani, 2014) using a limited teaching environment (Bocconi & Trentin, 2014) and surface learning that does not help the long-term memory (Varunki, Katajavuori, & Postareff, 2017). The reason for teaching that focuses on content knowledge while adopting the teacher-centered approach and a poor teaching environment arises and depends on the characteristics of the lecturer (Degago & Kaino, 2015; Le et al., 2018; Sadler, 2012). On the other hand, the combination of a student-centered approach with the acquisition of content or pedagogical content knowledge, including the use of a diverse teaching environment, is characterized by higher education institutions that have internalized the need to create instructional change that allows in-depth learning (Bocconi & Trentin, 2014; Varunki et al., 2017). A change in teaching approach, from a teacher-centered approach to a student-centered approach, from surface to deep learning, from a poor teaching environment to a diverse teaching environment, should allow pre-service science teachers to cope with and understand the challenges and changes that are taking place in schools following the changes in the diverse and dynamic 21st century society (Demirel, 2009; Valli & Valli, 2013).

In the past, if the substance of PCK was examined in courses designed to impart CK, while incorporating diverse environment teaching and student-centered approach, it was largely done from the lecturers' point of view. Furthermore, in most cases it employed the quantitative approach using the results of evaluation based on quantitative tests or questionnaires. Therefore, examining the integration of PC into courses designed to impart CK, while adopting diverse teaching environments and a student-centered teaching approach, using mix-method approaches from the students' point of view, is not a common practice and is not commonly used in pre-service science teacher training. Hence, the purpose of this study is to examine what pre-service science-teacher think about the integration of PCK into CK courses while incorporating diverse teaching environments and adopting student-centered approach. Hence, the literature review of the this article is based on approaches to teaching pre-service teachers with reference to the teacher-centered approach, the student-centered approach, imparting content knowledge, imparting pedagogical content knowledge and teaching environments.

2. Literature Review

2.1 Teacher-Centered Approach vs. Student-Centered Approach

In the past, most academic institutions have adopted a teacher-centered approach in which the lecturer is the center of the lesson (Ishii, 2017). This approach is, in most cases, based on frontal instruction in which student participation is passive and the lecturer has control over the class and classroom (Kirstein & Kunz, 2015). This approach includes a teaching environment in which there are only two elements. The first is the classroom that constitutes the learning space and self-study included in the

collaborative dimension (Bocconi & Trentin, 2014). The third element of the teaching environment, i.e. teaching methods, is one-dimensional and includes a lecture by the lecturer. The prevalent assumption in this view is that there is a transfer of knowledge from the lecturer to students based on lecturer explanations and lectures (Sadler, 2012). Therefore, the use of teaching methods that include, among other things, discussions, observations, experiences and work in small groups is much less important in this approach because the lecturer is the center of the lesson and the students are less active in the lessons (Kirstein & Kunz, 2015). Accordingly, most school teachers and parents believed that learning is a passive activity, and teachers should spend most of their time in frontal lectures transferring knowledge, keeping track of students as they read textbooks and complete writing assignments individually. In most cases, teaching in this method is inclusive and learning is a classroom does not allow for personal development in learning (Forzani, 2014). In this context, the aim is to create a unified knowledge level among the students, which will enable a high grade point in the course. This traditional approach of teaching, such as lectures in the halls, often fails to maintain the student's attention and interest (El-Ghareeb & Riad, 2011). Adopting this approach has often led to a sense of the incapability of these modes of instruction to prepare the pre-service teachers for the changing realities of modern classrooms in the 21st century (Blackwell, Futrell, & Imig, 2003). In most cases, this approach is considered surface learning(Plate, 2010; Varunki et al., 2017)Surface learning is where there is extrinsic motivation for learning and fear of failure (Marton & Saljo, 1976). This learning is considered learning that encompasses short-term memorization and recall techniques (Biggs, Kember, & Leung, 2001) rather than long-term learning (Kirstein & Kunz, 2015) or information replication (Chan, 2014). This approach hinders the possibility of understanding the learned context and how knowledge can be applied in other circumstances (Baeten, Struyven, & Dochy, 2013) and the underlying meaning of information (Biggs et al., 2001).

In contrast, teaching that promotes student centrality in the teaching process uses a diverse teaching environments (Bocconi & Trentin, 2014) that make the student active and engaged in learning (Kirstein & Kunz, 2015). In this approach, the diverse teaching environment includes a learning space, which can include different environments such as a laboratory, out-of-class outings in the immediate vicinity, or outings requiring transportation. The collaborative dimension of this approach is multifaceted and can include self-study, collaborative learning, and even Jigsaw learning (a collaborative learning method where each graduate student studied part of a topic, and then came together to assemble the pieces of the information to create a whole (Aronson, Blaney, Stephin, Sikes, & Snapp, 1978). The dimension of teaching methods is varied and can include mobile learning, game making, learning through drawing, modern technology and making a scientific poster. In this approach, students contribute to the learning process, and the lecturer conducts few frontal lectures (Kirstein & Kunz, 2015).

In this approach, it is possible to create a system of connections between the lecturer and the students and the students themselves (Degago & Kaino, 2015). In most cases, this method is considered to be

in-depth learning (Marton & Saljo, 1976). With this approach, students can feel better about what their students will experience in the future as a result of integrating diverse teaching methods. Using a variety of teaching methods is a model and can also enable pre-service teachers to develop effective teaching environments for their students in the future (Günes, Gökhan, Bati, Kaan, & Katranci, 2017). This pedagogical approach encourages engagement (Hager, 2015), changing perceptions, acquiring knowledge, and learning motivation (Ernest & Carpenter, 1984; Ridley & Lingle, 1996). The lecturers who use the student-centered approach do so in an attempt to change the student's worldview or their way of thinking about the material they study (Sadler, 2012).

The approach that views the student as a factor involved in the learning process is also called active learning. Active learning strategies emphasize constructivist traits in knowledge processing (Niemi, 2002). Another definition argues that active learning is usually defined as a teaching method that engages students in the learning process that requires students to do meaningful learning activities and think about what they are doing (Bonwell & James, 1991). While this definition can include traditional activities such as homework, in practice, active learning refers to activities performed during class. In most cases, active learning contrasts with the traditional lecture in which students passively receive information from the lecturer (Prince, 2004). Active learning strategies are designed to increase participant engagement. Teachers are responsible for producing the teaching environment that activates students through various tools. A wide variety of teaching methods are included in active learning strategies such as: tutorials, activity-based learning, active problem-solving processes, hands-on activities, collaborative learning, discussions, reading and writing in science and web-based teaching (Tafida, 2009). Others have defined active learning as one that allows students opportunities to make decisions about how they learn and are challenged to use their mental capacity while learning, and formulating active instruction as a process whereby students take responsibility for their learning and offer opportunities to make decisions about the learning process. Following this, active instruction requires students to use cognitive skills and complex tasks (Sahin-taskin, 2018). This study used the definition of active learning as formulated by Prince (Prince, 2004): Active learning is learning that involves the activation of students during the traditional lecture while promoting student engagement.

2.2 Construction of Content Knowledge (CK) and Pedagogical Content Knowledge (PCK)

Pre-service teacher training is a complex task lecturers face, as they are busy preparing the pre-service teacher to be good teachers (Loughran et al., 2008). Unlike most students in higher-education institutions that require CK, pre-service teachers also require PCK—knowledge how to teach. It can be said that the acquisition of PCK is a transformative process of pedagogical thinking in which CK is based and processed for the purpose of transferring and guiding certain knowledge teaching with reference to students' perceptions and difficulties (Shulman, 1986). The combination of CK and PCK is designed to allow pre-service teachers to deal with the 21st century classroom that includes diversityand dynamism (Blackwell et al., 2003). In most cases, there is agreement that the combination of CK and PCK must be conducted through the practical experience and courses that accompany this

experience (Ishii, 2017). In contrast, is there a controversy whether courses designed to impart CK should also include the content of PCK?

Content Knowledge can be taught to pre-service teachers in two ways. The first, the traditional way that has been in continuity since the beginning 19th century (Forzani, 2014) and even earlier since the early days of schools, where the center of the lesson is the teacher and the pre-service teachers are completely passive (Moore, 2005). Three decades ago, it was clear that the efforts of this approach were separating CK from PCK did not always correspond with real-life events in the classroom (Brown, Collins, & Duguid, 1989). To the proponents of this approach, the knowledge that students come with is inadequate and therefore the focus should be on imparting CK (Anderson & Clark, 2012). In addition, there is not enough time to invest in providing PCK while imparting CK due to time constraints (Usak, Ozden, & Eilks, 2011). Another reason for efforts to focus on teaching CK is the lack of knowledge of the lecturers who teach the pre-service teachers of the diverse teaching methods. Hence, lecturers do not have the knowledge and tools to integrate CK with PCK and therefore tend to focus on teaching facts and algorithms in the lecturer's approach (Loughran et al., 2008). Occasionally, a short time is allocated at the end of the course designed to impart CK that incorporates PCK. In this way, the pre-service teachers acquire CK (what to teach), but do not obtain the tools - how to teach. Therefore, in most cases, when the pre-service teachers come to teach they imitate what they have learned in the teacher-training institutions, that is, frontal teaching where the teacher is the center, which perpetuates the methods of teaching since the founding of first schools.

The approach referred to in this study is an approach that combines the acquisition of CK with the provision of PCK (Yli-Panula, Jeronen, Lemmetty, & Pauna, 2018) based on student-centered approach (KPSC-Knowledge-Pedagogy-Student-Centered). This approach is based, even if covertly, on the statement "Tell me and forget, teach me and remember, involve me and I will learn." This approach combines CK with PCK while generating great student involvement in the learning process (Brown et al., 1989). Some call this approachthe ecological approach. An approach that focuses on the interplay between "what to teach" and "how to teach" (Lunenberg, Korthagen, & Swennen, 2007). In this approach the lecturer is not the center of the lesson and the source of knowledge is not only in him (Niemi, 2002). In this approach, students learn CK while being active in the lesson (Cook-Sather, 2012). Students have an active influence on learning and engagement in the learning process (Niemi, 2002). They experiment on finding and acquiring knowledge in an active way (Tafida, 2009). Therefore, teaching that combines CK with PCK can impart different learning. This learning can be considered as "breadth" learning based on peer learning and "length" learning which also includes lecturer learning (Demirel, 2009). Learning "longitudinally" to a lecturer is quite different from his job when he is the main focus of the lesson. In this approach, the lecturer is a guide and tool for students in their learning process (Kirstein & Kunz, 2015; Niemi, 2002). Students in this teaching method can express their personal strengths and progress independently, depending on their abilities (Demirel, 2009).

2.3 Teaching Environment

Practice in a teaching environment began as early as the 1930s (Lewin, 1936). The teaching environment includes psychological, sociological, and physical aspects in the classroom and interactions that take place between teachers and students in the instructional contexts in which student learning occurs (Khine, Fraser, Afari, Oo, & Kyaw, 2018; Peer & Fraser, 2015). The psychological, sociological, physical, and interactions that occur in the teaching environment can be simulated into a three-axis system. One axis—teaching space, second axis, degree of collaboration and third axis-teaching methods (Bocconi & Trentin, 2014). Schools in which students are offered a suitable physical environment (Hill & Epps, 2010)—teaching space, proper teacher engagement, social and collaborative relationships between students—a degree of collaboration and challenging pedagogy—teaching methods may provide a school environment that can enhance the emotional and cognitive involvement of the students with the school (Yang et al., 2017).

Hence, this study examines the attitudes of pre-service science teachers in their first and second years in reference to the use of diverse teaching environments while imparting PCK integrated into the science courses they studied (imparting CK) focusing on the centrality of the student in the teaching process—using the approach—KPSC. The study also examined their attitudes towards the future ability of implementing diverse teaching environments using the KPSC model as school teachers.

3. Method

The study is a case study. The case study is a research approach that is increasingly used in educational settings (Barth & Thomas, 2012). This approach is based on a naturalistic and holistic research concept that includes a broad description and interpretation of the phenomenon (Brown, 2008).

3.1 Research Context

The study was conducted at the largest teacher-training college in Israel. The majority of students attending courses in the study range from 20 to 30 years old. The minority of students are older. About 95% of the course participants are women. This percentage faithfully represents the distribution of men and women in this college. The study was conducted within four courses taught at the Faculty of Science: three of the courses, “Nature”, “Ecology” and “Exploration Skills in the Teaching of Science,” are taught in the first semester of the first year during the undergraduate degree in education. The “Vertebrates” course is taught in the first semester of the second year of the first degree. All courses are affiliated with the science courses at the college. The “Nature” course is given to students in the early-childhood education training track. The courses “Ecology” and “Exploration Skills in Science Teaching” are taught by the students who are studying towards a teaching certificate in the elementary or secondary school. The Vertebrates course is taught by the students studying for a teaching certificate in the elementary track. In each of the courses there was a different composition of students. The common denominator in all courses is the use of a variety of instructional environments. The use of a variety of teaching environments is made throughout the courses and not necessarily at a particular

point in time. Different teaching environments were executed in each lesson.

3.2 Research Tool

This study uses mixed methods which included four research tools: a quantitative questionnaire, a qualitative questionnaire, interviews and student feedback at the end of each course.

3.2.1 The Quantitative Chapter

This two-chapter questionnaire was distributed to all students who participated in the four courses. Chapter A included an assessment of the teaching environments that include the three dimensions (Bocconi & Trentin, 2014). 1. The dimension of collaboration / the learning process. This dimension included three levels of collaboration: self-study in the classroom, group learning, and Jigsaw learning; 2. The dimension of space. This dimension included four spaces: laboratory, college outings, out-of-college outings, and zoo trip; 3. Dimension of teaching methods. This dimension included 10 teaching methods: cellphone use, game preparation, lab-report preparation, Kahoot internet quiz, drawing learning, scientific- poster preparation, reading articles, homework preparation, questioning and learning about real live animals in class. This chapter was evaluated according to the Likert scale of 1 (unnecessary) to 5 (very important). It was also given the option of marking the value 0, if a certain component of the three dimensions of the learning environment was not included in the course. Part B consisted of eight questions rated according to a Likert scale of1 (not at all) and 5 (to a large extent). These questions examined the student's perception of his ability to integrate the diverse teaching environment in the future as a teacher (Alpha Cronbach = 0.96). Each questionnaire received a running serial number that started at 1 and ended at 141. Therefore, when in the results section, a number appears next to the citation referring to the findings that originated from the anonymous questionnaires.

3.2.2 The Qualitative Chapter

Qualitative questionnaire: In this section, students were asked to answer two open-ended questions formulated as follows: a. What are the personal insights of each and every one of the students following the use of the various teaching environments that included the KPSC approach? b. To what extent did the various components of the three matrices used in the KPSC approach help you learn? Understand the material? As mentioned, each questionnaire received a serial number that started at 1 and ended at 141 and according to the number in the results section.

Interviews: 13 semi-structured interviews were conducted with students studying in the various courses. The first part of the interview focused on the background of the students and the second part related to the varied teaching methods, alternative assessment and their reference to the teaching methods in the college in general with a focus on the teaching methods they studied in the different science courses. Because the interviews were personal and the student's name was known, when a capital letter appears next to the citation, it means that the source of information is from the interview.

Feedback: This section included a qualitative analysis of anonymous feedback provided by students at the end of each course. This feedback includes a quantitative chapter to which this study does not refer,

and a qualitative chapter analyzed in this study.

3.2.2 Sample Size and Data Analysis

A total of 141 students from four different courses participated in the study, in three courses ("Nature", "Ecology" and "Exploration Skills in Science Teaching"): students who are in their first year of college (84.40%) and one course ("Vertebrates") taught students in their second year of study (15.60%).

The qualitative findings of the questionnaire, interviews and feedback were analyzed using the Constant Comparative Method. A constant comparative method is used by the researcher to develop data concepts by coding and analyzing the data. The constant comparison method combines systematic data collection, coding and analysis with theoretical sampling in order to create an integrated and data-based understanding. The researcher continually sorts the data collection, analyzes and encodes the information and strengthens the categories. The advantage of using this method is that the research starts with raw data. Through continuous comparisons, significant categories will emerge. In order for these categories to be sufficiently well-founded, the researcher must invest time in the analysis and data collection processes (Kolb, 2012). Data analysis was done using primary and secondary coding (first and second cycle coding) and category creation (Saldaña, 2009). This analysis was inductive analysis. Content analysis was also conducted (Armat, Assarroudi, Rad, Sharifi, & Heydari, 2018). The quantitative questionnaire was analyzed using descriptive statistics.

4. Results

4.1 Percentage of Respondents

A total of 141 students answered the questionnaire out of 183 students who studied in the four courses examined. This means that approximately 77% of students in all four courses filled out the questionnaire (Figure 1).

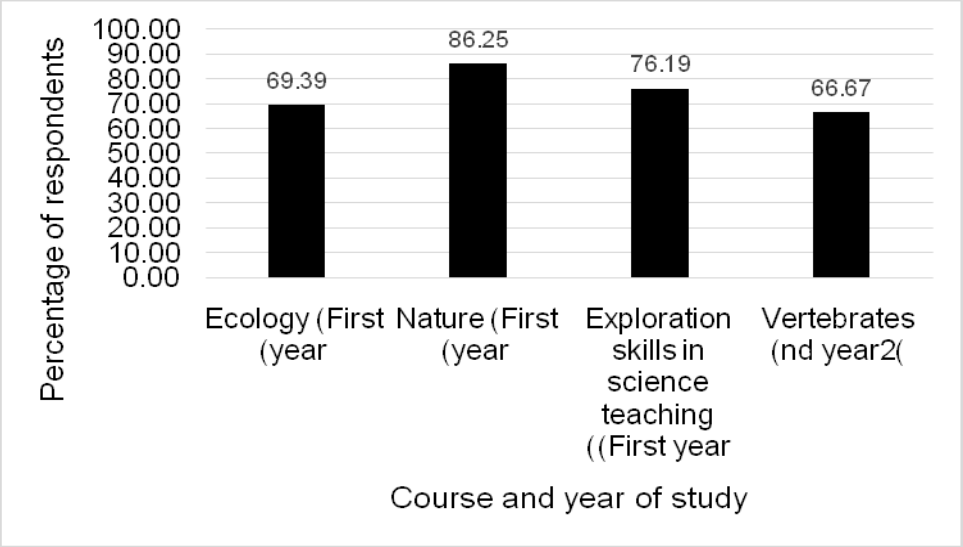


Figure 1. Percentage of Respondents to the Questionnaires in Each Course according to the School Years

4.2 The Teaching Environment in the Various Courses

The four courses in which the study was conducted included a three-dimensional teaching environment with different components. Not all the components of the different dimensions are used during the teaching process in the different courses. The teaching environment in the "Nature" course was the most varied and the largest number of components was used (15). The teaching environment in the course "Exploration Skills in Science Teaching" used the fewest (11) of the components (Figure 2).

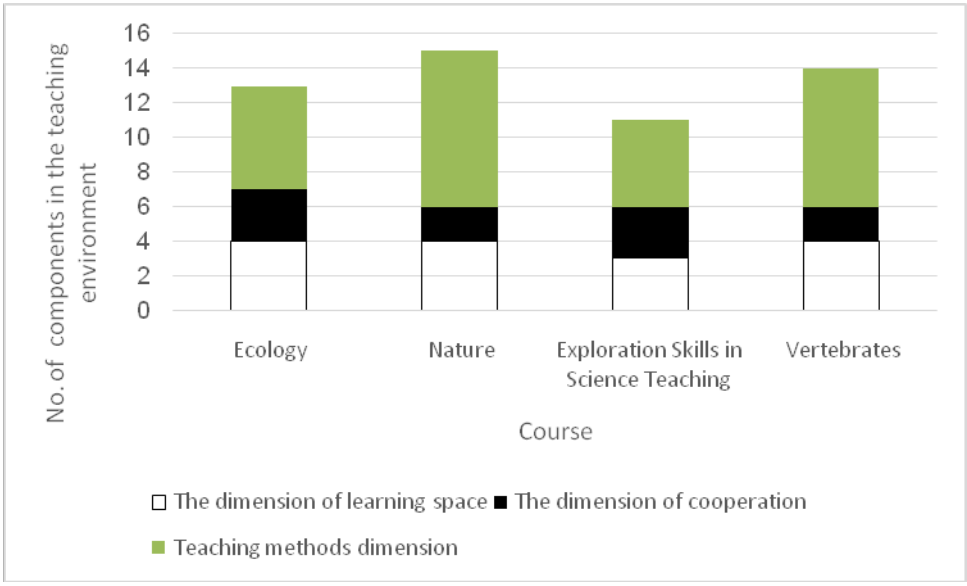


Figure 2. The number of Components in Each of the Three Dimensions of the Teaching Environment

4.3 Assessment of Teaching Environments

All components of the teaching environment in the three dimensions were assessed by the students (Figure 3). The lowest average score was 3.56 for the use of mobile phones in the Vertebrates course and the highest average value was 4.65 for the teaching of questioning in the "Science Teaching Skills" course.

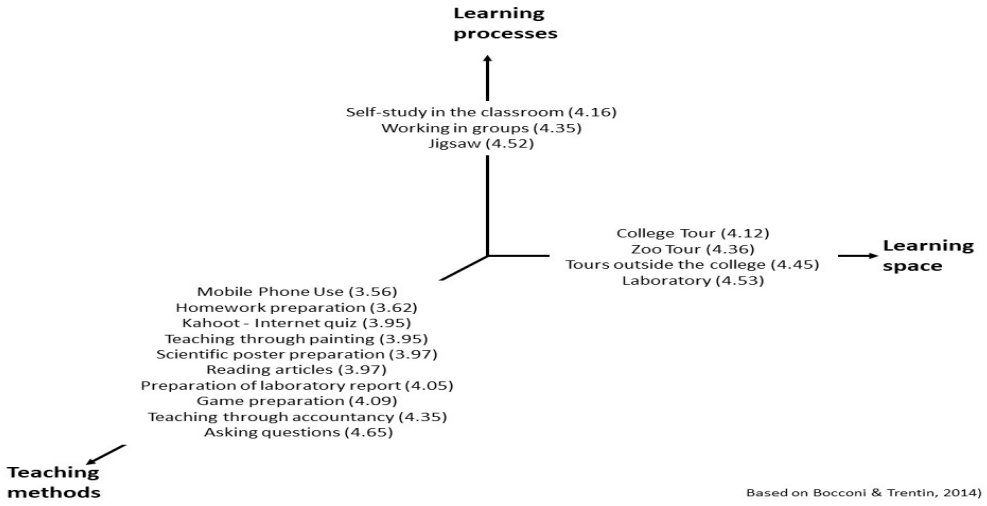


Figure 3. Students' Attitudes about the Various Components in the Three Dimensions (Average Grade in Brackets)

4.4 Qualitative Analysis

All three qualitative research tools (questions, feedback, and interviews) were inductively analyzed. A total of 129 questionnaires were analyzed in this way (91.48%), 139 written in the open section and 13 interviews. In the first reading of the student's answers to the open-ended questions, the feedback and the text of the interviews, 66 codes and 709 mentions of the students were found. Of all the references and codes, three major themes occurred: Students' perceptions of the use of diverse teaching environments, self-efficacy to apply diverse teaching environments and the impact of using diverse teaching environments on social networks outside the school class.

4.1.1 Student Perceptions of the Use of Diverse Teaching Environments

Students' perceptions were derived from the qualitative analysis conducted for both open-ended questions and interviews. According to the findings, there are three perceptions of students regarding the use of diverse teaching environments (Figure 4). About 81% of students have a positive attitude towards the use of diverse teaching environments in courses. Approximately13% of the students are students who, at the beginning of the course, experienced difficulty in using diverse teaching environments, but later understood their importance.. Approximately 6% of the students have only objected to the use of diverse teaching environments.

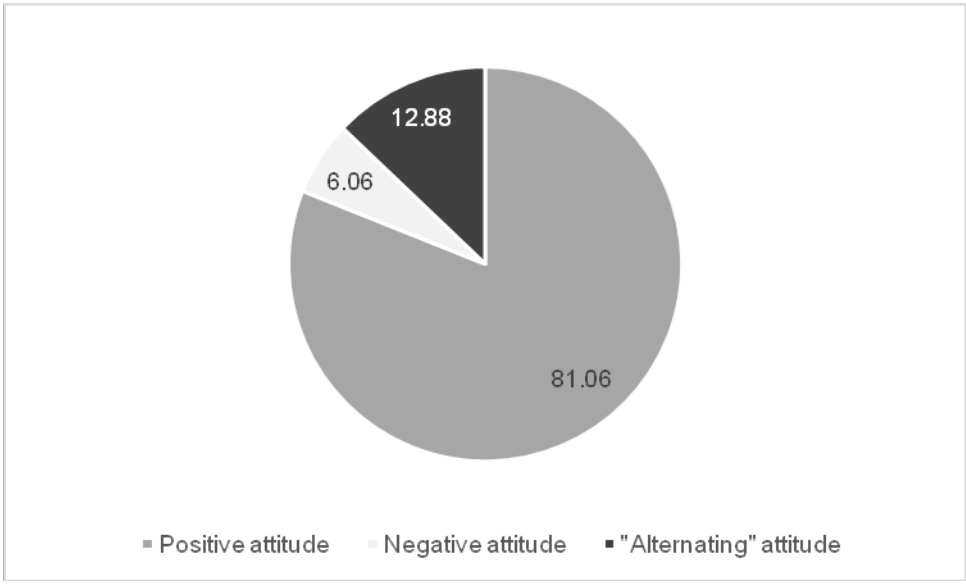


Figure 4. Distribution of Percentage of Different Students' Perceptions of Using Diverse Teaching Environments (Gray -Students Having Positive Attitude, Black - Students Who Negatively Related to Diverse Teaching Environments Early in the Course and Then Understood Their Importance. White - Students Who Have Some Opposition Towards Integrating Diverse Teaching Environments)

4.1.1.1 Students Have a Positive Outlook for Implementing Diverse Teaching Environments

Approximately 89% of the codes found in the initial analysis included a positive reference to teaching science courses through diverse teaching environments. At the beginning of the chapter, a sense of marvel will be described from using a diverse teaching environment. Then, the codes that have been awarded the highest number of references will be described in a centralized way in Table 1.

The use of diverse teaching environments across the different dimensions surprised a considerable number of students studying in the various courses. One student from the Ecology course wrote: "Finding that there are other methods of teaching and not just the classical method that the teacher speaks a whole lesson and the students listen and write—was important" (102). This student emphasized the dimension of cooperation. He came to know new teaching methods that enabled a different level of sharing from what was familiar to him from the time he had attended school. Another student from the Nature course (29) described the teaching method dimension: "We do not encounter these teaching methods every day, very different from my school days". This student describes what is familiar to him from his previous school life, which did not make use of diverse teaching methods. He recalled the teacher-centered method, where is at the center in front of the students.

Table 1. Examples of the Main Codes Mentioned and Representative Quotes

Code	Code's explanation	Quotes	Quote's explanation
Tours	The tours took place outside the college, included transportation and lasted for a full day.	• The tours really connected all the open points learned in the classroom and provided one complete picture and understanding of things (Ecology course, 63).	• The tour is not a separate part of the classroom, but the direct continuation of the classroom, with an important role in "tying up ends".
Jigsaw	Explicit references to "jigsaw" and the possibility of this method to change the way of teaching and place the student at the center.	• In Jigsaw you learn something and when you pass it on yourself, you learn it better (A).	• The student emphasizes that the need for collaboration generated during the use of "jigsaw" has allowed her to learn the information better due to the need to transfer it to another student.
Understating	A code that addressed the understanding of the material being studied.	• Teaching methods helped me understand how much the student is at the center and should make students think independently and come up with the right answers ... things that helped me understand the lesson better (Exploration Skills in Science Teaching course, 4).	• This student, though not directly, describes the importance of using two dimensions: the collaborative and the teaching methods, in the process of understanding the material taught in the lessons.
Memory	Teaching methods have enabled long-term memory enhancement	• The different ways of teaching created a situation where in each lesson I learned something new that was so interesting and became etched in my memory that I found myself passing it on to family, friends, and spouse at home - it is not forgotten after class and will not be forgotten after the test (Ecology course, 7)	• The student talks about a long-term memory that enables her not to forget what was learned immediately after the test. In addition, he mentions how teaching methods allowed him to remember the information learned in lessons over time and motivated him to share it with his family.
Senses	Students' attitudes towards the senses used during the lessons	• I was able to learn things a lot better when touching, and feeling. You can learn from a computer, books, notebooks, but it's	• 'A' refers to the three dimensions of the teaching environment. First, reservations towards the teaching space that uses books and notebooks. Second, the collaborative

		not the same. When you see, feel, touch, taste, you combine the experiences and will remember it better (Nature course, A)	space, "You combine", as one that aids memory. Finally, in her words the student does not doubt the correct way in which it is necessary to teach. Learning must be done through all five senses.
Social	The use of a variety of teaching methods has helped to develop social connections between the various students.	• The group work that they experimented with several times during the course fostered social connections.	• This student emphasizes that the dimension of collaboration in the course was a catalyst for creating the social connection among the students. From these students we can recognize that a social aspect is perhaps a by-product of the use of diverse teaching methods.
Positive learning experience	Creating the positive learning experience through diverse teaching environments	• Learning is a fun, memorable experience (Nature course, 119) • There was another positive learning experience (Vertebrate course, 35)	• Many students have had a positive learning experience as a result of the combination of diverse teaching environments in the courses, which they expressed in various forms and words.

To summarize this chapter, we can see that most students think that the use of diverse teaching environments and the adoption of the KPSC approach in class greatly contribute to the lessons. The contribution to the class is expressed in a wide variety of explanations s and facets mentioned by the students.

4.1.1.2 Students Who at the Beginning of the Course Experienced Difficulty in Using Diverse Teaching Environments but Later Understood Their Importance

Several students stated in their remarks the difficult start they had in the various courses in which the different teaching environments were integrated as part of the KPSC approach. Student (10) who studied in an ecology course describes what he felt at the beginning of the course:

On the first day, I didn't understand anything ... look outside the classroom for an answer? We didn't know what you wanted from us ... and along the way, I realized that going outside and exploring nature for yourself is the best way to understand.

This student describes a state of uncertainty and lack of understanding in the first lesson in relation to a new learning space-outside the classroom. This space was foreign to him and evoked uncertainty. However, he adds that after a while the picture became clear to him and he understood the importance of using this learning space and not just the classroom.

Another student also made some references to the difficult start as it was written:

The course was constructed in an original and interesting way. At the beginning of the course I had trouble understanding why the lecturer chose certain methods, but today I understand why... He helped me understand how I would like to teach later and what ways I could learn better. For my development as a teacher, I have seen how student engagement in learning helps their learning.

From this feedback, the process of internalizing the importance of using a variety of teaching spaces, especially extracurricular, and the collaborative dimension-working in groups, is evident. A student describes how, in the end, she realized that teaching that made the student active, expressed in extracurricular teaching and in group work, was important, which helped to encourage the use of a variety of teaching methods.

Contrary to the examples cited so far, where there is no detail about why students found it difficult to cope within a diverse teaching environment, a student from Ecology Course 110 explains why it was hard:

I did not understand how it contributes to all these things and probably it was due to fossilization; after the outing I understood the importance of the diverse methods…

The student takes responsibility for the misunderstanding and claims it is from his being used to something else.

An explanation for discomfort at the beginning of the course gives Student 49. This student studied an exploratory skills course in science teaching, and he explains why it was not difficult at first with the combination of many methods*: "By the time I started college, I was used to a very fossilized and specific teaching method-I didn't leave the classroom much as a student and I was used to the teacher teaching and us listening."* The student testifies that the school he studied in was very mediocre. Going out of the classroom to study was unacceptable and he had not been exposed to it. Therefore, it seemed strange to him. J., who graduated from high school only six years earlier, did not recognize the integration of extracurricular teaching as part of the teaching environment. To conclude this chapter, it can be said that students' concerns at the beginning of the course, regardless of their reasons, have been replaced by an appreciation for the diverse teaching environments used in the various courses that formed part of the KPSC approach.

4.1.1.3 Students Who Are Opposed to Integrating Diverse Teaching Environments

About 6% of students who answered the open questions belong to this group. Students' opposition to the integration of diverse teaching environments as part of the implementation of the KPSC approach included three categories. The first—"wasting time" as a result of diversity in the collaborative dimension, as described by student 104 in an ecology course: "*In my experience, I liked frontal learning, otherwise I waste time and energy on self-learning that does not advance me or develop my knowledge*." This student emphasizes his desire to continue to study the approach that characterizes the education system and includes the teacher-centered approach which is the source of knowledge. Even student 92 from the Nature course felt that they were wasting their time: "*I can relate less to self-learning, because I am really unsure of the material. I feel more confident when the material is*

delivered to me in the classroom straight from the lecturer." In this case, too, the student prefers the "teacher-centered" approach. A second category included reference to the confusion created by learning as a result of incorporating diverse teaching environments as testified by student number 70 who taught in the ecology course: "*So many methods are creating confusion because the material is not really taught thoroughly and therefore there is confusion*." This student is complaining. He said, caused a lack of depth in learning and thus created confusion. A third category included references to frustration as a result of the process of incorporating diverse teaching methods. Student 137 from Nature course wrote: "*I felt that frontal learning was the most meaningful to me, otherwise it frustrated me*." This student prefers the teaching method in which the lecturer at the center with a minimum level of collaboration, because he claims it causes him frustration in learning. Student 42 from the Vertebrates course complained about something else: "*I think the method is completely wrong. There is mainly a method of letting alone to do big works and studying the material alone. I did not learn from this method*." According to this student, the diverse teaching environment causes a great deal of burden, probably more than the usual frontal method and the sole purpose is to give assignments.

To conclude, most students have realized the importance of integrating diverse teaching environments throughout the various courses that result in changing the teaching approach. However, there were students who expressed reservations about using diverse teaching environments and preferred the traditional method where the knowledge center is the lecturer and the teaching environment is poor.

4.1.2 Self-Efficacy to Implement Diverse Teaching Environments as part of the KPSC Approach

As mentioned, this theme includes three levels of student self-efficacy to implement diverse teaching environments as part of their professional future KPSC approach as teachers. High, medium and low self-efficacy to implement diverse future teaching environments and confidence in the ability to use the KPSC approach in school.

4.1.2.1 High self-Efficacy to Implement the Diverse Teaching Environments in the Future and Confidence in the Ability to use the KPSC Approach at School

Student 84 who attended a Nature course is supposed to work in kindergarten and is an example of a student who is confident that he will incorporate the diverse teaching environments into his future teaching. This student wrote: "*Definitely taking my learning methods with me*." It is evident that this student has no doubt whatsoever and intends to apply the diverse teaching environments he has learned in the course in his kindergarten work. Another student (74) from the Nature Course wrote similar comments: "*I have acquired many tools and I can wholeheartedly say that I will adopt these teaching methods in the future*." Student 100 (Ecology course) wrote: "*My extracurricular teaching has helped me a lot. I learned to understand its importance and I will definitely do that in my classroom.*" Not only does this student commit to using extracurricular teaching in his or her future classroom, he explains why. He understands the great importance of extracurricular teaching. Unlike student 100, student 49, who took a science research course explains why he will apply the different teaching methods: "*I realized that there are other ways of teaching and learning besides frontal learning in the classroom.*"

The diversity of the learning-space dimension and the teaching- method dimension, can be harnessed for learning and he is sure that he will implement them in his classroom.

4.1.2.2 Medium Self-Efficacy to Implement Diverse Teaching Environments and Hope to Use the KPSC Approach

As mentioned, not all students who mentioned the process of implementing the diverse teaching environments were so confident that they would indeed integrate them during their teaching. A student (38) who studied in the Vertebrates course wrote: "*The ways in which I participated were very interesting and expansive. Learning outside, working in groups… I certainly hope I can pass on their teaching I experienced for my students*."

The student was able to appreciate all three dimensions of a diverse teaching environment and their contribution to his personal studies, but he is not sure, "*I certainly hope*" that he will indeed be able to teach through diverse teaching environments in the future. Another student, 111, who took the Ecology course wrote: "*I would love to pass on some of the methods I learned in my classroom in the future.*" This student talks only about wanting to incorporate the diverse methods, but does not mention his self-efficacy to do it. The anonymous feedback from the Nature course: "*The manner of learning while on-the-go certainly sets an example for us students how to act creatively in front of a classroom on any topic we want to convey*." While this statement does not have an obligation to apply the varied teaching methods in the future. The student who wrote this statement emphasizing that she was given creative tools to convey different subjects according to the variety of teaching methods which learned in the course.

4.1.2.3 Low Self-Efficacy to Implement Diverse Teaching Environments and Reservations about Implementing KPSC Approach

The third level includes a number of students, such as a student of 69 who studied in an ecology course who claimed: "*Teaching methods helped to understand the material, but they are not always suitable for all types of students*." This student understands the importance, but even before attempting to implement them as a full-time teacher in the education system, he defines his remarks with a defensive argument. Another student from the Ecology Course (72) wrote: "*I still cannot fully say that I agree and will be able to teach outside of the classroom and incorporate a variety of teaching methods but will not deny it outright*." Unlike Student 69, this student is not sure that diversity in teaching spaces and teaching methods is appropriate, and if they are appropriate, he is not sure that he will be able to apply them. However, like student 69, he does not negatively limit the attempt to implement these teaching methods.

To sum up this theme, we can say that there are three levels of self-efficacy to implement diverse teaching environments in the future. At the first level are students who can be assessed in high-education institutions, from which their future students will enjoy diverse teaching environments as part of the science study. Next are students who will try to incorporate diverse teaching environments and finally, students who will study the science profession with a very poor teaching

environment while emphasizing the teacher at the center as taught at the beginning of school days.

4.1.3 Impact of Diverse Teaching Environments and Implementation of the KPSC Approach on Social Networks Outside the Class

Some students testified that as a result of using diverse teaching environments as part of the KSPC approach, they addressed topics that had been learned even outside the course milieu. The students reported that the topics of study were the basis for Friday-night discussions with the family as described by a student (A) in the preschool track in her interview: *Every Friday, I would tell my parents what I had learned… I tell my family about birds and plants.* This student describes the importance of the three dimensions of the teaching environment: teaching space, collaboration and teaching methods and how they inspire her to share the information with her relatives. M., a student at the preschool track, also described her experience during nature walks with friends:

Teaching diversity made me constantly look at the environment, even outside ... when I go out with friends, I keep telling them to look at this bird or this flower ... It's a great feeling to have. I haven't had that feeling in the past; all my friends told me I am like a boy-scout master ... It's really fun; I've had no such thing in other courses. I think that because of my varied teaching, I remember things.

M. and A. describe how, in their opinion, the use of diverse teaching environments has helped them acquire knowledge that allows them to be "like a boy-scout master" who is considered to be highly knowledgeable about the environment. This knowledge gained through the diverse teaching environments gives them a very positive feeling. Another example of how positively students feel about learning through diverse teaching environments that help with long-term memory can be found in feedback at the conclusion of one of the courses. A student elaborated on her answer to the question "Additional notes and comments ...":

My boyfriend thinks I'm crazy. Every time we walk down the street, or in nature, I start to tell him about birds and flowers… I wasn't like that before; I didn't know anything about nature, flowers. I have no doubt that the outings, studying with my friends the different methods of teaching helped me learn and more than that, it's a very good feeling that you have knowledge and you remember it and you share it.

The student describes her good feeling following the acquisition of knowledge and ability to use it when the teaching environment is diverse. She specifically mentions the three dimensions of the teaching environment that contributed to her positive feeling towards her learning experience. Student 53 describes how he implements the diverse teaching methods with his children: "*With my own children, I apply the variety of teaching methods as we walk on the street in the afternoon*." Student S. from the elementary-school track, describes the effect of the various methods on his relationship with his father:

Following the lessons that incorporated a variety of teaching methods, I was able to remember the material. I often came out to talk to my dad, and tell him about what we learned in the course. Many things I remembered because we used a variety of methods that were even new to my dad. This created

a deep conversation base for us.

S. describes the effect of various teaching methods on his ability to retain the information he learned, which in turn, becomes a common platform for discourse with his father. To sum up this theme, students can say that the experience of learning in a diverse teaching environment that applies the KPSC approach has served as a source of inspiration and boosted their positivity in their individual personal lives as well.

5. Discussion

This study examined the perceptions of pre-service science teachers and the attitude of first and second-year students at the largest teacher-training college in Israel to integrate diverse teaching environments using the KPSC approach. The findings reveal three main points.

5.1 In-Depth Learning as a Result of Integrating CK and PCK

Diverse teaching environments that embrace a student-centered approach require more student investment because they are involved in learning (Grady, Simmie, & Kennedy, 2014). This approach in which students act, think, search, question and do not receive direct answers challenges students, but is rewarded with long-term knowledge retention that does not always exist when using teacher-centered approach (Duarte, 2013) as most students have testified in this study. However, most students understood the importance of using diverse teaching environments and its great contribution to the learning process. Students also claim that the diverse teaching environments will allow them to remember the course material for a long period of time after the course is completed. The diverse teaching methods based on active learning, experiential learning and self-learning allows students to feel the student-centered approach. This approach helps to create a fun atmosphere in school, create diversity in learning methods and develop curiosity. These provide the basis forin-depth learning based on thinking design and acquiring knowledge. In addition, students demonstrated a high sense of self-efficacy to apply diverse teaching environments when teaching in the future whether in school or in external circles such as with family or friends.

The students' learning process in the courses is characterized by the level of depth that is not intended solely for the purpose of achieving a high grade (Richardson, 2011). This process allows for long-term memory and student engagement in learning, taking into account the future needs of students (Duarte, 2013). Interestingly, though active learning in the sciences with a variety of teaching methods created a burden on some students, they preferred in-depth learning rather than conventional frontal learning, as other studies have argued (Párpala, Lindblom-ylänne, Komulainen, Litmanen, & Hirsto, 2010). It is possible, as various studies suggest (Qureshi & Ullah, 2014), that the teaching environment created during the courses, defined by students as creating pleasure, curiosity, and diversity, has also helped to embrace a deep learning approach for most students.

At the same time, about 6% of students have maintained that teacher-centered approach, which is also known as Chalk and Talk (Kirstein & Kunz, 2015; Laronde & MacLeod, 2012) is more effective.

Despite all efforts to make use of a diverse teaching environment that includes a variety of teaching methods based on the student-centered approach and extra-classroom teaching, these students remained in their minds. The course they went through in a variety of teaching environments failed to convince them that it was a more effective form of study that allowed for in-depth study rather than surface study. A minority's resistance from students to change their way of thinking is not new (Laronde & MacLeod, 2012). There are various learners and some students who, despite all the efforts made by the lecturers to acquire a new approach to learning, favor the method used in the early days of schools where the lecturer is the center (Diseth, Pallesen, Hovland, & Larsen, 2006). It is possible that for these students the audio channel is the strongest and therefore they prefer this approach. However, the fact that there are different teaching methods at the same time that students with different learning styles and different learning preferences are present, revealed to the pre-service teacher the problem of managing a lesson in which students with different needs. If the pre-service teachers want to reach to all of their students in the classroom, they will also need to use diverse teaching environments that are not only convenient to other students in the classroom. It is important to remember, lecturers may do a variety of activities to convince students to take different learning approaches, but they cannot do everything. Sometimes, lecturers' attempt to encourage depth learning based on a variety of instructional environments creates the opposite. Generates anxiety and resistance, as found in this study. Therefore, some students 'resistance can be expected to any attempts to encourage depth learning and use in diverse teaching environments (Baron, 2010). It is hoped that students who oppose the use of a variety of teaching environments will experience other teaching environments that will allow openness and understanding of the importance of using the teaching environments and the implications of these teaching environments (Usak et al., 2011). Possibly, and the more students who are challenged will experience and the better their learning experience, the more they will change their minds (Varunki et al., 2017).The basis for the hope that students who have not changed their mind about using diverse teaching environments will do so based on the understanding that student learning approaches are dynamic and unstable (Lietz & Matthews, 2010), and field of study, learning load (Párpala et al., 2010), motivation (Kyndt, Dochy, Struyven, & Cascallar, 2011), culture in general (Richardson, 1994), academic institution culture in particular (Labelle & Johnson, 2018), and age (Varunki et al., 2017). In conclusion, it should be borne in mind that a learning approach is not a genetic trait or personality construct, but rather teachable (Diseth et al., 2006).

5.2 Breaking the "Magic Circle" of Teacher Shortages

It is evident that most of the students who took courses in which diverse teaching environments were integrated while integrating the KPSC approach have undergone a process of internalizing the importance of using a variety of different teaching environments. The students knew that the different environments and the KPSC approach contain three key aspects: cognitive, social, and emotional. These aspects helped most students feel self-efficacy of making a statement about the future implementation of a diverse teaching environment in their future as school teachers (Figure 5).

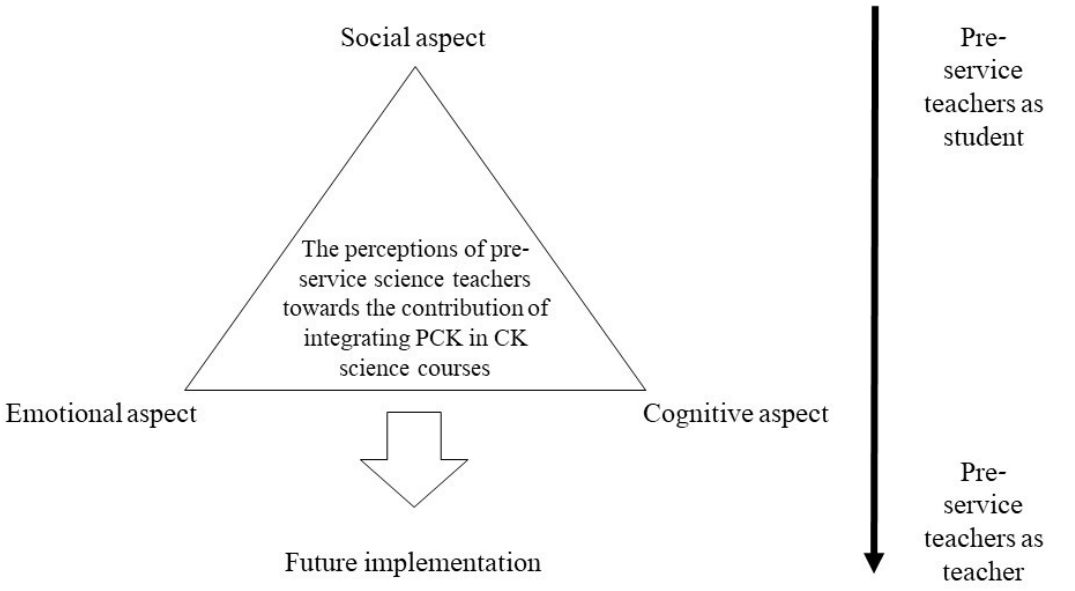


Figure 5. The Learning Process That Most Students Underwent in Courses Used in Diverse Teaching environments. The combination of the social Emotional, and Cognitive Aspects Creates a Sense of High Self-Efficacy to Implement Diverse Teaching Environments in the Future

It is possible that the teaching model in which students experienced varied teaching environments that created depth learning while altering student access to the center and long-term positive memory will be a model for them as studies (Laronde & MacLeod, 2012) and students use these diverse teaching environments as teachers (Hacieminoglu, 2016). Most students' openness to implementing diverse teaching environments can be the beginning of a process of "breaking the vicious circle" of the shortage of science teachers, at least in Israel (Arviv-elyashiv & Gal, 2017). This vicious cycle begins with the attitude of students from elementary, middle school, and high school to science topics. Today, quite a few students in Israeli schools are reluctant to study science (Goldschmidt, 2011). One of the main reasons is the boredom that students experience. Boredom that results from learning based on textbooks and teacher-centered approach and poor teaching environments (Hacıeminoğlu, Yılmaz-tüzün, & Ertepınar, 2014). Hence, the potential of elementary school students going through to study science in high school is small. Hence, even the potential for pre-service teachers to be directed to higher education institutions that train science teachers is small (Manny-Ican & Rosen, 2013). Therefore, it is possible that if the teaching of pre-service science teachers includes a combination of imparting CK and PCK, based on active learning that incorporates diverse teaching environments in which the student is the center (KPSC), most of the pre-service will apply these diverse teaching methods. As a result, Israeli students will enjoy diverse teaching methods and will also benefit during the science subject learning process. In this way, the potential of high school students will grow, which will also have a positive experience from science and accordingly the potential of pre-service teachers

to science will increase.

5.3 The "Food Web" Model for Science Study

Teaching that combines CK with PCK has also been referred to as the ecological approach (Lunenberg et al., 2007). On the basis of this evidence and the ideas of ecology, a new model for teaching pre-service teachers combining CK with PCK is offered here. This model can be called the Teaching Food web model (Figure6). A number of parallel principles exist between teaching pre-service teachers that combining CK with PCK and using a diverse teaching environment for the food web in nature (Table 2).

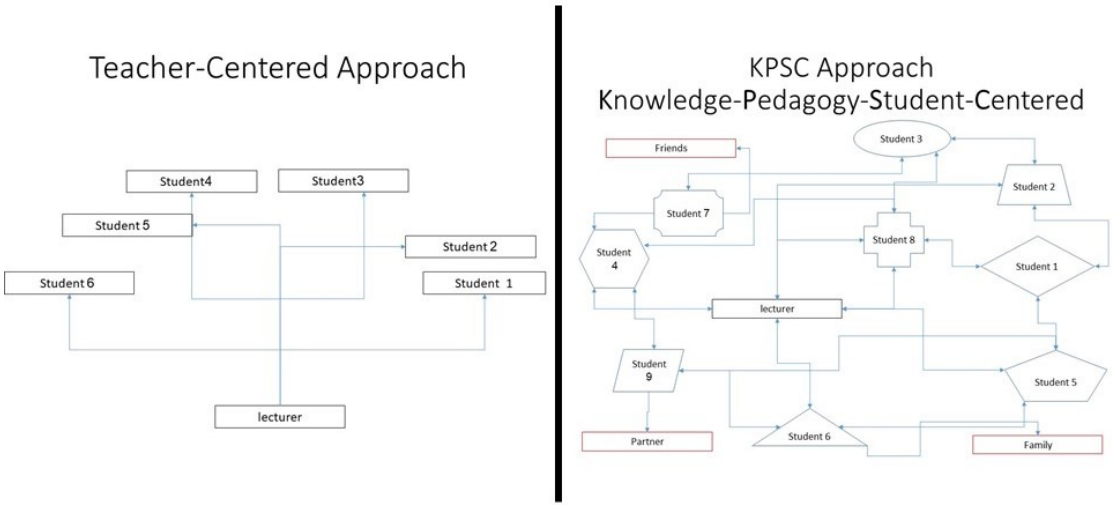
Table 2. Similarities and Differences Between the Food Web in Nature and the Different Teaching Approaches. The First Approach to Teaching KPSC and the Teacher-Centered Approach

	Food web in nature	KPSC Approach Knowledge-Pedagogy-Student-Centered	Teacher-Centered Approach
Definition	• omplete ecosystem nutrient relationship. A total of food chains in which energy flows between the various trophic levels and their relationships.	• he overall interrelationship between the partners and the teaching process, the total-knowledge-transfer paths between the lecturer and the students, between the students themselves and the students and the lecturer, and the connections between the lecturer and the students and between the students and themselves.	
Notable major factor	• oes not exist	• oes not exist	• eacher
Types of connections	• n the food web, there are connections within the tropical and between the tropical levels, for example, a relationship between a predator and a prey (different trophic	• here are three main types of relationships: between the students and themselves, between the students and the lecturer, and between the lecturer and the students. These connections are two-sided.	• n most cases, there is a single and one-sided relationship system in which an attempt is made to transfer knowledge from the lecturer to student.

	levels) or a relationship between the two rabbits (the same tropical level).		
Biodiversity at the individual level	• here is biodiversity within the tropical level. For example, deer and grasshopper are both herbivores.	• he self-learning options and the interrelationship during the teaching process allow for the continuous development of learners and the widening of learners' diversity according to the learning styles. For example, the curriculum includes a wide range of assessment methods, peer teaching, group learning, and testing that create the diversity among students dependent on each student's curiosity and personal investment.	• ll students are expected to reach a uniform level of understanding and variability among students is very limited, in view of the need to pass a single assessment which is usually based on a uniform test which is the result of a frontal lecture.
System type	• n open system that influences and is influenced by adjacent systems.	• n open system that allows for influences of interest outside the classroom such as friends and family.	• losed system. In most cases, the information remains at the student level and is not shared with social circles such as parents, friends and spouses.

In a teaching that incorporates diverse teaching environments that use the KPSC approach, much like the food web in nature, there is not one prominent central factor around which the food web is built. Teaching that adopts the KPSC approach prevents a situation where the lecturer is the center of the lesson. The adoption of the KPSC approach allows the transfer of the weight of the lesson from the lecturer to student. Following this transfer, three main types of relationships are formed, similar to the food web in nature. The first is the connection between the students and themselves. These relationships can simulate the relationships between individuals at the same tropical level. For example, connections between savannah herbivores. The other, between the lecturer and the students. This

relationship can be simulated between different tropical levels. This relationship between different tropical levels is two-sided. On the one hand, the students benefit from the lecturer's knowledge, but on the other hand, the lecturer feeds on the acquired knowledge of the students who operate independently during the implementation of the KPSC approach. This two-way relationship is similar to the relationship between the different levels in the natural food web. For example, herbivores feed on fruits. In this system both parties enjoy. The herb food gets energy while the plant gets a distributor. The same principle exists in the KPSC approach. Both the lecturer and the students benefit from the cave that is created as a result of the application of this teaching approach that uses diverse teaching environments. The KPSC approach and its use of diverse teaching enable each student to develop personally. In the case of this study, four teaching spaces, a collaborative scope and seven different modes of instruction, give a wide scope for each student to find the combination in which he can make the most of the teaching process and develop independently and uniquely. The variation between students is similar to the wide biodiversity available in the food web. A wide biodiversity that also exists within the same tropical level. For example, among the herbivores you can find a wide variety of different species, all of which eventually belong to the same tropical level. The last feature that resembles the food web in nature and teaching which uses diverse views while applying the KPSC approach, it is the fact that they are open systems that impact factors outside the food web or the classroom. In the case of KPSC teaching model, as the students testified, the knowledge they acquired during the lessons and that haveremained with them over time has encouraged them to share their knowledge with parents, spouses and friends who are not part of the classroom. The food web is also not a closed system; it influences and is influenced by nearby food webs.



Diverse Teaching Environments (Right) Versus the Low-Environments Approach, where the Teacher is in the Center (Left)

In summary, it is evident that the courses in which students studied and were based on diverse teaching

environments while implementing the KPSC approach created an enjoyable, varied learning environment that helped most students develop a high sense of self-efficacy to use a variety of active teaching environments.

6. Acknowledgments

I sincerely thank Dr. Orna Flick who supervised me and greatly assisted in the promotion of this article. I also thank Dr. Miri Dressler for her astute comments.

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