



## Virus Knowledge Test: A Validity and Reliability Study\*

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*Abstract* - Viruses have caused and continue to cause many epidemics for centuries. During these epidemics, there are many examples that are misunderstood and applied among the public. People need to recognise these entities and take appropriate measures. In the teaching process in Türkiye, students learn about the virus for the first time in the 9th grade biology course. With this study, it is aimed to develop a test that can be used to determine the students' knowledge level about the virus subject. It is a descriptive survey study in which data related to variables are collected. 99 students studying in the 9<sup>th</sup> grade of a state high school in Karesi district of Balıkesir city participated in the pilot application on voluntary basis. The data obtained were analysed with item difficulty and item discrimination indices from classical item statistics. The finalised Virus Knowledge Test (VBT) was administered to 9<sup>th</sup> grade 165 students from different randomly selected two state high schools in Karesi. The Cronbach  $\alpha$  reliability coefficient for the whole VBT was found to be 0.66. The fact that it is the first virus knowledge test with reliability and validity in the literature on the virus subject reveals the originality of the study.

*Keywords:* Virus, knowledge test, validity, reliability.

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## **Introduction**

Viruses have been causing pandemics and epidemics for centuries (Spanish flu, avian flu, ebola, covid-19). Mankind is faced with a new epidemic disease every moment. For this reason, individuals need to learn to live with viruses and cope with the diseases they cause.

Viruses are the smallest organisms ranging in size from 20-300 nanometres (Simon, 2015). They have protein sheaths (capsid) that protect nucleic acids (RNA or DNA). The capsid has the ability to allow the virus to live outside the cell and enter new cells (Madigan et al., 2017; Simon, 2015; Şimşekli, 2015). The fact that viruses contain genetic material in the form of nucleic acid packaged in an organised structure is the reason why they are classified as living, while the fact that they are not in the cell structure and cannot reproduce on their own is the reason why they are classified as non-living (Simon et al., 2017). When viewed by people, viruses are known to be harmful according to general belief. However, contrary to popular belief, viruses also have benefits. For example, the development of the human placenta in the evolutionary process was thanks to viral proteins (Flint et al., 2022). Viruses have their own genomes, but are dependent on the host cell for energy, metabolic intermediates and protein synthesis. Viruses are necessarily intracellular parasites because they cannot replicate without a hostcell (Flint et al., 2022; Madigan et al., 2017; Simon et al., 2017). Antiviral drugs are used to prevent the virus from multiplying in the body as a result of infection. The foundation of antiviral drugs was laid in 1967. Over time, antiviral drugs have been produced against different virus types. Although new antiviral drugs are produced every day, a complete treatment cannot be found due to the high genetic diversity of viruses and their rapid evolution (Dar et al., 2019). Using the ability of viruses to transfer their genetic material to the host, scientists have worked especially on bacteriophages in the middle of the 20<sup>th</sup> century. With the development of recombinant DNA technology, viruses have started to be used in gene transfer to cells for therapeutic purposes in the fields of cancer and viral infection (Dar et al., 2019; Flint et al., 2022).

During the investigation of the relationship between bacteria and viruses, a new generation genome editing technique (CRISPRs) was discovered, which enables editing in the genome. With this technique, the desired genes can be silenced and the necessary nucleotides can be replaced. Recently, this technique has been frequently used for human pathogenic viruses (Dar et al., 2019). Due to the rapid evolution of viruses, treatment types are also developing rapidly. For example, in addition to traditional vaccines, mRNA vaccines, which have a history of about 35 years, have spread more widely in the last 15 years. With mRNA

vaccines, mRNAs consisting of genetic codes of viruses that cause pathogenic effects are injected into the living body. It is then recognised by the immune system of the living being and antibody production is triggered. Unlike other vaccines, mRNA vaccines provide immunity without the risk of disease development by stimulating the living body for a certain period of time (Savaşçı & Gül, 2020). Viruses are used as vectors to carry the necessary genes to the living body. Although viral vectors provide high transfer during gene therapy, they can carry a limited size load (Baykara, 2016). There are also oncolytic viruses that can survive in tumour cells designed for cancer treatment. These viruses enable the elimination of tumour cells (Salman & Dinçkal, 2022). According to a news published in August 2024, the first phase trials of a vaccine named BNT116, developed by BioNTech to treat non-small cell lung cancer, were initiated in 7 countries including Türkiye. In this vaccine, mRNA model is used as in covid-19 vaccine (Euronews, 2024).

When the national literature is examined, there is only one study on the teaching of virus subject. In this study conducted by Dalgülge (2019), the effect of argumentation-based science learning approach on learning about bacteria and viruses with high school first-year students was examined. The number of studies on the teaching of virus, which is an extremely current and rapidly developing field of study, is insufficient. There are also misconception studies on virus in the literature. When these studies are examined, it is thought that viruses are thought to be living by some students and non-living by some students (Kurt & Ekici, 2013; Muzembo et al., 2022). In addition, there are the following statements about viruses containing a single type of genetic material: "It does not have DNA, it has RNA.", "Virus consists of RNA and protein sheath.", "Virus consists of DNA and sheath", "Viruses do not carry RNA". There is also a belief that the ribosome organelle is present in the structure of the virus (Kurt & Ekici, 2013). In the study conducted by Muzembo et al. (2022) in Africa, there are false beliefs that viruses are malicious and that they are an alien cell that negatively affects the immune system. It is thought that the virus is copied by its own department. The number of people who know that the vaccine is effective in preventing viral diseases is small (Muzembo et al., 2022). It is seen in many studies that the concept of bacteria and virus are used interchangeably (Büyük, 2017; Dumais & Hasni, 2009; Hürcan Gürler & Önder, 2014). It is not known that diseases such as influenza and flu are caused by viruses and it is widely believed that they are caused by bacteria (Büyük, 2017; Larson et al., 2009). Harmful microorganisms that cause diseases such as measles, polio, influenza, herpes, hepatitis B, AIDS, tuberculosis cannot be named (Hürcan & Gürler, 2014). It is stated that antibiotics are

used for viral diseases (Büyük, 2017; Hürcan Gürler & Önder, 2014; Yüzbaşıoğlu & Atav, 2004). The concept of virus cannot be associated with daily life (Hürcan Gürler & Önder, 2014; İlkörücü- Göçmençelebi, 2009; Yüzbaşıoğlu & Atav, 2004). It is thought that the immune system is formed as a result of virus infection (Dumais & Hasni, 2009). There is no thought that there may be virus particles in the air (Yağbasan & Gülçiçek, 2003). When foreign sources are examined, studies on the false beliefs of virus types such as Ebola and HIV among the public are found. These studies focus on the transmission types of diseases and religious beliefs (Bhagavathula et al., 2015; Kpanake et al., 2016). Saputri and Widyaningrum (2016) studied the misconceptions caused by the pictures in textbooks.

In Türkiye, the subject of virus is not included in primary and secondary school curricula. In the secondary school Biology course, the subject of virus is included in the "Living Worlds and Their Properties" unit at the 9th grade level. In Grade 11, the subject of lymph circulation in the "Circulatory System" unit, and in Grade 12, the subject of virus is mentioned in the "Genetic Code and Protein Synthesis" unit in the "Gene to Protein" unit. A student spends only 4 lesson hours with the virus subject during his/her entire secondary education life (Takmaz & Yılmaz, 2020).

In order for students to be successful in their daily lives, they need to be able to use the knowledge and skills gained at school in real life (Berberoğlu, 2006). In order to determine the current status of individuals in the teaching process, it is necessary to make measurement and evaluation and a knowledge test is needed (Erkuş, 2019, p. 82). Choosing the appropriate evaluation method for the teaching process is one of the most important factors that lead the student to success (Berberoğlu, 2006). Since students encounter the virus for the first time at an average age of 15, this process should be realised in a meaningful way. Knowledge/achievement tests are needed for the evaluation of the teaching.

The number of studies on test development in the studies on the virus subject is limited. In the study conducted by Dalgülge (2019), it was aimed to carry out argumentation-based teaching of bacteria and viruses, to determine and eliminate misconceptions. Pre and post knowledge tests were prepared by the researcher by taking expert opinion. In the study conducted by Hürcan and Önder (2014), with the concept test developed by taking expert opinion, students' associating the concepts of bacteria and viruses learned in the 7<sup>th</sup> grade science and technology course with daily life was determined. In this study by Mağden et al. (2003), in which the knowledge levels of high school senior students about AIDS were examined, question papers were prepared by experts in the field. The fact that these studies do

not cover the 9th grade virus topic of secondary biology course curriculum MoNE (Ministry of National Education) (2018) and that validity and reliability analyses were not conducted creates a need for a virus knowledge test in the literature.

In this study a Virus Knowledge Test (VKT) was developed to be used in the measurement and evaluation stage of the topic's instructional process, in accordance with both the objectives and the teaching-learning (context-based learning) strategy suggested by the curriculum. The aim of this study is to prove the validity, reliability, item discrimination index and item difficulty index of the Virus Knowledge Test (VKT) and to prove the item quality.

## **Method**

### **Research Design**

Survey method is used in studies where data are collected to determine the characteristics of the universe such as ability, opinion, attitude, belief or knowledge. Survey studies in which only data on variables are collected are descriptive survey studies (Sezgin Selçuk, 2019, p.140-141). This study is also a descriptive survey research.

### **Participants**

The population of this study consists of 9<sup>th</sup> grade high school students in Türkiye. The sampling method used in this study is the convenience sampling method, which selects individuals who are easily accessible and volunteer to participate in the study (Creswell et al.,2008). In the study, students studying in the 9<sup>th</sup> grade of a public high school in Karesi district of Balıkesir province took part. A total of 99 students (53 girls and 46 boys, 13-14 aged) participated in the pilot study and 165 students (90 girls and 75 boys, 13-14 aged) participated in the main study on a voluntary basis.

### **Development of the Data Collection Tool**

There is a need for a virus knowledge test due to the limited time allocated to the virus subject in the secondary biology course curriculum (MoNE, 2018), and the lack of a knowledge test consisting of items suitable for authentic measurement and evaluation, which is compatible with the context-based learning approach on this subject in the literature. For this reason, a knowledge test consisting of 16 items was developed by taking into account the learning outcomes in the curriculum, the recommended teaching and learning activities and the misconceptions in the related literature. The following steps were followed in the development of the knowledge test:

### ***Identification of Outcomes***

The learning outcomes in the secondary biology curriculum MoNE (2018) were reviewed. The following acquisitions related to viruses were selected from the subject of "Living Organisms and Their Properties" in the "World of Living Things" unit at the ninth grade level:

"9.3.2.3. Explains the general characteristics of viruses.

- a. The reasons why viruses are not included in biological classification categories are emphasised.
- b. The effects of viruses on human health are discussed through rabies, hepatitis, influenza, herpes and AIDS diseases. Precautions to be taken against viral diseases are emphasised.
- c. It is emphasised that viruses offer new opportunities for studies in the field of genetic engineering." (p.18)

### ***Preparation of Knowledge Test Items and Obtaining Expert Opinions***

Before preparing the items in the knowledge test on the virus topic, the misconceptions in the literature were reviewed. Since the target group was 9<sup>th</sup> grade, misconceptions at both secondary and high school levels were examined, and the misconceptions that individuals may bring from previous years and the misconceptions that may exist in their current position were taken into consideration. A item pool containing 16 items was created by blending the objectives selected from the curriculum, misconceptions in the literature, and the textbooks in the MoNE 9<sup>th</sup> Grade Biology (2022) textbook. Since the visuals used in the items were not among the existing visuals, drawings were made by the researchers when necessary. The relationship of the items with the subject acquisitions and misconceptions is given in Table 1.

**Table 1** Outcome-Misconception-Item Relationship

Acquisition	Misconceptions and misunderstandings	Item number
9.3.2.3.a. The reasons why viruses are not included in biological classification categories are briefly stated.	<ul style="list-style-type: none"> <li>- Viruses show living and non-living characteristics (Kurt &amp; Ekici, 2013; Muzembo et al., 2022).</li> <li>- They do not have DNA, they have RNA (Kurt &amp; Ekici, 2013).</li> <li>- The structure of the virus contains ribosome (Kurt &amp; Ekici, 2013).</li> <li>- Virus consists of RNA and protein sheath (Kurt &amp; Ekici, 2013).</li> <li>- Virus consists of DNA and sheath (Kurt &amp; Ekici, 2013).</li> <li>- Viruses do not carry RNA (Kurt &amp; Ekici, 2013).</li> <li>- Viruses are malicious (Muzembo et al., 2022).</li> <li>- The virus is replicated by its own part (Muzembo et al., 2022).</li> <li>- The concept of bacteria and virus are used interchangeably (Büyük, 2017; Dumais &amp; Hasni, 2009; Hürcan Gürler &amp; Önder, 2014).</li> </ul>	<ul style="list-style-type: none"> <li>Item 1</li> <li>Item 2</li> <li>Item 8</li> <li>Item 16</li> </ul>
9.3.2.3.b. The effects of viruses on human health are discussed through rabies, hepatitis, influenza, herpes, AIDS diseases. Precautions against viral diseases are emphasised.	<ul style="list-style-type: none"> <li>- Influenza is caused by bacteria (no relationship has been established with the virus) (Larson et al., 2009).</li> <li>- It is not known that flu and cold are caused by viruses (Büyük, 2017).</li> <li>- It is thought that antibiotics are used for viruses (Büyük, 2017; Hürcan Gürler &amp; Önder, 2014; Yüzbaşıoğlu &amp; Atav, 2004).</li> <li>- They cannot name harmful microorganisms that cause diseases such as measles, polio, influenza, herpes, hepatitis B, AIDS, tuberculosis (Hürcan &amp; Gürler, 2014).</li> <li>- There is no thought that there may be virus particles in the air (Yağbasan &amp; Gülçiçek, 2003).</li> <li>- It negatively affects the body's immune system (Muzembo et al., 2022).</li> <li>- The immune system is formed as a result of virus infection (Dumais &amp; Hasni, 2009).</li> </ul>	<ul style="list-style-type: none"> <li>Item 3</li> <li>Item 4</li> <li>Item 6</li> <li>Item 7</li> <li>Item 10</li> <li>Item 11</li> <li>Item 12</li> <li>Item 13</li> <li>Item 14</li> <li>Item 15</li> </ul>
9.3.2.3.c. It is emphasised that viruses offer new opportunities for studies in the field of genetic engineering.	<ul style="list-style-type: none"> <li>- The concept of virus cannot be associated with daily life (Hürcan Gürler &amp; Önder, 2014; İlkörücü-Göçmençelebi 2009, Yüzbaşıoğlu &amp; Atav, 2004).</li> </ul>	<ul style="list-style-type: none"> <li>Item 5</li> <li>Item 9</li> </ul>

An Expert Opinion Form was prepared to facilitate the determination of the content validity of the knowledge test created by the researchers and to provide the opportunity to evaluate it on common criteria. In the expert opinion form, firstly, the purpose for which the

knowledge test was prepared was stated. The acquisitions of the items were explained in writing. A section was prepared to include demographic information (gender, professional status, education level, field of expertise and duration of experience) of the experts. The table given in Table 2 was added under each item and the experts were asked to evaluate each item separately.

**Table 2** Example of an Expert Opinion Chart

Item 1				
Feature	Suitable for	Must be reorganised	Should be excluded from the test	Recommendation
Outcome relationship				
Activity relationship				
Pedagogically appropriate				
Substance difficulty				
Item root				
The suitability of the written language in terms of grammar				
Understandability				
Carrying bias				
Page structure				
Post format				
Font size				
Your advice on the item				

The opinions and suggestions of five experts in the field were obtained by using an expert opinion form. Demographic information of the experts is given in Table 3. In line with the opinions expressed by these experts, necessary arrangements were made in the item by the researchers.

**Table 3** Demographic Information of the Experts

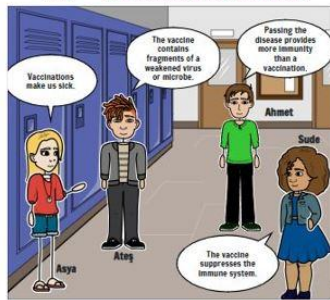
	Gender	Occupational status	Education level	Area of expertise	Experience (years)
1	Woman	Assoc. Prof. Dr.	PhD	Measurement and evaluation in education	7
2	Male	Assoc. Prof. Dr.	PhD	Molecular systematics	14
3	Woman	Teacher	Master's degree	Biology education	37
4	Woman	Teacher	Bachelor's degree	Turkish language and literature	21
5	Male	Teacher	Bachelor's degree	Turkish language and literature	2



**Pilot Application of VBT and Data Analysis**

The prepared knowledge test was applied face-to-face to 99 students in a qualified high school located in Karesi district of Balikesir city. During the pilot application, students were given 40 minutes. In the evaluation of the knowledge test, scoring criteria and answer key were created by the researchers. In Figure 1, answer keys for two items are given as an example.

13. Asya, Ateş, Ahmet and Sude are discussing about the vaccine.



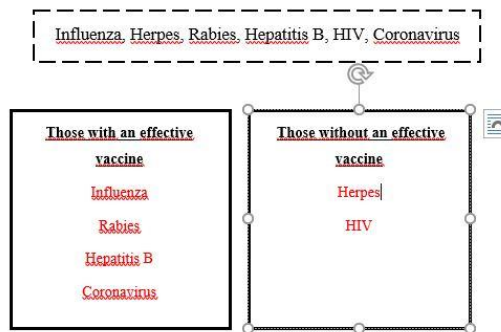
Who do you think has the right idea? Put an x in the box you think is correct.

- Asya     Ateş     Ahmet     Sude

Explain why you think so.

Introducing the virus into the body naturally can cause the disease to be more severe. Since the vaccine injects virus particles into the body, the immune system recognises these particles and produces antibodies. There is no particle or agent in the vaccine that allows the virus to reproduce in our body. Vaccines do not make us sick. On the contrary, it activates the immune system and ensures that antibodies are produced faster when we encounter the virus.

4. Scientists produce vaccines against viral diseases. However, an effective vaccine for some types of viruses cannot yet be produced. Classify the following types of viruses separately: those that have an effective vaccine and those that do not have an effective vaccine.



**Figure 1** Example of Answer Key

Three different teachers were asked to evaluate the tests collected from the students using the answer key. The demographic information of the three teachers who made the scoring is given in Table 4.

**Table 4** Demographic Information of the Raters

Rater	Occupational status	Education level	Area of expertise	Experience
Rater A	Teacher	PhD student	Biology education	11 years
Rater B	Teacher	Biology teacher	Biology education	9 years
Rater C	Teacher	PhD student	Biology education	5 years

To maintain scorer objectivity, they were asked to score by considering the answer key. The scoring criteria consisted of a binary system as true and false (coding as 0 and 1) was chosen for reliability analysis.

In order to measure inter-rater reliability, scoring was performed by 3 different raters and the inter-rater reliability coefficient was calculated by Pearson correlation (Table 5). The agreement between all raters was above .81, indicating that the inter-rater reliability was almost perfect (Landis & Koch, 1977). This emphasises the importance of the answer key and scoring criteria.

**Table 5** Inter-Rater Reliability Coefficients

Rater	Rater A	Rater B	Rater C
Rater A	1	.864	.974
Rater B	.864	1	.945
Rater C	.974	.945	1

Since inter-rater reliability shows that the scoring does not change from one rater to another, the scores obtained were used to calculate item difficulty and item discrimination indices (Kutlu et al., 2009).

The data of this study were analysed with item difficulty and item discrimination indices from Classical Item Statistics (Koğar, 2021). The item difficulty index is calculated as the ratio of the number of correct answers to the item to the total number of students. It is classified as very easy between .80 - 1.00, easy between .60 - .79, moderate between .40 - .59, difficult between .20 - .39, and very difficult between .00 - .19 (Crocker & Algina, 1986). Item discrimination index is the power to distinguish between an individual with a low score and an individual with a high score. It is calculated by correlation analysis and takes a value between -1 and +1 (Koğar, 2021; Şata, 2022). In the item discrimination index, .40 and above discriminates very well; .30 - .39 is used without correction; .20 - .29 is used with correction; .19 and below should be removed from the scale or revised (Crocker & Algina, 1986; Ebel, 1965).

According to the results of the data analysis, the revised VBT was finalised. The test, whose pilot study was completed in this way, was applied to 165 students from a different school at a similar level. The test data of 29 students who answered the test incompletely (leaving unanswered items) were not included in the analysis. Item analysis was performed on the obtained data and the reliability of the test was determined.

### **Validity and Reliability**

A high-quality knowledge test should have high validity and reliability. Reliability is a prerequisite for validity. However, a test with high reliability may not be valid (Ercan & Kan,

2004). In the literature, expert opinion is used for test validity (Dalgülge, 2019; Hürcan & Önder, 2014; Mağden et al., 2003). As in this study, it is more accurate to look at the validity of the results obtained from the test and to analyse the items (Gönen et al., 2011). Validity types are content validity (the degree to which the scale serves the purpose), criterion validity (the relationship between the scores obtained from the scale and the criteria determined), construct validity (the pattern formed by interrelated items) and face validity (whether a test appears to measure what it's supposed to measure) (Ercan & Kan, 2004).

In this study, five experts in the fields of measurement and evaluation, molecular systematics, biology education, Turkish language and literature were asked to evaluate the items to determine content validity. The fact that all items of the VBT belong to the virus subject and cover the gains of MoNE (2018) shows that it provides construct validity. The instructions and items at the beginning of the test show that the test measures the level of knowledge about the virus subject.

There are many definitions of reliability (Erkuş et al., 2020): correlation between parallel tests (Crocker & Algina, 1986; Gulliksen, 1967; Lord & Novick, 1968); consistency of the scores of the same individuals taking the same test in different situations (Anastasi, 1976); internal consistency of the scores gained by an individual (Ghiselli et al., 1981); reproducibility of the result obtained from the instrument (Magnusson, 1967). Reliability is the state of being free from random errors, consistency and reproducibility of test scores (Gönen et al., 2011). Cronbach-Alpha method was preferred to measure the reliability of VBT. In addition, Pearson Correlation was used to determine the inter-rater reliability.

### **Findings**

Item analysis was conducted to answer the question "What is the item difficulty index, item discrimination index and reliability of each item of VBT?". In this section, the findings of the pilot application and the implementation of VBT are given.

#### **Item Difficulty and Item Discrimination Indices in Pilot Application of the Test**

Difficulty and discrimination indices of the test items are given in Table 6. According to the item discrimination index (Crocker & Algina, 1986), items 1, 7, 8, 11 and 15 distinguish very well; items 5, 9, 12 and 14 are used without correction; item 16 is used with correction; item 2, 3, 4, 6, 10 and 13 should be revised.

**Table 6** Item Difficulty and Item Discrimination Indices in the Pilot Study

Item	Item difficulty index (P <sub>j</sub> )	Item difficulty level	Item discrimination index (r)	Item discrimination level
1	0.37	Difficult	0.42	Distinguishes very well
2	0.13	Very difficult	0.15	Should be reviewed
3	0.50	Medium level	0.15	Should be reviewed
4	0.23	Very difficult	0.07	Should be reviewed
5	0.31	Difficult	0.34	Used without correction
6	0.41	Medium level	0.13	Should be reviewed
7	0.32	Difficult	0.51	Distinguishes very well
8	0.22	Difficult	0.47	Distinguishes very well
9	0.14	Very difficult	0.32	Used without correction
10	0.22	Difficult	0.13	Should be reviewed
11	0.37	Difficult	0.55	Distinguishes very well
12	0.12	Very difficult	0.35	Used without correction
13	0.80	Very easy	0.18	Should be reviewed
14	0.11	Very difficult	0.30	Used without correction
15	0.08	Very difficult	0.47	Distinguishes very well
16	0.34	Difficult	0.29	Used by correction

According to the item difficulty index, items 2, 4, 9, 12, 14 and 15 were classified as very difficult; items 1, 5, 7, 8, 10, 11 and 16 as difficult; items 3 and 6 as medium; item 13 as very easy.

As a result of the pilot application, Cronbach  $\alpha$  reliability coefficient for the whole test was determined as 0.58. According to the item discrimination level, the test was finalised after the 7 items, which were classified as should be revised and can be used with correction, were edited by the researchers.

### Item Difficulty and Item Discrimination Indices of VBT

The difficulty and discrimination indices of the test items from the analysis of the data obtained by reapplication of the final version of VBT are given in Table 7. According to the item discrimination index (Crocker & Algina, 1986), items 3, 7, 10 and 13 were classified as very good discriminators; items 4, 5, 6, 9, 11, 14, 15 and 16 were classified as used without correction; items 1, 2, 8 and 12 were classified as used with correction.

**Table 7** Item Difficulty and Discrimination Index of VBT

Item	Item difficulty index (P <sub>j</sub> )	Item difficulty level	Item discrimination index (r)	Item discrimination level
1	0.85	Very Easy	0.20	Used by correction
2	0.06	Very difficult	0.21	Used by correction
3	0.07	Very difficult	0.43	Distinguishes very well
4	0.31	Difficulty	0.36	Used without correction
5	0.13	Very difficult	0.30	Used without correction
6	0.61	Easy	0.38	Used without correction
7	0.50	Medium Level	0.44	Distinguishes very well
8	0.10	Very difficult	0.23	Used by correction
9	0.29	Difficulty	0.36	Used without correction
10	0.44	Medium Level	0.41	Distinguishes very well
11	0.44	Medium Level	0.30	Used without correction
12	0.21	Difficulty	0.26	Used by correction
13	0.71	Easy	0.48	Distinguishes very well
14	0.19	Very difficult	0.32	Used without correction
15	0.12	Very difficult	0.37	Used without correction
16	0.51	Medium Level	0.38	Used without correction

According to the item difficulty index, items 2, 3, 5, 8, 14 and 15 were classified as very difficult; items 4, 9 and 12 as difficult; items 7, 10, 11 and 16 as medium; items 6 and 13 as easy; item 1 as very easy.

Cronbach  $\alpha$  reliability coefficient for the whole VBT was found to be 0.66.

### Conclusion and Suggestions

In order to develop the measurement tool, firstly, the learning outcomes in the secondary biology course curriculum MoNE (2018) were determined. Items of VBT were prepared by considering these acquisitions and misconceptions in the literature.

Good quality items allow students to create answers from their own point of view and produce original solutions to the problems they encounter during their daily experiences (Gülbetekin et al., 2019). They are effective in developing high-level thinking skills such as organising and synthesising information. Although it is thought to be easy to prepare, it is quite difficult to prepare a high quality item many of the drawings in the items in the VBT were made by the researchers with special programmes. Item contents were formed with data

taken from daily life. The items were prepared in a way that students would think at a high level, form their own answers and organise their knowledge.

Expert opinions were taken to ensure the content validity of the prepared virus knowledge test. The pilot application of the test consisting of 16 items with content validity was carried out. The item difficulty index, item discrimination index and reliability of the VBT consisting of 16 items applied to 99 high school students in the pilot application and 165 high school students in the final application were examined. According to the results of the items difficulty index of the pilot application, 6 items were classified as very difficult, 7 items as difficult, 2 items as medium level, 1 item as easy. Item discrimination indices were determined as 5 items discriminate very well, 4 items are used without correction, 1 item is used with correction, 6 items should be revised. The Cronbach  $\alpha$  reliability coefficient of the test in the pilot application was 0.58, indicating that it had low reliability. Considering these results, the test items were reviewed and reorganised by the experts.

According to the item difficulty index results obtained from the re-application of the edited version of the test, 6 items were classified as very difficult, 3 items as difficult, 4 items as medium level, 2 item as easy, 1 item as very easy. Item discrimination indices were determined as 4 items discriminate very well, 8 items are used without correction, 4 items are used with correction. The Cronbach  $\alpha$  reliability coefficient of the VBT was 0.66, which indicates that the reliability is at a moderate level. The low number of items in the measurement tool may cause the reliability coefficient to be low (Kılıç, 2016). The high number of items categorised as very difficult and the high number of items requiring editing can be shown as factors that cause low reliability.

The fact that students think that long items are difficult reduces the rate of answering the questions (Koretz et al., 1993). It is thought that some of the items classified as very difficult in VBT are not answered by many students because they are too long. Long items require students to read and comprehend the text carefully and express their answers in writing, so the success rate of students in such exams is low (Temizkan & Sallabaş, 2011). During the implementation of VBT, it should be emphasised to the students that the long items should not scare them and that long items do not always mean that they are difficult. In today's national exams, long and interpretation-based items, which are called new generation, are used quite a lot. Students should overcome their prejudices against such items.

The most important disadvantage of items is scoring (Bahar et al., 2015). In this study, in order to make the scoring more reliable, scoring criteria were determined, an answer key was created and all students' first and second items were scored. The inter-rater reliability coefficient proves that the scoring is reliable. In this study, the importance of preparing the answer key in a very clear way was once again revealed.

When the obtained data were analysed, it was determined that VBT was valid and reliable for 9<sup>th</sup> grade high school students. This knowledge test can be used to measure the knowledge levels of students in the "World of Living Things" unit in which the virus subject is taught in biology courses.

In this study, a knowledge test on virus was introduced to the literature. VBT, which was developed to determine the effectiveness of teaching the subject and student achievement, will make a great contribution to the literature since it is the first study in the literature and the items are related to daily life.

Since the Covid-19 pandemic is a socio-scientific event that confronts individuals with scientific, ethical and moral dilemmas, it should be included in the curriculum to improve individuals' decision-making, scientific thinking and reasoning skills (Evren Yapıcıoğlu, 2020; Tyrrell & Calinger, 2020). The virus topic is included in the curriculum as the last unit and the last topic. It is necessary to teach such important socio-scientific subjects without interruption. The application of the developed VBT to a larger number of 9<sup>th</sup> grade students studying in Türkiye will contribute to increase the validity and reliability of the test.

## **Compliance with Ethical Standards**

### *Disclosure of potential conflicts of interest*

There is no conflict of interest to declare.

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### *CRedit author statement*

All authors contributed equally to this work. The order of authorship has been arranged as agreed by all parties.

### *Research involving Human Participants and/or Animals*

Since this study involved human participants, ethics committee permission was obtained.

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## **Virüs Bilgi Testi: Geçerlik ve Güvenirlik Çalışması**

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### **Özet:**

Virüsler yüzyıllardır birçok salgın hastalığa neden olmuş ve olmaya devam etmektedir. Bu salgınlar sırasında halk arasında yanlış anlaşılan ve uygulanan birçok örnek vardır. İnsanların bu varlıkları tanınması ve uygun önlemleri alması gerekmektedir. Türkiye'deki öğretim sürecinde öğrenciler virüsü ilk kez 9. sınıf biyoloji dersinde öğrenmektedir. Bu çalışma ile öğrencilerin virüs konusu ile ilgili bilgi düzeylerini belirlemede kullanılacak bir test geliştirilmesi amaçlanmıştır. Değişkenlere ilişkin verilerin toplandığı betimsel bir tarama çalışmasıdır. Pilot uygulamaya Balıkesir ili Karesi ilçesinde bulunan bir devlet lisesinin 9. sınıfında öğrenim gören 99 öğrenci gönüllülük esasına göre katılmıştır. Elde edilen veriler klasik madde istatistiklerinden madde güçlük ve madde ayırt edicilik indeksleri ile analiz edilmiştir. Son hali verilen Virüs Bilgi Testi (VBT), Karesi'den rastgele seçilen iki farklı devlet lisesinin 9. sınıflarında öğrenim gören 165 öğrenciye uygulanmıştır. VBT'nin tamamı için Cronbach  $\alpha$  güvenirlilik katsayısı 0.66 olarak bulunmuştur. Virüs konusunda literatürde güvenilirliği ve geçerliliği olan ilk virüs bilgi testi olması çalışmanın özgünlüğünü ortaya koymaktadır.

*Anahtar kelimeler:* Virüs, bilgi testi, geçerlik, güvenirlilik.

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