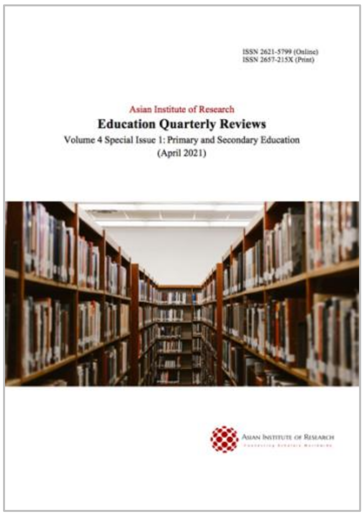

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Situational Interest and Its Sources: A Comparison Between Expressed and Observed Situational Interest about Heat Transfer

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Abstract
Latest studies on situational interest (SI) point out that the expressed situational interest (ESI) and observed situational interest (OSI) of students that emerge during science courses differentiate from each other. However, the studies aiming to determine this difference are rare. Accordingly, the purpose of this qualitative case study is to compare the ESI and OSI of middle school students emerging during a science course and determine what type of sources these students show in relation to their SI changes. Turkish six-graders (N= 30, age 11–12 years) participated in a heat transfer course, and this course was video-recorded. The SI of the students was measured repeatedly in different sequences and periods of the course and examined by combining student self-evaluations and observations from the video recordings. As a result of the study, it was observed that although the SI of the students increased especially during hands-on activities, it decreased in general towards the end of the course, ESI and OSI differentiated with time, and the prominent sources included novelty, personal relevance, concreteness and engagement.

Keywords: Science Education, Observed Situational Interest, Expressed Situational Interest, Heat Transfer, Middle School Students

1. Introduction

In terms of the fact that interest is a psychological state or a positively charged cognitive and affective experience that involves environmental factors in a particular situation, it is related to motivation towards learning (Ainley, Hidi, & Berndorff, 2002; Hidi, 2006; Hidi & Renninger, 2006; Palmer, Dixon, & Archer, 2016; Rheinberg, 2008). Motivation itself is formed through individual/object interactions where the aforementioned conditions are interpreted within the needs system of individuals (Hidi, 2006; Ryan & Deci, 2002). Therefore, it may be stated that positive experiences related to these interactions will increase individuals' motivation towards learning. Moreover, adequate motivation is a requirement for learning to take place, and it is needed for this motivation to be provided by high attention focused on the learning activity or task at hand (Deci, 1992; Durik & Harackiewicz, 2007; Rheinberg, 2008; Rotgans & Schmidt, 2018; Sansone & Thoman, 2005). When it is considered in the context of high motivation and focused attention, interest may be thought alongside SI that is argued to be in closer relationships with individualized motivation that is discussed within the individual needs system that constitutes the foundation of learning experiences (Loukomies, Juuti, & Lavonen, 2015).

SI and individual interest are different concepts that have a certain level of hierarchical relationship (Krapp, 2002). Thus, they are generally discussed independently of each other in educational research (Hidi, 1990). As opposed to individual interest, which shows a permanent connection to the values and knowledge structures of individuals and is considered as a relatively enduring predisposition, SI is a temporary state that is triggered with the help of an environmental stimulus that attracts attention spontaneously (Hidi & Renninger, 2006; Schraw, Flowerday, & Lehman, 2001). For example, a striking demonstration of a funny experiment carried out in the classroom may stimulate the focused attention of some students who generally have lower individual interest in the science course (Palmer, 2009). Since individual interest exhibits a general predisposition, this accumulation is more suitable to be classified in interest categories where it is examined on the basis of vocational interest (Dierks, Höffler, Blankenburg, Peters, & Parchmann, 2016; Duruk, 2020). Above all, it may be argued that SI is a useful gateway and predictor in the road to individual interest (Durik & Harackiewicz, 2007; Hidi, 2006; Linnenbrink-Garcia et al. 2010; Loukomies et al. 2015).

Theoretically, SI is examined under two components—*triggered-SI* and *maintained-SI* (Hidi & Renninger, 2006). While triggered-SI refers to the driving interest that precedes individuals' encounters of more environmental stimuli during their learning experiences, maintained-SI rather indicates holding this temporary interest that is formed in terms of allowing the understanding of the content offered by the learning material to the student. Triggered-SI is directly associated with the learning environment's capacity to catch the attention of students (Linnenbrink-Garcia et al. 2010). Specifically, in terms of this component, it is highly important that activities or tasks that are included in learning environments create positive learning experiences in students, and these experiences are accompanied by positive emotions. This is because emotions play a significant supportive role in the transition from triggered-SI to maintained-SI (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000). Transformation of triggered-SI into maintained-SI by increasing these positive emotion experiences requires the support of the activities provided by the teacher conducting the instruction inside the classroom and the contents of these activities (Loukomies et al. 2015). Hence, due to its situation-specific structure, SI is also closely related to the SI sources by which the learning environments that are supported with the activity contents which are used during learning situations are nourished. In educational research, several sources related to SI such as novelty (Dohn, 2011; Palmer et al. 2016; Renninger & Hidi, 2002; Silvia, 2008), task concreteness (Tapola, Veermans, & Niemivirta, 2013), personal relevance (Harackiewicz et al. 2000; Renninger & Hidi, 2002; Palmer et al. 2016), humor (Dohn, Madsen, & Malte, 2009) and engagement (Sun & Rueda, 2012) are being discussed. It has been observed that findings related to these sources indicate that the SI of students increases as they learn new information and encounter new contents, as the tangibility and personal relevance of the aforementioned tasks at hand increase, and as they feel humor during activities. Nevertheless, the potential sources of SI have been rarely questioned within studies conducted in the field of science education (Dohn, 2013). It has been observed that studies have usually been conducted inside the classroom (Kang, Scharmann, Kang, & Noh, 2010; Lin, Hong, & Chen, 2013; Logtenberg, Van Boxtel, & van Hout-Wolters, 2011; Loukomies et al. 2015; Palmer, 2009; Palmer et al. 2016) or in outdoor environments (Bølling, Hartmeyer, & Bentsen, 2019; Dohn, 2011). It has drawn attention that, while some researchers planned instruction based on SI measurements in the form of a single session (Loukomies et al. 2015; Palmer, 2009; Rotgans & Schmidt, 2010), others spread instruction through a semester (Volgkulluksn, Matewos, Sinatra, & Marsh, 2018; Palmer et al. 2016). Furthermore, it has been seen that studies on SI have been conducted with almost all types of samples including undergraduates (Dohn et al. 2009; Linnenbrink-Garcia et al. 2010; Palmer, 2004; Palmer et al. 2016), primary school students (Loukomies et al. 2015; Rotgans & Schmidt, 2017, 2018), middle school students (Ayotte-Beaudet, Potvin, & Riopel, 2019; Linnenbrink-Garcia et al. 2010) and high school students (Dohn, 2011; Knogler et al. 2015; Palmer, 2009; Rotgans & Schmidt, 2014). Among those studying subject matter, it has been observed that studies investigating subject matter such as physical science (Lin, Hong, & Chen, 2013; Palmer, 2004), density (Kang et al. 2010) and heat transfer (Loukomies et al. 2015) have utilized instruction approaches such as student-generated questions (Logtenberg, et al. 2011), a discrepant event (Kang et al. 2010) and scientific inquiry skills (Lin et al. 2013; Palmer, 2009).

It is stated that the number of studies where SI and its effects in motivating students in science classes towards learning have been investigated is very low (Palmer, 2009). However, there is a need for studies that include practices that will make the science course more fun for students (Palmer et al. 2016). This study considered the literature review provided above and provided various warrants in terms of presenting the originality of the study. First, in the relevant literature, only one study examining SI by making a distinction between ESI and OSI was encountered (e.g. Loukomies et al. 2015). Therefore, the aforementioned study was taken as a reference in this study. Accordingly, the topic of heat transfer, repeated measurements of SI excluding an electronic clicker, instructional sequences and periods that were used by the researchers were adopted exactly in relation to the implementation stage of this study. Second, it has been reported that interest in the science course generally decreases along with increasing age (Tytler, Osborne, Williams, Tytler, & Cripps, 2008). For the purpose of testing this issue in the context of SI, as opposed to the researchers who worked with fourth-grade students, this study worked with sixth-grade students in an older age group. Third, before the implementations, determination of student prior knowledge regarding heat transfer was not carried out. This was because it was stated that student prior knowledge is more closely related to the development of individual interest rather than SI (Dohn et al. 2009). Fourth, in their study, among three different sequences, the researchers used only one demonstration in the first sequence for an SI trigger, they used small group activities in the second sequence, and they used student presentations in the third. In this study, these and many more were used in a way to include various instructional tools in most sequences (e.g., demonstrations, experiments, videos, teacher-led conversations, general discussions). This was because a previous study determined that, in the triggering and holding of SI, presentation of several sources of interest together indicated the formation of a strong interest (Dohn, 2013). Fifth, in order to more clearly observe the decreasing and increasing SI in this study, throughout the periods, the study included relatively concrete activities (e.g., experiments) and activities that students generally enjoy engaging in (e.g., listening to a song, reading a poem), as well as demonstrations and teacher-led conversations. Sixth, considering that there could be students with low levels of prior knowledge on heat transfer before the implementation (Duruk, Akgün, & Güngörmez, 2021), it may be stated that utilization of concreteness and engagement-providing activities may compensate for the fact that no prior knowledge measurement was made (Tapola et al. 2013). Overall, this study aims to fill the gap in and contribute to the science education literature by means of the issues above through examining middle school students' SI and comparing ESI and OSI in a real classroom context.

The key research questions guiding the study were:
(1) Are the expressed and observed SIs of students consistent throughout a science course?
(2) What kind of sources do students have in relation to their expressed SIs?

2. Method

2.1 Research Design

This study adopted a qualitative approach to the inquiry of SI in practice. Specifically, the case study approach was considered the most appropriate research design for this study to explore the complexity of issues related to SI in the school context. Qualitative studies are studies where qualitative data collection methods such as observation, interviews and document analysis are used, and a process that aims to realistically and comprehensively present perceptions and events in their natural environment is followed (Merriam & Tisdell, 2015). This study was planned and carried out with a holistic multiple case study design as a qualitative research method. In a holistic multiple case study design, the objective is to reveal results obtained regarding a certain, studied case (Baxter & Jack, 2008). The middle school students who participated in the specifically designed instructional context constituted the cases.

2.2 Participants

The participants of the study were determined with the method of convenience sampling, which is a purposive sampling method. The participants were thirty (13 female, 17 male) grade 6 students and a science teacher recruited from a public middle school. The school where the implementations were carried out is located in a district with a high socioeconomic level in one of the metropolitan provinces of Turkey. The science teacher had a total work duration of three years at this school. The students who were enrolled in a compulsory science course within the school year of 2015-2016 participated in the heat and temperature unit with heat transfer as the focal topic.

2.3 Instructional Context

In Turkey, classes are held in 40-minute periods between which 10-minute breaks are provided. For the implementation sequences to be distinctively distinguished from each other and for a better observation of changes in SI, it was decided with the implementer teacher to hold a 70-minute block class. The instructional context of this class is presented in Table 1.

Table 1: Instructional context of the science course

Measurement time	Sequences	Activities in the classroom
		Initial measurement
(0-10)	1	• Questions as starting prompts used in opening discussions • Heat transfer: collision of particles • Using the forms of Think-Pair-Share • Related experiment: Heat conductivity
(10-20)	1	• Demonstration and teacher-led conversation: a video about heat conduction • Demonstration and teacher-led conversation: lecture about heat radiation • Using the forms of Think-Pair-Share • Related experiment: Heat radiation
(20-30)	2	• Demonstration and teacher-led conversation: A video about the greenhouse effect • Demonstration and teacher-led conversation: The disadvantages of the greenhouse effect. • Global warning prevention methods
(30-40)	2	• Demonstration and teacher-led conversation: convection • Demonstration and teacher-led conversation: Cloud formation • Demonstration and teacher-led conversation: Hot air balloons
(40-50)	3	• Demonstration and teacher-led conversation: Heat conduction • Related experiment: Heat Convection
(50-60)	3	• General discussion • Listening to a song about the topic
(60-70)	3	• General discussion • Reading a poem about the topic

Before starting the implementation, the students in the classroom were divided into five groups, each consisting of six students, and all students participated in the activities provided throughout the implementation in their assigned groups. After each group selected its own group leader and informed the teacher about their selection, the forms to be used in the measurement of SI were distributed to the students, and information was provided on how to fill the forms. At the end of each period of the class consisting of 3 sequences and 7 periods, the students were asked to take notes on their evaluations regarding whether the class was fun or boring.

In the first period of the class, the students were asked the questions: “what do you think about a metal spoon inside a pot on a stove getting hotter?”, “what do you think about solid fat melting inside a hot pan?”, “how should we select houses to live in in regions that are hot or have cold winters?”, “why is the Earth cold at nights?” and “why nights with clear weather are colder than cloudy nights?” These questions were asked to trigger the preliminary knowledge of the students regarding the concepts and help them get motivated to learn new concepts. Afterward, using slides, the topics of the transfer of heat energy through conduction and collision of particles were discussed, and right after this, a related experiment was conducted. For the experiment, each group was given a glass of hot water, a wooden spoon, a metal spoon and a plastic spoon. After leaving the spoons inside the glass, the students were asked to touch each spoon and share their comments on the temperatures of these spoons. After the students observed the spoons one by one, the first period of the class was completed.

In the second period of the class, after the students were instructed to watch a video about forms of heat transfer, their opinions were asked, they were taught the topic of transfer through radiation, and the period continued with the question-answer technique with the participation of all groups. After this, the period went on with an experiment on transfer via radiation. For the experiment, each group was given a candle and a container to keep the candle stationary. The group leaders were given lighters and instructed to light the candle. Time was provided for the students to understand how the burning candle warmed up their both hands. Following this time, various questions were asked to the students, and with the completion of the experiment, the second period of the class ended.

In the third period of the class, the teacher firstly provided information about the greenhouse effect for the students, and afterwards, the students watched a video on the topic. After the video, the harmful effects of global warming were emphasized, and an intergroup discussion was held on what could be done to prevent these harmful effects. The discussions were supported by visuals provided by the teacher. With the completion of the discussions, the second period of the class ended.

In the fourth period of the class, the teacher taught the topic of convection, and mainly the formation of clouds was focused on. Discussions were held with the students on how clouds are formed, and the working principle of hot air balloons was mentioned. These discussions were, again, supported by visuals provided by the teacher.

In the fifth period of the class, a convection experiment was conducted. In this demonstration experiment, each group used four glasses of water, two hot and the other two cold, and red and blue poster paint. Before starting the experiment, the students were asked whether or not the hot water and the cold water would mix, and after their responses were obtained, red poster paint was added to the hot water glasses, and blue poster paint was added to the cold water glasses. After this, the top of the cold water glass was covered with paper, and the cold water glass was placed upside down on the top of the hot water glass. The students were asked whether or not the waters would mix if the paper separating the glasses was removed. After the guesses that were made, the teacher made sure that the students observed the hot water moving up after the teacher pulled the paper away. The same procedure was repeated with the hot water glass on the top this time. The students were asked whether or not the water would mix. After guesses were made in relation to this case, it was observed that the hot water and the cold water did not mix when the paper was pulled away. After the experiment ended, it was made sure that the groups discussed why the waters did not mix. After the discussions, a general repetition was made to summarize the experiment process.

In the sixth period of the class, by using questions related to all topics that had been covered, a general classroom-wide discussion took place under the supervision of the teacher. After this discussion, the students watched a video clip of a song about the forms of heat transfer. In the last period of the class, the students watched a course review video again, and each group was asked to write a poem about the topic. The group leaders recited the poems for the entire classroom.

2.4 Data Collection

All data were collected during the course of one day (Rotgans & Schmidt, 2010). The data were collected by using video recordings of the class and the SI evaluation forms developed by the author. A self-report questionnaire was used to identify sources of SI. In determination of SI, it is a prevalent method to collect data through video recordings (Bølling et al. 2019; Loukomies et al. 2015). As recommended, a video camera was positioned at the back of the classroom in a way that all groups would be included in the frame. The video recording was used for the purpose of collecting data regarding the observed SIs of the students in the class consisting of 3 sequences and 7 periods in total. The measurement took place 7 times during the course. The other data collection instruments, the SI evaluation forms consisted of two parts. The first part included scores given by the students regarding whether the class was boring or fun for each period, while the second part included the justifications the students provided for the scores they assigned. In other words, the students were asked to first score the class after each period in the form of 1-very boring, 2-boring, 3-alright, 4-fun and 5-very fun, and then, write down their reasons for giving these scores.

2.5 Data Analysis

In this study, in order to find answers to the research questions, an analysis of a video recording and SI evaluation forms was carried out. In the analysis of the video recording, the analysis of the periods consisting of 10 minutes each within the 70-minute class hour in terms of SI was carried out separately. Before starting the analysis of the video recording, the author, the implementer science teacher and a researcher who is an expert in the field of science education gathered to discuss the analysis framework that would lead the data analysis process of the study. In this meeting, discussions were held about the main assumptions and components of the theoretical framework based on which the analysis would be conducted (Silvia, 2008), and for being able to achieve consistent scoring, it was aimed to adopt a common understanding regarding the analysis. These components were as follows: (1) the student does not participate in the activity, and their attention is in a different direction, (2) the interest of the students is insufficient, and they appear tired and bored, (3) the interest of the student in the activity and their facial expressions are unclear, (4) the student raises their hand to participate in the activity, and their facial expressions are positive, (5) the student is happy during the activity and is having fun. This framework provided an opportunity of the analysis where SI was scored on 5 hierarchical levels. Each student was independently evaluated through the video recording in terms of observed SI by one pair of observers including the implementer science teacher (observer 1) and a science education expert (observer 2). The interobserver reliability of the analysis including seven periods all together was found .81 as meritorious (Miles, Huberman, & Saldaña, 2018).

In the analysis of the first part of the SI evaluation forms, the author took the average of the scores given by each student to all seven periods in the range of 1-5. The values on the graphs are given based on these averages. In the assessment of the second part, the reasons for the scores were calculated collectively. It was assumed that a higher frequency of a reason would indicate that the reason in question was more effective in the scoring made by the students.

3. Results

This section subsequently presents the overall graph of expressed and observed SI, the individual SI change graphs of students selected as examples, and finally, the reasons for the increases and decreases in SI for each sequence and period.

While looking for an answer to the first research question (How do the observed and expressed SIs of students differentiate from each other?), especially the video recordings of the class and the individual SI evaluation forms were utilized. Following the separate analysis of these recordings carried out by two different observers, the graph given in Figure 1 was obtained.

As shown in Figure 1, it was observed that the students had a high level of SI at the beginning of the class. On the other hand, it was determined that this general tendency started to change after the first twenty minutes. Following the completion of the first twenty minutes of the class, it was seen that both student and observer evaluations indicated a decrease in SI. As opposed to the increase in SI starting with the fourth period and continuing until the end of the fifth period determined by the second observer, the first observer and the students reported a decrease in SI for the same periods. As opposed to the increase in SI starting with the fifth period and continuing until the end of the sixth period determined by the students, both observers determined a reduction in SI. For the time starting with the sixth period towards the end of the seventh period, it was observed that both the students and the observers collectively reported a decrease in SI. Table 2 presents the descriptive statistical values that were taken as a reference for the findings shown in Figure 1 and the interpretations of these findings.

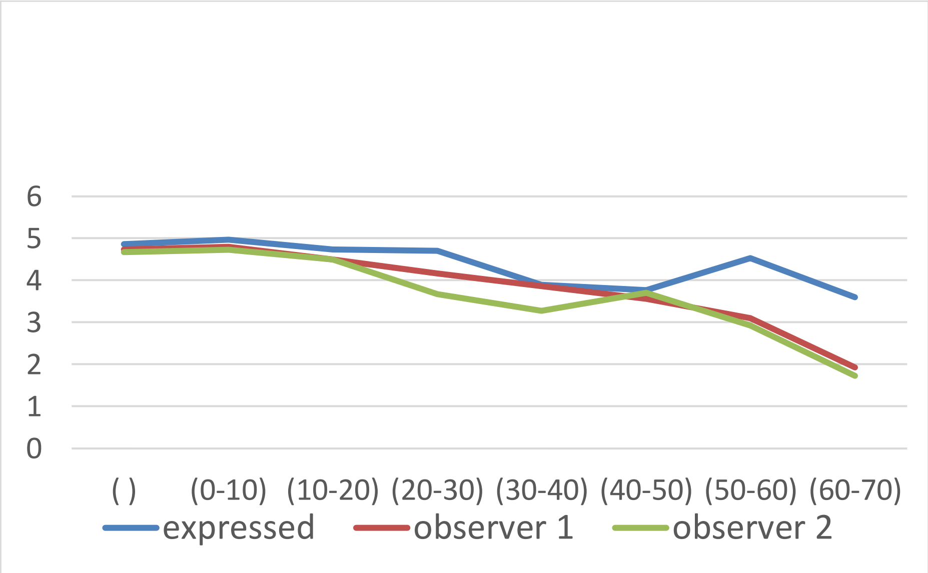

Figure 1: The comparison of all students' expressed and observed SI

Table 2: Means (X) and standard deviations (SD) based on single measurements and sequences, based on observations and students' evaluations

	Sequence 1		**Sequence 2**		**Sequence 3**		
Measurement	(0-10)	(10-20)	(20-30)	(30-40)	(40-50)	(50-60)	(60-70)
X_obs1 **(SD)**	4.80 (0.41)	4.50 (0.68)	4.17 (0.986)	3.87 (1.07)	3.57 (1.07)	3.10 (1.03)	1.93 (1.11)
X_obs2 **(SD)**	4.73 (0.45)	4.50 (0.57)	3.67 (0.61)	3.27 (0.74)	3.70 (1.09)	2.93 (0.91)	1.73 (1.05)
X_students **(SD)**	4.97 (0.18)	4.73 (0.58)	4.70 (0.75)	3.90 (1.21)	3.77 (1.27)	4.53 (1.11)	3.60 (1.65)
X_obs1 **(SD)**	4.65 (0.58)	4.65 (0.58)	4.02 (1.03)	4.02 (1.03)	2.87 (1.27)	2.87 (1.27)	2.87 (1.27)
X_obs2 **(SD)**	4.62 (0.52)	4.62 (0.52)	3.47 (0.70)	3.47 (0.70)	2.80 (1.02)	2.80 (1.30)	2.80 (1.30)
X_students **(SD)**	4.85 (0.44)	4.85 (0.44)	4.3 (1.07)	4.3 (1.07)	3.97 (1.40)	3.97 (1.40)	3.97 (1.40)

To be able to more specifically examine the overall graph, it may be useful to examine the individual SI change graphs of students who were selected as examples. Accordingly, the individual SI graphs of four students considered to be information-rich are presented comparatively below.

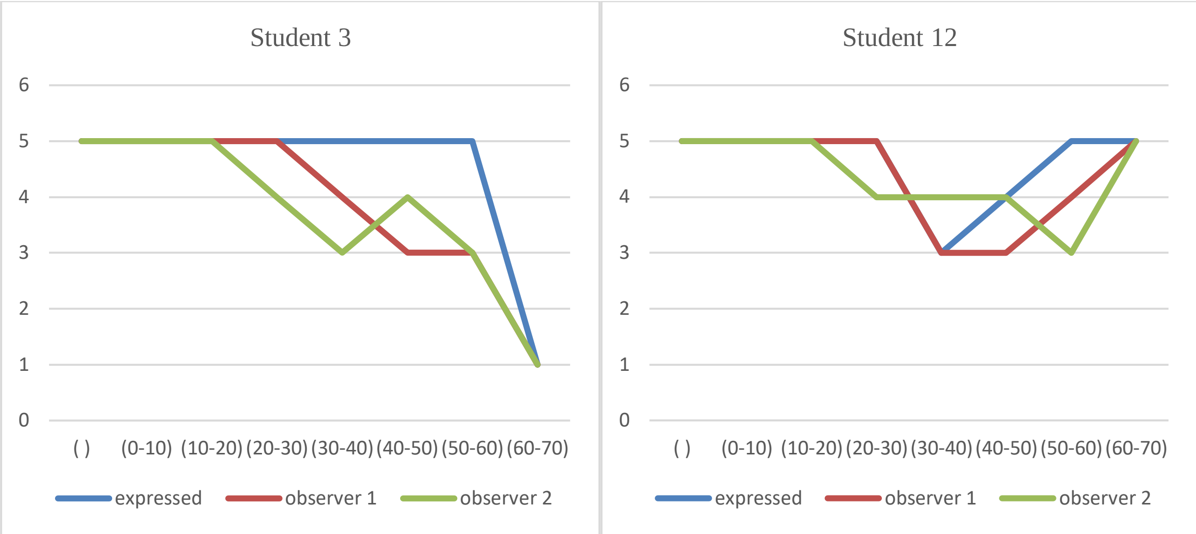

Figure 2: Pairwise comparison of SI

As seen in Figure 2, it was observed that both students had similar SI trends until the end of the second period. While Student 3 reported that their interest did not change from the third period to the sixth period, Student 12 stated that their interest decreased starting with the third period, while it increased throughout the fourth and fifth periods.

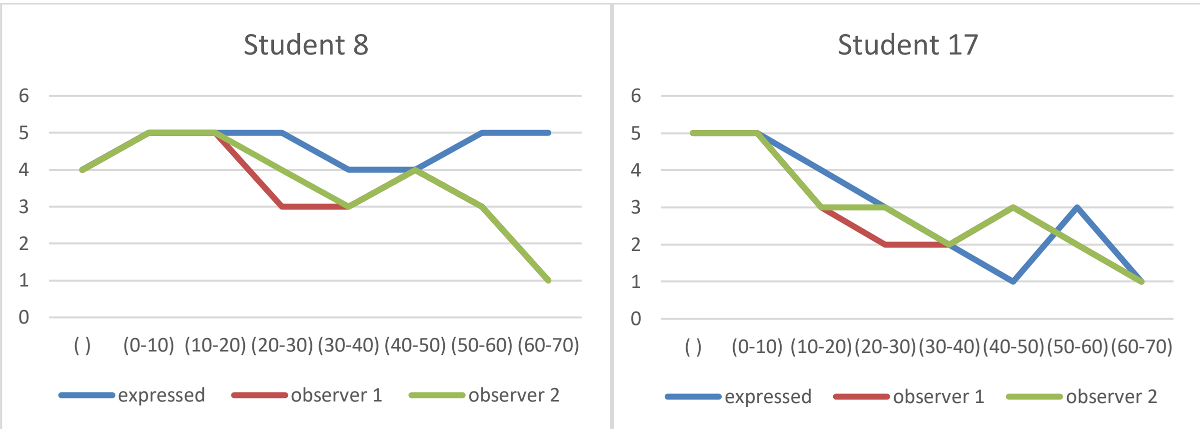

Figure 3: Pairwise comparison of SI

Figure 3 shows that the interest of both students started to decrease by the end of the first and second periods. On the other hand, it was observed that the interests of the students showed a different trend after these periods. After these periods, while Student 8 reported an increasing trend starting with the fifth period, Student 17 reported a decrease from the first period to the fifth period followed by an increase similarly starting with the fifth period. In contrast to the former, Student 17 reported a regular decrease starting with the sixth period.

The reasons for the increases and decreases in SI levels for each sequence and period were obtained as a result of the analysis of the individual SI evaluation forms of the students. The determined reasons are presented below separately for the periods under each sequence based on their frequency of expression.
(0-10 m)

In this period,
The class was found to be fun by:
- 26 students as they found the experiments fun
- 3 students as they learned new information
- 1 student as they considered the observers to be fun
- 1 student due to the interesting nature of the experimental materials.

Not only because it was the beginning of the class but also due to the inclusion of the experiments, the observers evaluated the interests of the students to be high. While the first observer measured the mean SI of the students as 4.80 (SD: 0.41), the second observer measured the same parameter as 4.73 (SD: 0.45). The class that started with asking questions managed to draw the attention of the students, and the responsibility was in the hands of the students during the experiment. All students checked the spoons one by one during the experiment, and it was observed that their interest was high, and all of them participated in the class, because they were asked to fill out think-gather-share questionnaires about the experiment.
(10-20 m)
In this period,

The class was found to be fun by:
- 4 students as they used candles in the experiments
- 4 students as they learned new information
- 1 student due to the funny situations that experienced while trying to light the candles
- 10 students as they generally considered the experiment to be fun.

However, it was stated that the class started to be boring by:
- 1 student as they had a complaint about the group leader
- 1 student as they thought their group members were behaving selfishly
- 1 student as they thought the class became boring in general
- 1 student as it was inappropriate for children to play with fire, and we provided them with lighters to light the candles.

The evaluations made by the observers also indicated that the interest in the class dropped. While the mean SI of the students was measured as 4.50 (SD: 0.68) by the first observed, the second observed measured the same parameter also as 4.50 (SD: 0.57). The students became dormant while a video about heat transfer through conduction was being watched, whereas they were remobilized with the experiment that was conducted about transfer through radiation. At this stage, the task of lighting the candle assigned to the group leader led funny moments to be experienced by the students, and it was sufficient to motivate the students. However, some students were troubled by the fact that the task was assigned to the group leaders only. When the students who tried to intervene in cases where the leaders were not able to light the candles were not given the opportunity, behaviors of walking away from the class and backing out of the experiment were observed.
(20-30 m)

The class was found to be fun by:
- 13 students due to the experiments conducted in the first two periods
- 3 students as they generally liked the science course
- 7 students as they learned new information
- 1 student who mentioned the applicability of the experiments in daily life.

While 4 students expressed that the class was boring due to the increase in noise in the environment, the evaluations of 2 students were considered invalid. In contrast to the evaluations of the vast majority of the students, the observers witnessed that the interest in the class decreased. While the mean interest expressed by the students was 4.70 (SD: 0.75), the mean interest measured by the first observer was 4.17 (SD: 1.21), and that measured by the second observer was 3.67 (SD: 0.61). The observers stated that, although the interest levels of the students dropped, these levels were still high. The active participation of the students in the class ended, and

as there was only a video presentation and a lecture on the topics, although there were students who interest in the class continued with the excitement of the previously conducted experiments, there were also students who lost interest.
(30-40 m)

The class was found to be boring by:
- 10 students as they did not like the videos
- 2 students as the topics did not draw their attention
- 1 student as they did not like the topic
- 1 student as the experiments ended
- 2 students as they had headaches due to noise
- 5 students as they did not like the videos
- 2 students as they did not learn new information
- 2 students without a reason.

On the other hand, 2 students stated that the fun aspect of the class continued as they learned new topics. The evaluation of one student in this period was considered invalid. As there were no experiments or videos in this period, the interest of the students decreased, and although it was attempted to keep their interest live with questions-answers, and although the observer wanted to ensure that everyone would have a say in a 30-person classroom, they were not able to, and there were students who got offended by the observer and did not listen to the class as they were not given an opportunity to speak. One student was distracted from the class as they could not listen to the entire response to their question after they were given an opportunity to speak. When the students whose interest decreased started to make noise as the class progressed, they led other students whose interest had not dropped to be distracted from the class. As it was a block class, when the break bell rang for other classrooms, the interest of the students dropped even further.
(40-50 m)

The class was found to be fun by:
- 2 students as they liked the videos
- 1 student as they found the experiment funny
- 5 students as they found the experiment fun
- 2 students as they liked the question-answer part.

It was thought that the class was boring by
- 9 students as the videos were boring
- 2 students as the class lasted a long time
- 1 student as the lecture was poor
- 1 student as they found the experiment boring
- 1 student due to noise
- 1 student as they though this part of the class was boring
- 1 student as they did not learn a new thing
- 1 student as the videos ended
- 1 student as they had a headache.

While the mean evaluation of the students regarding their interest was 3.77 (SD: 1.27), the observers made evaluations indicating that the interest levels increased in comparison to the previous period. The mean interest level of the students was reported as 3.57 (SD: 1.03) by the first observer and as 3.70 (SD: 1.27) by the second observer. In this period, the observer wanted the students to regain interest by conducting a demonstration experiment and became somewhat successful in this. However, the fact that the experiment was a demonstration experiment was evaluated to be boring by some students. It was tried to continue with questions-answers.
(50-60 m)
- 24 students thought the course became fun again as they liked the song
- 3 students stated that they could not reach the mood completely while the music led them to have a little

bit more interest
- 1 student thought the class was boring as they did not like the song
- 1 student thought the class was boring as they were completely distracted from the class
- The response of 1 student was considered invalid for this period.

In this period, although the students liked the song, they could not gather recover interest. The noise level that increased due to the prolonged class and distracted attention lead the students to lose interest. While the first observer assessed the mean interest of the students in this period as 3.10 (SD: 1.03), the second observer provided the score of 2.93 (SD: 0.91).
(60-70 m)
- 10 students considered the class to be fun as they liked the poem recited in this period

On the other hand, the class was found to be boring by:
- 7 students as they did not like the poem
- 1 student as there was too much noise, and they could not listen to the class
- 4 students as the poem was not properly recited
- 1 student as they did not like the person who recited the poem
- 1 student as it was the end of the class.

However, in this period, among the students who stated that the class was fun, one stated this because the person reciting the poem was their closes friend, and another stated this because they were in a relationship with the person who recited the poem. The fact that multiple persons recited the poem, and the voice of some of these were weak led the exhausted students to completely lose interest and the students who tried to maintain their interest to have reduced interest.

4. Discussion, Conclusions and Implications

As a result of this study, like in previous studies, it was found that the SI levels of students could be increased (e.g. Dohn, 2013; Loukomies et al. 2015; Palmer, 2009; Rotgans & Schmidt, 2011; Tapola et al. 2013). At the outset of the science course, it was reported that the SI levels of the students were high. This was an expected result, because positive emotions are key to SI in the classroom, and students generally express relatively high interest at the beginning of courses (Vongkulluksn et al. 2018). It is also worth noting that this high SI level was achieved in relation to a topic that is considered to be difficult by students like heat transfer. However, this interest started to decrease towards the end of the second period. This result was consistent with the prior research that has investigated how SI changed in regular science courses at school (Loukomies et al. 2015; Rotgans & Schmidt, 2010), except for the study by Tapola et al. (2013) who provided evidence that SI was rather stable in two-task conditions. Furthermore, students' SI at the beginning of the course was predicted by mastery-intrinsic goal orientation and subject-specific interest (Tapola et al. 2013). The results in this study showed that the SI level of the students declined for the first time with the presentation of the first video demonstration following the experiment related to heat conduction in the second period of the course. This reduction may be interpreted in the context of sources such as that the students were different in terms of their subject-specific interest (Tapola et al. 2013), topic-related personal relevance (Palmer et al. 2016; Renninger & Hidi, 2002) or concreteness (Tapola et al. 2013). In particular, the SI of the students who achieved active involvement through hands-on activities (e.g., experiments) in the first period and at the beginning of the second period decreased in the transition to the teacher-led demonstrations that require relatively less engagement. According to Sun and Rueda (2012), SI has a significant correlation with all components of engagement. That is, as engagement decreases, SI also decreased. Additionally, hands-on activities provide students with concrete experiences (Holstermann, Grube, & Bögeholz, 2010). In a study which investigated the SI of sixth-grade students in terms of task characteristics (Tapola et al. 2013), the students performed better in the more concrete tasks. It may be considered that, along with previous results, this result that was derived from a similar sample could explain the decrease in SI in the transition from experimentation to demonstration.

It was observed that the ESI and OSI evaluations of the students and the observers generally differed throughout the last 5 periods. In one of the rare studies making this comparison, Loukomies et al. (2015), as in the case of this study, compared the ESI and OSI values of fourth-grade students participating in collaborative tasks during a science course held on the topic of heat transfer. As a result of their analyses, they concluded that ESI and OSI values were generally not consistent with each other. In this study, it was seen that the inconsistency between the ESI and observer evaluations was the highest in the sixth and seventh periods. In the sixth period, the general discussion in the classroom was followed by listening to a song about the topics. It was observed that, with the help of the song, there was a sudden increase in the ESI of the students in comparison to the previous period. In the last period involving reading a poem about the topic, the ESI values started to drop again. While the difference between ESI and OSI was in the same direction in the seventh period, it was in the opposite direction in the sixth period. These results that were obtained may be discussed in terms of some contextual variables. In the third period, the finding that OSI changed although ESI did not change may be explained by that the video about the greenhouse effect was perceived to be more interesting and novel in comparison to previous activity contents in the class (Palmer et al. 2016). This way, the students might have preserved their ESI trend in the first two periods. The first substantial drop in terms of ESI was experienced in the fourth period, and the OSI values were consistent with this. In this period, the fact that the class started with a video and continued with demonstrations regarding cloud formation and hot air balloons may have preceded the drop in student engagement and the subsequent drop in ESI (Sun & Rueda, 2012). One of the sources of SI, humor, may have been effective in the increase by the help of the song (Dohn et al. 2009). Moreover, the same expected SI increase could not be achieved during the poem. Rather than humor, this situation may be explained by personal relevance and the fact that the poem activity required less active involvement (Renninger & Hidi, 2002). Overall, the difference between ESI and OSI may be interpreted from different perspectives. SI is influenced by situation-specific effects, and these effects have a strong influence on ESI (Knogler et al. 2015). The observers may have subjectively interpreted the states of the students by assessing them over their gestures and facial expressions in the video recordings, and they might have developed an incorrect view in relation to the situation (Loukomies et al. 2015).

Finally, various sources in relation to the students' ESI emerged during the science course. The prominent source that drove the students' SI positively was hands-on activities provided to the students with active engagement (Blankenburg et al. 2016). In this study, ESI was reported to be high in the first, second and sixth periods where active engagement was relatively high. Other sources that could be mentioned are personal relevance (Renninger & Hidi, 2002), novelty (Ayotte-Beaudet et al. 2019), knowledge-deprivation (Rotgans & Schmidt, 2014), humor (Dohn et al. 2009) and concreteness (Tapola et al. 2013). As the reason for their high ESI in the first three periods, the students proposed their learning of new information in compliance with the knowledge-deprivation theory. The experiments were generally associated with humor and concreteness by the students, and as the positive effects of the aforementioned sources decreased, it was determined that both ESI and OSI values decreased towards the end of the class.

Regarding the research questions for which answers were sought in the scope of the study, the following conclusions were reached:

- SI had a general tendency to decrease towards the end of the class.
- The ESI and OSI of the students were generally inconsistent, except for two periods.
- The inconsistency levels were lower in the periods where the experiments were dominant, except for the fifth period.
- ESI, which dropped towards the end of the class, increased with activities involving personal relevance and novelty.
- The sources in relation to ESI proposed by the students were similar to those reported in studies in the fields of both educational psychology and science education.

These results are valid within the context of some limitations. First, the results regarding the increase and decrease in SI observed throughout the periods were limited to the seventy-minute, single-session science class designed and implemented in the scope of this study. For increasing ecological validity, new, similar science courses may be designed by taking into account the class hours accepted by each country on the level of middle school. Second, the ESI values were limited to the self-reporting of the students. In this study, the short time that was lost for the students to make their ESI evaluations in the transitions between the periods was neglected. It may be recommended for future studies to utilize electronic clickers for students to be able to make these evaluations in real-time. Third, in order to increase SI, which generally decreases towards the end of the class, in future studies, the use of activities based on active learning may be increased especially in later periods. Fourth, as SI has a situation-specific nature, the results obtained with this study were limited to the SI that emerged while teaching middle school students the topic of heat transfer. Besides heat transfer, which is one of the topics that are considered to be difficult for students in general, it may be recommended to conduct studies on other topics that are included in the science curriculum. Finally, it could carry the literature further to categorize students in terms of personal relevance and academic achievement before determining SI and examine SI development by comparisons among these categories on the basis of ESI and OSI.

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