Exploring Experienced Chemistry Teachers' Science- Teaching Orientations (STOs) via a Card-Sorting Task: Physical-Chemical Change Topic[1]

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Abstract: This research focused on the clarification of science teacher orientations (STOs) as a component of pedagogical content knowledge via a *card-sorting task* containing seven scenarios concerning physical-chemical change topic (PCC) developed by the authors. This research was designed according to the case study model as a qualitative research method that's why the participants were four experienced chemistry teachers who taught in different high schools at ninth grade were examined in their classes without any manipulations. The data were collected through card- sorting task. At the end of the research, it was concluded that the experienced chemistry teachers held different science teaching orientations. It has also been determined that each teacher adopts more than one orientation at the same time. They were in favor of student-centered orientations no matter they perform them in practice. Clarifying experienced chemistry teachers' science teaching orientations with a single instrument cannot be sufficient; different instruments should be used instead.

Keywords: Science teaching orientations, card-sorting task, experienced chemistry teachers, physical-chemical changes.

Özet: Bu araştırmada, yazarlar tarafından fiziksel-kimyasal değişim (FKD) konusu kapsamında geliştirilen yedi senaryodan oluşan kart gruplama aktivitesi ile alan eğitimi bilgisinin bir bileşeni olan fen öğretimine yönelimin aydınlatılmasına odaklanılmıştır. Araştırma, nitel araştırma yöntemlerinden durum çalışması modeline göre gerçekleştirlmiştir. Bu nedenle, katılımcılar dokuzuncu sınıf düzeyinde farklı ortaöğretim kurumlarında kendi sınıf ortamında herhangi bir müdahale olmadan görev yapan deneyimli dört kimya öğretmenidir. Veriler, kart gruplama aktivitesi ile toplanmıştır. Araştırma sonunda, deneyimli kimya öğretmenlerinin farklı fen öğretimi yönelimlerine sahip oldukları sonucuna varılmıştır. Ayrıca, her öğretmenin aynı anda birden fazla yönelimi benimsediği belirlenmiştir. Deneyimli kimya öğretmenleri her ne kadar sınıf içinde uygulamasalar bile kart gruplama aktivitesinde genel olarak öğrenci merkezli anlayıştan yana tercihlerde

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bulundukları belirlenmiştir. Çalışma sonunda deneyimli kimya öğretmenlerinin fen öğretimine yönelimlerinin tek bir veri toplama aracı ile belirlenmesinin yeterli olmayacağı, bu nedenle farklı araçların da kullanılmasının daha uygun olduğu söylenebilir.

Anahtar kelimeler: Fen öğretimine yönelim, kart gruplama aktivitesi, deneyimli kimya öğretmenleri, fiziksel kimyasal değişimler.

INTRODUCTION

Teaching is a precious process for both students and teachers. At the end of the teaching, not only students learn, also teachers learn how to teach. It is because teaching is not only telling the content knowledge to students. It is the knowledge about how to teach the content knowledge to students. The valuable dimension of teaching is learning about teaching.

Shulman (1986) emphasized that content knowledge consists of three categories a) subject matter knowledge, b) pedagogical content knowledge (PCK) and c) curricular knowledge. He defined content knowledge as both chunk and framework of the knowledge in the teacher's mind rather than subject matter knowledge. Pedagogical content knowledge (PCK), the second category of content knowledge, is defined as:

> "…the most regularly taught topics in one's area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, and demonstrations in a word, the ways of representing and formulating the subject that make it comprehensible to others. (Shulman, 1986 p. 9)"

Shulman (1987) broadened his classification, and he suggested seven categories as *content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, knowledge of educational contexts, knowledge of educational ends, purposes, and values, and their philosophical and historical grounds* (p. 8).

Different models of pedagogical content knowledge have been suggested by other researchers (Cochran et al., 1991, 1993; Fernandez-Balboa and Stiehl, 1995; Grossman (1990) cited in Xiaoyan , 2007; Hashweh, 2005; Marks, 1990; Park and Oliver, 2008a, 2008b; Veal and MaKinster, 1999). Magnusson, Krajcik and Borko (1999) suggested a model in which PCK contains five components as orientations towards science teaching, knowledge of curriculum, knowledge of students' understandings, knowledge of assessment, and knowledge of instructional strategies. Science teaching orientations are one of these components connected to a teachers' knowledge and beliefs about the purposes and goals of science teaching. Science teaching orientations guide teachers' practices (Magnusson et al., 1999).

Orientations towards science teaching

Since science teaching orientations directors the interpretations of this study, science teaching orientations are the conceptual framework for the present study. Differences between teachers' practices provide researchers to become aware of the differences in their minds towards teaching, learning, students, success, etc. Since the classroom is the most powerful environment to reflect teachers' thoughts about shaping and constructing their practices and acting processes (Putnam and Borko, 2000), teachers' practices can be a predictor of teachers' thoughts. Hewson and Hewson (1989) defined conceptions of teaching science as:

> "…the set of ideas, understandings, and interpretation of experience concerning the teacher and teaching, the nature and content of science and the learners and learning which the teacher uses in making decisions about teaching, both

in planning and execution. These include curricular decisions and instructional strategies (p. 194)."

In progress of time, researchers widened this knowledge base. Later on, Magnusson et al., (1999) called knowledge base as orientations towards science teaching whose types are process (developing students' science process skills), academic rigor (challenging students with different activities or problems), didactic (transmitting the subject matter knowledge), conceptual change (overcoming students' misconception in a manner making them first dissatisfied pre-existing knowledge and then considering adequacy of alternative explanations), activity-driven (performing hands-on activities with the aim of discovery or verification), discovery (helping students to discover the patterns), project-based science (teacher and students plan a project in the light of a driving question and develop a product, reflecting the understanding), inquiry (representing science as an inquiry), guided inquiry (the teacher behaves as a guide and scaffolds students from investigating problems to the end of drawing conclusions) (Magnusson et al., 1999, pp. 100-101).

Each orientation has its purpose. These orientations ranged from the most content-based one to the most inquiry-based one. There is not an obligation to adopting only one orientation. Conversely, a teacher can assume more than one orientation. However, the critical point is that the teacher should prefer an orientation with a valid purpose. A teacher may use the same materials or perform the same experiments in the light of different orientations, but he should design the course under the purpose. In other words, the teacher must reflect the intent of the orientation which he preferred.

Additionally, the teacher can hold multiple orientations even with the most different purposes. This becomes possible when the hold orientation is the most appropriate one according to the context. As a result, teachers should be aware of what orientation is, how it differentiates a course, etc. since he shapes his instruction (assessment, curriculum, understandings, strategies) via his orientation. In the related literature, science teaching orientations were examined via various tools. Some of those researches are like the following: Demirdöğen (2016) delved into the complexities of science teaching orientations and their interaction with the other components of pedagogical content knowledge of prospective science teachers via Content Representation (CoRe). At the end of the research, it was concluded that participants held multiple purposes and goals for teaching science and participants' beliefs about the nature of science do not directly interact with his/her PCK.

Furthermore, beliefs about teaching and learning mostly interacted with knowledge of instructional strategies. Yıldız Feyzioğlu, Feyzioğlu, and Demirci (2016) performed research to identify the science teachers' science teaching orientations and how their orientations changed according to gender, professional seniority and school context via The Pedagogy of Science Teaching Test. It was found that the participants held guided inquiry. Additionally, female teachers are more than male teachers, teachers with 11-20 years teaching profession more than 1-10 years and teachers working in city-center more than in sub-districts were in favor of guided inquiry orientation. Teachers shaped their orientations based on the physical circumstances of their current school. Mavuru and Ramnarain (2018) investigated how social context shaped Grade 9 Natural Sciences teachers' orientations via The Reformed Teaching Observation Protocol. In light of findings, it was concluded that social contexts influenced teachers' orientations. Teachers' teachings became more process and activity-driven. Curriculum coverage and exams lost their importance. Instead of them, learners' confidence and motivating students gained importance. Ladachart (2019) aimed to examine the relationship between prospective biology teachers' science teaching orientation and understanding of nature of science via an open-ended questionnaire called V-NOS and a multiple-choice test called POSST. At the end of the research, it was found that the understanding of NOS may not be an indicator of orientations in favor of inquiry-based.

As seen from the literature, detecting orientations towards science teaching of experienced chemistry teachers' is vital to render their teaching practice. There are several methods to reveal of orientations towards science teaching of teachers. In this study, the card-sorting task was used to disclose the experienced chemistry teachers' science teaching orientations.

This paper offers clarification of science teacher orientations (STOs) as a component of pedagogical content knowledge via a *card-sorting task* contains seven scenarios concerning physical-chemical change (PCC) topic developed by the authors and comparison of STOs with their practice.

Research Question

1. What are the experienced chemistry teachers' science teaching orientations identified via card-sorting task?
2. How was the comparison of the experienced chemistry teachers' choices of the card-sorting task?

METHOD

Research Design

This research was designed according to the case study as a qualitative research method in which how and why questions were asked, the researcher had little control over the events, and the focus was on the participants' real teaching activities (Yin, 2003). In this study, the participants were examined in their classes without any manipulation from researchers, and the investigation of the research questions for every participant teacher constituted each case.

Participants

In qualitative researches, the participants are assigned through purposive sampling to provide the most profound data from relatively small groups. The participants were selected purposefully through criterion sampling (Patton, 2002; Denzin and Lincoln, 2005; Creswell, 2013). In criterion sampling, the researchers choose cases according to pre-determined criteria. The critical point of this technique is that all cases or participants should meet the criteria. The pre-determined criteria were as follows: Having teaching experience more than fifteen years, teaching at the ninth-grade chemistry course, being open to cooperation, and participating voluntarily. Four experienced chemistry teachers consented to the research two weeks before the data collection process. All the participants teaching in different high schools met the predetermined criteria. They were not informed about each other. The participants' original names were not used anywhere in the study. They were referred with given pseudonyms as Toprak, Oya, Nur, and Gonca.

Table 1. The characteristics of the participants

Participants	Nur	Gonca	Oya	Toprak
Gender	Female	Female	Female	Male
Teaching experience (yrs)	32	28	21	18
Type of their current school	Science High School	Vocational High School	Anatolian High School	Anatolian High School
Educational background	Chemistry Teaching	Chemistry Teaching	Chemistry Teaching	Chemistry and Pedagogical Training Program
Post-graduation degree	M. Sc	-	-	-

The research was conducted in different high schools in which the same Chemistry Curriculum in the city center was followed. The schools varied in terms of students' achievement levels. Science high schools had the most upper achieving students.

Data collection sources

In this research, data were collected through card- sorting task.

The Card- Sorting Task

The card- sorting task, was utilized for determining participants' science teaching orientations. In the task, the author prepared different scenarios, each of them representing a different science teaching orientation placed in the PCK model by Magnusson et al. (1999). The scenarios were developed by the researchers in the light of related literature (Aydın, 2012; Friedrichsen and Dana, 2003, 2005). In the end, there were seven different scenarios as following: Didactic, process, activity-driven, guided inquiry, discovery, academic rigor, and conceptual change. Scenarios were utilized after expert opinions and revisions suggested by them. Through the task, the researchers focused more on revealing the participants' knowledge and beliefs rather than identifying their orientation precisely.

The instruction of the card-sorting task was performed in the light of Aydın (2012) and Friedrichsen and Dana's (2003) researches. The card- sorting task was utilized as follows:

1. At first, the first researcher showed the scenarios to each participant for a few minutes to read and examine them.
2. Then the participants were asked to classify the scenarios into three groups; i) best representing their teaching, ii) not representing their teaching and iii) unsure about whether representing their teaching.
3. The researcher asked the following questions to the participants about the scenarios in the first group they assigned as reflecting their teaching:
   i) What do you expect from this scenario as a teacher?
   ii) Which scenarios can help you to achieve the goals you have adopted as a teacher?
4. The researcher asked the following questions to the participants about the scenarios in the second group they assigned as not reflecting their teaching:
   i) What would you do for this scenario to represent your teaching?
   ii) Why do these scenarios not reflect you?
5. The researchers asked the participants to rank the scenarios in the first group from the best representing to the least representing their teaching. And then, the participants answered the following questions:
   i) Which criteria did you pay attention in this order? What is the reason for your ranking?
   ii) What are the common features of these scenarios?
   iii) Which features of these scenarios apply to you?
6. The researchers asked the participants to answer the following questions about the scenarios in the third group they assigned as unsure whether representing their teaching:
   i) Why are you not sure about the scenarios in this group?
   ii) What changes can you make in these scenarios to represent your teaching?
7. Are there any other strategies you prefer besides these scenarios? Could you please explain?

Data analysis

In this study, data were analyzed through content analysis. In this analysis, texts are interpreted by the use of both pre-existing categories and emerged themes, so that data could be reduced and interrogated (Cohen, Manion and Morricon, 2007, p.476). In other words, content analysis is a reducing and sense-making process of qualitative data to determine its consistencies and meanings (Patton, 2002).

At the first step, the card -sorting task was conducted individually for each participant, and the interviews of the card- sorting task were transcribed verbatim. The participants' practices were delineated intensely with the help of field notes. By this way, the data were prepared for analysis.

At the beginning of the analysis process, all transcripts were read several times. The participants' answers and classification of the scenarios placed in the card- sorting task were determined. A table was constituted for each teacher to illustrate the classifications of the scenarios representing their teaching or not.

The findings of each participant were presented individually. After the first author completed the analysis, the second author checked and corrected the misunderstood points.

Findings

In this part, the findings are presented respectively according to the research questions.

The experienced chemistry teachers' science teaching orientations identified via card- sorting task

In this part participants' preferences in the card- sorting task are presented respectively. The first participant was Nur and findings were shown in Table 2.

Table 2. Nur's card- sorting task's findings

Category	Types of science teaching orientations
Representing	Process Activity-driven Guided inquiry
Not representing	Didactic Discovery Academic rigor Conceptual change
Unsure	**-**

In card- sorting task, Nur placed the scenarios towards the process, activity-driven, and guided-inquiry orientations into the best-representing category. Her scenarios were varying from the best representing to the least representing with the following order: Activity-driven, process, conceptual learning, guided inquiry. She stated that her reasons to choose these orientations were their congruency with the organization of her teaching, their relevance with laboratory work and the integration of laboratory work to daily life. Conversely, she pointed out that the scenarios towards conceptual change, academic rigor, discovery and didactic orientations did not represent her teaching. For her, didactic orientation's focus was on students' existing knowledge, not on the new knowledge; discovery orientation was not suitable for early degrees, and academic rigor was not practical for teaching dissolution of salt. Even though the students wanted to discover something, Nur thought that this was not possible. She, therefore, assigned these scenarios into not representing the category. She added that there was not a scenario that she was unsure about representing her teaching.

The second participant was Gonca and findings were shown in Table 3.

Table 3. Gonca's card- sorting task's findings

Category	Types of science teaching orientations
Representing	Process Guided inquiry Discovery Activity-driven
Not representing	-
Unsure	Didactic Academic rigor

In card- sorting task, Gonca placed the scenarios towards activity-driven, discovery, guided inquiry and process into the best-representing category. Her scenarios were varying from the best representing to least representing with the following order: Process, activity-driven, discovery, guided inquiry, and conceptual change. The reason behind her preferences was, in the most general sense, shift from concrete to abstract. Then she expanded her teaching step by step as following: She prefers starting the lesson with developing students scientific skills through an experiment (process), then using a representation and explaining what happens during the experiment in terms of particle nature of matter (activity-driven), providing students to decide whether an example of physical or a chemical change (discovery), scaffolding students' about designing an experiment (guided-inquiry), with different examples of confusing students and making them dissatisfied about their existing knowledge and then providing them to think more and then enhancing their understanding. There was not any scenario that Gonca thought that was not representing her teaching. At last, Gonca was unsure about that didactic and academic rigor were representing her teaching or not.
The third participant was Oya and her findings were shown in Table 4.

Table 4. Oya's card- sorting task's findings

Category	Types of science teaching orientations
Representing	Didactic Activity-driven Discovery Guided inquiry
Not representing	Process Conceptual change Academic rigor
Unsure	-

In card- sorting task, Oya placed the scenarios towards didactic, activity-driven, discovery and guided inquiry into the best-representing category. Her scenarios were varying from the best representing to least representing with the following order: Didactic, discovery, activity driven and guided inquiry. The reason behind her ordering was these scenarios' being congruent with her teaching sequence during a class hour. She preferred didactic orientation for diagnosing students' preparedness level. She said her discovery orientation encouraged students to comprehend the construct of the knowledge as a whole. The scenarios towards process, conceptual change, academic rigor, and misconception orientations were not representing her teaching. According to her, since process orientation requires laboratory work, she had not to hold process orientation. The unavailability of physical circumstances and the intensity of the curriculum limited her to hold process orientation. Therefore, she could not allocate enough time for laboratory work. On the other side, she explained the reason she had kept away from conceptual change orientation was that it made her nervous. She was afraid and felt herself under pressure if she could disorient the students' misconceptions instead of fixing them. Finally, she was unsure that academic rigor orientation represented her teaching but did not explain the reasons. Oya concluded her teaching as driving from simple to complex through connecting both prior and new knowledge. She said she used all the scenarios, but the context made her differentiate the orientation.

The last participant was Toprak and findings were shown in Table 5.

Table 5. Toprak's card- sorting task's findings

Category	Types of science teaching orientations
Representing	Didactic, Activity-driven
Not representing	Process, Guided inquiry Conceptual change
Unsure	Discovery, Academic rigor

In card-sorting task, Toprak placed the scenarios towards didactic and activity-driven, into the best-representing category. His scenarios varied from the best representing to least representing with the following order: Didactic and activity-driven. The reasons for his preferences were his familiarity with that way of teaching, students' low levels of achievement, and practicality of the content, and measurability of the student success. In contrast, he pointed out the scenarios towards process, guided inquiry, and conceptual change in terms of not representing his teaching and not being suitable for his school context. Finally, he was unsure whether the scenarios towards discovery and academic rigor represented his teaching. However, he added that these orientations could be held in different types of schools. During the card- sorting task, Toprak emphasized physical conditions, crowded classes, time as constraints of his teaching. If the conditions were better without any limitation, he would be in favor of process orientation. Unfortunately, he felt obliged to hold didactic orientation.

The comparison of the experienced chemistry teachers' choices of the card-sorting task

In this part, the comparison of all of the participants' choices in the card-sorting task is presented in Table 6.

Table 6. Findings of the comparison of the participants' choices in the card-sorting task

Types of science teaching orientations	Category		
	Representing	Not representing	Unsure
Didactic	Oya, Toprak	Nur	Gonca
Activity-driven	Nur, Gonca, Oya, Toprak	-	-
Academic rigor	-	Nur, Oya	Gonca
Guided inquiry	Nur, Gonca, Oya	Toprak	-
Discovery	Gonca, Oya	Nur	Toprak
Conceptual change	-	Oya, Toprak	-
Process	Nur, Gonca	Nur, Oya, Toprak	-

In card- sorting task, activity-driven was the most preferred science teaching orientation in the best-representing category. None of the participants assigned academic rigor and conceptual change into this category. Furthermore, process was in not representing category more than the others. Since being the most preferred orientation in the best-representing category, in not representing category this orientation was not written. At last, only Gonca and Toprak selected some of the orientations in the unsure category. They were didactic, academic rigor and discovery.

DISCUSSION

In this research, the experienced chemistry teachers' science teaching orientations were determined via card-sorting task. In the beginning, when the participants can be classified

from teacher-centered to student-centered, the order was as following Toprak (the most teacher-centered), Nur, Oya, Gonca (the most student-centered).
In card- sorting task, Nur expressed that her science teaching orientations were activity-driven, guided-inquiry and process. She was teaching to the most successful students rather than other participants; that's why she challenged students with difficult questions. Her focus was on chemistry content knowledge as well as students' behaviors. She had taught chemistry through cause-effect relations.

Gonca was the most student-centered teacher despite teaching in a school with students' low level of achievement as much as Toprak's students. In light of Gonca's findings, in card- sorting task Gonca expressed that her science teaching orientations were discovery, process, activity-driven, guided inquiry. She preferred the scenarios providing a shift from concrete to abstract nature of matter. She gave priority to meaningful learning. Even though her students were not successful, interestingly, she refused didactic orientation due to its being superficial according to her. According to her, the philosophy of chemistry was driving her teaching.

Toprak was the most teacher-centered (Friedrichsen, Van Driel and Abell, 2011) teacher in the research and gave priority to transmitting knowledge thoroughly to the students (Magnusson et al. 1999). In card- sorting task, Toprak expressed that his science teaching orientations were didactic and activity-driven. He could determine his orientation as didactic. A teacher with his didactic orientation, asks questions, transmits knowledge directly, pays attention to summative assessment and believes that students have a passive role in learning (Mansour, 2009). His inclinations were in favor of more teacher-centered orientations.

On the other hand, he refused the more student-centered orientations for instance, guided-inquiry. When the reasons behind his preferences were asked, he hides behind students' low level of achievement, accustomedness, not being suitable to his school, crowded classes, inadequate physical circumstances, students' unwilling to everything. He was the most unwilling participant in his teaching. He was complaining about whatever he did in terms of teaching. In accordance with Keller, Neumann and Fischer's (2017) findings, his low level of motivation affected students' interest during the course and students were also unwilling to the course. He perceived himself as the person who transmits the knowledge to the students and anything more. He had not any effort about performing an extra activity to develop students' minds. Moreover, he assigned academic rigor into the unsure category. He was in favor of teaching chemistry as a solid conceptual knowledge base.

Oya was the second student-centered participant after Gonca. In card- sorting task Oya expressed that her science teaching orientations were didactic, activity-driven and guided-inquiry. She refused process orientation since it requires laboratory work and the laboratory's not being suitable for usage. This result was compatible with Ramnarain and Schuster's (2014) research in terms of physical circumstances' influencing teachers' teaching. Additionally, she refused conceptual change with the reason for feeling nervous about fixing students' minds. Teachers adapt the orientations that they feel effective and safe while practising (Ramnarain and Schuster, 2014). But then, she put academic rigor into not representing the category.

When all the findings of participants' preferences, it was seen that activity-driven was the most preferred orientation in the best-representing category. Then guided inquiry was in second place, and discovery and didactic were in third place. Academic rigor and conceptual change were assigned to the best-representing category. It was found that one of the participants, Oya, was in fear of being bad at overcoming a misconception. That's why she avoided conceptual change during her task. It can be conveniently said that participants were aware of student-centered teaching.

For this reason, they were in favor of more student-centered orientations like guided inquiry, discovery and process no matter performing them in practice. Three of the participants assigned process into not representing category due to this orientation's requiring laboratory. They associated process with only laboratory and experiment. Unfortunately, they were not knowledgeable about that not all of the science process skills can be aimed to develop only with experiment. For example, communication can be improved through discussion. As explained before, participants did not select didactic orientation except Nur and activity- driven in not representing category since they mirrored themselves as in the mind of student-centered teachers. The unsure category left mostly blank. The participants were primarily sure about their teaching in their understanding.

In the end, it can be said that in the card-sorting task the participants put the scenarios into different categories. They had held multi orientations similar to the related literature (Aydın (2012), Cohen and Yarden (2009), Friedrichsen and Dana (2005), Üner (2016). Another result was that physical circumstances, university entrance exam, time, teachers' beliefs, educational system, students' levels of achievement and school context influenced or shaped teachers' science teaching orientations. This finding was congruent with the results gathered from Friedrichsen and Dana's research (2005). Teachers can pay attention to learners' socio-cultural background, everyday experiences, learning context in their teaching. As a result, their orientations can be influenced (Mavuru and Ramnarain, 2018). Due to the lack of resources and full classes teachers can lead to teacher-centered teaching activities (Yıldız Feyzioğlu, Feyzioğlu and Demirci, 2016). In addition to these teachers' educational background have potential on their different science teaching orientations. Because, in Ladachart's (2019) research, prospective biology teachers' orientations varied between active direct and guided inquiry as a result of their prior experiences in high school as students where science was taught through hands-on activities and guided inquiry. Depending on the differentiation of teachers' science teaching orientations, their knowledge of teaching strategies differed synchronously. As Demirdöğen (2016) stated that beliefs about teaching and learning interacted knowledge of instructional strategies (p. 518) in other words teachers' teaching practice.

In the light of these results, it can be suggested that experienced chemistry teachers should be aware of what science teaching orientation is, how they can redound on teaching practice, in which circumstances they can be differentiated. Also, prospective chemistry teachers should learn the importance of science teaching orientation in an undergraduate degree. Both experienced and prospective teachers should be knowledgeable about science teaching orientations influence on teaching.

Uncovering a teacher's science teaching orientations via only interviews may be performed easily due to its requirement of less time than observing teaching practice in the classroom. Also, observation requires access to the class (Boesforder, 2015). And the researcher has to struggle more in the observation process. But on the other hand, despite these challenges science teaching orientations can be revealed accurately when incorporating observation into data collection. Because, teachers can sail under false colors, in other words, can behave differently from their own. For the nest researches, associating the card-sorting task with teaching practice can be more valuable.

REFERENCES

Aydın, S. (2012). *Examination of chemistry teachers' topic-specific nature of pedagogical content knowledge in electrochemistry and radioactivity* (Unpublished doctoral dissertation). Middle East Technical University, Ankara, Turkey.

Boesforder, S. B. (2015). Using Teachers' Choice of Representations to Understand the Translation of Their Orientation Toward Science Teaching to Their Practice. *Electronic Journal of Science Education, 19*(1), 1-20.

Cochran, K. F., King, A. and DeRuiter, J. A. (1991). Pedagogical content knowledge: a tentative model for teacher preparation. Paper presented at the annual meeting of the American Educational Research Association, Chicago, 1-23.

Cochran, K. F., DeRuiter, J. A. and King, R. A. (1993). Pedagogical content knowing: an integrative model for teacher preparation. *Journal of Teacher Education, 44*(4), 263-270.

Cohen, L., Manion, L. and Morrison, K. (2007). *Research methods in education*. New York: Routledge.

Cohen, R. and Yarden, A. (2009). Experienced junior-high-school teachers' PCK in light of a curriculum change: "The cell is to be studied longitudinally." *Research in Science Education, 39*(1), 131-155.

Creswell, J.W. (2013). *Nitel araştırma yöntemleri: Beş yaklaşıma göre nitel araştırma ve araştırma deseni* (3. Baskıdan Çeviri). (Çeviri Editörleri: M. Bütün & S.B.Demir). Ankara: Siyasal Yayın Dağıtım.

Demirdöğen, B. (2016). Interaction between science teaching orientation and pedagogical content knowledge components. *Journal of Science Teacher Education, 27*(5), 495–532.

Denzin, N. K. and Lincoln, Y. S. (Eds.). (2005). *The Sage handbook of qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.

Fernandez-Balboa, J. and Stiehl, J. (1995). The generic nature of pedagogical content knowledge among college professors. *Teaching and Teacher Education, 11*(3), 293-306.

Friedrichsen, P. M. and Dana, T. M. (2003). Using a card-sorting task to elicit and clarify science teaching orientations. *Journal of Science Teacher Education, 14*(4), 291-309.

Friedrichsen, P. M. and Dana, T. M. (2005). Substantive-level theory of highly regarded secondary biology teachers' science teaching orientations. *Journal of Research in Science Teaching, 42*(2), 218-244.

Friedrichsen, P., Van Driel, J. H. and Abell, S. K. (2011). Taking a closer look at science teaching orientations. *Science Education, 95*(2), 358 – 376.

Hashweh, M. Z. (2005). Teacher pedagogical constructions: a reconfiguration of pedagogical content knowledge. *Teachers and Teaching: Theory and Practice*, *11*(3), 273-292.

Hewson, P. W. and Hewson, M. G. A'B. (1989). Analysis and use of a task for identifying conceptions of teaching science. *Journal of Education for Teaching, 15*(3), 191–209.

Keller, M. M., Neumann, K. and Fischer, H. E. (2017). The impact of physics teachers' pedagogical content knowledge and motivation on students' achievement and interest. *Journal of Research in Science Teaching, 54*(5), 586-614.

Ladachart, L. (2019). Correlation between understanding about nature of science and orientation to teaching science: An exploratory study with Thai first-year preservice biology teachers. *Journal of Education in Science, Environment and Health (JESEH), 5*(1), 134-145. DOI:10.21891/jeseh.512428.

Magnusson, S., Krajcik, J. and Borko, H. (1999). Nature, sources and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 95-132). Dordrecht, The Netherlands: Kluwer Academic.

Mansour, N. (2009). Science teachers' beliefs and practices: issues, implications and research agenda. *International Journal of Environmental & Science Education, 4*(1), 25-48.

Marks, R. (1990). Pedagogical content knowledge: from a methematical case to a modified conception. *Journal of Teacher Education, 41*(3), 3-11.

Mavuru, L. and Ramnarain, U. (2018). Relationship between Teaching Context and Teachers' Orientations to Science Teaching*, EURASIA Journal of Mathematics, Science and Technology Education, 14*(8), 1-14.

Park, S. and Oliver, J. S. (2008a). National Board Certification (NBC) as a Catalyst for teachers' learning about teaching: The effects of the NBC process on candidate teachers' PCK development. *Journal of Research in Science Teaching, 45*(7), 812-834.

Park, S. and Oliver, J. S. (2008b). Revisiting the conseptualisation of pedagogical content knowledge (PCK): PCK as a tool to understand teachers as professionals. *Research in Science Education*, *38*(3), 261-284.

Patton, M.Q. (2002). *Qualitative research & evaluation methods*. Thousand Oaks, CA: Sage Publications.

Putnam, R. T. and Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning. *Educational Researcher, 29*(1), 4-15.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Xiaoyan, Z. (2007). Understanding PCK: its background, components and models — a comprehensive review on pck in the past two decades. *CELEA Journal (Bim onthly), 30*(5), 84-93.

Yıldız Feyzioğlu, E., Feyzioğlu, B. and Demirci, N. (2016). Aktif doğrudan veya yapılandırılmış buluş: Fen bilimleri öğretmenlerinin fen öğretimi yönelimlerinin belirlenmesi. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 1*(39), 150-173.

Veal, W. R. and MaKinster, J. G. (1999). Pedagogical content knowledge taxonomies. *Electronic Journal of Science Education, 3*(4), 1-19 .

Üner, S. (2016). *Kimya öğretmenlerinin pedagojik alan bilgisinin konuya özgü doğasının incelenmesi ve öğrencilerin öğretmenlerinin pedagojik alan bilgisine ilişkin algıları*. (Yayımlanmamış Doktora Tezi), Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage.