Cypriot Journal of Educational Sciences

Volume 13, Issue 3, (2018) 275-287

www.cjes.eu

Application of writing-to-learn in science to primary school students

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Suggested Citation:
Alkis Kucukaydin, M. (2018). Application of writing-to-learn in science to primary school students. *Cypriot Journal of Educational Science. 13*(3), 275–287.

Received from February 01, 2018; revised from June 18, 2018; accepted from September 20, 2018.
Selection and peer review under responsibility of Prof Dr. Huseyin Uzunboylu, Near East University, Cyprus.

Abstract

In this study, the mix-method design sequential explanatory design has been used. The students in the study group consist of 13 fourth-grade students who were studying in one of Turkey's far-flung corners. Over a period of 3 months, enriched write-to-learn strategies were implemented on the students. In this context, students wrote a letter and a journal related to the Past and Present Enlightenment Tools unit. In addition, they were presented with a story related to the unit and were asked to complete it. Two weeks after the end of the study, interviews were held to see the permanence of the students' conceptual learning. The writings of the student were scored with authentic data collection tools. According to the findings obtained, write-lo-learn strategies have been influential on science conceptual learning. However, the greatest conceptual learning was achieved through story completion activities. A number of suggestions have been presented in the direction of findings obtained from the study.

Keywords: conceptual learning, primary school students, writing-to-learn.

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1. Introduction

Through many studies conducted in the field of education, the positive effects of learning by writing on students have been proven. These influences have been classified as the development of critical thinking and the construction of new knowledge (Mason & Boscolo, 2000; Spivey, 1990), contribution to interdisciplinary learning (Rivard, 1994), better understanding of teaching objectives (Wiley & Voss, 1996) and contribution to learning (Galbraith, 1992). When investigations conducted over the last 10 years are examined, writing-to-learn strategies are used in examining the measurement of scientific literacy levels, and their relationship with the school and the curriculum (Lyons & Quinn 2010; Tytler, 2007). It has been found that the strategies used in these studies contribute to the level of scientific literacy of the students and help to develop a positive attitude towards science.

Teaching through writing, which is one of the most important teaching activities, was first established in the 1930s with the understanding of John Dewey's progressive education and continues to be used to this day at all levels and areas of education (Klein, 1999). The expression 'writing' is generally used to uncover the relationships between ideas as well as overriding the components that make up the strategy write-to-learn (WTL). This strategy is mostly used for the purpose of disclosing experiences of science experiments, or scientific literacy levels (Pelger & Nilsson, 2016; Tomas & Ritchie, 2015). According to Waywood (1994), WTL basically consists of a four process structure. In the summary part of these processes, important sections or ideas from the lesson can be taken note of, certain related ideas can be grouped under a specific title and can then be formulated using the appropriate words and language. In the exemplification process, the appropriate examples from the summary are explained and discussed. In questioning the process of producing questions begins with the intention of revealing false conceptions that lie beneath the ideas. The main purpose of this process is to serve learning. In the final process, application, the ideas that emerge in the lesson are explained and implemented. All these processes emerge as an important point for students to acquire the skills necessary for the conceptual understanding of scientific literacy, and scientific writing (Pelger & Nilsson, 2016). WTL is seen as a useful paedagogical approach on the basis of the learning process. This paedagogical approach is used for teaching students by teachers; however, student learning does not always automatically show progress (Fry & Villagomez, 2012). According to Chen, Hand and McDowell (2013) WTL activities also have an impact on epistemological beliefs and are an important tool in structuring knowledge. This tool can be used on an individual basis as well as being effective in group work. The ideas of individuals in peer groups, their feedback and criticism can bring out conceptual learning. Because students in the group will take responsibility and will improve their control mechanism in the decision making process. However for WTL strategies to be effective, they must be applied by teachers correctly. In this regard, Hand and Prain (2002), who implemented a professional development course for in-service teachers, talk about a five-dimensional WTL strategy for successful learning in science (Figure 1). Hand and Prain (2002) noted that these five dimensions have a structure that is locked together, and that the writing practices in traditional science classes are based on these elements, but that the writing task is not limited to these dimensions. For this reason they have mentioned that the dimensions should be enriched with different combinations, and that the teachers should surround these enrichments with a theoretical infrastructure and a pragmatic paedagogical approach.

Klein and Rose (2010) explained the enrichment of WTL in education, in an analytical way. Accordingly, the existing ideas that the students have can be examined in depth by means of analytical writing methods just like argumentation. However, some researchers have pointed out that the students need reading and writing more than laboratory applications in order to achieve scientific literacy goals in science education (Mackenzie & Gardener 2006; Ritchie, Rigano & Duane, 2008). Gillespie Rouse, Graham and Comptonc (2017) stated that the writing process had been through a series of mental processes in order to achieve the desired goal. For this purpose, at each WTL, it is mentioned that the process of relatively organising the information, releasing the preliminary information and the establishment of the relationship between the ideas will take place. This will enable students to spend more time with new information and open a path for better learning.

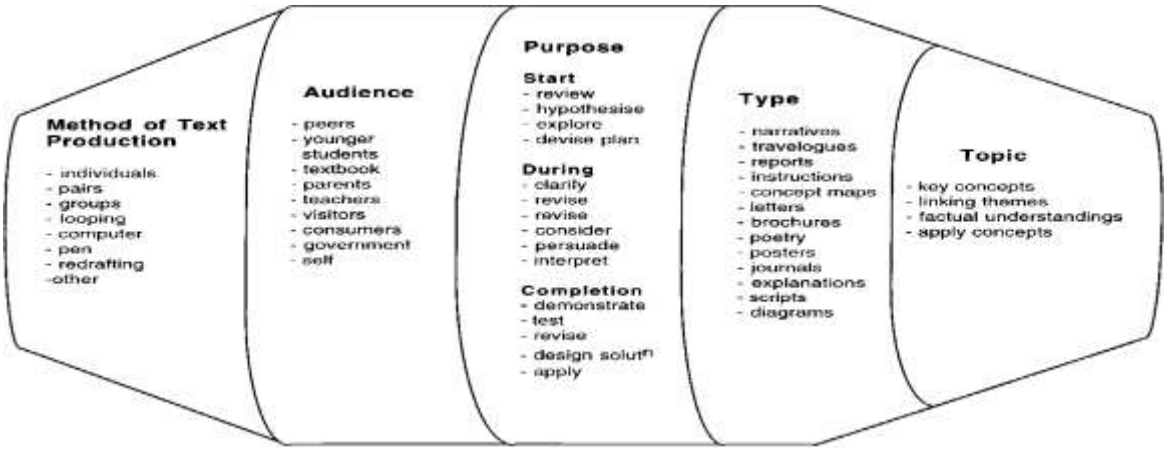

Figure 1. Model for WTL (Hand & Prain, 2002, p. 743).

Klein (2000) argues that the WTL strategies of primary school students must be specifically investigated because the strategies used during this period of initial learning are very important. Both in Turkey [Ministry of National Education (MNE), 2013] and at an international level [National Research Council (NRC), 2012], science education researchers emphasise that primary school students should be directed towards scientific research and that they need to gain the ability to interpret and explain their research findings. At this point, the importance of the action of writing regarding the students' structuring of knowledge emerges. According to Hand, Prain and Wallace (2002), WTL practices in science allow students to understand the information in a language they understand without having to repeat the same information over again, thus increasing their conceptual perception by contributing to them making stronger connections between concepts. According to Mason and Boscolo (2000), researchers in the field of writing, students made concept changes more easily with writing activities. In this context, it is clear that conceptual learning in students will be easier and more efficient with multiple writing activities.

1.1. Evaluating the effectiveness of WTL strategy

Chen et al. (2013) attempted to unravel the conceptual perceptions of the 4th and 11th grade students in the force and motion unit with the collaboratively writing method. It was seen that letters written by older students at the beginning, middle, and end of the unit to younger students, led to positive changes in students. Accordingly, conceptual learning has become more prevalent among students with low socioeconomic status, especially girls and especially talented students. It has also helped students with conceptual learning which students have found to be challenging. Klein (2000) examined the cognitive processes of elementary students through WTL strategies. The study was conducted with an analysis based on seven factors (Text Production, Searching From Experiment, Brainstorming, Elaborative Genre, Goal Setting, Searching From Text and Reviewing Beliefs). It has been seen that WTL strategies used by elementary students are very sophisticated and show differences within themselves. Hand and Prain (2002) presented a group of eight junior secondary science teachers who obtained results from a professional development course, in which WTL strategies were introduced. WTL tasks in the related science curriculum were offered to the teachers teaching at the course which took place. It has been seen that these tasks are based on beliefs, interests and practices of teachers. Klein and Rose (2010) aimed to improve student interpretations through the use of analytical WTL. For this purpose, it has been focused on argument writing and explanation writing areas. At the end of the focusing study, both the argument type information and the explanation type information and the explanation text quality information type have made significant progress. Chang, Rao, Stewart, Farley and Li (2016) developed a paedagogical approach focused on WTL practices. This approach is intended to be shared with other faculty members with

the aim of improving their practices. In certain periods, the members came together to discuss and evaluate their teaching in terms of their own experience. After a series of workshops studies it was seen that there was positive progress in terms of the paedagogical approach of members. This has led researchers to examine the effects of informal writing on specific paedagogical approaches. Balgopal, Wallace and Dahlberg (2012) have developed a writing heuristic in the teaching of ecology. In the model they called 'Cognitive-Affective-Behavior Writing-to-Learn Model' (CAB-WTL), the students wrote an essay about an ecological issue. At the first stage of essay, students wrote about what they know and remember about this ecological issue they have identified, and they studied journals about the subject. In the next stage, they are asked to write about how this affected them as a member of society and how they would solve the problem as a member of society. In this study, which was implemented using CAB-WTL, it was seen that the level of ecological literacy increased by 50%. Gillespie Rouse et al. (2017) used the WTL strategies in the teaching of balance in the fourth grade. For this purpose, an experiment and control group was created and the effects of the strategies were attempted to be revealed. At the beginning of the application, students' knowledge of balance and writing skills were examined. The students' ability to write was measured with the TOWL-4 story composition subtest. The preliminary information on balance was measured using a multiple choice test. Measurements made in a similar way after the applications were compared with the preliminary measurements. Significant differences were found in the students' balance related information after the comparison. However, a statistical difference in their writing skills was not found. Hohenshell and Hand (2006) investigated the difference between traditional laboratory practices and laboratory practices based on heuristic writing skills based on WTL strategies, and the contribution to the students' argumentation skills, conceptual understandings, and research inquiry skills. The study was conducted with mixed-method, quasi-experimental, pre-test/post-test design with a non-random sample. As a result of the study conducted throughout the 7-week unit, it was found that writing practices differed significantly between students' conceptual understanding and different thinking. The study also found that female students benefited more from writing activities than male students. Fernandes (2012) examined the writing skills of engineering students. In the case study, the contribution of the 2-week application to the writing skills of the students was determined.

1.2. Context of investigation

In this study, the WTL strategy was used to clarify the conceptual understanding that fourth-grade primary school students have related to science. In this context, a study plan was prepared according to the model proposed by Hand and Prain (2002) and the study was enriched (Table 1). According to this plan, the students individually used the enriched WTL strategy throughout the 'Past and Present Enlightenment Tools unit' (PPET). It was requested that students write letters and journals and take part in story completion activities regarding the concepts covered in the unit. During the writing applications, students were interrupted and constant feedback was given.

Table 1. Model of research

Method of text production	Audience	Purpose	Type	Topic
-individuals -pen	-self	**Start** -explore **During** -clarity -revise -consider **Completion** -design solute -apply	-letters -journals -narratives	-key concepts -linking themes -factual understanding -apply concepts

The study was conducted by the class teachers of the students and I was not composed of experiment or control groups. The PPET unit was specifically selected in the study. There are two reasons for choosing this unit in the study. First, no research was found in the available literature on the mentioned unit. The second is that the PPET unit is a current issue and has advantages that students can learn and sample through life. Also it has a socioscientific approach. This study is thought to have many important aspects. First, a very limited number of studies have been carried out at primary school level (Chen et al., 2013; Gillespie Rouse et al., 2017; Klein, 2000). Yet writing activities should be started at an early age and cognitive processes must be actuated (Klein, 2000). At the same time writing practices have been enriched for the development of writing skills. The impact levels and conceptual meanings of the writing activities carried out in the study are preliminary. For this reason, the qualitative and quantitative analyses have been used together to try and show student understandings.

From this context, it is aimed to examine students' conceptual perceptions by using appropriate assessment techniques in the study. With this target, the writing of letters, journals and story completion activities have been carried out from the WTL strategies. The research questions of the study in this context are:

– How much do the letter, journal writing and story completion activities affect the students' conceptual perceptions?
– What is the level of the effect of the activities on the permanence of conceptual perceptions?

2. Methodology

This study is a mix-method study where qualitative and quantitative research patterns are used together. Sequential explanatory design of mix-method designs was used in the study (Creswell, 2003). In this design, quantitative data may be pre-collected and analysed before qualitative data can be obtained or, conversely, qualitative data may be collected and analysed before quantitative data can be obtained. Thus, both types of data can be collected first depending on the researcher's priorities and needs. Priority is not given to qualitative or quantitative data types and in some cases both data types may be given equal importance. Data analysis is usually combined in the interpretation and discussion sections. This design is useful for enabling broader or alternative viewpoints, for supporting research participants and for better understanding of what is being worked on (Creswell, 2003). In this study, qualitative data collection was started after the data were collected quantitatively and an attempt was made to obtain more in-depth information through qualitative analysis. In other words, the study was carried out quantitatively to qualitatively. In the quantitative aspect of the study, the stories, letters and journals written by the students were evaluated. Interviews were used in the qualitative dimension. The study was conducted over a 3-month period. The students in the study consisted of 13 fourth-grade students that live in a small rural town in Turkey. Six of the students were girls and seven of them were boys. All of the students (10 years of age) families had a similar background and made a living by farming. The students who were almost at the same academic level had never been involved in creative writing other than the class notes their teacher's got them to write. The research continued in this class, in which the characteristics are specified by the author of the study.

2.1. Research procedure

In the first step of the study, the related literature was read and the stories developed according to the WTL strategies were read (Ritchie et al., 2008; Tomas & Ritchie, 2015). Without providing a specific unit or aimed theme, these stories have been guiding in the story-building process, even though it is aimed at improving scientific literacy in general. Within the scope of this study, a half-completed story about lighting technologies and light pollution was developed and presented to the students for completion. The prepared story is a sociological story that includes the concept of light pollution. The

purpose of completing the story was to examine the students' correct and proper use of the concepts. Feedback was given to the students about the stories and a student-centred approach was adopted.

In order to diversify the WTL strategies, the PPET unit had a daily writing activity after each science class. The students reflected the information and concepts they learned in science classes that day, as homework, in their journals. In the journals written, there were descriptions of what was learnt, what they wanted to learn, what they did not learn, what they were curious about, and the explanation of the concepts they had learned. The journals were reviewed after each lecture and feedback was given in the form of the researcher adding statements or extracting statements that were deemed unnecessary. Baxter, Bass and Glaser (2001) suggest that the use of journals in science classes encourages students and provides the ability to see the students' research and the development of knowledge. Keeping a science journal encourages students to write as a natural part of their daily science class experiences. Science research on student journals (Klentschy, 2005; Lynch, 2003; Morrison, 2005; Morrison, 2008; Ruiz-Primo, Li, Ayala & Shavelson, 2004) shows that journals improve the students' achievements in standard tests, and provides teachers with feedback regarding their teachings. Therefore, the teacher understands how each student thinks, their strengths and weaknesses and begin to understand their mistakes and why they make them. Science journals can be used for two purposes in general. For determining the class level or evaluating individual understandings of the students (Shavelson, 2001). In this study, science journals were used to expose individual conceptual understandings of students. Individual evaluations were made for this reason.

In the other part of the study, students were asked to write a letter to the third grade. In the letter, they wrote they were asked to cover all the concepts in the PPET unit, and they were asked to think about how they could teach this unit to the younger students. The study at the end of the unit was conducted in a classroom environment and homework was not given. Therefore, feedback was attempted to be given instantly in the classroom and all of the concepts to be used were reminded repeatedly. The units and concepts in the study and the application periods are detailed in Table 2.

Structured interviews were conducted with all 13 students in the qualitative dimension of the study. Interviews were conducted 2 weeks from the end of the WTL applications. Thus, the continuity and the quality of conceptual understandings were also examined. Face-to-face interviews were held with each student for approximately 15 minutes. In the interview, the students were asked; *What differences have developed between the past and the present daylighting tools, what can you say about the effects of the lighting tools used today, what do you think about the effects of unnecessary lighting on people and the environment*? These questions were presented as open-ended questions and shaped according to the answers given by the students.

Table 2. The design of the study

	Quantitative dimension	
WTL strategy	**Applied unit and concepts**	**Application time**
Story	PPET	2 weeks
	-Light pollution	
Letters	PPET	2 weeks
	-True lightening	
	-Light pollution	
	-Lightening and eye health	
	-Lighting tools used from past to present	
Journals	PPET	6 weeks
	-True lightening	
	-Light pollution	
	-Lightening and eye health	
Qualitative dimension		
Interview	Learned concepts and understanding	2 weeks after application

2.2. Data analysis

Both qualitative and quantitative research methods were used in order to be able to respond to the research questions in the study, and their analyses were also done according to these research methods. Matrices were used for story completion, letter and journal applications in the study. The matrix used for scientific literacy by Tomas and Ritchie (2015) was adapted to this study in story completion activity (Appendix A). According to this matrix, students can get minimum two and maximum eight points. Researchers have reported that it is reliable based on the long period of use of the matrix. The scores received were used in interpreting the socioscientific story. The stories written by the students were coded with a science teacher so that side coding was avoided.

The journals written by the students throughout the PPET unit and the letters which they have written to a lower class have been evaluated with the rubric method. The reason for using the same rubrics for journals and letters is that there are no argumentation practices in the writing activities and that they focus entirely on conceptual understanding. For this reason, Shavelson (2001) used the proposed measurement tool to measure conceptual and procedural understandings. The measurement tool used is presented in Table 3.

Table 3. Interpretation of the scores obtained from letters and journals

		Interpretation	Derived letter and journal score
NA	Not applicable	No interpretation	Instructional task does not require any conceptual or procedural understanding
NU	No understanding	0	Examples or procedures described are completely incorrect
PU	Partial understanding	1	Relationships between concepts or descriptions of observations are only partially accurate or incomplete
AU	Adequate understanding	2	Comparisons between concepts or descriptions of a plan of investigation are appropriate, accurate and complete
AdU	Advanced understanding	3	Communication focuses on justifying responses/choices/ decisions based on the concepts learned or the communication provides relevant data/evidence to formulate the interpretation.

The scores obtained from letters, journals and story writing were statistically processed. The statistical significance of the writing activities applied was calculated accordingly. In the qualitative dimension of the study students were interviewed and their conceptual understanding was attempted to be revealed. Interviewing is an effective tool for finding out the beliefs, attitudes, ideas or feelings of individuals or groups (Saldana, 2011). For this reason, a form of a semi-structured interview consisting of open-ended questions was prepared and the answers given to the interview questions by the students were transferred in writing on paper. This transferred information was used to measure the permanence of conceptual understandings obtained through WTL strategies. At the point of permanence the authenticity of the information that the pupils presented, they were again checking by a science teacher. Thus, student interview data were thus checked twice. The data obtained from interview have been analysed in a descriptive way depending on the science curriculum earnings.

3. Findings

In this part of the study, the products they produced using the WTL strategies during the PPET unit, obtained from the students writing studies were assessed. This assessment is presented in the form of separate data obtained from quantitative and qualitative dimensions.

3.1. Findings from the quantitative section of the study

In this part of the study, the letters and journals that the students were made to write, related to the PPET unit and the data obtained from the story completion activity were presented. Whether there was a significant difference in the conceptual understanding gained from the writing activities was calculated with Friedman's variance analysis. The data obtained from the calculation are presented in Table 4.

Table 4. Comparison of scores obtained from students' writing activities

	N	χ^2	SD	*p*
Story-Letter-Journals	13	17.714	2	0.001

SD = standard deviation.

As shown in Table 4, as a result of the Friedman test conducted to compare the difference between the scores of the stories, letters and journals of the 13 students in the study group; the difference between the story, letter and journal assessment was statistically significant [χ^2 (2, N = 13), $p < 0.05$]. When the rank order of the variables was examined, it was found that the journal (2.54) was higher than the letter (2.31) and story evaluation (1.15). To identify the source of this difference the Wilcoxon signed rank test was conducted and the results are presented in Table 5.

Table 5. The Wilcoxon signed rank test results for students' comparisons of story, letter and journal evaluations

		N	Mean rank	Sum of ranks	*z*	*p*
Letter-Story	Negative ranks	0	0	0.00	3.076*	0.002
	Positive ranks	12	6.50	78.00		
	Ties	1	-			
	Total	13	-			
Journal-Letter	Negative ranks	1	6.00	6.00	1.000*	0.317
	Positive ranks	5	3.00	15.00		
	Ties	7	-	-		
	Total	13	-	-		
Journal-Story	Negative ranks	1	5.00	5.00	2.679*	0.007
	Positive ranks	11	6.64	73.00		
	Ties	1	-	-		
	Total	13	-	-		

*Based on negative ranks.

As shown in Table 5 according to the result of Wilcoxon signed rank test a result in favour of the story can be seen. When the rank order and sum of the difference scores are taken into account, there is a significant difference in favour of the story based on positive rankings between letter and story evaluation ($z = -3.076$, $p < 0.05$). Another statistically significant result in Table 5 relates to the comparison of journal and story assessment scores. According to this, the difference between journal and story evaluation scores of students was found to be significant ($z = -2.679$, $p < 0.05$). When ranking averages and totals are examined it is seen that the point differences are in favour of positive rankings and the story's assessment. According to another result shown in Table 5, the difference between the Wilcoxon signed rank test daily evaluations, and the letter evaluation point averages was not statistically significant ($z = -1.000$, $p > 0.05$).

According to the results of the analysis, the story writing activity had more of an effect on conceptual learning than letter and journal writing activities. According to this, the graphical presentation of the scores of the students according to the criteria of story writing activity is presented in Figure 2.

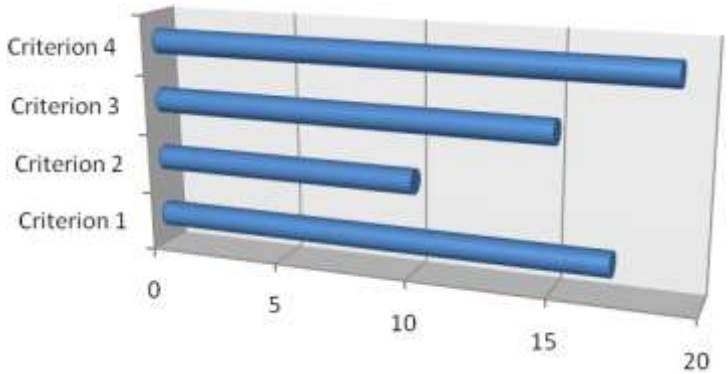

Figure 2. Scores taken from the criteria of the story writing activity

When Figure 2 is examined, the highest scores of the students are in the subject of 'How the stop light pollution' in Criterion 4. The lowest score is in the 'Lightening and crime issues' subject of Criterion 2. In this case, it is possible to say that students' conceptual learning in relational situations is weaker than other conceptual learning.

3.2. The study's findings from the qualitative section

In this part of the study, the results of the interviews conducted with the students 2 weeks after the writing activities are presented. The interviews were carried out individually with each student and conceptual learning was emphasised. Examples from the answers that students gave to the interview questions are as follows. Samples from students are presented with codes (like S1, S2).

Researcher: from past to present, what do you think about the lighting tools used?

Student answer: *Long-term lighting has replaced short-term lighting (S13), Electrical lighting is being used instead of non-electrical lighting (S1), Today's lighting tools are lighter and easier to move (S4)*

Researcher: What do you think about the effects of lighting tools used today?

Student answer: *Today's lighting tools are more efficient (S5), Today's lighting tools make technology necessary and this is bad for the environment (S2), today's lighting tools cause light pollution (S9)*

Researcher: What do you think about the effects of unnecessary lighting on people and the environment?

Student response: *Our electricity bills are high due to unnecessary lighting (S6), Sea turtles are dying because of unnecessary lighting (S7), Natural resources are reduced due to unnecessary lighting (S3).*

When the students' answers to the questions of the researcher are examined, it is seen that conceptual learning showed continuity and the students answered the questions directed to them according to related science earnings.

4. Discussion and conclusions

According to the findings of this mixed-design study in which WTL strategies including keeping a journal, letter writing and story completing activities, WTL strategies have a positive impact on the students' conceptual understanding. This finding supports many theoretical and applied studies which claim that writing activities support conceptual learning (Chen et al., 2013; Gunel, Hand & Gunduz, 2006; Gunel, Hand & McDermott, 2009). Knipper and Duggan (2006) state that WTL strategies invite

students to think, contribute to language learning, and help gain a wider perspective. In this case, it is possible to say that WTL strategies are a useful activity that can be used in science lessons at all levels of education starting from primary school.

It has been determined that in the course of the study, students reached conceptual learning through the WTL strategy of story completing the most. There may be many reasons why most conceptual learning is achieved through story completion out of the letter, journal and story writing activities carried out throughout the same unit. First, students may not always be able to present their science learning and knowledge in writing in full (Tomas & Ritchie, 2015). However, they may have the opportunity to show their learning here when presented with a half-story set in a certain way. Moreover, the fact that the students in this age group have strong imaginations may have helped to express their learning more clearly through stories. A criterion for each section of the story in the matrix was determined in the evaluation of the scores obtained from the story completion activity. In line with these criteria, it has been seen that students have a good understanding of the causes of light pollution in the city which is included in the unit, how to prevent light pollution and the conceptual understandings of required lighting. However, when socioscientific fiction was added to the story presented for completion, they were not as successful in the scoring provided for this criterion. This is important for the assessment of WTL strategies. Because while the conceptual structure of solely learned information can be achieved with WTL strategies, it has not proved to be as successful when multiple elements are added to this conceptual structure. Gillespie Rouse et al. (2017) stated that children at primary school age cannot have specific schemes in scientific writing activities. In this study, the greatest potential to affect science education due to this is the necessity of putting the background information of the students in the foreground. This situation shows the repetition and importance of writing activities.

As part of the WTL strategy of letter writing activities, students wrote a scientific letter to a lower grade class. The written letters also have a characteristic that can be considered as a self-evaluation of the student. Because the student will become aware of what they have learnt and conceptual learning will take place in the direction of their own criteria. This ensures that the students are more careful (Tomas & Ritchie, 2015). In addition, students entered the zone of proximal development, which Vygotsky (1978) described, during the teaching of their own knowledge to their peers. According to Chen et al. (2013) entering the zone of proximal development has been supportive in the development of students' negotiation skills and has also undertaken a fundamental task in the development of special information.

An interview was held 2 weeks after the end of the writing activities conducted with the students. According to the findings obtained after the interview, the conceptual understandings of the students showed continuity. It is therefore possible to say that WTL strategies support permanence in conceptual learning and activate cognitive learning. Ruiz-Primo, Li, Tsai and Schneider (2010) point out that the students' explanations show conceptual learning. At the same time, it was revealed that students did not have misconceptions and that they were able to explain themselves in many different ways. As a matter of fact, White and Gustone (1992) stated that through a structured interview in science classes, students would be able to voice their understanding which they cannot express in writing. In this study, interviewing has been an effective means of collecting data in terms of uncovering conceptual understandings. Mixed method designs, which also allow for quantitative analysis of written works, give a different perspective to research (Tomas & Ritchie, 2015). In addition, authentic data collection tools have enriched the study. This will also give readers the opportunity to a look at scientific learning from a wider perspective.

4.1. Implications

The greatest suggestion that can be gained from the findings of this study is related to WTL strategies. Because it is seen that as a result of the writing activities students are showing important progress in science conceptual understanding. The relevant literature notes that these advances are

cognitive (Fry & Villagomez, 2012; Hubner, Nuckles & Renkl, 2010) and that scientific language is used (Gunel et al., 2009). Therefore, enriching the WTL strategies and applying them to science classes, especially from primary school age, may be important in terms of the use of conceptual learning and scientific language. Only conceptual learning is emphasised in the study, but attitudes towards student achievement or writing activities have not been examined. Researchers can examine the effect of WTL strategies on attitudes before and after implementation in science classes and its contribution to achievements.

In the study, it was observed that there was important conceptual learning especially in story completion activities, but it was also seen that the criteria in the story evaluation the students got a low score when a socioscientific approach was needed. This can be examined both in terms of writing activities and a socioscientific point of view. The use of socio-science-based WTL strategies is recommended for future research.

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A. Appendices

A.1. Story scoring matrix

Criterion 1	The reason of light pollution
0	The reason of light pollution is not mentioned
1	The reason of light pollution is partly mentioned
2	The reason of light pollution is mentioned exactly
Criterion 2	Lightening and crime issues
0	There is not any relation between lightening and crime issue
1	Only lightening/crime issue is included or relation between lightening and crime issue is partly mentioned
2	Detailed formation is given related to lightening and crime issue
Criterion 3	How the true lightening should be
0	It is not mentioned about true lightening
1	Partly information is given about convenient and true lightening
2	True and convenient lightening is explained through examples
Criterion 4	How the stop light pollution
0	It is not mentioned about how to stop light pollution
1	It is not mentioned about how to stop light pollution but not explained sufficiently
2	It is given suggestions about how to stop light pollution and explained sufficiently
Total score:	

A.2. Writing task

Dilay, a member of a non-governmental organisation, thinks that animal nature is destroyed because of technology. An event happened last summer holiday makes her believe that lighting technologies are used unnecessarily. Dilay realised that hatching caretta carettas headed towards a wrong direction think that it is the reflection of the moon on the waves. Turtles moving away from the sea were endangered and they were in danger of being hunted by predators. It was later understood that caretta carettas walked through the wrong direction because cafeteria's light on the beach was stronger. So Dilay believes that as human beings was should consider animals around as.

During a conference, Dilay told this event and expected support for her ideas. But one of the audiences in the conference stood up saying that crime rates at night were decreased thanks to lighting. Ms. Aydan who is a specialist on lighting intervened and said that lighting did not prevent crime, the reason of crime was not light or darkness and criminals should not be chased on the sky.

And then she talked about light pollution and lighting.

Your task is to complete this story by using 200–250 words. You can do research on it. Let Ms. Aydan talk about sufficient lighting and prevention of light pollution.

Be careful with this point while completing your story:

– You should answer the question of what light pollution is,
– You should prove whether there is a relationship between lighting crime matter,
– You should mention how sufficient lighting should be,
– You should mention how to prevent light pollution.