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ORIGINAL ARTICLE

Pre-service Science Teachers' Conceptions of Sound: The Role of Task Value Beliefs

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ABSTRACT

This study aimed to determine the extent of pre-service science teachers' (PTS) process and materialistic understanding of sound concept and the role of their task value beliefs in their scientific conception of sound. With this aim, the Sound Concept Inventory Instrument (SCII) was translated and adapted to Turkish. The SCII was administered to 320 PTS from four universities across Turkey. The average percentages of correct responses of PTS to the main and subcategory questions of the SCII showed that PTS hold both materialistic and process views of sound. Moreover, the results of the regression analysis indicated that PTSs' task value belief was a significant predictor of their scientific view of sound. Based on these findings, a number of recommendations have been suggested for PTS education programs in Turkey.

KEY WORDS: conceptual learning; pre-service teachers; science education; sound physics; task value

INTRODUCTION

Numerous studies in science education, over the past four decades, have revealed that students come to class with pre-existing knowledge and ideas about the concepts and topics to be taught, which are not always compatible with the scientific ones (Duit and Treagust, 2003; Eshach et al., 2018; Vosniadou and Brewer, 1987). In fact, research findings suggest that students tend to demonstrate an inadequate grasp of several scientific concepts (Kaltakci Gurel et al., 2015; Güneş, 2017) including light (Andersson and Karrqvist, 1983; Bardar et al., 2007), acid-base chemistry (Artdej et al., 2010), solution chemistry (Adadan and Savasci, 2012), heat and temperature (Baser and Geban, 2007), electricity (Allen, 2014), sound (Eshach et al., 2016), and waves (Caleon and Subramaniam, 2010). Houle and Barnet (2008) stated that students try to understand the physical world around them and while doing it they develop their mental models and theories which are generally in conflict with the scientifically accepted explanations. Moreover, Yip (1998) suggested that students can experience difficulty in building scientifically acceptable conceptions due to misunderstandings during instruction, inaccurate teaching, their daily life experiences, and language usage.

According to Reiner et al. (2000), the important cause of students' inadequate conceptions is their tendency to assign materialistic properties to scientific concepts which are abstract in their nature. In fact, related research demonstrated that students from different grade levels tend to show materialistic thinking with regard to a variety of scientific concepts including the concept of sound (Eshach et al., 2018). Since students' conceptions are deeply rooted and the conceptions inconsistent with the scientifically acceptable ones interfere with meaningful learning (Eaton et al., 1983; Tekkaya, 2002), teachers should be aware of students' misconceptions and try to remediate them by providing relevant instruction. To be able to achieve this, sources of students' difficulties to develop an adequate understanding of the concepts should be identified. The research literature point to teachers being one of the possible reasons for the development of inadequate conceptions among students since pre-service and, even, in-service teachers have difficulty in developing scientifically acceptable conceptions (Cheung et al., 2009; Harrell and Subramaniam, 2015; Sanders, 1993; Yip, 1998).

Accordingly, the present study aimed to examine pre-service science teachers' (PTS) conceptions of sound and the role of task value beliefs in their conceptual understanding. The current study has important implications for PTS education programs in improving students' conceptions about sound.

CONCEPTION OF SOUND

It is well known that there are several misconceptions about scientific concepts which are frequently studied by educational researchers. However, there is a relatively low number of studies on the conceptual understanding of sound. For example, Duit (2009) provides a database including the list of more than 8300 studies, which have examined students' and teachers' understanding of scientific concepts. The number of studies on the conception of sound is limited to <20 studies.

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Sound, however, is one of the important concepts in science curriculum, which can help students, better understand the physical world around them (Eshach, 2014). For example, students with an adequate conceptual understanding of sound and related concepts in science can recognize the working principles of a stethoscope or ultrasound and they can provide scientifically acceptable explanations regarding whether it is possible to hear sound in water or why listening to loud music is harmful (Eshach and Schwartz, 2006). In addition, as pointed out by researchers in the field (e.g., Eshach and Schwartz, 2006; Hrepic et al., 2010), development of scientifically acceptable conceptions about sound, which is a wave phenomenon, can help students better comprehend classical as well as modern physics. Therefore, conducting further studies on the conception of sound to determine whether students have misconceptions of sound can be considered crucial to be able to find out appropriate methods to remediate them with scientifically acceptable conceptions.

Related literature on the conception of sound showed that students hold a materialistic view of sound (Eshach, 2014). Namely, students ascribe the properties and behaviors of materials to these abstract concepts and may think that sound is a substance which consists of particles and have physical properties of matter such as being pushable, frictional, containable, consumable, and so on although, in reality, it is a process of energy transmission through a substance (Houle and Barnett, 2008). This materialistic view of sound can be observed in students at different grade levels. For example, in a study conducted by Eshach and Schwatz (2006), eighth-grade students were found to attribute materialistic properties to sound consistent with some aspects of substance schema, which reflected the properties of substances as proposed by Reiner et al. (2000). More specifically, they described sound as something pushable, frictional, containable, and transitional. The students also explained sound in terms of other properties of substances including its stability, corpuscular nature, additive properties, and inertial characteristics different than as explained by Reiner et al. (2000). For example, a number of students perceived that if the sound was to be sent to a room, it would spread out in the room and hit the wall. When it reaches the wall, the wall applies a force against the sound, thus it cannot pass through the wall and is driven back. Those explanations represent the pushable and transitional characteristics of substances (Eshach and Schwatz. 2006).

This materialistic view of sound exists not only among K-12 students but also among undergraduate students (Linder, 1993; Linder and Erickson, 1989). In a recent study conducted with Taiwanese students from grade seven to the undergraduate level, Eshach et al. (2018) found that students from all different grade levels agreed with the statements reflecting materialistic thinking of the sound concept. That study also showed that many students hold both materialistic and scientific views of sound, which indicates that the scientific view of sound is not completely understood by students. Moreover, although students in higher grades learned more about the sound, those students could not replace their materialistic view with the scientific view of sound (Eshach et al., 2018). Considering Taiwanese students' high academic performance (generally among the highest ones) in the international exams such as Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS), Eshach et al. (2018) concluded that materialistic view of sound is an important barrier even for high achievers.

In Turkey, the physics of sound is one of the topics included in the third, fourth, and sixth grades' (students aged approximately 8, 9, and 11) science curricula (MoNE, 2018) and thus, elementary and middle school teachers should be aware of the misconceptions about sound that they and their students may have. Moreover, it is worth to examine PTSs' conceptual understanding of sound, because science teachers' scientific conceptions have high potential to play a role in students' understanding of scientific concepts.

The teacher education curriculum is determined by the Higher Education Council and all public universities implement this common curriculum in Turkey. The physics of sound is covered in a physics course offered as a compulsory course in science teacher education programs in Turkey (HEC, 2018). Namely, the topics of sound waves and sound intensity are one of the 12 topics within the 2nd year physics course curriculum, which is taught for 4 h/week during the 14-week semester. The subject content of that topic is very intense as it includes movement, kinematics, dynamics, energy, reflection, diffraction, and interference of waves, standing waves, resonance, and the Doppler Effect as well as sound waves and sound intensity. This suggests that only around two class hours can be devoted to that topic, in the program, which includes the subject of sound. It would seem that this limited time frame is not sufficient to teach such extensive physical phenomena. In this sense, pre-service teachers' conception of sound can be considered to have, mostly, developed before the start of their teacher-training program at the university. Determining PTSs' conception of sound would offer insights about whether they graduate with sufficient content knowledge to teach middle school students. In line with the discussion presented above, one of the main objectives of this study was to adapt the sound concept inventory instrument (SCII) which is a measurement tool including several misconceptions about sound, especially focusing on materialistic view of sound, into Turkish.

Adaptation of the SCII into Turkish is important since such inventories are rare in the sound topic (Duit, 2009). A limited number of studies have quantitatively examined students' conception of sound (Eshach et al., 2016). Although, in Turkey, a conceptual test for the topic of sound was developed by Demirci and Efe (2007), it was not specifically designed to distinguish materialistic and process understanding of sound; rather, its aim was to determine students' level of misconceptions about sound. The Turkish adaptation of the SCII would provide an opportunity to compare the findings related to conceptions of sound in Turkey with those found in international contexts. English and Mandarin

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versions of the SCII are readily available and have been used in a number of countries such as Israel (Eshach, 2014) and Taiwan (Eshach et al., 2018).

SCII

Based on Reiner et al.'s (2000) substance scheme, Eshach and Schwartz (2006) determined students' materialistic thinking of sound and found out the main categories of their various conceptions. Considering those main themes and findings of related research, Eshach (2014) developed the SCII to assess students' conceptual understanding of sound and provided evidence for its validity and reliability. The SCII consists of 20 questions and a total of 71 response items. Forty-eight of those focus on the substance characteristics of sound and represent the materialistic view of sound while the remaining 23 items include statements reflecting scientifically acceptable conceptions attributing process characteristics to sound. The Materialistic properties of sound were classified within ten subthemes:

> (i) Sound is invisible material (six items); (ii) sound has a corpuscular nature it has surface and volume (20 items); (iii) sound is pushable able to push and be pushed by objects (11 items); (iv) sound is pushable by the medium (five items); (v) sound is frictional it experiences "drag" when moving in contact with some surface (eight items); (vi) sound is containable able to be contained by something (8 items); (vii) sound is consumable it can be depleted (two items); (viii) sound is gravity sensitive the force of gravity acts upon it (three items); (ix) the size or number of "sound particles" influences hearing—more particles and bigger ones make us hear louder (seven items); (x) sound can pass in a vacuum (three items) – this indicates, according to Hrepic et al. (2010), that sound is perceived as an entity of its own which does not need any medium to propagate. (Eshach et al., 2018, p. 666)

The response items were in true-false item format. Namely, students were asked to indicate whether each given statement was true or false and they were also asked to indicate their level of confidence in their response. In addition, a space was provided for each question to allow students to details about their ideas in case none of the response items fit their own point of views. Students were also informed that each question may have more than one item that can be the correct answer. This way, students' responses would allow researcher understand whether students hold both materialistic and process views of sound. When students agree with both kinds of items, it can be interpreted that the students have not fully understood the process characteristics of sound. A sample question from SCII is provided below with its items (Eshach, 2014):

> Imagine that sounds are made inside a room. If you shut the door, the sound heard on its other side will hardly be heard. This is because:
>
> a. A significant part of the sound particles are rebuffed (like a ball) by the walls and the door. True/False. Certainty level in answer: 1, 2, 3, 4, 5
> b. A significant part of the sound is "absorbed" (like water in a sponge) in the walls and door and thus most of it does not travel out. True/False. Certainty level in answer: 1, 2, 3, 4, and 5
> c. The walls and door significantly prevent the transmission of changes in air pressure from inside the room to its outside. True/False. Certainty level in answer: 1, 2, 3, 4, and 5
> d. None of the above choices fits my basic viewpoint. My basic viewpoint is (please explain your viewpoint in the space provided below):___. (p. 12)

In this question, item *c* is the scientific answer that relates the sound to changes in medium's pressure or density, which is expected to be known by students. On the other hand, while items a and b represent the materialistic view of sound and indicate that sound is pushable by objects and is containable, respectively. When all questions of the SCII are considered, the conclusion that the SCII is a comprehensive and useful tool to measure students' understanding of sound concept, in terms of materialistic and process views, can be reached.

EXPECTANCY-VALUE THEORY AND CONCEPTUAL UNDERSTANDING

Although the previous research on conceptual understanding ignored the role of motivational constructs, recent research has emphasized the interactions of cognitive and motivational constructs in the formation of scientifically acceptable conceptions (Gregoire, 2003; Strike and Posner, 1992). Similarly, there are several studies investigating the role of motivational constructs in conceptual understanding, and a number of those studies have been guided by the expectancy-value theory (Johnson and Sinatra, 2013, Jones et al., 2015). According to the expectancy-value theory, students' achievement related performances can be anticipated from their expectations of success and their subjective task value beliefs (Eccles and Wigfield, 2002; Wigfield and Eccles 2000). Expectancy for success, in this theory, concerns students' beliefs about how well they will do in future events, tasks, or tests. On the other hand, task value involves beliefs about why students are performing the task (Pintrich and Schunk, 2002). Eccles (1983) proposed that task value beliefs have four sub-components, namely: Intrinsic value, attainment value, utility value, and cost. Among these sub-components, intrinsic value has conceptual similarities with intrinsic motivation (Deci and Ryan, 1985; Ryan and Deci, 2017) and interest (Hidi and Harackieewicz, 2000) and refers to the enjoyment that students feel while performing a task. Attainment value involves importance of performing well on the tasks. Utility value concerns usefulness of the task with regard to students' future plans or goals. Cost value is related to how participating in one task limits engagement in other tasks (Pintrich and Schunk, 2002; Wigfield and Eccles 2000).

Guided by the expectancy-value theory, Johnson and Sinatra (2013) examined the association between college students' task

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values, engagement, and their conceptual understanding. The authors found that induction of either an attainment value or a utility value among college students improved their engagement and conceptual understanding. According to Johnson and Sinatra (2013), students with high task values can make more meaningful connections between new ideas or concepts. For example, students with high utility value are likely to pay their attention to conceptual components useful for their current or future situation and goals leading to improvement in engagement and conceptual understanding. On the other hand, in the absence of any sorts of task value, conceptual understanding may be the poorest because in such a case, students fail to activate their prior knowledge and establish meaningful connections. Similar to those findings, Jones et al. (2015) reported that task values were significantly linked to engagement and the association of utility value with both engagement and conceptual understanding was stronger than that of attainment value. In fact, task values' importance in conceptual understanding was pointed out earlier by Miller et al. (1999); according to the authors if there was a lack of utility or attainment value, then whether students would demonstrate a deep engagement in a task necessary for meaningful learning should be questioned. In addition, as another sub-component of task value, intrinsic value, which is conceptually similar to intrinsic motivation and interest, appears to be positively related to conceptual understanding. For example, focusing on fifth-grade students, Mason et al. (2008) reported that students who are highly interested in the topic of light and vision were more likely to change their existing conceptions with scientifically acceptable ones compared to students with lower levels of interest. According to the researchers in the field, interest can contribute to better conceptual understanding through attention (Pintrich and Schunk, 2002). Highly interested students are expected to pay a better attention to the task resulting in improved conceptual understanding. In addition, according to Tobias (1994), activation of prior knowledge can be easier for students with higher levels of interest leading to better understanding. High interest can also reduce the demands for regulation of effort and time and in this way more space can be available in working memory for better. In line with these ideas and research findings, the current study aims to determine to what extent PSTs' task value beliefs predict their conceptual understanding of sound.

Overall, the present study was designed to address the following research questions:

1) To what extent do PTSs hold process and materialistic views of sound?
2) To what extent do PTSs' task value beliefs predict their scientific conception of sound?

METHODOLOGY

Design of the Study

The present study was a cross-sectional quantitative study. The data were collected using the SCII and the task value questionnaire (TVQ) for learning sound. The instruments were administered during a regular class hour.

Sample

Participants of the study were 320 (246 females, 72 males, and two did not specify their gender) middle school PSTs attending science education programs in four public universities in Turkey. They were selected using convenient sampling method considering the ease of access and time constraints. Ethical procedures required by each university were considered. Participants were informed about the purpose about the study and confidentiality of the data. They were voluntarily participated in the study. The average of the grade point average of the participants was 2.36 (SD = 0.54) out of four.

Instruments

SCII

The SCII developed by Eshach (2014) was used to assess PTSs' conceptual understanding of sound. Eshach (2014) found Cronbach's alpha coefficient for the entire instrument to be 0.91, while the reliabilities for process items and materialistic items were found to be 0.81 and 0.83, respectively. In the current study, first, the SCII was translated and adapted into Turkish by the authors. Two physics specialists who had advance levels of English compared the original English version of the instrument and its Turkish translation to ensure that both versions had the same meaning. Subject specialists suggested a number of minor revisions. After completion of the revisions, two physics teachers examined the translated version in terms of clarity and its consistency with the sound topics taught in schools. Finally, a Turkish language expert checked the instrument for grammar. Internal consistency of the Turkish version of the instrument was calculated by KR20 formula and found to be 0.69 for the entire questionnaire (71 items), 0.67 for process properties items (23 items), and 0.80 for material properties items.

Students' responses to open-ended questions were also examined. Those open-ended questions provided participants with an opportunity to explain their thinking in case the items presented to them did not reflect their views. Only a few students filled those spaces and most of the responses indicated that they had no idea about the related question or they did not know the answer. Since we did not realize any comments which had a potential to make a remarkable contribution to the responses, those students' responses to the "true" and "false" questions were left as they were. There were also few responses, which were in line with the options provided to students but with different wording. We included those answers to the data analysis.

TVQ for learning sound

The items from the task value sub-scale of the MSLQ (Pintrich et al., 1993) were modified to assess PTSs' task value beliefs in learning the concept of sound. Additional items were also prepared using the items from Johnson and Sinatra's (2013) study to represent better the related construct. The response scale of items was on a seven-point Likert scale ranging from "1=not at all true of me" to "7=very true of me." The modified TVQ was prepared to include three sub-scales representing

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sub-components of task value beliefs, namely, intrinsic value (n = 3, e.g., "I read about sound related topics just for pleasure"), utility value (n = 3, e.g., "I think, what I learn about sound is useful for me to understand other concepts in physics"), and attainment value (n = 3, e.g., "It is important for me, as a science teacher candidate, to understand sound related concepts"). The results of the confirmatory factor analysis (CFA) did not support the three-factor structure of the task value scale. Thus, we preferred to use it as a single factor and the results of CFA for the single factor task value scale showed a good model fit to the data ($\chi^2_{(27)} = 273.21$, $\rho < 0$; CFI = 0.92; SRMR = 0.07; NNFI = 0.90). Moreover, Cronbach's alpha was found to be 0.80 indicating high internal consistency.

Data Analysis

First, as suggested by Eshach et al. (2016), to deal with guessing, we calculated summed scores for correct answers (calculated by scoring correct answers 1 and wrong answers −1 and, then, by summing these scores) and summed weighted scores (calculated by multiplying each score with the confidence level of related item and, then, by summing these weighted scores). Afterward, we conducted correlation analysis with these summed scores and summed weighted scores. The correlation was found to be 0.95, which indicates that the risk of guessing is low in this study.

Then, to find answers to the first and second research questions, we needed to recode the data. "True" responses to process properties and "false" responses to materialistic properties items were correct answers and were scored as 1 point. PSTs' "false" responses to process properties and "true" responses to materialistic properties items were incorrect answers and were scored as 0 point. The average of the correct responses represents the proportion of PSTs' understanding of process (scientific) characteristics of sound. Thus, the higher scores PSTs get from each main category and sub-category, the more scientifically acceptable (process) their thinking is.

For the last research question which focused on predicting PSTs' scientific conceptions of sound through their task value beliefs, we only considered the correct responses of PSTs' who were confident in their answers (4 or 5). Namely, we scored 1 point if the confidence level of a correct answer was 4 or 5. All other responses, including the ones, which were correct, but PST's were not confident (1, 2, and 3) about their answer, were scored 0 point. Afterward, we computed a total correct score (representing the process view of sound) to be predicted by task value.

RESULTS

Regarding the first research question focusing on the determination of the extent of PSTs' understanding of process properties of sound, findings showed that PSTs' percentage of overall correct answers agreeing with process properties and disagreeing with materialistic properties items was 49% (Table 1). Participants' seemed confident in their answers for the SCII part (3.62). The percentage of correct answers to process and materialistic properties items was found to be 75% and 36%, respectively. Namely, percentage of correct answers to process view items that were marked as "true" is considerably higher than the correct answers to materialistic view items marked as "false." Although participants agreed with 75% of the process view items, they agreed with 64% of the materialistic view items. PSTs' mean confidence levels about the responses they provided to process view items were 3.57 and 3.65 for materialistic view items. These findings indicated that PSTs' hold both materialistic and process views about sound.

Moreover, PSTs' percentages of correct answers to sub-categories of process view (72% and 75%) were generally higher than the percentages of their correct answers to materialistic view sub-categories (ranging between 22% and 72%). The lowest rate of correct answers was given to materialistic view subcategory of "hearing is influenced by size or number of sound particles" (22%) and "pushable by objects" (24%), while the highest rate of correct answers was given to materialistic view sub-categories of "sound passes in vacuum" (72%) and "sound is gravity sensitive" (62%). For sub-categories, PSTs' mean confidence levels about their responses ranged between 3.49 and 3.75.

A linear regression analysis was performed to answer the second research question, which aimed to find out whether PSTs' task value beliefs could predict their scientific views of sound. Before the analysis, all the underlying assumptions of linearity, normality, and homoscedasticity were checked. The data were also checked for possible outliers. After ensuring that all the assumptions were satisfied, regression analysis was conducted. In the data, task value scores ranged from 1

Table 1: Mean scores and standard deviations for the SCTI

Issue	Mean of correct answers	SD of correct answers	Mean of confidence	SD of confidence
Entire questionnaire	0.49	0.09	3.62	0.62
Process properties	0.75	0.15	3.57	0.65
Connected to medium's particles movement	0.72	0.27	3.60	0.79
Relates to changes in medium's pressure or density	0.75	0.16	3.56	0.66
Materialistic properties	0.36	0.13	3.65	0.62
Invisible material	0.37	0.21	3.69	0.71
Corpuscular	0.25	0.15	3.66	0.63
Pushable by objects	0.24	0.17	3.64	0.65
Pushable by medium	0.35	0.24	3.54	0.77
Frictional	0.50	0.23	3.59	0.72
Containable	0.34	0.19	3.63	0.72
Consumable	0.27	0.32	3.60	0.89
Gravity sensitive	0.62	0.33	3.49	0.97
Hearing is influenced by size or number of sound particles	0.22	0.21	3.70	0.66
Pass in vacuum	0.72	0.31	3.75	0.96

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to 7 (M = 4.89, SD = 1.11), while the scores on the dependent variable ranged from 0 to 60 (M = 18.87, SD = 10.22). As shown in Table 2, although task value beliefs significantly and positively predicted PSTs' scientific views of sound ($\beta = 0.17$, $\rho < 0.01$), the explained variance was found to be quite low ($F_{(1,318)} = 9501$, $\rho < 0.01$, $R^2 = 0.03$).

DISCUSSION

This study aimed to determine Turkish PTSs' sound conceptions, and predict their process thinking levels through their task value beliefs. For these specified purposes, first, the SCII was adapted into Turkish for these PSTs. It is well-known that replacing students' alternative conceptions with scientifically accepted concepts is hard (Klammer, 1998). If teachers have misconceptions on a certain aspect, then their students are more likely to have these misconceptions (Hashweh, 1987; Yates and Marek, 2014). In Turkey, the middle school science education curriculum has recently been revised (MoNE, 2018). In this new curriculum, while the sound topic is first introduced in third and fourth grades, the main definition of sound and its properties are more broadly included in the sixth-grade science curriculum. This suggests that, students will mostly construct their understanding of sound regarding main properties of sound, its propagation in different mediums, acoustic constructs, hearing, velocity of sound, and the sources of sound in sixth grade. Thus, middle school science teachers' conception of sound will have an important role in their students' learning of sound. Therefore, determining PSTs' misconceptions are crucial.

In the present study, findings showed that PSTs average score for the entire test was 49%. They have both process and materialistic views about sound. Although their rate of process views is considerably high (75%), the percentage of their materialistic thinking should not be underestimated (64%). Besides, PSTs were moderately confident in their answers. It can be inferred that although PSTs mostly know that sound is a wave and it is related to the changes in the density and pressure in the air, they also viewed sound to be an invisible material, which has size and weight, can be pushed, can be contained, and is frictional, containable, consumable, and corpuscular. The lowest rate of the incorrect answers was given to the items indicating that sound passes in vacuum (28%). This shows that PSTs mostly know that sound needs a materialistic medium to pass. As stated by Eshach et al. (2014), the experiment which is about the ringing bell (or clock) in a vacuum is very common in the sources explaining sound physics and this might be the reason of getting high rate of correct answers to this materialistic view subcategory. The highest rate of incorrect answers (78%) of PSTs was on the "Hearing is influenced by size or number of sound particles" indicating that although PSTs have high rate of process view of sound they still incorrectly think that sound consists of particles and their size and weights are related to the hearing.

Table 2: Results of the regression analysis

Values	B	SE B	β
Constant	11.21*	2.6	
Task value	1.57*	0.51	0.17*
R^2		0.03	

*ρ<0.01

Considering the findings of Eshach et al.'s (2018) which showed that Taiwanese students who were among the highest achievers in international exams such as PISA and TIMSS have materialistic views of sound to a certain extent (the percentages of agreement with materialistic items [namely, incorrect responses] ranged between 35% for university students majoring in science or science related areas and 61% for seventh graders) as well as process view, it is disappointing to find out the 64% agreement with materialistic items for Turkish PSTs. On the other hand, another study conducted in Israel (Eshach, 2014) showed that ninth grade students' percentage of agreement with process items were 39% and with materialistic items were about 76%. Keeping in mind that samples of each study are not representing the all students in related country and direct comparison of the findings is not appropriate, this study and, in turn, adaptation of SCII is a good starting point for Turkey to determine quantitatively the materialistic views of students and teachers. As stated before, in Turkey, there is a limited emphasis on the sound topic in science teacher education programs. When the course description is considered, approximately 2 h may be devoted to this topic. Considering PSTs' this high rate of materialistic views, it can be suggested that science teacher education should cover the sound topic more extensively and need to focus on eliminating materialistic vies of sound and enhancing the scientific conception of sound. The scientific understanding of sound topic is also important to understand a number of daily phenomena such as the harmful effects of loud music, the notion of acoustic rooms, working principles of ultrasonic devices, and stethoscope.

Another finding of this study showed that PSTs' task value beliefs were positively and significantly related to their scientific conception of sound. Namely, although the amount of explained variance is low (3%), it can be said that the more PSTs enjoyed learning about physics of sound, and thought that knowing the sound topic would be beneficial for them as a teacher candidate and that learning sound topic is important for feeling successful, the higher they scored on the SCII. Therefore, PSTs may be informed about the existence of sound topic in the middle school curriculum during their teacher-training program and the importance of developing a scientific understanding of sound for their students can be emphasized. This way, PSTs' task value beliefs about the sound topic can be improved which, in return, is expected to increase their scientific conceptions.

CONCLUSIONS

To make purposeful suggestions based on the current findings to help PSTs have a better understanding of scientific concepts,

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there is a need to consider conceptual change literature as well. Indeed, there are various approaches proposed in the literature to explain the underlying mechanisms of conceptual change, in other words, how individuals reorganize or replace their inadequate conceptions to accommodate the scientifically acceptable ones. For example, according to Posner et al. (1982), if students are to replace their existing inadequate conceptions by scientifically acceptable conceptions, they must feel dissatisfaction with their current conceptions (dissatisfaction), new conceptions must offer better explanations (intelligibility), the new conceptions must have ability to generate solutions to problems and must cohere with concepts in different fields (plausibility), and the new conceptions must produce new insights and have the capacity to bring about new discoveries (fruitfulness). Different from approaches to conceptual change based on Posner et al.'s (1982) work, Chi (1992) did not suggest the use of cognitive conflict to promote radical conceptual change. According to Chi (1992), experiencing cognitive conflict can cause frustration in students but not conceptual change. On the other hand, Hunt (1963, as cited in Pintrich and Schunk, 2002) claimed that when there is an optimal level of incongruity between prior knowledge and new information, students become intrinsically motivated and demonstrate investigative behaviors to diminish the incongruity. On the other hand, if there is too much incongruity, then this can lead to frustration. In the current study, a positive link was found between students' task value including intrinsic value as a sub-component, which is conceptually similar to intrinsic motivation, and adequate conceptions of sound. Thus, in line with this finding and the conceptual change approach proposed by Posner et al. (1982), the present study suggests that to deal with PSTs materialistic view of sound and change it, they can be provided with opportunities to become dissatisfied with their existing conceptions. However, the incongruity posed should not be too much since PSTs may experience frustration and lose their interest. In addition, consolidating the suggestions of Chi (1992) and Posner et al. (1982), it is recommended that PSTs should be able to realize that new conception provides better explanations. When this happens, they can recognize the link between their efforts to deal with the incongruity posed to them and their current conceptions with greater applicability in different fields and greater consistency with other concepts. This can enhance the value that they attach to class work.

In addition, considering the conceptual change literature, Eshach et al. (2016) also suggested several ways to reduce materialistic conception of sound such as taking materialistic properties of sound into account in the classroom teaching and textbooks, doing conceptual change activities, and explicitly discussing about the materialistic view of sound with students. Discussing the questions of the SCII may also be a useful starting point to the instruction about sound (Eshach et al., 2016). Not only in teacher education but also in middle and secondary science education these strategies should be considered to foster students' scientific conception of sound. Besides, the translation of the SCII would be beneficial for science educators and researchers in Turkey to determine students' understanding of sound concept or the effect of a specific teaching method or the course by using this inventory as a pre- and post-test.

Although providing deep insights about PSTs' conception of sound, the current study has a number of limitations that should be acknowledged. Namely, although the aim was to examine PST's task value beliefs in terms of intrinsic value, attainment value, and utility value, this could not be achieved due to the poor model fit of the three-factor structure. Thus, task value was examined as a unidimensional construct, which provided a good fit to the data. Thus, future studies could revise the instrument so that the contribution of each sub-component to students' conception of sound was investigated separately leading to more specific implications.

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APPENDIX

Sample items from Turkish version of SCII

Aşağıda yer alan ses testinde belirli olgulara yönelik maddeler halinde belirtilmiş çeşitli ifadeler vardır. Her ifade için doğru "D" veya yanlış "Y" seçeneklerinden birini işaretleyiniz. Ayrıca, bu cevabınızdan ne kadar emin olduğunuzu belirtmek için, 1'den (Hiç emin değilim) 5'e (Çok eminim) kadar olan sayılardan uygun olanı işaretleyiniz. Her olgu için birden fazla ifadenin doğru olabileceğini unutmayın. Katkılarınız için teşekkür ederiz**.**

1. Duymadığımız bir ses olabilir mi?

a. Evet. Kulaklarımız yalnızca belirli boyutlardaki ses taneciklerini kabul eder. Hayvanların kulakları ise farklı boyutlardaki ses taneciklerini kabul eder. Bu nedenle onlar bizim duymadığımız sesleri duyabilir veya duyduklarımızı duyamayabilirler
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

b. Evet. Duyabiliyoruz; çünkü kulak zarı kendisini çevreleyen havanın hareketindeki değişiklikleri algılayabilir. Kulak zarımız belirli bir hava basıncı aralığında çalışır
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

c. Yukarıdaki seçeneklerden hiçbiri benim temel bakış açıma uymuyor. Benim temel bakış açım (Lütfen bakış açınızı aşağıdaki alana yazınız)

2. Lütfen aşağıda verilen sesin özellikleriyle ilgili ifadeleri yanıtlayın

a. Ses, hava basıncına bağlı olarak havanın yoğunluğundaki hareketli bir değişikliktir
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

b. Ses hareket eder; çünkü hava onu iter
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

c. Ses, görünmez bir sıvı gibi hareket eder
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

d. Ses madde değildir
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

e. Yukarıdaki seçeneklerden hiçbiri benim temel bakış açıma uymuyor. Benim temel bakış açım (Lütfen bakış açınızı aşağıdaki alana yazınız)

3. Bir çalar saat, vakumlu bir fanus (pompayla içindeki havası boşaltılabilen cam veya plastik bir kap) içine yerleştiriliyor. Saat, fanusun kenarlarına ve tabanına dokunmuyor. Fanusun içinde hava varken fanusun dışında duran bir adam çalar saatin sesini duyabilir. Daha sonra fanusun içindeki hava boşaltılıyor. Bu durumda, adam

a. Alarmı duyamaz; çünkü ses fanusun içinde hapsolur ve dışarı çıkamaz
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

b. Alarmı duyar; çünkü alarm sesi etrafındaki havanın varlığı ile bağlantılı değildir
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

c. Alarmı daha yüksek sesle duyacak; çünkü artık hava sese sürtünmüyor ve sesin hareket etme kabiliyetini bozmuyordur
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

d. Eğer fanusa girseydi alarmı duyabilirdi. (Adamın nefes alamayacağı gerçeğini göz ardı ederek)
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

e. Alarmın sesi çok azalır; çünkü hava basıncındaki değişimleri (ses) iletecek hava yoktur
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

f. Yukarıdaki seçeneklerden hiçbiri benim temel bakış açıma uymuyor. Benim temel bakış açım (Lütfen bakış açınızı aşağıdaki alana yazınız)

4. Plastik, ahşap, demir ve strafor (köpük) gibi farklı malzemelerden üretilmiş birkaç uzun ve ince masanın olduğu bir ortam düşünün. Şimdi kulağınızı bir masanın bir ucuna (her defasında farklı olan) yerleştirin ve birisi masanın diğer ucuna vursun

a. Strafor masada ses duyulacaktır; çünkü straforun yoğunluğu azdır ve ses ile strafor tanecikleri arasında yalnızca küçük bir sürtünme vardır.
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

b. Ahşap masada ses duyulacaktır; çünkü ahşabın yoğunluğu fazladır ve yoğunluk değişimi (ses) bir uçtan diğerine ilerleyebilir.
D/Y. Cevabın kesinlik düzeyi: 1, 2, 3, 4, 5

c. Yukarıdaki seçeneklerden hiçbiri benim temel bakış açıma uymuyor. Benim temel bakış açım (Lütfen bakış açınızı aşağıdaki alana yazınız):