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Development of Eighth Grade Students' Epistemological Beliefs through Writing-to-Learn Activities

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ABSTRACT The aim of the present study was to develop the epistemological beliefs of eighth grade students through writing-to-learn (WTL) activities. A one-group pretest-posttest quasi-experimental research design was utilized in the study. The sample group consisted of a total of 18 eighth grade students, attending a secondary school in the rural part of Trabzon in Turkey. To improve the epistemological beliefs of students, WTL activities were developed and utilized in the "Matter and its Structure" unit of the science subject. Each WTL activity focused on one dimension of epistemology, such as source of knowledge, organization of knowledge, certainty of knowledge, speed of learning, and learning control. The WTL activities in the study were conducted throughout a total of 24 lessons. Semi-structured interviews were employed to collect data. Beliefs regarding each dimension of epistemology were identified to be at the level of absolutist, multiplist or evaluatist by means of the "Epistemological Belief Levels Rubric". The findings of the study revealed that the WTL activities increased students' levels of the epistemological beliefs. Hence, students' epistemological beliefs can be developed further by dwelling more on the history of science unit within the subject of science by raising students' awareness.

Keywords Epistemological Beliefs, Writing-to-Learn, Science Instruction

1. INTRODUCTION

The beliefs that individuals have underlie all their decisions and conducts (Hofer & Pintrich, 1997; Pajares, 1992). As for epistemological beliefs, they play an active role in individuals' attribution of meaning to what they experience and the information they receive. Epistemological beliefs can be defined as individuals' subjective beliefs regarding what the concept of "knowledge" means, and how knowing and learning take place (Schommer, 1990). Schommer (1994) put forward a model called epistemological belief system which includes dimensions such as source of knowledge, organization of knowledge, certainty of knowledge, speed of learning, and learning control that reveal the multi-dimensional and independent structure of epistemological beliefs. According to this system, individuals with naive epistemological beliefs have an intense belief that knowledge is simple, that knowledge is innate, that learning takes place immediately, and that knowledge is unalterable, whereas individuals with sophisticated epistemological beliefs have an intense belief that knowledge is complex, that knowledge is formed through experience and effort, that learning is over time and that knowledge changes (Buehl & Alexander, 2001).

Hence, having sophisticated epistemological beliefs is of crucial importance since students with sophisticated epistemological beliefs make use of a higher number of and higher-order cognitive information processing strategies throughout their learning activities. Furthermore, these students display a higher level of academic performance, a positive attitude towards their school, and can establish diversified and profound thoughts and ideas (Deryakulu & Büyüköztürk, 2002). Çavuş (2013) has reported that, compared to students possessing naive epistemological beliefs, those who have sophisticated epistemological beliefs establish more sophisticated cause-effect relationships in socio-scientific subjects, produce responses including more comprehensive explanations and can foresee possible different results and present suggestions.

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beliefs necessitates instructional implementations in which particularly students are active, knowledge is constructed by the students themselves, and learning is based on the student's participation (Kuzgun & Deryakulu, 2014). Writing-to-learn (WTL) contributes to students' ability to comment on their own thoughts, think critically and express their own feelings and experiences, produce rational responses, provide real-life-related responses and develop higher order cognitive functions including solving problems (Atasoy, 2012; Mason & Boscolo, 2000). It is determined that WTL activities (journal writing and explanatory writing) had a positive effect on conceptual understanding because of allowing the writer to clarify his or her knowledge, organize the ideas to be written, and reflect on the learning experience. On grounds that these abilities of students are developed together with a high level of epistemological beliefs, it seems that the impact of learning through writing on epistemological beliefs is an important area that needs to be investigated.

1.1. Writing-to-Learn (WTL)

Writing is an important learning mechanism in expressing our opinions about a certain topic, in reorganizing our opinions about a topic, and in partly discovering our ideas and dreams (Graham, 2008). If we want our students to use WTL, students should be prevented from copying the information written by their teachers; rather, they should be given the opportunity to make use of their ability to think and reason so that they can write using their own voice of expression (Hand, Prain, Lawrence & Yore, 1999; Mason & Boscolo, 2000). Teachers also need to establish an appropriate learning environment and must encourage students to become engaged in WTL activities (Kieft, Rijlaarsdam & Bergh, 2006).

WTL extends the retention period of scientific knowledge and reinforces initial knowledge and new ideas (Rivard & Straw, 2000). Writing is a higher order cognitive activity which entails the ability to coordinate one's own knowledge and fundamental abilities by various means (Walker, Shippen, Alberto, Houchins, & Cihak, 2005). It is reported that WTL activities encourage students to access scientific information, and enable them to adapt to a learning environment where epistemological beliefs and reasoning strategies are exercised (Prain & Hand, 1999; Yore, Bisanz & Hand, 2003). Therefore, in this study, it was investigated how WTL activities affect epistemological beliefs.

1.2. Literature Review on Epistemological Beliefs

Numerous studies on epistemological beliefs have been identified in the literature of the last 30 years. Among these studies, the ones that have an important place in the literature are those studying the relationship between individuals' epistemological beliefs and such factors as problem solving abilities (Aksan & Sözer, 2007; Charoula & Valanides, 2012; Schommer & Dunnell, 1997), academic achievement (Schommer & Dunnell, 1997; Schommer-Aikins, Mau, Brookhart, & Hutter, 2000; Schommer-Aikins, Duell & Hutter, 2005; Topçu & Tüzün, 2009; Youn, Yang, Choi, 2001), learning/teaching strategies (Chan, 2004; Deryakulu, 2004; Hashweh, 1996; Mahasneh, 2018; Uslu, 2018), gender, area of study and grade level at school (Aydemir, Aydemir & Boz, 2013; Chen, Xu, Xiao & Zhou, 2019; Gürol, Altunbaş & Karaaslan, 2010; Meral & Çolak, 2009; Topçu & Tüzün, 2009). According to the findings of these studies, individuals with a high level of epistemological beliefs have the tendency to persist in their efforts to learn and, as a result, achieve a higher level of academic achievement. It has been revealed that students who believe that learning is not an innate ability have a high level of academic achievement (Schommer-Aikins, Mau, Brookhart & Hutter, 2000). In a study by Schommer and Dunnell (1997), it was revealed that students who were of the belief that learning is an innate and rapid process and that knowledge is absolute had a low level of academic achievement and problem solving ability. According to Youn, Yang and Choi (2001), there is a positive correlation between students' levels of academic achievement and their epistemological beliefs of knowledge. Furthermore, there is also a relationship between epistemological beliefs and understanding of teaching/learning (Chan, 2004). Teachers with sophisticated epistemological beliefs are more sensitive towards various views of students (Hashweh, 1996). In other studies, a positive correlation has been reported between epistemological beliefs and the ability to solve problems, establish associations with daily life, reason and think critically (Aksan & Sözer, 2007; Belet & Güven, 2011; Charoula & Valanides, 2012). Based on all these findings, it seems clear that in order to reach the expected academic achievement in educational environments, it is essential to develop students' epistemological beliefs.

It is put forward that epistemological beliefs have an impact on individuals' approach to knowledge, their academic achievement, their levels of success in their courses and their motivation, and that these beliefs start to form substantially as of primary school level (Aksu, Demir & Sümer, 2002). Thus, it is evident that students' epistemological beliefs should be developed during their primary education. However, when the related literature is examined, it is observed that the sample groups of studies are comprised of individuals within higher age groups, such as teachers, undergraduate students and high school level students (e.g. Aksan & Sözer, 2007; Aydemir, Aydemir & Boz, 2013; Chan, 2004; Charoula & Valanides, 2012; Cheng, Chan, Tang & Cheng, 2009; Deryakulu & Büyüköztürk, 2002; Deryakulu, 2004; Meral & Çolak, 2009; Oksal, Şengerci & Bilgin, 2007; Özkan-Hıdıroğlu & Hıdıroğlu, 2016; Topçu & Tüzün, 2009; Trakulphadetkrai, 2012; Schommer, 1990; Schommer, Crouse & Rhodes,

1992; Youn, Yang & Choi, 2001). However, there seems to be limited amount of research conducted with secondary school students (Schommer-Aikins, Mau, Brookhart & Hutter, 2000; Schommer-Aikins, Duell & Hutter, 2005). These studies were primarily conducted to identify epistemological beliefs and to examine the relationship between these beliefs and some demographic factors.

A literature review also yields studies in which the effect of implementations of different teaching methods and techniques on epistemological beliefs was examined (for example, cognitive coaching method--Demir, 2009; peer teaching--Gok, 2018; nature of science--Johnson & Willoughby, 2018; classroom discussing-- King, Levesque, Weckerly & Blythe, 2000; research-based laboratory activities--Deniz, 2011; May & Etkina, 2002). Studies on the effect of writing on epistemological beliefs are quite limited. These are also related to reflective journal writing (Brownlee, Petriwskyj, Thorpe, Stacey & Gibson, 2011; Dart, Boulton-Lewis, Brownlee & McCrindle, 1998; Güven, 2013). Reflective journal writing has included student teachers' beliefs about learning and teaching (Dart, Boulton-Lewis, Brownlee & McCrindle, 1998), reflecting their own field experiences (Brownlee, Petriwskyj, Thorpe, Stacey & Gibson, 2011) and laboratory experiences (Güven, 2013). They concluded that reflective journal writing enabled epistemological beliefs to progress in a positive way.

1.3. Schommer's Epistemological Beliefs System

According to Schommer (1994), epistemological beliefs are individuals' beliefs about the source, certainty and organization of knowledge and the speed and control of learning. Schommer (1992), proposed a five-factor epistemological beliefs system. The current study, in which students' epistemological beliefs were examined, is based on the five dimensions of this system. These dimensions are explained as follows:

The first dimension (organization of knowledge) is the simple versus complex nature of knowledge. The shallow or easily comprehensible aspect of knowledge results in epistemological beliefs related to whether or not content is formed with the combination of different concepts.

The second dimension (certainty of knowledge) is the unchanging nature of knowledge, that is its certainty. In this dimension, beliefs are put forward as regards knowledge being unchangeable, regardless of whether or not knowledge is unconditionally accurate and whether or not it changes.

The third dimension (source of knowledge) involves presenting the view regarding whether knowledge is derived from an authority or a subjective source. Individuals holding naive epistemological beliefs think that source of knowledge is the authorities and experts whereas those holding sophisticated beliefs content that knowledge is produced through extensive observation, reasoning, and judgements (Schommer-Aikins, 2004).

In the fourth dimension (speed of learning), the speed of acquiring knowledge is addressed. In this dimension, the answer to the question of whether knowledge is acquired instantly or step by step with experience is sought. It expresses the dimension of belief based on whether knowledge is formed instantly through learning.

The fifth dimension is learning control. This dimension entails the notion that the learning process is changeable and is developmental, as opposed to the belief that the learning phenomenon is something that exists as of birth and is unchangeable.

1.4. The Aim of the Study

The aim of the present study was to identify the impact of WTL activities on eighth grade students' levels of epistemological beliefs.

2. METHOD

A one-group pretest-posttest quasi-experimental design was employed in the present study. This model was chosen owing to the lack of a class that could be assigned as a control group in the school where the study was being conducted. In this model where the implementation was applied in a single group, measurements were made before and after the implementation. The progress between the pre- and post-measurement was accepted as the impact of the intervention (Karasar, 2012).

In the present study, the initial epistemological belief levels of the secondary students were identified and subsequently, the WTL activities to develop these levels were implemented. Then, the final interviews were conducted on whether or not the implementation was effective and, thus, the effectiveness of the WTL activities was evaluated.

2.1. Sample

The study group was composed of 18 eighth grade students (10 males and 8 females). Convenient sampling strategy was used in recruitment of students. This was because the second researcher was working at the school in which data were collected and this eased access to participants as well as the process (Büyüköztürk, KılıçÇakmak, Akgün, Karadeniz, & Demirel, 2018). According to the science teacher, the overall success level of these students was either low or moderate. The science teacher explained the science lessons to this class by lecturing and frequently had students do multiple-choice tests to prepare them for the high school entrance exam. These students, who were in their final year at secondary school, spent most of their time preparing for the high school entrance exam. According to science teachers, these students do not have a sufficient level of reasoning skills since they are focused more on solving multiple-choice tests to prepare for the high school entrance exam. Hence, in exams including open-ended questions, they

have difficulty in writing what they know or making inferences.

2.2. The Preparation and Implementation of WTL Activities

In this section, the identification of the topic, and the development and the implementation of the writing activities are addressed under separate headings.

2.3. The Identification of the Topic

The WTL activities were prepared based on the topics within the Unit of "Matter and its Structure". The topics were as follows: the particle structure of matter (views proposed on the structure of the atom from history to today), pure matter, mixtures, separation of mixtures, home wastes-recycling, and chemical industry. These topics were believed to overlap with the contexts of the dimensions of epistemological beliefs and consist more of theoretical explanations at the conceptual level. By taking into consideration the entirety of the unit, the writing activities were prepared to include all the topics.

2.4. The Development of the WTL Activities

Explanatory writing involving question prompts to solve problem cases was used as WTL activity.The activities were designed in the format of worksheets (see Appendix A for a sample of an activity). During the preparation of the worksheets, special attention was paid to preparing questions that would enable students to think while they wrote, to question, and lay the foundation to assist them in structuring arguments in their minds. In addition, it was ensured that the contexts established in the writing activities would lead to discussions of the epistemological belief dimensions. The prepared activities were examined by an expert who had conducted research on writing and epistemological beliefs, and based on the recommendations made, the necessary modifications were made. The validity of the language used in the activities was examined by a language expert and the necessary modifications were made based on the feedback. The prepared activities were then piloted on nine students. The results were evaluated by one researcher and an expert and finally, the decision regarding its appropriateness was made.

2.5. The Implementation of the WTL Activities

The WTL activities were implemented in the science classes for six weeks (a total of 24 lessons) – one activity each week – by the second researcher. The schedule presented in Table 1 was followed in the implementation of the writing activities.

Table 1 The implementation schedule

Implementation week	Title of the implemented activity
1st week	Historical Development of Atomic Models
2nd week	Definition of Element
3rd week	Mixtures
4th week	Separation of Mixtures
5th week	Recycling
6th week	The Chemical Industry

The science lessons were initially taught theoretically by the teacher. Subsequently, the writing activity related to the topic was distributed in a worksheet format to the students, who were asked to complete the blanks with their opinions regarding the questions. Subsequently, the students were asked to exchange the worksheet they had completed with that of their peer to read what their peer had written and then they were required to hold a class discussion. This enabled the students to assume the responsibility of completing their own worksheet completely. The students were also given the opportunity to revise what they had written by thinking about the questions again after class.

2.6. Data Collection

Semi-structured interviews based on epistemological beliefs were prepared and used as a means to collect data. A question for each dimension of the epistemological belief was prepared for the interview (Appendix B). In the preparation of these questions, interview forms (Güven, 2013) and scales (Deryakulu & Büyüköztürk, 2002; Evcim, 2010) that existed in the related literature and similarly aimed to identify students' epistemological beliefs were benefitted from.

The questions prepared for the interviews were modified based on the suggestions made by two experts in terms of comprehensibility, scope and content. Subsequently, the questions were piloted on three students who were not part of the sample group. As a result of the pilot study, the interview questions were evaluated based on comprehensibility and the retrieval of possible expected responses.

The interviews were held on one-on-one basis with 18 eighth grade students.

2.7. Data Analysis

For the data analysis of the study, the "Epistemological Belief Levels Rubric" was utilized. This rubric was prepared based on the five-factor epistemological belief levels defined by Schommer (1990) and those defined by Khun (2001) as absolutist, multiplist and evaluatist. It is stated that individuals holding "absolutist", that is naive, epistemological beliefs believe in the certainty of knowledge, believe that knowledge is derived from external sources, that one must confide in these sources (authorities) and that knowledge is accumulated. It is argued that for individuals with "multiplist", or moderate level of, epistemological beliefs, knowledge lacks certainty, knowledge cannot be known directly and knowledge can change from person to person. In addition, it is stated that claims are views that are freely chosen subjective, personal views and that each view possesses equal rights. Finally, it is argued that individuals with "evaluatist", that is high, epistemological

beliefs, believe that knowledge lacks certainty. It is asserted that the claims put forward by these people are their own beliefs or judgments, and that when these judgments are presented, proof is also used and discussed so that those with the highest validity are accepted as true knowledge. Furthermore, it is maintained that the individuals at this level use critical thinking to strengthen their arguments and the find it useful in reinforcing the meaning conveyed in their arguments.

To increase the reliability of the rubric developed in the study, the sample performances of the scales developed by education scholars were examined. The feedback of education scholars working in this area was received for the criteria in the rubric and their descriptors, and the results of the implementation were scored by two separate raters. To increase the validity of the rubric prepared, initially a pilot study was conducted with nine students. In this way, the predetermined criteria were found to be addressing the students' explanations.

The data obtained by means of the interviews were analyzed via the "Epistemological Belief Levels Rubric" (Table 2). In this way, the students' epistemological belief levels were categorized as absolutist, multiplist and evaluatist within each epistemological belief dimension (source of knowledge, organization of knowledge, certainty of knowledge, speed of learning, and learning control).

The data obtained from the interviews were evaluated simultaneously by the researchers. Subsequently, the compatibility between the evaluations was checked, and a discussion was held on the incompatible data to reach a common decision.

3. RESULT AND DISCUSSION

In this section, the data regarding epistemological beliefs identified via the pre- and post-interviews of the WTL activities are presented. The levels identified for each epistemological belief dimension were compared in percentages between the pre- and post- interviews.

Figure 1 displays the comparative percentages of the epistemological belief levels based on the students' interview responses to the question on the source of knowledge dimension. As can be observed in Figure 1, when the students' responses given to the questions on the dimension of source of knowledge are examined, the number of students with epistemological beliefs at the absolutist level has decreased by 50%.

A student response at the absolutist level was as follows: "…may have learned it at school in the science lesson." Based on this statement, it can be deduced that the student considers the source of knowledge as books of authority and expert teachers.

The number of students at the multiplist level of epistemological beliefs increased from 14% to 50%. A student response at this level was as follows: "May have researched and learned it. May have asked the electrician or saw it elsewhere. May have even searched it on the

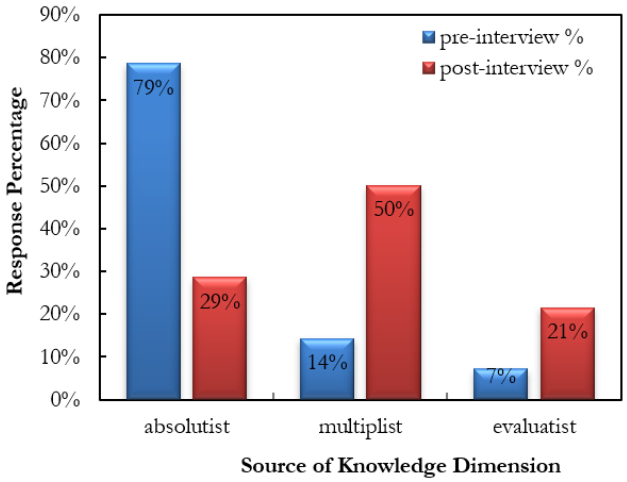

Figure 1 Student responses to the question on the source of knowledge dimension

Table 2 Epistemological belief levels rubric

Dimensions	Absolutist	Multiplist	Evaluatist
Source of Knowledge	Sources of knowledge are authorities and experts	The claims are subjective, personal views freely chosen by the individuals themselves and each view has equal rights.	Individuals interpret and question events based on objective and subjective tools and, thus, make inferences to arrive at conclusions.
Organization of Knowledge	The belief that knowledge is segmental	The belief that knowledge is partially related with other knowledge	The belief that knowledge is complex and is integrated with each other
Certainty of Knowledge	The belief in the certainty, absoluteness, and clarity of knowledge	The belief in the subjectivity and the lack of certainty and directness of knowledge	The belief in the continuous change, renewal and active organization of knowledge
Speed of Learning	The belief that either there is rapid learning or no learning at all	The belief that if learning has not occurred instantly, it will occur by means of reviews and exercises	The belief that learning is a staged process
Learning Control	The belief that the learning ability is innate, constant and unchangeable	The belief that the learning ability is not innate, but acquired	The belief that learning occurs with experience and that learning is an ability that can undergo change

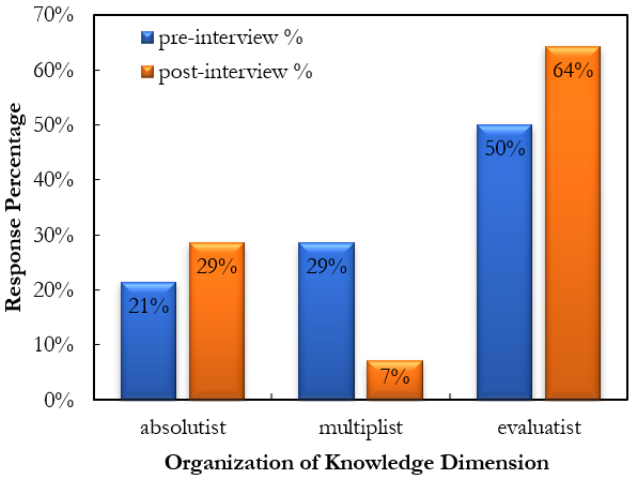

Figure 2 The student responses to the question on the organization of knowledge dimension

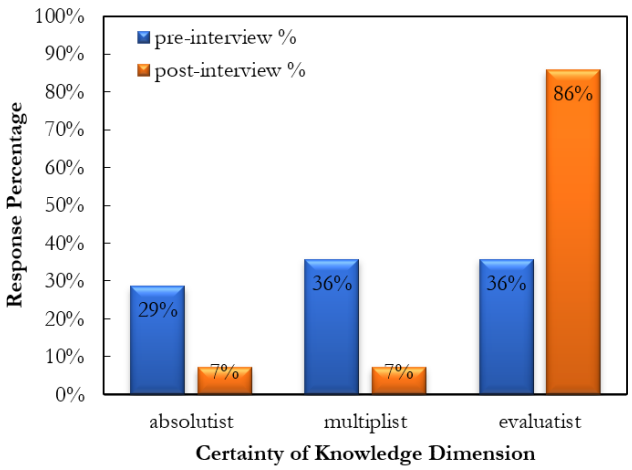

Figure 3 The student responses given to the question on the certainty of knowledge dimension

Internet and read comments." It can be understood from the student's explanation that s/he considers that source of knowledge can be learnt by making use of different sources and that doing research is one way of obtaining knowledge.

The number of students at the evaluatist level of epistemological beliefs increased by 14%. A sample student response at this level was as follows: "May have tried and made observations. In this way s/he may have decided which one is the brightest." This statement implies that the source of knowledge for these individuals is their own objective and subjective interpretations and questioning of events and, thus, they make inferences to arrive at conclusions.

Figure 2 portrays the comparative percentages of epistemological levels based on students' responses to the interview question based on the organization of knowledge dimension. As can be observed in Figure 2, there is a decrease in the percentage of student responses at the multiplist level of epistemological beliefs in the organization of knowledge dimension, while there is an increase in the percentage of responses at the absolutist and evaluatist levels. A sample student response reflecting the absolutist level is as follows: "I also believe that not learning the knowledge in a lower class does not have an effect on learning the new knowledge. We are learning new knowledge every year. Learning new knowledge does not really necessitate knowing other knowledge." It can be deduced from this explanation that the student considers knowledge in segments.

The number of students at the multiplist level of epistemological beliefs decreased by 21%. A sample student response of a student at this level of epistemological beliefs is as follows: "…some knowledge, especially in mathematics, if your mathematics in the lower class was not good, you still cannot do it because it is related to the topic learnt in the previous year. The teacher reviews us the topic but it is not sufficient for me. But science is not like that. I mean, to understand the topics you explain, that don't include computations you explain, I don't need other knowledge and I am more successful. I mean depending on the subject, or even topic, some are related and others are easy, simple; they can be learnt without knowing anything else." It can be inferred from this explanation that the student considers knowledge to be partly related with each other.

A sample student response at the evaluatist level is as follows: "I think all subjects are interrelated. For example, while we are solving a problem on heat and temperature in your lesson, we use our mathematics knowledge. While drawing the structure of DNA in the notebook, we add aesthetics by remembering the charcoal drawing technique of our visual arts teacher.

In the writing activity we did, we used the knowledge we learned in Turkish. We learned the movements of the Earth both in science and in social sciences." Based on this explanation, it can be understood that the student sees knowledge as integrated with one another.

Figure 3 displays the comparative percentages of epistemological levels based on students' responses to the interview question based on the dimension of accuracy of knowledge. As can be observed in Figure 3, in the certainty of knowledge dimension, almost all the students produced responses in the post-interview at the evaluatist level. The number of students at the evaluatist level increased from 26% to 86%. A sample student response at the evaluatist level is as follows: "I think it's associated with technology. As time proceeds, technology develops, new devices emerge; they seem more profound with these devices. You know it is also in the writing activity. There were views related to the structure of the atom throughout history. Like this. There's no end to it. For the time being, this is the best model that can explain it. In the future, a new technology can develop. They will use that. A completely different model will appear. And I think that's what happened with the white light." It can

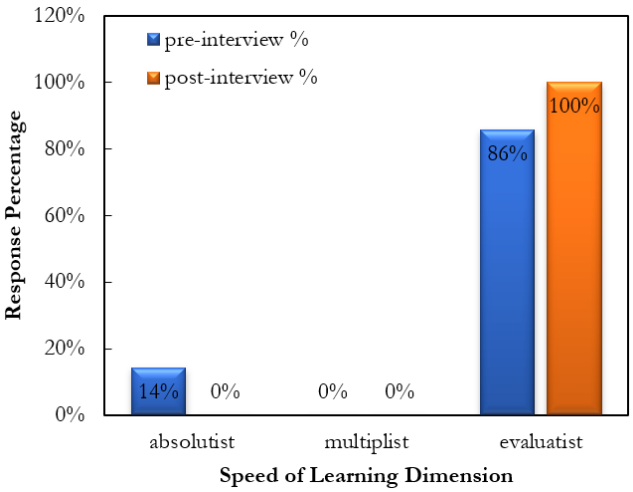

Figure 4 The student responses given to the question on the speed of learning dimension

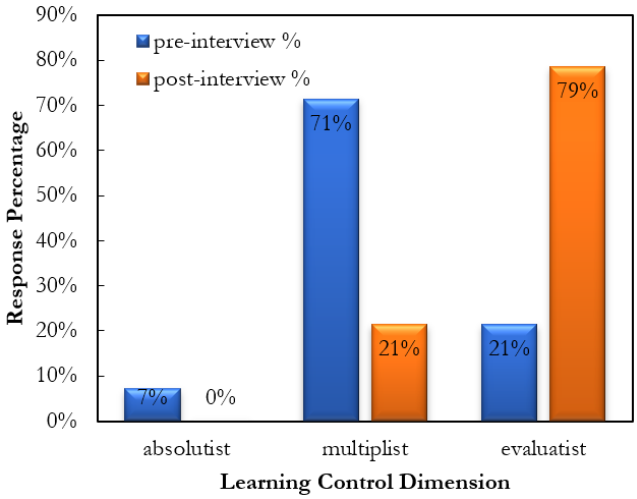

Figure 5 The student responses given to the question on the learning control dimension

be inferred from this explanation that the student considers knowledge to be changing continuously, to be renewing itself, and to have an active structure.

A sample student response at the multiplist level is as follows: " I think scientists looked at the white light from different perspectives and then decided whether or not it was pure. In the past science was not developed. Books and libraries were limited. Their preliminary knowledge and experiment equipment at the time they examined the white light were probably insufficient. Considering that it says 'Later', probably facilities in Newton's times were more varied. So he arrived at the correct [result]. Perhaps in the future they will even say that light is not white." This explanation shows that this student regards knowledge as not absolute and as changeable over time.

A sample student response at the absolutist level is as follows: "Newton found that light is not pure through research and experiment. So he did the previous experiments inaccurately because the result of the experiment was that white light is not pure. In fact, last year we did a colour wheel in class and saw the white. I mean when you set up the experiment accurately, the result is always the same." This explanation shows that knowledge is observed as precise, absolute, and clear by the student.

Figure 4 displays the comparative percentages of epistemological levels based on students' responses to the interview question based on the speed of learning dimension. As can be observed in Figure 4, in the speed of learning dimension, all the students made explanations at the evaluatist level in the post-interview. A sample student response at the evaluatist level is as follows: "There is never 100% learning in class. I always have to review it at home and do exercises so that I can learn it. For example, last Sunday, I went to the bazaar with my mum, [so] I couldn't come to school. I read the summary you sent us. I looked at the example in the book. Then I could solve the [questions in the] photocopy. Can I solve all the questions? Of course not. But in time, with your assistance as well, I think I can catch up." Based on this response, it can be understood that the student sees learning as a staged process.

A sample student response at the absolutist level is as follows: "Exactly, if I learned it in class, it means I learned it. Otherwise, I can never learn it later on. I have to hear it from someone else." This explanation implies that the student regards learning as a rapid and instant event.

Figure 5 displays the comparative percentages of epistemological levels based on students' responses to the interview questions based on the learning control dimension. As can be observed in Figure 5, while a majority of the students were at the multiplist level in the learning control dimension in the pre-interview, they reached the evaluatist level in the post-interview. A sample student response at the evaluatist level is as follows: "…For example, my science was always bad in previous years. This year I paid more attention, I studied regularly. In the exam during the first term, I did the best in science. When that was the case, I studied science harder. Now, I am able to understand the topics more easily. While writing (in the activities) Aziz Sancar was mentioned as being at moderate level of intelligence but he always studied hard and won the Nobel prize. Who knows? Maybe we will create a more updated version of the atom model we wrote on that paper." It can be deduced from this explanation that the student considers learning as a process acquired through experience and as an ability that can change.

The number of students at the multiplist level of epistemological beliefs decreased by 50%. A student explanation at this level is as follows: "Rather than ability, it is studying in the right and disciplined way. If Ahmet changes his study habits, he will probably be successful. When he finds the right way to study, it will be much easier for him to be successful." It can be understood from this explanation that the student believes that the

learning ability is not innate rather it can be acquired by studying.

A sample student response at the absolutist level is as follows: "… I study mathematics more than anyone else. Still I can't get a very good grade. I've got no talent for numbers. I am trying to pass the exam. Otherwise, what I have got to do with mathematics?" It can be inferred from this explanation that learning control is associated with intelligence, which is considered innate and fixed and unchangeable.

In summary, it was revealed that the number of students at the absolutist level of epistemological beliefs decreased in all the dimensions (except the organization of knowledge dimension). While the number of students at the multiplist level of epistemological beliefs increased in the source of knowledge dimension, it decreased in the other dimensions, except for learning speed. Finally, there has been an increase in the number of students at the evaluatist level of epistemological beliefs across all the dimensions.

4. CONCLUSION

In this section, how the WTL activities impacted the five dimensions (source of knowledge, organization of knowledge, certainty of knowledge, speed of learning and learning control) of 8th grade students' epistemological beliefs is discussed in light of the findings.

In the present study, it was revealed that the science lessons conducted by means of WTL activities had a positive impact on all dimensions of epistemological beliefs. Other studies investigating the impact of writing on epistemological beliefs have also found a positive interaction (Brownlee, Petriwskyj, Thorpe, Stacey & Gibson, 2011; Güven, 2013). Güven (2013) found that reflective journal writing provides a development of student teachers' source of knowledge, organization of knowledge, speed of learning and learning control dimensions, but no change in their beliefs about certainty of knowledge. Some research has shown that interventions have developed all dimensions of epistemological beliefs (Deniz, 2011), while others have shown that a few dimensions have improved and a few have remained the same (Chai, Teo & Lee, 2009; Chen & Chang, 2008). It is understood that the different interventions influenced the different epistemological belief dimensions. In the study, the observed positive development in the dimensions of certainty of knowledge, source of knowledge and organization of knowledge is attributed to the fact that the historical development of atom models and the definition of element were addressed in the worksheet and the variation in the models was examined because when students were explaining their opinions, they frequently mentioned the samples in the writing activities. With discussions held on such questions as "What do you think 'developing different models of the atom' means?, Can a new atom model emerge in the future?, Why?, Is the current definition of element sufficient in defining 'element'?" in the writing activities, an attempt was made to raise students' awareness to the fact that knowledge is a subject to change. In addition, some activities with a positive impact on the development of epistemological beliefs among the WTL activities used in the study can be listed as follows: directing students towards establishing their own atom models, having them question how the mixtures need to be separated, directing them towards developing a green and economic new detergent and subsequently having them make inferences. The reason why these activities were beneficial was that while they were writing their responses, they got the opportunity to make interpretations about their own opinions, and expressed their own feelings and experiences. By doing so, they were able to develop higher order cognitive functions, such as thinking critically, providing reasoned responses, relating their responses to daily life (Albert, 2000; Dicamilla & Anton, 1997; Stonewater, 2002). Other studies also reported the positive impact of various interventions in class on students' epistemological beliefs (Chai, Teo & Lee, 2009; Chen & Chang, 2008; Deniz, 2011; King, Levesque, Weckerly & Blythe, 2000). For example, in a study conducted in the year 2000 by King, Levesque, Weckerly & Blythe, it was reported that class discussions in which students were required to talk on the topics of knowledge and learning influenced students' epistemological beliefs positively.

It is believed that the progress observed in the dimension of learning control could be attributed to the activity of questioning by whom and how the new knowledge in the WTL activities was discovered and the ability of the human being to discover and produce new things. The discussions on such questions as "How could the scientists who developed these models have obtained information about atoms?, If you were in pursuit of a model based on the structure of the atom, with which activity and from which point would you start your endeavour?" are believed to influence students' epistemological beliefs positively by encouraging them to make interpretations and inferences, build empathy, put themselves in the shoes of the person mentioned in the activity, question the decisions they take and reflect on their learning process. Ensuring that students reflect their views on the nature of knowledge and learning affects their epistemological beliefs (May & Etkina, 2002).

Based on the work, we recommend some points: First, more time should be spent on the topics in the history of science unit in science lessons, in which students should be made aware of the fact that knowledge can change over time, and depending on whether or not the topic is convenient, students should be encouraged to design their own models of a pre-determined topic. Second, as in the WTL activities, instead of providing students with

information directly, in-class research activities and discussions can be used effectively to enable students to draw their own inferences and, thus, construct knowledge; in this way, their epistemological beliefs can be developed. Third, similar implementations can be done in a longer period of time and the implementation period can be evaluated to reflect both teacher and student experiences.

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