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Abstract

This study examines the individual contextual characteristics of elementary school students in Korea during the phase of interest development, using Phase of Interest Development (PIT) and Process-Person-Context-Time (PPCT) models. Four students from each level of interest development were selected to participate, and they wrote photo-journals for 12 weeks while meeting with the researcher every two weeks for semi-structured interviews. The results show that students with higher levels of interest in science tend to participate more in science activities, become more independent, and re-engage in activities. The findings suggest that factors within the microsystem, such as schoolteachers or parents, may have an influence on students’ interest in science, regardless of their level of interest. This study contributes to the theoretical foundation of interest in science research and may be useful for developing strategies to increase students’ interest in science.

Keywords

interest in science – Phase of Interest Development (PIT) – photo-journal – Process-Person-Context-Time (PPCT)
1 Introduction

A worldwide decline in interest in science has been a major concern for science educators (Potvin & Hasni, 2014; Renninger & Hidi, 2011) because lack of interest can contribute to decreasing participation in science- and technology-related industries and can adversely affect students’ pursuance of scientific careers (Kang et al., 2019; Shahali et al., 2019). In this study, interest is conceptualized as the interaction between a person and their surrounding environment, which has a dual meaning as both a psychological state and a set of motivational variables and environmental conditions (Renninger & Hidi, 2016). Interest in science is defined as the combination of an individual’s area of interest and the object-specific domain of science (Renninger & Hidi, 2016).

The Trends in International Mathematics and Science Study (TIMSS) has shown that Korean students’ scientific achievement has been consistently high, while their affective domain has been relatively low (Kwak, 2019). That is, Korean students, perform well in science but do not find it enjoyable. One of the goals of science education is to promote scientific literacy, which aims to make science accessible to all students, regardless of whether they become scientists. Therefore, it is important to foster students’ interest in science, helping them to see that science is not difficult or remote from daily life but is closely related to it. However, the dynamics of students’ interest in science remain a complex and underexplored topic (Renninger & Hidi, 2022). Given that interest involves both individual and environmental factors, an integrated approach to understanding interest in science is needed (Renninger & Hidi, 2016). Furthermore, the declining trend of interest in science is a global issue that calls for a broader investigation (Renninger & Hidi, 2016; Wigfield & Cambria, 2010).

Previous studies have explored various factors that can influence on interest in science (Renninger & Hidi, 2019; Renninger & Hidi, 2020). Interest in science consists of two central axes: individual motivation and environmental factors, which include domain specificity (Renninger & Hidi, 2016). However, describing students’ interest in science based on a single element or specific context has limitations. To address this issue, recent studies have employed principles of neuroscience to analyze interest in science from a learning sciences perspective (Renninger & Hidi, 2022). However, interpreting interest in science through this new lens may only provide a different perspective. Ultimately, there are limitations to deeply illuminating the concept of interest in science.

As previous studies have shown students’ interest in science begins to decline around the age of ten (Osborne et al., 2003), the present study sought
to examine the trend of students’ decreasing interest in science (Anderhag et al., 2016; Potvin & Hasni, 2014) by conducting research with Korean elementary school students in the upper grades. Specifically, this study focused on the lower level of interest in science displayed by Korean students despite their high academic achievement (Kwak, 2019) to analyse individual contextual characteristics of students who have shown very low trends in the affective field of science in contrast to their high academic achievement.

In this study, participants were selected based on their specific phase of interest development, and their science-related activities and experiences were investigated. Four elementary school students, each representing a distinct phase of interest development, were selected for an in-depth case study. The study focuses on how individual internal characteristics and external factors interact to shape students’ interest in science. Using Bronfenbrenner and Morris’s (2006) ecological framework PPCT model, this study aims to examine aspects of interest in science and derive findings that can inform the global situation where interest in science has been declining.

2 Research Questions

Specifically, this study explores the individual contextual characteristics of Korean elementary school students based on the four phases of interest development observed in Korean students, who tend to show higher cognitive results in science and lower affective domain results. Based on this direction, this study addresses the following two research questions

1. What are the aspects of Korean elementary school students’ science-related activities in each phase of interest development?
2. What are the individual contextual characteristics of Korean elementary school students’ science-related activities by each phase of interest development?

This study does not aim to explore each variable related to interest in science or the relationship between variables and interest. Instead, it analyzes empirical cases that consider students’ individual contextual characteristics based on the phases of their interest development. Adding cases of students’ approaches to statistical approaches for students who demonstrate high academic achievement but low science interest, as seen in Korea, may help establish a theoretical basis for exploring changes in interest in science. By analyzing the interest in science of Korean elementary school students at the age where a decrease in interest can occur, we hope to shed light on the individual characteristics of students at different phases of interest development.
and to contribute to international comparative research on this topic. In establishing a theoretical direction for interest in science based on empirical cases, specific guidelines for exploring science interest variables or factors can be developed for future studies.

3 Theoretical Background

3.1 Interest in Science

Since Dewey (1913) emphasized the power of interest in the context of learning, psychologists and educators have continued to study the importance of interest (Renninger & Hidi, 2019). Interest in science is viewed as the interaction of individual motivational variables and external environmental changes (Renninger & Hidi, 2016). However, interest in science has shown a steady decline (Hagay & Baram-Tsabari, 2015; Vedder-Weiss & Fortus, 2012). This raises concerns for science educators as decline in interest means that students may avoid science or perceive it negatively. This decreasingly positive perception of science may make it difficult for students living in society in the future where challenging socio-scientific issues (SSIs) and complex problems will require that people be able to engage in scientifically literate decision-making (Krapp & Prenzel, 2011). Thus, it may be time to pay more in-depth attention to the situation in which interest in science decreases.

Previous studies have shown that participation in science or positive emotions related to science can impact academic achievement (Ainley & Ainley, 2011; Bathgate et al., 2013; Dohn, 2013). These studies have also explored the relationship between interest in science and various motivational variables (Fryer & Ainley, 2019; Kastuhandani & Ke, 2022; Krapp, 2002), as well as the factors that may affect interest in science in school (Cheung, 2018; Dorfner et al., 2018; Durik et al., 2015; Durik & Harackiewicz, 2007; Roth et al., 2011). Moreover, researchers have attempted to develop interest measures and testing tools (Ely et al., 2013; Linnenbrink-Garcia et al., 2010; Renninger & Pozos-Brewer, 2015; Renninger & Schofield, 2014; Rotgans & Schmidt, 2011). In recent years, research on interest in science has focused on revealing how interest changes over time (Höft & Bernholt, 2019; Wang & Hazari, 2018). This line of inquiry involves defining and dividing interests in science into different categories and then exploring the various variables and relationships that exist between them. One of the primary goals of this research has been to explain the process of how students’ interest in science changes (Renninger & Hidi, 2019;
Renninger & Hidi, 2022). However, identifying changes in interest in science has been challenging due to the nature of interest itself.

3.2 The Four Phases of Interest Development

Using Hidi and Renninger’s (2006) four phases of development model allows researchers to explore how an individual’s internal motivation and external environment can influence their interest in science over time. The model describes four phases of interest development, which explain the gradual process of progressing from initial stimulation to higher levels of interest. These phases are Situational Interest I, Situational Interest II, Individual Interest I, and Individual Interest II.

Situational Interest I is the earliest phase of interest development, where learners participate in the content individually or in groups and may experience positive or negative emotions. Learners may briefly perform their tasks, and repeated participation may lead to Situational Interest II. In this phase, repeated participation in prepared environments or conditions within a specific content area can foster positive affect toward science and enhance social interactions. Individual Interest I can occur when learners perform tasks independently and have curiosity about a given content area. Learners can understand the goal of the task and participate in the search process to achieve it. They may try to examine areas they are curious about and self-regulate, leading to positive emotions and perceptions of themselves. Individual Interest II is the phase in which interest reaches its highest development. The learner participates in content repeatedly, often and independently. They develop their own curiosity and work on finding answers to their own questions, overcoming any obstacles they encounter. Feedback from others can help them gain new insights and further their understanding of the subject. The initial phase of interest starts with one-time participation or simple curiosity, and as the interest gradually develops, interest may result in continuous participation, repeated exposure to situations, and self-regulating tendencies, and it may activate more individual internal variables.

Hidi and Renninger (2006) proposed, refined, and distinguished the characteristics, requirements, and requirements of learners that fit each model phase. Reninger (2009) then provided a more in-depth subdivision and description of the four phases model of interest development in terms of individual internal motivation. It is important to note that interest development is not a linear process and can be influenced by various internal and external factors (Renninger & Su, 2012).
Bronfenbrenner and Morris (2006) developed the ecological system theory and introduced the Process-Person-Context-Time (PPCT) model, which illustrates an individual’s development within their contextual categories of surrounding environmental factors. Individual congenital characteristics, such as Force, Resource, and Demand, are revealed in each context and can affect the proximal process, either promoting or inhibiting it. For example, Force characteristics relate to dynamic personality characteristics, while Resource characteristics include biological, mental, or experimental resources, and Demand characteristics are relatively easy-to-see elements such as gender, externality, and social environment. These three types of characteristics may function for a variety of reasons as useful or influential factors in initiating the proximal process.

Context consists of four environmental variable systems, including microsystem, mesosystem, exosystem, and macrosystem (Tudge et al., 2016). The microsystem involves other people, objects, and symbols, such as teachers and friends. The mesosystem includes the relationship between two or more elements in the microsystem. The exosystem comprises contexts outside of where the developing individuals are situated, and the macrosystem is related...
to sociocultural resources and capital such as values and culture. In this study, the microsystem is more directly related to a student’s life.

Time is also a critical component of the PPCT model. Time is divided into three components, including microtime, mesotime, and macrotime (Tudge et al., 2009; Tudge et al., 2016). Microtime refers to the continuous time during which specific activities and interactions occur, while mesotime reflects continuous interaction during an individual’s development, in units such as days, weeks, months, and years. Macrotme reflects changes and social norms occurring during historical events and over generations.

The PPCT model process can be helpful to analyze a student’s personal characteristics in terms of their interaction with the external environment. This model can be applied to understanding an individual’s interest in science as it refers to their psychological factors and interactions with the external environment. The most central area of the PPCT model is the proximal process, which is defined as an interaction between an individual and their environment (Navarro et al., 2022), and is key to understanding an individual’s development.

4 Research Method

4.1 Study Participants and Setting

This case study was conducted with four students, one boy and three girls, who were enrolled in an elementary school located in Seoul, Korea (refer to Table 1 for more details). All four students willingly agreed to participate in this study, with the consent of their parents. Research participants were selected based on their interest development, according to Renninger’s (2009) identification criteria.

Three hundred and thirty elementary school students who responded to an official letter were surveyed three times in a year on their preferences, participation in science-related activities, and interest in science. Three elementary schools that were physically accessible to researchers and were geographically close were selected as preferred locations. Students who participated in all three surveys were classified based on their interest in science, nature of science, academic achievements, and participation and preference in science-related activities in terms of the four phases of interest development (Hidi & Renninger, 2006). From the study subjects who had participated in all three surveys, 31 students who showed results consistent with the four phases of interest development were then selected. Fifteen students who had consented themselves and had their parents’ consent participated in the study. Four of these 15 students were selected as the subjects for the case study, one corresponding to each of the four phases of interest development.
Table 2 summarizes the individual classification codes, grade, age, genders, and results of 1 year of interest in science (average value of 5.0). The data were compiled by comprehensively analyzing and reviewing sources such as scientific activity records, interview contents, and survey results for each student (Hidi & Renninger, 2006). The four students wrote photo-journals for 12 weeks (during 6 weeks of vacation and 6 weeks of school) when they participated in science-related activities and experiences as they were recognized by students in their daily lives. Figure 1 delineates an overview of the research design and data collection process.

The students used Polaroid cameras to capture moments when they participated in and experienced science-related activities. They also described the activities, including the date, weather, mood, what they participated in, what they wanted to do next time, and their thoughts or feelings about the activity. Before beginning to write the photo-journals, the researcher provided the participants with basic guidelines during a preliminary meeting. The researcher met with the participants once every two weeks to examine changes in their interest in science and conducted semi-structured interviews on their photo-journals. The survey results, photo-journal data, semi-structured
Data Collection

Data were collected through a survey administered three times over the course of one year, as well as through the students’ photo-journals created over a 12-week period and semi-structured interviews. The researcher conducted an interview with each student every two weeks, for a total of six interviews per student (see Figure 1).

5.1 Survey Results

The questionnaires were administered at three elementary schools using Zimmerman and Bell’s (2014) Science Activity Task (SAT) protocol, which consists of 36 activities. The protocol was revised to reflect the current educational context in Korea, resulting in a modified list of 20 activities (see Table 3). The questionnaire was reviewed by five science education professors from universities in the Seoul metropolitan area, as well as three doctoral students in science education and one professor in mathematics education.

<table>
<thead>
<tr>
<th>Task number</th>
<th>Task description</th>
<th>Task number</th>
<th>Task description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Using electricity (Battery, light bulb, electronics, etc.)</td>
<td>11</td>
<td>Cooking</td>
</tr>
<tr>
<td>2</td>
<td>Taking things apart, assembling or fixing broken things</td>
<td>12</td>
<td>Participating in science-related competitions and events</td>
</tr>
<tr>
<td>3</td>
<td>Making something using toys or tools such as magnets</td>
<td>13</td>
<td>Going to museums, zoos, science museums, and aquariums</td>
</tr>
<tr>
<td>4</td>
<td>Using a computer or the internet</td>
<td>14</td>
<td>Watching science-related video materials or talking about science at school</td>
</tr>
</tbody>
</table>
To measure interest in science, the questions from the 2006 PISA were modified to reflect the science education context in Korea and were translated into Korean. The resulting interest in science test is presented in Table 4. Each item was scored on a Likert scale from 1 to 5.

### 5.2 Photo-Journal

Photo-journals were used to document science-related activities in students’ daily lives. Photo-journals are a tool for indirectly reflecting on the lives of
students who are developing interest in science and are used by researchers to specifically explore points of contact with science, such as participation and experience in science-related activities (Madden & Angelo, 2016; Zimmerman, 2008).

To create their photo-journals, students used polaroid cameras to take photos during science-related activities and wrote detailed descriptions of the science content, including the activity time, other participants, people they wished to participate with next time, and their thoughts and emotions regarding the activity. Additionally, the students’ emotional aspects were recorded to reflect the psychological aspects of their interests. The students were asked to write a photo-journal for 12 weeks, comprising of six weeks during school and six weeks during vacation. The study considered the fatigue that students may have felt during this period. To encourage student participation, the researchers provided an incentive of a polaroid camera and film at the end of the study.

In total, the four students wrote 152 photo-journal entries, averaging 38 entries per student.

5.3 **Semi-Structured Interviews**

The researcher conducted semi-structured interviews while reviewing each student’s photo-journal in face-to-face meetings held with study participants once every 2 weeks. The semi-structured interviews were conducted individually and lasted for about 15 minutes each time. At each interview, the interest in science test was also administered to determine if there had been any changes. If there was a change in the students’ interest in science, a question and answer session was conducted to explore the reasons and psychological status behind the change. As the face-to-face meetings with students continued, the researchers developed closer relationships with them, enabling the students to speak more freely about the questions asked in the previous interview.

The semi-structured interviews were intended to provide interpretations of the students’ lives and science-related activities and were considered a tool for students to reflect on their participation in science education both in and out of school (Epstein et al., 2006; Luce & Hsi, 2015; Smith et al., 2012). The interviews were conducted using a series of questions, beginning with an introduction to the photo-journal written by the student. The interview questions included topics such as family relationships, relationships with friends, attendance at academies, online media usage, favorite subjects, thoughts about science, comparisons with other subjects, future dreams, visits, and experiences (Table 5).
### Table 5  List of questionnaire subjects for semi-structured interview

<table>
<thead>
<tr>
<th>Question area</th>
<th>Topic examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Family members, parents’ occupations, whether parents participate or support in science-related activities</td>
</tr>
<tr>
<td>Students’ future hopes</td>
<td>Future dreams, time, reason for selecting a job, parents’ hopes</td>
</tr>
<tr>
<td>Subject</td>
<td>Subject preferences, science preference rankings and reasons, science grades, changes in scientific performance and reasons for changes</td>
</tr>
<tr>
<td>Private academy</td>
<td>Academy (study room, after school, etc.) class experience and period, reasons for taking classes</td>
</tr>
<tr>
<td>Media</td>
<td>Computers, smartphones, TVs, iPads, laptops</td>
</tr>
<tr>
<td>Science museum</td>
<td>Experience in visiting informal educational institutions, revisit or not, and reasons for visiting</td>
</tr>
<tr>
<td>Friends</td>
<td>Interaction with friends, conversation, activities, influence of friends who like/dislike science</td>
</tr>
<tr>
<td>Ideas about science</td>
<td>Reasons for liking or not liking science</td>
</tr>
<tr>
<td>Comparisons between classes</td>
<td>Comparison of school and academy classes, comparison science class experience by grade</td>
</tr>
<tr>
<td>Inquiry</td>
<td>Personal experience with experiments and inventions, pursuing topics of interest</td>
</tr>
</tbody>
</table>

### 6 Data Analysis

#### 6.1 Analysis Methods

The first research question aimed to explore which science activities students participated in during each phase of interest development. The results of the one-year survey and students’ science-related activities recorded in their photo-journals were classified based on the revised SAT activities. Since the photo-journal focused on science-related activities as recognized by the students, other activities were considered science-related if they were not classified as modified SATs. The process of exploring the external environment was considered a starting point for students to create contact with science. By synthesizing the survey and case-study results for each student, the researcher was able to consider each students’ phase of interest development and their points of contact for engaging in science in their external environment. The
questionnaire results were calculated as an average value based on a score of 5 on a Likert scale. The results during the survey period (three times for one year) and the average of the start and end of the case study (six times for twelve weeks) were helpful for determining the students’ phases of interest development. The preferred and actual participation rates as measured by the SAT were classified by selecting only the highest items for one year. All activities recorded by students in their photo-journals were based on the modified SATs.

The second research question aimed to explore individual contextual characteristics of Korean elementary school students’ science-related activities by delineating each phase of interest development based on the PPCT model. In addition, the photo-journal entries recorded by the students and the transcribed interview data were interpreted inductively. In this study, the scope of the analysis was limited to factors that can have a positive educational effect on students at each phase of interest development.

6.2 Validity and Reliability

The student survey results, the photo-journals of the study participants, and the interest in science test results for the entire study period were compiled, and the semi-structured interviews with the students were transcribed. The reliability of this study was ensured through triangulation with verification methods, which considered the diversity of data collection and peer evaluation with the elementary school teachers (who served as co-researchers) in whose science classes the study was conducted. For example, in the first research question, the validity of the survey results based on the modified SATs was improved by comparing them with co-researchers’ input. The validity of the interest in science test results was also cross-checked. In the second research question, the validity of the inductively interpreted results from the photo-journal and interview data was enhanced. To improve the validity of the research results interpretation, the survey data, photo-journal, interview transcripts, and the results analyzed by the researcher were shared and discussed with co-researchers.

7 Results

7.1 Students’ Science-Related Activities in Each Phase of Interest Development

The aim of the first research question was to explore students’ engagement in science-related activities in relation to each phase of interest development. This exploration aimed to identify environments where students can have
positive interactions with science and to suggest goals for fostering students’ interest in science. In order to accomplish this goal, Zimmerman and Bell’s (2014) list of 36 science-related activities was revised to account for the educational context variables in Korea, resulting in a list of 20 activities. Additionally, interest in science test scores were taken into consideration, and photo-journal activities that showed the highest frequency for each phase of interest development were inductively analyzed and categorized to make inferences about students’ interests.

7.1.1 The Case of an Individual Interest II Student – Jongmin
Jongmin demonstrated the highest score in all categories of the interest in science test survey, with consistently high scores throughout the year. In this case study, Jongmin had the highest results on the six interests in science test during the study period, with an average of 5 points (as shown in Table 6). He also exhibited the highest level of participation and preference in science-related activities, with more than 10 activities in all three of the surveys (summarized in Table 7). This indicates that his high level of interest in science-related activities led him to engage in student-centered manipulative activities repeatedly.

Jongmin’s photo-journal documented 57 science-related activities were classified as modified SATs, including doing experiments at home (N = 27), making observations at school or other locations (N = 11), conducting experiments in school science classes (N = 6), participating in science-related competitions and events (N = 3), cooking (N = 3), participating in science-related after-school programs or clubs (N = 2), reading science books or magazines (N = 2), watching science-related TV programs (N = 2), and participating in outdoor activities such as fishing, camping, hiking, and astronomical observation (N = 1). Thirty-three of Jongmin’s 57 activities (57.9%) involved participating in manipulative activities and experiments within a given environment such as school or home. These

<table>
<thead>
<tr>
<th>Code</th>
<th>Gender</th>
<th>Interest in science test (Survey; max 5.0)</th>
<th>Interest in science test (Case study; max 5.0)</th>
<th>Phase of interest in science development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
</tr>
<tr>
<td>Jongmin</td>
<td>Male</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

10.1163/23641177-BJA10064 | ASIA-PACIFIC SCIENCE EDUCATION (2023) 1–32
<table>
<thead>
<tr>
<th>Survey</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 1st    | 1. Using electricity (battery, light bulb, electronics etc.)  
        | 2. Taking things apart, assembling or fixing broken things  
        | 3. Using a computer or the internet  
        | 4. Taking care of animals or growing plants  
        | 5. Doing experiments in school science classes  
        | 6. Doing experiments at home  
        | 7. Observing at school or other places  
        | 8. Cooking  
        | 9. Watching science-related TV programs  
        | 10. Reading science books or magazines |
| 2nd    | 1. Using electricity (battery, light bulb, electronics etc.)  
        | 2. Taking things apart, assembling or fixing broken things  
        | 3. Making something using toys or tools such as magnets  
        | 4. Using a computer or the internet  
        | 5. Taking care of animals or growing plants  
        | 6. Doing experiments in school science classes  
        | 7. Doing experiments at home  
        | 8. Observing at school or other places  
        | 9. Cooking  
        | 10. Going to museums, zoos, science museums, aquariums  
        | 11. Watching science-related video materials or talking about science at school |
| 3rd    | 1. Using electricity (battery, light bulb, electronics etc.).  
        | 2. Taking things apart, assembling or fixing broken things  
        | 3. Making something using toys or tools such as magnets  
        | 4. Using a computer or the internet  
        | 5. Taking care of animals or growing plants  
        | 6. Doing experiments at home  
        | 7. Cooking  
        | 8. Going to museums, zoos, science museums, aquariums  
        | 9. Watching science-related video materials or talking about science at school  
        | 10. Watching science-related TV programs |
results were consistent with the findings of the survey and case study, which indicated that doing experiments at home was a common activity.

7.1.2 The Case of an Individual Interest 1 Student – Dayeon

Dayeon's survey results showed her scientific interest remained the highest over the course of the initial survey year and during the 12-week case study (Table 8). The initial surveys showed 7 to 8 activities with the highest participation and preference each time (Table 9), with four activities consistently showing the highest participation and preference: using computers or internet; doing outdoor activities such as fishing, camping, hiking, and astronomical observation; going to museums, zoos, science museums, and aquariums; and reading science textbooks at school. The classification of science-related activities in Dayeon's photo-journal as revised SATs resulted in 20 activities. The most frequently occurring activities were doing experiments at home ($N = 7$), doing outdoor activities such as fishing, camping, hiking, and astronomical observation ($N = 4$), and reading science books or magazines ($N = 3$). The survey and case study both showed that Dayeon often participated in doing outdoor activities such as fishing, camping, hiking, and astronomical observation and reading science books or magazines, which was confirmed by her photo-journal.

**Table 8** Dayeon's interest in science test results

<table>
<thead>
<tr>
<th>Code</th>
<th>Gender</th>
<th>Interest in science test (Survey; max 5.0)</th>
<th>Interest in science test (Case study; max 5.0)</th>
<th>Phase of interest in science development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
</tr>
<tr>
<td>Dayeon</td>
<td>Female</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table 9** Dayeon's initial survey results

<table>
<thead>
<tr>
<th>Survey</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>1. Using a computer or the internet</td>
</tr>
<tr>
<td></td>
<td>2. Doing outdoor activities such as fishing, camping, hiking, and astronomical observation</td>
</tr>
<tr>
<td></td>
<td>3. Doing experiments in school science classes</td>
</tr>
<tr>
<td></td>
<td>4. Doing experiments at home</td>
</tr>
</tbody>
</table>
Survey Activity
5. Going to museums, zoos, science museums, aquariums
6. Reading science textbooks at school
7. Reading science books or magazines

2nd
1. Using a computer or the internet
2. Doing outdoor activities such as fishing, camping, hiking, and astronomical observation
3. Going to museums, zoos, science museums, aquariums
4. Participating in science-related competitions and events
5. Watching science-related TV programs
6. Reading science textbooks at school
7. Reading science books or magazines

3rd
1. Using a computer or the internet
2. Doing outdoor activities such as fishing, camping, hiking, and astronomical observation
3. Doing experiments in school science classes
4. Going to museums, zoos, science museums, aquariums
5. Watching science-related video materials or talking about science at school
6. Watching science-related TV programs
7. Reading science textbooks at school
8. Reading science books or magazines

7.1.3 The Case of a Situational Interest II Student – Mia
Mia’s score were consistently 3.6 out of 5.0 during the initial survey year and 3.4 during the case-study period (Table 10). She consistently had the highest preference and participation in two activities during that period: using a computer or the internet and taking care of animals or growing plants (Table 11). Mia wrote 48 photo-journal entries during the case-study period. The three activities listed in the order of highest frequency were reading science books or magazines \((N = 40)\), watching science-related TV programs \((N = 4)\), and taking care of animals or growing plants \((N = 3)\). The activity of reading science books and magazines accounted for 83% of the entries. The case-study results showed that taking care of animals or growing plants was a common activity.
Table 10  Student Mia’s interest in science test results

<table>
<thead>
<tr>
<th>Code</th>
<th>Gender</th>
<th>Interest in science test (Survey; max 5.0)</th>
<th>Interest in science test (Case study; max 5.0)</th>
<th>Phase of interest in science development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
</tr>
<tr>
<td>Mia</td>
<td>Female</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 11  Student Mia’s initial survey results

<table>
<thead>
<tr>
<th>Survey</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>1. Using a computer or the internet</td>
</tr>
<tr>
<td></td>
<td>2. Taking care of animals or growing plants</td>
</tr>
<tr>
<td></td>
<td>3. Doing outdoor activities such as fishing, camping, hiking, and astrono-</td>
</tr>
<tr>
<td></td>
<td>mical observation</td>
</tr>
<tr>
<td>2nd</td>
<td>1. Using a computer or the internet</td>
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<tr>
<td></td>
<td>2. Taking care of animals or growing plants</td>
</tr>
<tr>
<td></td>
<td>3. Cooking</td>
</tr>
<tr>
<td>3rd</td>
<td>1. Using a computer or the internet</td>
</tr>
<tr>
<td></td>
<td>2. Taking care of animals or growing plants</td>
</tr>
<tr>
<td></td>
<td>3. Cooking</td>
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7.1.4 The Case of a Situational Interest I Student – Dara

Dara’s interest in science surveys showed that her interest in science decrease over the course of the year. This result continued during the subsequent case study (Table 12). Given the global trend of decreasing interest that has been reported in previous studies, this may be typical of a decrease in interest in science in Korea. The three initial surveys showed that Dara had the highest participation and preference in using a computer or the internet and cooking (Table 13). During the case-study period, the 40 photo-journal activities classified as modified SATs that occurred most frequently were doing experiments at home ($N = 26$), doing observations at school or other place ($N = 6$), and doing
experiments in school science classes \((N = 4)\). In addition, there were activities such as studying science at an academy \((N = 1)\), cooking \((N = 1)\), and going to museums, zoos, science museums, and aquariums \((N = 1)\). There were 30 examples of where Dara conducted experiments home and school, accounting for 75% of all activities.

The results of initial three surveys and the case-study period for one case in each of the four phases of interest in science and were analyzed for participation and preference in science-related activities. The higher interest development, the more participation in science-related activities tend to be. During the case-study period, two students in Individual Interest I and II, and one in

<table>
<thead>
<tr>
<th>Table 12</th>
<th>Dara’s interest in science test results</th>
</tr>
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<tbody>
<tr>
<td>Code</td>
<td>Gender</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Dara</td>
<td>Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 13</th>
<th>Dara’s initial survey results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>Activity</td>
</tr>
</tbody>
</table>
| 1st | 1. Making something using toys or tools such as magnets  
2. Using a computer or the internet  
3. Taking care of animals or growing plants  
4. Cooking |
| 2nd | 1. Using a computer or the internet  
2. Cooking  
3. Going to museums, zoos, science museums, aquariums. |
| 3rd | 1. Using a computer or the internet  
2. Taking care of animals or growing plants  
3. Cooking |
Situational Interest I report in their photo-journals that they participated most frequently in experimental activities at home. The student in the Situational Interest II phase most frequently read science books or magazines. The results showed that the case-study students who participated in this study participated in various activities; however, it is necessary to examine differences in quality of participation. The photo-journals provide a more in-depth approach to the characteristics of the activities the students participated in most frequently for each phase of interest development.

7.2 Individual Characteristics of Students’ Science-Related Activities by Each Phase of Interest Development

The second research question aimed to investigate the individual contextual characteristics of students’ science-related activities for each phase of interest development using the PPCT model. The PPCT model emphasizes the significance of the microsystem, which refers to the immediate environment in which an individual interacts directly, such as family, school, and peers (Bronfenbrenner & Morris, 1998). By examining students’ interest in science within their microsystem, the study can identify and analyze how personal factors interact with the external environment.

7.2.1 Science as an Individual Interest – The Case of Jongmin and Dayeon

Jongmin reported that he often did experiments at home. In this section, Jeongmin’s photo-journal documents (Figure 2) an experiment in which he froze perfume for about a week and made observations about the perfume over time. In an interview, he reported he had answered his questions about the experiment by posting on the internet to find answers and then wrote them in the photo-journal. Later, he answered that being able to find answers through interaction with science teachers at school. This activity, which was conducted at home, showed this student’s ability to answer his questions independently over a week of thinking, writing in the photo-journal, searching the internet to find answers, and discussing the appropriateness of his answers through interactions with the school science teacher.

Jongmin demonstrated relatively rich scientific cultural capital compared to other students in the home environment. For example, during a semi-structured interview, he reported that both his parents his were educational workers and that his mother his was a teacher. He gave high scores (5 points) to statements such as “My parents think science is fun,” “My parents think it’s important to learn science,” and “My future dream is to choose a science job.” When he was curious about something, his first priority was to search the internet with his
parents his. He had already decided to pursue a career related to science since the first grade of elementary school, when he became curious about how to use and make electronic devices. His photo-journal also showed active engagement with science through using the internet and computers, reading books, and watching science-related TV shows.

In the school environment, Jongmin actively participated in experiments and rated his participation and preference in doing experiments in school science classes the highest. He showed a strong willingness to solve questions about science on his own and rated participation and preference the highest in reading science books, magazines, and textbooks. As shown in Figure 2, when
he was curious to find more information about a science-related activity, he directly conducted the experiment for a week and carried it out to find the answer on his own.

Dayeon also reported doing experiments at home. Figure 3 shows an activity in which she and her mother worked on an experiment designed to help students learn about the bones of the skeleton. During the semi-structured interview, she described participating in the experiment all day at home, which involved reading a science book and fitting bone models. Although she participated in the activity alone, her mother appropriately intervened with the content, and Dayeon reported that it was fun to teach her mother about...
the bone model fitting. During the interview, she also mentioned that she had forgotten what she had learned in the past but was able to review it using the paper bone model with the help of her mother. This was an example of participation in manipulative activities and positive interactions with her mother in a science subject that she had learned in the past.

Dayeon demonstrated relatively rich scientific and cultural capital in her home environment. Her parents were an IT office worker and an education-related researcher. During the semi-structured interviews, she gave the highest score (5 points) to statements such as “My parents think science is fun,” “My parents think it’s important for me to learn science,” and “My parents will be happy if I choose a science-related job as my future dream.” When faced with questions, Dayeon’s first choice for seeking answers was her parents, followed by her teachers and the internet. She expressed her desire to become an environmental activist, a career choice that she made after developing an interest in the environment by reading books and watching videos related to the environment with her mother during her vacations after second grade. During the interviews, Dayeon gave 4 out of 5 points for statements such as “I want to have a career related to science” and “I want to be a scientist.” Watching science-related TV she was given 3 points out of 5. In the school environment, she showed a positive attitude towards science subjects, ranking them as science, mathematics, and physical education. Dayeon gave the highest score of 5 points for her participation in experiments during school science classes. In addition, Figure 3 shows that she studied scientific knowledge to review and had a positive perception of her science teacher at school, expressing appreciation for the teacher’s kind response to her questions. Dayeon preferred reading texts such as science books, magazines, and science textbooks.

7.2.2 Science as a Situational Interest – The Cases of Mia and Dara
In the case of Mia (Situational Interest II phase), she frequently read science books or magazines. An example from Mia’s photo-journal (Figure 4) shows an activity related to magnets from a science book. In her photo-journal of her, she wrote, “It is amazing that the earth is also like a magnet,” which expressed the novelty of the idea that both the earth and magnets are magnetic, and that magnets could be useful objects in everyday life. During the interview, Mia reported being unsure of how magnets could be helpful in daily life. She explained that she wrote about what she found interesting in her photo-journal and that she read science books and magazines alone in all her activities her. Mia’s photo-journal she expressed the hope that she could continue these activities with her parents and close friends.
Mia's home environment had relatively less abundant scientific and cultural capital than Jongmin and Dayeon. For example, she rated the semi-structured questions about her parents' scientific orientation between 3 and 4 points. Her priority of contact targets to solve questions was friends, teachers, and searching the internet. Mia's career choice was for her to become an animation artist. She decided to pursue this career when she watched a video or animation right before entering elementary school at the age of 7 and said that she wanted to draw well and look cool. She gave three points to two questions about wanting a career related to science and wanting to become a scientist, but she had never considered a career in science. In the semi-structured interview, she gave reading science-related books or magazines and watching science-related TV the highest score.

In the school environment, Mia's preference for art and physical education was high, but there was no preference for science. When participating in science classes, she tended to be dependent on friends or teachers. If she had any questions during science-related activities or classes, she would ask her friends or her teacher if her friends her did not know the answer. The most frequent activity in Mia's photo-journal was reading science magazines, but the process involving exploring phenomena or participating in the process of finding answers was not common. There were only questions about phenomena.

Dara (Situational Interest I phase) did an experiment at home activity (Figure 5). She wrote that when moisturizing lipstick was applied, cracked lips became soft, and a picture of the moisturizing lipstick applied by the student was attached (Figure 5). Although she wrote an emotional expression that it was amazing that the lips became soft after applying moisturizing lipstick,
there were no other questions or curiosities. In the interview process, she only shared the empirical content that she felt the lips were softened by applying moisturizing lipstick and the feeling that she felt better, but she only expressed the feeling of amazement.

Dara did not receive active support from her parents in her family environment. Not only did she not actively participate in science-related activities or purchase science-related books, but she also felt that her parents were not interested in science-related activities. For example, she rated 3 points to the question of whether she thought it was important to learn science and whether her parents would support her if she chose a science-related job as her future dream. Her preferred sources for finding answers were friends and the internet, and she did not ask her parents for help. Dara reported that she dreamed of becoming a singer since the third grade of elementary school,
as she loved idol singers’ songs and dances. In the school environment, she preferred music and physical education the most. During music class, she enjoyed activities such as singing or dancing with her friends. However, she showed no active interest in science classes and did not participate. When she had questions about science, she did not ask friends or science teachers. She also reported that she did not like researching things and was too lazy to search for answers.

8 Conclusions and Limitations

This study aimed to refine the concepts of interest development for elementary school students in Korea, using the PPCT model. Four students were selected as case studies, with one student representing each of the four phases of interest development. By considering the interaction of science interest characteristics with the external environment, this study sought to derive the development mechanism and provide educational implications for Korean elementary school students by providing empirical examples to supplement the affective aspects inherent in science interest.

First, the results show commonalities and differences in the cases of students at each phase of interest development. Commonalities include various forms of participation in science-related activities (sats) that were found in all students in the early phases of interest development. Students’ photo-journals included various forms of science-related participation, such as participating in science experiments and reading science magazines at home or school. These interactions may affect the outcome of interest in science, as interest is viewed as the result of the interaction of an individual’s internal motivation and the surrounding environment (Renninger & Hidi, 2016). In this respect, participating in science-related activities and reading science-related books or magazines may themselves be factors related to interest in science. The biggest difference at each phase of interest development may be the re-participation and repeatability of science-related activities. This is consistent with the characteristics of interest development phases and applicable to the specificity of the science domain. Repeated participation and persistence in various experimental activities related to science may be helpful in developing interest in science.

Second, the higher a student’s interest in science becomes, the more independent they are in the proximal process. In other words, students in the Situational Interest phases tend to depend on their peers in the process of participating in science-related activities. However, regardless of the phase of interest development, there is a teacher’s presence to contact to solve questions
about science. In a school environment, teachers have left open the possibility of a medium through which positive interaction can occur around science subjects. While science has often been regarded as a discipline that involves logic, the results showed that the personal element rather than the logical aspect may have a more significant effect on interest in science. Teachers may act as a positive interaction factor for students, which may have a positive impact on students’ science interests when students participate in science activities such as direct manipulation or thinking.

9 Limitations

This study highlights the challenges of applying the concept of academic interest to the domain of science, which has its own specific characteristics. While interest has been extensively studied in cognitive and developmental psychology, research on domain-specific interest has also been conducted (Hidi & Reninger, 2016). However, the current study focuses only on Korean elementary school students who showed low interest in science, limiting the generalizability of its findings. Moreover, while the PPCT model considers the interaction between individuals and their proximal environments, interest is a dynamic construct that can change over time in response to new stimuli or attributes. Therefore, the present study has some limitations in that it only examines one case at each phase of interest development and relies on a 1-year survey and a 12-week case study. Despite these limitations, this study provides some empirical examples of the affective aspects of interest development in science and offers some educational implications for Korean elementary school students.

10 Implications and Discussion

Based on the conclusions of this study, positive follow-up measures are suggested as follows. First, this case study shows the pattern of increasing interest due to experimental activities in science. Some kinds of scientific experiments may be commonly preferred activities for students in the phase of individual interest and may be a factor that causes the activation of the proximal process. In other words, if experimental activities are used in a positive direction with teachers in school science classes, they may have a positive effect on students’ interest in science. This indicates the need for teachers’ positive progress in learning methods involving students directly participating, manipulating, or thinking in science classes.
Second, as interest develops, students’ close processes such as support for scientific and cultural capital and human resources may be activated (Palmer et al., 2016; Renninger & Hidi, 2020). However, not all students have the same scientific and cultural capital, and even students from the same culture will all be in different educational contexts. In other words, considering the realistic situation that the backgrounds of all students are different, science teachers may be an important factor in increasing or decreasing interest in science in the common environment of schools (Xu et al., 2012). That is, the variable of teachers in the school environment may play a decisive role in increasing or decreasing students’ interest in science. In this context, this study proposes the necessity of in-depth research examining the variables of teachers and increases or decreases of interest in science between difference cultural background.

Abbreviations

PIT Phase of Interest Development
PPCT Process-Person-Context-Time
SAT Science Related Activities

Acknowledgements

The author would like to thank the students who participated in this study.

Ethical Considerations

Approval to conduct this study was granted by the Seoul National University Ethics Review Board. The data collected from this study has obtained the necessary clearance from the guardians and the students involved. The names of the participants used in this study are all pseudonyms.

About the Author

Yoon-Sung Choi received his doctoral degree from the Department of Science Education at Seoul National University in Seoul, Republic of Korea. One of his goals is to contribute to the research about student interest in science,
especially in the context of the Korean education system. Ultimately, his research strives to conduct a comprehensive analysis of interest in science and to contribute to theoretical understandings about interest and its impact on students’ science learning, engagement, and achievement.

References


