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Okul Öncesi Öğretmen Adaylarının Bilimsel Kavramların İçselleştirmesinde Grafikleri Zihin Aracı Olarak Kullanmaları

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Özet – Bu çalışma okul öncesi öğretmen adaylarının topladıkları verileri anlamada bir zihin aracı olarak grafikleri nasıl kullandıklarını ve grafik kullanımının öğretmen adaylarının bilimsel kavramları içselleştirmesini nasıl kolaylaştırdığını incelemeyi amaçlamaktadır. Yirmi altı okul öncesi öğretmen adayı çalışmaya katılmıştır. Araştırma verileri katılımcı gözlem tekniği ile toplanmıştır. Gözlemler ve gözlem esnasında sınıfta öğrenciler arasında meydana gelen konuşmalar alan notları biçiminde kaydedilmiştir. Bu çalışma verilerin analizi ve yorumlanmasında Vygotsky'nin sosyo-kültürel kuramını temel almıştır. Sonuçlar grafik kullanımının bilişsel yükü azaltarak ve örüntü tanılama ve örüntüden sonuç çıkarma gibi yüksek düzey zihinsel fonksiyonların işlemesini sağlayarak okul öncesi öğretmen adaylarının hedeflenen bilimsel kavramları anlamalarını kolaylaştırdığını göstermiştir.

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Key words: okul öncesi öğretmen adayları, fen eğitimi dersi, sosyo-kültürel kuram, zihin araçları, astronomi.

Geniş Özet

Giriş

Araçlar öğrencilerin kendi başlarına tamamlayabileceklerinin ötesindeki öğrenme ödevlerini başarmada onlara yardımcı olan bir kaynaktır. Araçlar öğrencilerin kapasitelerini genişleterek ve öğrenme ödevlerini öğrenciler için başa çıkılabilir bir hale dönüştürerek bilimsel kavram ve becerilerin edinilmesinin de dahil olduğu pek çok alandaki performanslarını arttırır (Hewson, 2004). Grafikler fen derslerinde sıklıkla kullanılan araçlardır. Değişkenler arasındaki ilişkileri temsil etmede ve büyük miktarda veriyi özetlemede kullanılabilecek en

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uygun araç grafiklerdir (Roth & Bowen, 1999). Genelde zihin araçlarının özelde de grafiklerin öğrenciler tarafından bilimsel kavram ve becerilerin inşası ve kazanımında nasıl kullanıldığına ilişkin sınırılı sayıda çalışma bulunmaktadır (Jones et al., 1998). Bu çalışma okul öncesi öğretmen adaylarının Fen Eğitimi dersi kapsamında topladıkları verileri anlamada bir zihin aracı olarak grafikleri nasıl kullandıklarını ve grafik kullanımının öğretmen adaylarının bilimsel kavramları içselleştirmesini nasıl kolaylaştırdığını incelemeyi amaçlamaktadır.

Yöntem

Araştırma verilerinin toplanması, çözümlenmesi ve yorumunda nitel yöntem benimsenmiştir. Amerika Birleşik Devletlerinde büyük bir araştırma üniversitesinde öğrenim gören toplam yirmi altı okul öncesi öğretmen adayı çalışmaya katılmıştır. Katılımcıların tümü kadındır. Katılımcıların büyük çoğunluğu Avrupa, biri Afrika, diğeri ise Asya kökenli Amerikalılardan oluşmaktadır. Araştırma verileri katılımcı gözlem tekniği ile toplanmıştır. Gözlemler ve gözlem esnasında sınıfta öğrenciler arasında meydana gelen konuşmalar alan notları biçiminde kaydedilmiştir. Bu çalışmada verilerin analizi ve yorumlanmasında Vygotsky'nin sosyo-kültürel kuramı temel alınmış ve veriler işaret, araç ve içselleştirme kavramları kullanılarak yorumlanmıştır.

Bulgular

Bulgular ders süresince pek çok pedagojik tekniğin işe koşulduğunu ortaya koymuştur. Fen eğitimi kapsamında ayın evrelerine ilişkin iki ay süresince gözlem yapan okul öncesi öğretmen adaylarının bu gözlemlerini kendi sözcükleriyle betimlemesine müsaade edilmiş, evrelerin bilimsel tanımları ise daha sonra tanıtılmıştır. Bu yaklaşım öğretmen adaylarının sahip oldukları "gündelik dil"i sınıfta bilimsel olguları anlamak için bir kaynak olarak kullanmalarını sağlamıştır. Gözledikleri olguları önce kendi sözcükleriyle tanımlayıp ardında bilimsel terminolojinin sunulması bilimsel kavramlarının içselleştirilmesine katkı yapmış gözükmektedir. Fen eğitimi dersi süresince öğretmen adaylarının gözledikleri olgular arasındaki ilişkileri görmesi ve ayın evrelerinin oluşumuna ilişkin nedensel bir açıklama geliştirebilmeleri için bazı pedagojik teknikler kullanılmıştır. Bu tekniklerden biri öğretmenin konuşma hızı, tonlaması ve vurgusunu kullanım tarzıdır. Ders süresince öğretmen adaylarının sahip olduğu bazı kavram yanılgıları da, Ayın sadece akşam vakti gözlenebileceği gibi, yeri geldikçe ele alınmıştır. Öğretmen adaylarının gözlemlerini grafik formuna dönüştürmesi, bu gözlemleri akranlarıyla sınıfta paylaşması ve gözlemlere ilişkin örüntülerin tespit edilmesi ayın evrelerine ilişkin bilimsel bir açıklama inşa etmelerini kolaylaştırmıştır.

Tartışma ve Sonuç

Öğretmen adaylarının Ayın evrelerine ilişkin gözlemlerini grafik kullanarak betimlemesi verileri düzenli ve anlaşılır hale getirmelerini ve bu da verilerdeki örüntüleri daha etkili bir biçimde görüp anlamalarını mümkün kılmıştır. Sonuçlar grafik kullanımının bilişsel yükü azaltarak ve örüntü tanılama ve örüntüden sonuç çıkarma gibi yüksek düzey zihinsel fonksiyonların işlemesini sağlayarak okul öncesi öğretmen adaylarının hedeflenen bilimsel kavramları anlamalarını kolaylaştırdığını göstermiştir.

Preservice Early Childhood Teachers Use of Graphs as Mental Tools in Internalizing Scientific Concepts

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Abstract – The purpose of this study was to examine how preservice early childhood teachers used graphs as a mental tool in a science methods course to make sense of their data and how graph use facilitated preservice teachers' internalization of scientific concepts. Twenty-six preservice early childhood teachers participated in the study. Data were collected through participant observation technique. Field notes were kept to record observations and discourse taking place during the classroom observations. The current study utilized a Vygotskian framework in the analysis and the interpretation of the study data. The results demonstrated that using the graph as a mediating tool facilitated preservice teachers' understanding of the targeted science concepts by organizing their data in a way that could reduce the burden of cognitive load to process information, which made it possible for higher psychological functions, such as seeing patterns and deriving conclusions from the pattern, to operate more efficiently.

Key words : preservice early childhood teachers, science methods course, socio-cultural theory, mental tools, astronomy.

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Introduction

Although Vygotsky (1978) was not the first to recognize the important role tools play in human evolution, he perhaps was the first to emphasize the role of tools in human reasoning. According to Vygotsky, tools are crucial for the development of higher mental functions. Higher mental functions develop through gaining mastery over the use of tools, such as maps, computers, and graphs. Tools mediate higher order thinking and facilitate internalization of cultural and scientific concepts and procedures (Wells & Claxton, 2002). Vygotsky's conceptualization of tools as mediating artifacts in the development of the human mind led researchers to examine the tool dependent nature of the human mind.

Vygostkian researchers emphasize the discursive and tool-dependent nature of human cognition. From this perspective, human cognition is not restricted to an individual's "mind." Rather cognition is distributed in the human sociocultural environment which encompasses tools that are created to support cognitive processing. Therefore, the issue of the relationship between human reasoning and tools takes on a position of importance in understanding human reasoning (Rogoff, 2003; Schoultz, Saljo, & Wyndhamn, 2001).

Tools, acting as a structural resource, aid learners in accomplishing a task that is beyond their independent performance. Tools extend learners' capabilities and transform tasks in more manageable forms, thereby promoting learners' task performances in various domains including the learning of science concepts and skills (Hewson, 2004). The graph is a tool frequently used in science classes. "Graphs are extremely useful to scientists because they constitute the best tools to represent covariation between continuous measures and are useful to summarize large amounts of data in economical ways" (Roth & Bowen, 1999, p.181).

The relationship between the phenomena and their representation on graphs is not intrinsic. Reconstruction and interpretation of observations on graphs depends on the scientific content and understanding of the function of the tool (Roth & Bowen, 1999). Graph use also communicates its producers' and users' way of consensually seeing and knowing. Therefore, the use of graphs both mediates content learning and the way of thinking that produced the content itself. For example, a study with 14 preservice teachers demonstrated that tools facilitated the internalization of science content knowledge and pedagogical content knowledge (Jones, Rua, & Carter, 1998). Preservice teachers not only learned the science content knowledge, but also learned the way this knowledge was produced and the way it can be taught to children. Science or science education as a cultural enterprise offers appropriate ways of asking and answering questions about scientific phenomena (Lemke, 2001). A graph, a tool and cultural artifact of the scientific community, represents, communicates, and mediates scientists' ways of doing things, that is, their cultural practices.

Despite the efforts to examine the tool dependent nature of the human mind in the research literature, few studies have focused on how tools are used by learners in constructing understandings of science concepts and skills (Jones et al., 1998). Although representation is an important aspect of science, our knowledge about how learners understand and use graphical representations is very limited (Jones et al., 1998; Roth & Bowen, 1999). Therefore, the current study examined preservice early childhood teachers' use of graphs in a science methods course to make sense of the data they collected.

Purpose of the Study

The focus of this study was to explore how pre-service early childhood teachers used graphs as a mental tool in a science class to make sense of their data and how graph use facilitated their internalization of scientific concepts. The current study invoked a Vygotskian framework to examine the participants' use of a scientific tool in a graduate level science methods course.

Methodology

Participants and Setting

Twenty-six preservice teachers majoring in early childhood education at a major Midwestern research university in the U.S. were participants in this study. All participants were female. Twenty-four participants were European-American, one participant was African-American, and one participant was Asian-American.

Data Collection and Analysis

Data were collected through a participant observation technique (Glesne & Peshkin, 1992). Field notes were kept to record observations and the discourse taking place between the course instructor and preservice teachers and among the preservice teachers. Personal reflections regarding observations and field notes were also recorded immediately after each observation. A total of five observations (each lasting about 2 to 3 hours) were made for the study.

Observational data were recorded as field notes entries. These field notes were analyzed using an inductive approach to identify patterns and recurrent themes in the preservice teachers' utterances and actions (Bogdan & Biklen, 1982). Three sociocultural concepts were utilized to interpret the data: sign, tool, and internalization. Excerpts from the field notes are provided to support and illustrate the interpretation of the data.

Findings and Discussion

In this section, findings are presented under the three subtitles that identify and describe the series of instructional episodes during which we made observations and gathered data in the early childhood science methods course.

Collecting lunar data: How can you describe the different phases of the moon?

Once per week over a four week period, the participants used a planetarium software, *Starry Night*, to collect two-weeks of moon data during each class meeting time. A total of 8 weeks of moon data were gathered and recorded. The *Starry Night* program allows users to observe the sky from their own geographic location and at the current date and time. The observation location as well as the date and the time of the observation can be manipulated with the software (Trundle & Bell, 2003). The program allows users to go forward and backward in time, and they can observe the objects in the sky, including the moon, from Columbus, Ohio as well as Istanbul Turkey. By using the magnify feature of the program, users can zoom in on the moon image. The function produces a small pop up window that provides additional information about the moon including the percentage of disc illumination, altitude, and rises and set times. The software also provides a feature to measure the angular separation between celestial objects (e.g., moon and the sun), which is a very difficult task to accomplish using observations in nature (Trundle & Bell, 2003).

The preservice teachers in this study worked in small groups of two to three people during the data collection and analysis periods. To make moon observations, the instructor first demonstrated how to use the software program by having the preservice teachers locate the moon in images that were projected on two computer screens. Then, data were recorded on a moon graph (data chart), which was specifically designed to record moon observations. The shape of the moon, percentage of disc illumination (the percentage of the visible surface of the moon we can see), the angular separation between the moon and the sun, the direction in the sky where the moon was observed, and the time of observation.

After a brief introduction of the simulation program, the location and date were set, and the moon was located on the screen. The instructor asked preservice teachers to describe the shape of the moon.

Excerpt #1

Instructor: What does it look like?

Preservice teachers: More than half moon

Preservice teachers: Waxing moon

Instructor: Young children usually do not use this term (waxing moon). What term children might use to describe this moon?

Throughout the data collection and analysis period, the instructor asked preservice teachers to describe the shapes of the moon using their own words. Preservice teachers were also asked to think about the terms children use to describe the shape of the moon. At the very end of the moon project scientific terms for the phases of the moon were introduced. Through this pedagogical approach, where preservice teachers first used their own words to describe the phases of the moon then learned the scientific words to describe them, internalization of scientific terminology and scaffolding occurred. This process allowed preservice teachers to use the resource, everyday language; they brought the science classroom to make sense of what they were learning. Science has its own discourse, and most of the time it is difficult for learners to make a transition from everyday discourse to scientific discourse (Mercer, Dawes, Wegerif, & Sams, 2004; Renshaw & Brown, 2007). Allowing and encouraging preservice teachers to use their own language eased their transition from everyday discourse to scientific discourse. Preservice teachers were also encouraged to use this pedagogical approach in their teaching several times during the moon project.

Excerpt #2

Instructor: Focus on language children use and understand. They sometimes use the term sliver and sometimes backward C to describe this moon (a waxing crescent).

Accurately drawing moon shapes was important. The instructor modeled how to draw shapes of the moon on the board and pointed out what preservice teachers should pay attention to in order to accurately represent the moon.

Excerpt #3

Instructor: You find the mid point (she finds midpoint of the circle and starts drawing by taking into account of the midpoints) and how it shifts in orientation relative to the horizon. Both ends have to touch the mid points. See (pointing the midpoints).

The angular separation data were collected by clicking on the moon and dragging a line between the moon and the sun. Preservice teachers recorded the angular separation on the space provided on their moon graph. However, there was something that preservice teachers needed to pay attention in recording the angular separation.

Excerpt #4

Instructor: What is the angular separation?

Preservice teachers: 55

Instructor: 55… ***degrees*** [stressing], always use a unit with numbers

Preservice teachers: ***Degrees***.

Using a unit with numbers is crucial for scientific observations in order to establish a common ground for the communication of the data collected. The instructor pointed out the importance of using units by stressing the term degrees. The following excerpt shows how the instructor checked to see if preservice teachers understood how to incorporate the use of units in their observations.

Excerpt #5

Instructor: Forty ***foourrr*** [stressing signals preservice teachers that instructor expects them to complete sentence]

Preservice teachers: ***Degrees***

Instructor: 44 degrees of what? What we are measuring?

Preservice teachers: Angular separation.

Sharing and analyzing the lunar data: What patterns can you see in your data?

Each week at the beginning of the class preservice teachers shared the data they collected during the previous week. Shared data were recorded on an enlarged class moon graph (moon chart). Over the instructional period, each preservice teacher was expected to contribute at least two days worth of data to this graph. The chart consisted of two larger papers that had seven circles on the first line and seven circles on the second line, for a total of 14 circles. These 14 circles represented the moon over a two week period. Preservice teachers recorded the shape of the moon, disc illumination, angular separation, direction, and observation time for a given date on the chart. When all observations were recorded, the moon chart was posted on the board and analyzed by the preservice teachers and the instructor. The analysis involved looking for patterns in the recorded and shared data.

A summary of the instruction involving the analysis of the moon chart follows. The analysis first focused on the shape of the moon. Identifying and describing the different shapes of the moon is the first step toward the understanding of the cause of moon phases that leads to these different appearances of the moon. During the analysis of the moon data, shapes of the moon were carefully identified and described using preservice teachers' own terms.

Excerpt #7

Instructor: How do you describe the moon on January 9?

Preservice teachers: Potbelly

Instructor: Yes, it looks like a potbelly. It is more than half, less than full.

Excerpt #8

Instructor: What are the distinct shapes you see?

A preservice teacher: Backward C

A preservice teacher: Little

Instructor: Is it a potbelly or bowl?

A preservice teacher: Crescent moon

Instructor: Most children won't say crescent. What words would they use?

A preservice teacher: Sliver

A preservice teacher: Fingernail

The next step in the data analysis involved looking for patterns in the shapes over a given time period. Seeing patterns in the data might be one of the most important parts of the scientific practice, and in the case of understanding the cause of the moon phases, it is vital that learners see the regularly recurring pattern in the phases of the moon.

Excerpt #6

Instructor: Use your own word and tell me what is happening to the moon's appearance from January 9 to 15?

A preservice teacher: It is getting smaller.

A preservice teacher: Less of the moon is visible each day.

The third step in the analysis focused on of the angular separation between the sun and moon and the patterns associated with how the angle changed from day to day. The excerpt below exemplifies how the instructor pointed out the relationship between the angular separation and the shapes of the moon, and how preservice teachers immediately recognized this relationship from the way instructor spoke.

Excerpt #9

Instructor: What was happening to the degrees of angular separation from January 11 to January 15?

Preservice teachers : Degree was getting smaller. The angle was getting smaller

Instructor: What was happening as the degree was getting smaller?...[no response from the preservice teachers] as the degree got smaller we saw *less of the moon* [preservice teachers and the instructor at the same time: stressed].

Seeing the relationship between the angular separation and the different phases of the moon was crucial to understanding the cause of moon phases. Several times during the moon project the instructor deliberately directed preservice teachers' attention to this relationship. This relationship was not immediately obvious to the preservice teachers, but it became explicit when the instructor invited preservice teachers to see it through the pace of her speech (Macbeth, 2000). As Rogoff (2003) puts it, seeing connections often involves support from other people pointing out where to look. Students generally do not see the connection automatically; a skilled teacher can help them recognize the relationships or patterns. The excerpt below provides supporting evidence of the preservice teachers' understanding of the relationship between the angular separation and the shapes of the moon.

Excerpt #10

Instructor: What was happening to the angle?

Preservice teachers: The angle was getting smaller

Instructor: As the angle got smaller what happened to the moon's appearance?

A preservice teacher: Moon also got smaller.

Instructor: Was the moon actually changing size and getting smaller?

Preservice teachers: Noo.. the visible part of the moon was getting smaller. We were seeing less of the moon.

The excerpt above also demonstrates the instructor's effort to address a common misconception that the size of the moon changes. This misconception is commonly held among young children, but rarely seen in adults (Roald & Mikalsen 2001; Za'rour, 1976). However, a teacher's description of the change in appearance of the moon using the phrase "getting smaller" or "getting bigger" might reinforce or lead children to develop this misconception. Therefore, this issue needs to be addressed during the instruction by making it clear that the appearance of the moon changes over time while the size and shape of the moon remains constant or the same.

Fourth focal point in the instructional sequence was the analysis of the direction in the sky where the moon was located during each observation during targeted observation period of two weeks. It is important to keep track of moon's day to day movement in the sky to understand the cause of the moon phases. A moon graph posted on the board made it easy to see the pattern in the moon's day to day movement in the sky as the moon orbits the Earth. This particular phenomenon required observations at about the same time each day.

Excerpt #11

Instructor: What is the first direction we noted for when the moon was observed?

Preservice teachers: West

Instructor: Okay, if we look at the moon at about the same time each day, what happened to the direction we observed the moon?

Preservice teachers: From day to day moon appears to move toward the south.

The final key point in the instruction involved the analysis of the time of day when the moon was observed. One of the most common misconceptions held by many people, including adults and children, is that we can only see the moon during the nighttime (Hobson, Trundle & Saçkes, 2010; Küçüközer & Bostan, 2010; Trundle, Saçkes, Smith, & Miller, 2012). The recorded times of moon observations allowed preservice teachers to recognize that we can see the moon during the daytime as well as during the nighttime depending on the phase of the moon.

Excerpt #12

Instructor: At what time of day did we see the moon this week?

Preservice teachers: Morning

Instructor: We see moon during the *daytime* [stressed]

Excerpt #13

Instructor: Was this a morning or evening moon this week?

Preservice teachers: It was a morning moon

Conclusion

The aim of this study was use the sociocultural framework to examine preservice early childhood teachers' use of a graph in a science methods course. The following sociocultural concepts were utilized to interpret the findings of this study: sign, tool, and internalization. During moon observations, preservice teachers represented different phases of the moon by filling-in the circles on the moon log. The depictions they created signified the different phases of the moon, and they learned how to label these depictions of the moon from the instructor, that is, the application of scientific names to the different phases. These drawings preservice teachers created can be considered as signs of the different phases of the moon, because they make it possible for preservice teachers to mentally operate on different lunar concepts, including shapes, sequence, and the cause of the moon phases without referring to the actual representation of the moon phases. However, these signs were not very well developed signs, because, like eidetic-like representations, they were direct representations of the different shapes of the moon.

After preservice teachers collected 2 months worth of moon observation data, preservice teachers shared their data with their peers to look at patterns and anomalies in their data. This activity helped preservice teachers to construct following lunar concepts, shape, sequence, and the cause of the moon phases. To share and make sense of their data, preservice teachers needed a tool that makes it possible to share their data, search for, and identify patterns as well as anomalies in their data. The moon graph was a tool that helped preservice teachers to accomplish this task. Using the moon graph as a tool, preservice teachers manipulated signs, data, to process the raw information they gathered. This tool allowed preservice teachers to organize their data in a way that could reduce the burden of cognitive load to process information, which made it possible for higher psychological functions, such as seeing patterns and deriving conclusions from the pattern, to operate more efficiently (Hobson et al., 2010). The moon graph helped preservice teachers see all the data they collected the previous week on one large chart. It helped them to easily organize the data, see patterns in the data, and derive a conclusion from the set of data they collected. All this higher order thinking became possible due to use of the moon graph.

Preservice teachers first got verbal instruction about how to use the moon graph, including what kind of information they need to record on the graph. Then, the instructor modeled how to use the graph and what kind of questions to ask to analyze the data on the graph. The instructor also guided preservice teachers in the interpretation of the data represented on the graph by asking guiding questions. Asking the right questions is important for the scientific practice. The right questions show preservice teachers where to focus their attention and where to look for patterns or answers. Most of the time the preservice teachers inferred the scientifically accurate answer to the questions from the way the instructor asked the questions (i.e., paces of her speech or tone of her voice).

The instructor modeled how a scientist questions his/her own reasoning. Preservice teachers learned not only the content knowledge related to the science concepts, but they also learned science process skills (scientific practice) that produced the content knowledge they were learning. This process showed them that science is not a collection of factual knowledge, rather it is a way of reasoning, asking analytical questions, and making inferences based on the data. The graph, as a mediating device, not only helped preservice teachers understand lunar concepts, but it also helped them understand the way scientists use data and the types of questions scientists ask while using the graph. In this manner, the moon graph was not only a tool that facilitated preservice teachers learning, but it also was an artifact that represented the cultural practice of the scientific community.

During the moon observation part of the instruction, preservice teachers observed different phases of the moon and labeled these different shapes of the moon by using their own terms. For example, preservice teachers used the terms banana moon, sliver moon, and fingernail moon to describe the crescent moon. Preservice teachers also described the way the moon's appearance changed, its sequence, during their observation time by using their own terms as well. For example, they used the terms "getting smaller" or "thinner" for the waning sequence of the day to day changes in the moon's appearance, and they used the terms "getting bigger" or "fatter" for the waxing sequence of the moon. Only after preservice teachers gathered data, used their own terms for the above described lunar concepts (shape and sequence) ,and shared the data with their classmates did the instructor introduce scientific concepts (terminology). Internalization of these concepts by the preservice teachers was accomplished via preservice teachers' interactions with their peers and the instructor (sharing their own terms for the concepts).

The preservice teachers were commenting on and sharing their own definitions for the lunar concepts throughout the moon project. They also were sharing their ideas and trying to interpret what instructor asked from them by talking to each other instead of directly asking the instructor for additional information. After they reached a consensus about what to do as a group, the preservice teachers individually recorded and analyzed their data.

Questions provided by the instructor functioned as guides that led preservice teachers to understand the targeted lunar concepts. The meaning of the questions written on the board, such as “What is your basis for your prediction?” usually were understood through discussion by the preservice teachers in their small groups. Rather than asking the instructor for clarification, preservice teachers were interpreting meanings first in small groups and then individually after which they wrote and recorded their answers and understandings on their own. Therefore, it seems reasonable to assert that the internalization of lunar concepts started on the social level, with classroom discourse and the discussion and sharing of preservice teachers’ own terms and their interpretations of data. The internalization then concluded on an individual level. The explanation of concepts was first introduced in the social plane, and then concepts were installed or constructed on preservice teachers’ own preconceptions/definitions (Driver, Asoko, Leach, Scott, Mortimer, 1994). The instructor deliberately attempted to situate the targeted concepts in preservice teachers’ experience, and thus made concepts recognizable for them. Establishing links between the new and previous concepts seemed to play the vital role in internalization process.

In summary, using the moon graph as a mediating tool facilitated preservice teachers’ understanding of the lunar concepts by organizing the data in a way that allowed them to process it efficiently. It also allowed them to understand the way scientists use this tool in their daily practices. The overall findings of this study highlight the crucial role mental tools play in the learning of science concepts and skills within the context of inquiry based science methods courses. Further studies with diverse learners and contexts should be conducted to examine the tool dependent nature of the learners' mind in general and how learners understand and use graphical representations in particular.

References

Bogdan, R. C., & Biklen, S. K. (1982). *Qualitative research for education: An introduction to theory and methods*. Allyn and Bacon MA:Boston.

Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23*(7), 5-12.

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction.* New York: Longman.

Hewson, P., W. (2004). Resources for science learning: Tools, tasks, and environment. *International Journal of Science and Mathematics Education, 2*, 201-225.

Hobson, S. M., Trundle, K. C., & Saçkes, M. (2010). Using a planetarium software program to promote conceptual change with young children. *Journal of Science Education and Technology, 19*(2), 165-176.

Jones, M. G., Rua, M. J., & Carter, G. (1998). Science teachers' conceptual growth within Vygotsky's zone of proximal development. *Journal of Research in Science Teaching, 35*(9), 967-985.

Kallery, M., & Psillos, D. (2001). Preschool teachers' content knowledge in science: Their understanding of elementary science concepts and of issues raised by children's questions. *International Journals of Early Years Education, 9*(3), 165-179.

Lemke, J., L. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching, 38*(3), 296-316.

Mercer, N., Dawes, L., Wegerif, R., & Sams, C. (2004). Reasoning as a scientist: Ways of helping children to use language to learn science. *British Educational Research Journal, 30*(3), 359-377.

Macbeth, D. (2000). On an actual apparatus for conceptual change. *Science Education, 84*(2), 228-264.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Renshaw, P., & Brown, R. A. J. (2007). Formats of classroom talk for integrating everyday and scientific discourse: Replacement, interweaving, contextual privileging and pastiche. *Language and Education, 21*(6), 531-549.

Roald, I., & Mikalsen, O. (2001) Configuration and dynamics of the Earth-Sun-Moon system: An investigation into conceptions of deaf and hearing pupils. *International Journal of Science Education*, *23,* 423-440.

Rogoff, B. (2003). *The cultural nature of human development*. New York: Oxford Univeristy Press.

Roth, W., & Bowen, G. M. (1999). Of cannibals, missionaries, and coverts: Graphing competencies from grade 8 to professional science inside (classrooms) and outside (field/laboratory). *Science, Technology, & Human Values, 24*(2), 179-212.

Schoultz, J., Saljo, R., & Wyndhamn, J. (2001). Heavenly talk: Discourse, artifacts, and children's understanding of elementary astronomy. *Human Development, 44*, 103-118.

Trundle, K. C., Saçkes, M., Smith, M. M., & Miller, H. L. (2012, September). Preschoolers' ideas about day and night and objects in the sky. *Paper presented at the annual meeting of the International Congress on Early Childhood Education*. Adana, Turkey, September 12-15.

Wells, G., & Claxton, G. (2002). Introduction: Sociocultural perspective on the future of education. In G. Wells & G. Claxton (Eds.). *Learning or life in the 21st century* (pp.1-18). Oxford, UK: Blackwell Publishers.

Vygotsky, L. V. (1978). *Mind in society: The development of higher psychologicalprocess*. (edited by, M. Cole, V. John-Steiner, S. Scribner, E. Souberman).Massachusetts: Harvard University Press.

Za'rour, G. I. (1976). Interpretation of natural phenomena by Lebanese school children. *Science Education, 60*(2), 277-287.