Needs Analysis for a Web-Based Learning System to Develop Students' Science Process Skills

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Abstract

The aim of this study was to explore the needs for the identification ofdesign elements of a web-based learning system that would help students develop their science process skills (SPS) to be used in science lessons. A descriptive survey method was adopted as the methodology of the study. Survey data was collected from a sample of 36 teachers and 196 middle school students (grades 5 to 8). The results of the study indicated that students had difficulty in learning science subjects. They thought that they could learn the subjects in the science course better with technological and educational support, and various teaching activities. Teachers stated that the web-based education system should meet the following requirements be simple and understandable, be relevant to real/everyday life, be an interactive system, which is rich in content and images, and include various multimedia elements such as simulations, animations, and 3D materials. On the other hand, many students stated that a web-based learning system that will help them learn the subjects in the science course should have course videos (educational videos), test/solved/sample questions, practice exams, accurate and reliable information. In addition, the students stated that this web-based learning system should be simple and understandable, have easy and rich content, be interactive and have a good technical infrastructure. Both teachers and students thought that "observing", and "experimenting" skills would be improved the most in technology-enhanced learning environments. In addition, teachers stated that the benefits of developing students' science process skills in real life would be "gaining a scientific perspective on events", "awareness of the problem(s) around them", "science literacy", "enabling the student to access the information himself/herself", "expanding perspectives on events", and "able to solve the problems they encounter more easily".

Keywords: Needs Analysis, Science Process Skills, Teacher Needs, Student Needs, Science Education, Web-Based Learning Environments

INTRODUCTION

In the twenty-first century, the development of internet technology in the learning environment has become the basic need of every student. Traditional learning needs to be developed as it does not support active learning. One of the learning environments to meet the needs of the teaching and learning process is the web-based learning environment(Hamzah et al.,2017). Today, particularly after the pandemic, e-learning is one of the most common education methods due to its need in today's world (Pandian et al., 2023).

The web is a well-established reality, albeit virtual. Educators who are aware of the potential of technology have adopted it to generate new web-based learning environments (Mioduser et al., 2000). Teaching on the web is more than just creating a colorful web page.Effective online learning requires the integration of active learning, motivation, and assessment principles with creative web design (Cook & Dupras, 2004).

"One step ahead for technology, two steps back for pedagogy". This phrase seems to describe the pattern that has influenced educators' assimilation of new technologies over the past few decades (Mioduser et al., 2000, p.73). For an e-learning environment to be successful, several aspects which it is based on need to be considered, such as domain knowledge, conceptual learning theory, instructional design, user interface design, and assessment of the overall quality of learning (Nam & Smith-Jackson, 2007). Web-based learning, despite its technological possibilities, provides students with additional information that complements or enhances the knowledge created in the classroom. Meanwhile, mediated assistance interacts with the learning outcomes perceived by students through web-based learning, which further strengthens students' academic transitions, particularly as the instructor continually adjusts instructional design to address students' learning problems (Zhang, 2021). Berge (1999, p.9) also stated that there are variable elements that a designer can choose to use in the web-based learning environment: "The salient variables are teaching methods, types of interaction (interpersonal and intrapersonal), performance level (teacher versus student-control), task/content versus social interaction, and feedback".Web-based learning environment and the associated learning activities improve students' motivation. Some factors believed to enhance intrinsic motivation (challenge, control, curiosity, and fantasy)integrated into the instructional design of the web-based learning tool (Wang & Reeves, 2007).

According to Hadjerrouit (2010), web-based learning resources are potentially powerful tools for improving teaching and learning processes in school education. They can provide teachers and students with different and exciting experiences not possible in a traditional classroom. On the other hand, technology and software experts are involved in the development of web-based learning resources rather than teachers and students. In addition, user involvement in the development process of web-based learning resources is also lacking.Kay et al. (2009) analyzed teacher perceptions of the use of web-based learning tools in middle and secondary school classrooms.Most teachers rated web-based learning tools as easy to use and engaging for students. They also reported that web-based learning tools encourage successful learning. Some teachers reported that significant time was spent searching for suitable web-based learning tools and preparing lessons. Technological problems with web-based learning tools were not reported very often, and the focus was mostly on internet speed. What is recommended by teachers is that it is vital to be prepared and to devote time to selecting, testing, and preparing materials to ensure successful use of web-based learning tools.The increased accessibility, affordability and capacity of the Internet have created significant opportunities design, development and implementation of a house enriched with the innovative methodsin the classroom (Chandra & Fisher, 2009). Current online learning environments are still largely asynchronous and text-based, allowing student interaction with static content (e.g., text, images, videos) (Greenhow et al., 2022).

The internet is a dynamic environment that is constantly evolving. Some practices create new opportunities for educators to design and develop learning activities for active student engagement. In other words, considering the development of today's digital teaching technologies, it can be said that web-

based learning environments have the potential to enrich them with these technologies. As new web-based models and technologies are usedin learning environments, there is a need to create students' perceptions of these initiatives(Chandra & Fisher, 2009). In addition, since today's web-based learning systems should allow student-teacher interaction, the needs of teachers should also be considered when developing web-based learning systems (Wang & Wang, 2009).In such learning systems, teachers should be able to constantly monitorthe interaction of students with learning resources, give feedbackeasily, upload learning content easily to the system, and analyze student interactions on the content.

A web-based learning system that can meet the needs of both teachers and students only if it is developed by followinga few steps (Astuti et al., 2020). These are content analysis, material resource analysis, user analysis, software requirement analysis, hardware requirement analysis and analysis of other learning materials.Whether the learning system provides feedback to its users plays a crucial role in web-based education (Vasilyeva et al., 2007). Nearly all the aforementioned analyzes were tried to be made within the scope of the project in which this study was produced.

Web-based instruction offers students the opportunity to learn without being limited by time and place. Also, with video and audio equipment, interaction becomes more active as children cannot communicate with others by typing. Web-based instruction is available wherever students can learn wherever there is a network. In addition, cartoon figures that children are interested in can be included in the content and the interface to increase active learning and provide learning effects (Chou, 2013). "Content-related quality of teaching", "organization of teaching," and "subjective learning success" are important for students' satisfaction with online learning (Tietz et al., 2022).

Web-based learning environments including declarative information and opportunities for practice provide concrete visualization through 'hands-on' activities and simulated activities. In these learning environments, children are also provided with ample opportunities to repeat and practice the skill (Mohd-Saat, 2004).Well-designed online tutorials can be more effective in teaching science process skills (SPS) to undergraduate students compared to traditional ways (Kramer et al., 2018). Web-based virtual labsoffersignificant support to students and help them develop their conceptual understanding of science and SPS (El-Sabagh, 2011).

The literature on the design of technology-enriched learning environments has extended so far. In learning environment designs, it should be known for whom the design is made, and the needs of these individuals should be clearly identified(Ireland, 2003). Determining the needs of teachers and students for these learning environments, web-based teaching tools or systems, should be the first step in the development of them. Therefore, in the current study it was aimed to explore teachers and students needs for a web-based activelearning environments that is expected to help students develop SPS to be used in science lessons.

This study seeks answers to the following questions:

- What are the views of students on subjects that are difficult to learn in the science class?
- What are the views of studentson how they can learn science subjects better?
- What are the views of teachers and students about which technological tools can help students learn science subjects better?
- What are the views of teachers and students on the effect of technology use in science lessons on SPS?
- What are the views of teachers and students on the features of the web-based teaching system?
- What are the views of teachers about the features of the activities that should be in a web-based active learning environment?
- What are the views of teachers about the definitions about SPS?
- What are the examples given by teachers and students regarding the use of SPS in science lessons?
- What are the views of teacherson which SPS of students would be developed with technology-supported learning environments?
- What are the views of teachersabout the benefits of developing students' SPS in real life?

METHOD

Descriptive survey method was adopted in the current study.

SAMPLE OF THE STUDY

A total of 36 science teachers (25 females & 11 males) aged between 24 and 52 and a total of 196 students (111 females & 85 males) from the 5th grade (n=36), 6th grade (n=76), 7th grade (n=61), and 8th grade (n=23) middle school students participated in the study (Figure 1).Professional experience of teachers varies between 1 and 26 years. 15 of the teachers were 1-5 years, 10 of them 6-10 years, 9of them 11-16 years and 4 of them was over 17 years of professional experience.

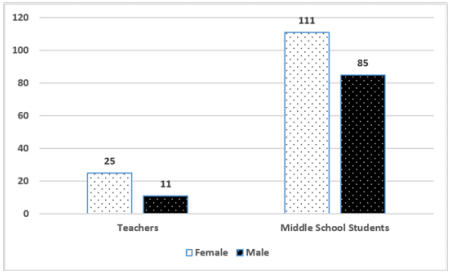

Figure 1 Distribution of Participants

DATA COLLECTION TOOLS

Within the scope of the needs analysis studies of the TÜBİTAK 1001 project,separate questionnaires were prepared for teachers and middle school students. 20 questions were asked to the teachers and 11 questions to the students within the scope of needs analysis studies. In some questions, teachers and students were given the option to choose more than one alternative, and another option was added, where they could comment on the possibility of giving different answers from the alternatives presented to the survey. These questionnaires were submitted to expert opinions in order to determine the needs of teachers and students regarding the use of technology and SPS in science lessons. Necessary alterations and improvements were made on the questionnaires within the framework of the feedback received from the expert opinions. These questionnaires were delivered to teachers and students via google forms. Most of the students filled these forms under the supervision of their science teachers in classroom lessons during online education. The data of the study were collected in the spring term of the 2020-2021 academic year.

RESULTS

Within the scope of the development of a web-based active learning system, a needs analysis study was carried out, and in this context, the views of teachers and middle school students were consulted. The answers given by the teachers and students to the survey questions were presented below.

STUDENT VIEWS ON SUBJECTS THAT ARE DIFFICULT TO LEARN IN THE SCIENCE CLASS

Middle school students were asked whether they had difficulty in learning the subjects in the science course, and if there were units and subjects, they had difficulty with, why they could not learn these subjects. The answers given by the students to these questions are given in Table 1.

Table 1 Science Subjects that Students have Difficulty in Learning and the Reasons for not Learning these Subjects

Science subjects that students have difficulty with	f	Reasons why students cannot learn science subjects	f
Physical Events (Force and Motion, Sound and Its Properties, Transmission of Electricity)	28	Non-visualization of topics/concepts/events	30
Living Beings and Life (Systems in Our Body, Systems and Health in Our Body)	27	Ineffectiveness in doing math operations	18
Earth and Universe (Solar System and Eclipses)	18	Unable to memorize formulas	16
Matter and its Nature (Matter and Heat)	14	Uninteresting topics	11
		Being indifferent to science class	8
		Inadequate technological tools and equipment	6
		Inadequate laboratory and equipment	5
		Less time devoted to science lessons	4

While 71.4% (*n*=140) of the students stated that they had no difficulty in learning the subjects in the science course, 28.6% (*n*=56) stated that they had difficulties. The science subjects that students had difficulties in learning were as follows: "Physical Events (Force and Motion, Sound and Its Properties, Transmission of Electricity)" (*n*=28), "Living Things and Life (Systems in Our Body, Systems and Health in Our Body)" (*n*=27). They stated that they had difficulty in learning the subjects in the units "Earth and Universe (Solar System and Eclipses)" (*n*=18), "Matter and Its Nature (Matter and Heat)" (*n*=14). The reasons why students had difficulty in learning science subjects were non-visualize the subjects/ concepts/events in their minds (*n*=30), ineffective in doing math operations (*n*=18), unable to memorize formulas (*n*=16), uninteresting topics (*n*=11), being indifferent to science class (*n*=8), inadequate technological tools and equipment (*n*=6), inadequate laboratory and equipment (*n*=5),less time devoted to science lessons (*n*=4) (Table 1).

HOW TO LEARN SCIENCE LESSON BETTER

The students were asked how they could learn the science lesson better. The views of the students on how they can learn science subjects better are given in Table 2.

Table 2 Students' Views on How they can Learn Science Subjects Better

How can the subjects in science class learn better?			f
Individual Effort		By solving tests/questions	18
		By repeating the subjects	17
		By working (regularly, carefully, well, hard)	11
		Writing (taking notes, summarizing)	4
		By listening well	2
Support	Technological Support	By watching lesson videos	9
	Educational Support	With the support of technological tools (tablet, phone, smart board)	5
		Course/Extra Lesson/Private Lesson	9
Teaching Activities		By experimenting	15
		With face-to-face lessons	9
		Applied lessons	5
		Detailed/intensive/well-education	5
		With the increase of course hours/numbers	3
		With fun lessons	3
		Observation	2

Students thought that they can learn the subjects in the science course better with their individual efforts (*n*=52), technological and educational support (*n*=23), and various teaching activities (*n*=42). While some of the students who learnedby theirindividual efforts thought that they could learn by solving tests/ questions (*n*=18) and repeating the subjects (*n*=17), working (*n*=11), writing (*n*=4) and listening well (*n*=2), some of them thought that they could learn better with technology (*n*=14) and educational support (*n*=9). In addition to these, some students stated that they could learn better by experimenting (*n*=15), face-to-face lessons (*n*=9), applied lessons (*n*=5), detailed/ intensive/ well-education (*n*=5), increased course hours/numbers (*n*=3), fun lessons (*n*=3) and observation (*n*=2) (Table 2).

LEARNING SCIENCE SUBJECTS WITH TECHNOLOGICAL TOOLS

Teachers and students were asked with which technological tools students could learn science subjects better.The answers given by the teachers and students are given in Table 3.

Table 3 Learning Science Subjects with Technological Tools

Learning science subjects with technological tools			
Teachers	**f**	**Students**	**f**
Tablet	21	Computer	144
Computer	20	Smart phone	83
Smart phone	15	Tablet	72
Lesson videos	6	Experiments	2
Multimedia technologies (simulation/animation)	5	AR/VR glasses	2
AR/AR glasses	2	Smart board	1
Experiment kits	2	Tutorial book	1
3D devices	1	3D devices	1
Virtual lab	1	TV	1

While most of the teachers thought that science subjects can be taught with technological tools such as tablets (*n*=21), computers (*n*=20), and smartphones (*n*=15), most of the students think that they would learn science subjects better using computers (*n*=144), smartphones (*n*=144), and tablets (*n*=83). Apart from these, there were also teachers and students who thought that science can learnt better with different technological tools such as multimedia technologies, AR/VR glasses, 3D devices, and virtual labs (Table 3).

THE EFFECT OF TECHNOLOGY USE IN SCIENCE LESSONS ON SPS

The teachers were asked which SPS would be improved by using technology in science teaching, and the students were asked which of the presented SPSs can be improved in science lessons.The views of teachers and students on the effect of technology use in science lessons on SPS are given in Table 4.

Table 4 The Effect of Technology use in Science Lessons on SPS

		Teachers	**Students**
		f	**f**
Science Process Skills	Observing	14	131
	Experimenting	9	125
	Measuring	4	96
	Estimating/Hypothesizing	4	93
	Using Data and Modeling	4	93
	Recording Data	5	88
	Classifying	3	87
	Changing and Controlling Variables	4	70
	None of them	-	29
Other Skills	Interpreting/Inferring	10	
	Development in cognitive and affective domains (Motivation, comprehension, self-confidence)	6	
	Analyzing/Synthesizing	3	
	Critical and creative thinking	2	
	Problem solving	1	

The teachers stated that using technology in science teaching would improve the SPS of observing (*n*=14), experimenting (*n*=9), recording data (*n*=5), measuring (*n*=4), estimating/hypothesizing (*n*=4), using data and modeling (*n*=4), classifying (*n*=3), changing and controlling variables (*n*=4). In addition to these skills, teachers stated that other skills such as “interpreting/inferring” (*n*=10), “development in cognitive and affective areas” (*n*=6), “analyzing/synthesizing” (*n*=3), “critical and creative thinking” (*n*=2) and “problem-solving” (*n*=1) could also be developed.The majority of the students also thought that science courses were quite suitable for “observing” (*n*=131) and “experimenting” (*n*=125). These skills are followed by “measuring” (*n*=96), “estimating/hypothesizing” (*n*=93), “using data and modeling” (*n*=93), “recording data” (*n*=88), “classifying” (*n*=87), and “changing and controlling

variables" (n=70). Aside from these, some of the students (n=29) stated that the science course did not develop any of the specified SPS (Table 4).

FEATURES OF THE WEB-BASED TEACHING SYSTEM

Teachers and students were asked what the features of a web-based teaching system should be, and the answers were given in Table 5.

Table 5 Features of the Web-Based Teaching System

Features of the web-based teaching system					
		Teachers	**f**	**Students**	**f**
Educational Content	The nature ofeducational content	Simple and understandable	8	Lecturing (Tutorial videos/Lecture videos)	56
		Related to real/daily life	3	Including test questions, solved questions, sample questions, practice exams	32
		Suitability with the students' ages	3	Containing accurate, reliable information	17
		Suitable for educational goals	2	Simple, understandable, easy	13
		Concretizing the concepts	2	Enjoyable	6
		At different difficulty levels	1	Original	1
		Enjoyable	1	Suitable for educational gains	1
				Related to daily life	1
		Content diversity	4	Rich content	18
	Content variety	Activity	2		
		Test	2		
		Game	1		
Technological Content	Technological material nature	Visual richness	5		
		Interesting, striking visuals	4		
		Clear, understandable visuals	2		
	Technology use	Interactive	8	Interactive	4
		Easy to use, simple	7	Good technical infrastructure	4
		Easily accessible	5	Saving feature	1
		Good design, good technical infrastructure	4		
	Multimedia technologies	3D materials	4		
		Simulations	2		
		Animations	2		
		Video	1		

Teachers stated that the features of a web-based teaching system should be simple and understandable (n=8), related to real/daily life (n=3), diverse in terms of content (n=9), rich/good in visual terms (n=11), an interactive system (n=8), and including multimedia technologies such as 3D materials, simulations,

animations (*n*=9). On the other hand, many students (*n*=56) pointed out that a website that would help them learn the subjects in the science course should include lecture videos (*n*=56), test/solved/sample questions, practice exams (*n*=32), contain accurate, reliable information (*n*=17), simple, understandable, easy (*n*=13), have rich content (*n*=18), interactive (n=4), and good technical infrastructure (*n*=4) (Table 5).

FEATURES OF THE ACTIVITIES THAT SHOULD BE IN A WEB-BASED ACTIVE LEARNING ENVIRONMENT

The teachers were asked about the characteristics of the activities that should be in the web-based active learning environment. The answers are given in Table 6.

According to teachers, thefeatures of activities that a web-based active learning environment should hold are: "interesting/fun" (*n*=33), "associated with daily life" (*n*=33), "game based" (*n*=30), "tutorial on the subject" (*n*=29), "assessment and evaluation" (*n*=26), "help with repetition" (*n*=22), and "prepare for exams" (*n*=20) (Table 6).

Table 6 Features of Activities that Should be in a Web-Based Active Learning Environment

Features of activities that should be in a web-based active learning environment	f
Interesting/fun	33
Associated with daily life	33
Game-based	30
Tutorial on the subject	29
Assessment and evaluation	26
Help with repetition	22
Prepare for exams	20

SPS DEFINITIONS

Teachers were asked to define SPS. Their answers were given in Table 7.

Table 7 SPS Definitions

SPS	Definitions	f
Estimating/ Hypothesizing	To speculate about the outcome of the subject or event, to speculate	19
	Creating a problem statement/Defining the problem situation	3
	Assumption/Truth to investigate the truth about a situation	2
	Making predictions, making inferences based on results	1
	The idea that is correctly defended and tried to be proven	1
	To anticipate the possible consequences of an event or situation, to produce scientifically testable solution(s) for the outcome of a problem	1
Recording Data	Saving results/measured values, taking notes	24
	Edit data	1
Changing and Controlling Variable	Controlled experiment (changing or controlling variables in an experiment)	19
	Independent, dependent, controlled variables	5
Using Data and Modeling	Creating a product suitable for the data (model, design, mock-up, etc.)	14
	Reaching mathematical results using data	5
	Showing data/findings with figures, pictures, graphs, etc.	4
Experimenting	Testing the hypothesis, testing the problem	12
	Experimenting, observing, preparing the setup	11
Classifying	To group, classify, categorize according to similarities or differences	23
Observing	To observe, perceive	12
	Experiencing with our sense organs	6
Measuring	To compare	5
	Finding value, calculating in units, expressing numerically	5
	Measuring with a measuring tool	4

Teachers defined SPS of "estimating/ hypothesizing" (*n*=27), "recording data" (*n*=25), "changing and controlling variables" (*n*=24), "using data and modeling" (*n*=23), "experimenting" (*n*=23), "classifying" (*n*=23), "observing" (*n*=18) and "measuring" (*n*=14). Teachers defined "observing" as perceiving, experiencing with our sense organs; "measuring" as comparing, finding value, calculating in units, expressing numerically, measuring with a measuring tool; "classifying" as grouping, classifying, classification according to similarities or differences; "recording data" as recording results/measured values, taking notes, processing; "estimating/hypothesizing" as hypothesizing/ predicting the outcome of the predicted subject or event, speculating; "using data and modeling" as creating a product suitable for the data (model, design, mock-up, etc.);"changing and controlling variables" as controlled experiment; "experimenting" as testing the hypothesis, testing the problem, experimenting, observing, preparing the mechanism (Table 7).

SPS EXAMPLES OF USES

Teachers and students were asked to give some examples of SPS use in science lessons. Their answers were given in Table 8.

Table 8 SPS Examples of Uses in Science Lessons

SPS	Teachers		Students	
	Examples	**f**	**Examples**	**f**
Observing	Observation in experiments (including reading and practice)	15	Looking at the moon and stars with a telescope	113
	Presented images		Observing the color change on the litmus paper	
	Examining with a microscope		Examine the structure of the leaf	
			Examine animal heart	
			Examining cells with a microscope	
Measuring	Measuring quantities such as force, mass, volume, length, temperature	6	Measuring air pressure	98
	Measuring on a dynamometer		Measuring the temperature of cold and hot water	
	Measuring the distance traveled by the vehicle on friction/frictionless ground		Measuring the angle	
			Measuring the mass and volume of substances	
Classifying	Classification of living things	5	Classification of living species	92
	Grouping levers, pulleys in simple machines unit		Classifying animals	
	Listing electricity as conductors and non-conductors		Classification of substances according to their physical states	
	Classification of substances as pure and impure or solid, liquid, gas		Classify solutions	
			Classification of liquids according to their density	
Recording Data	Note down the observations made in the experiments	3	Comparing the forces of objects measured with a dynamometer by writing them down on a piece of paper	83

Recording Data	As the weight suspended on the dynamometer increases, measuring the amount of extension in the spring, and recording them in a table	3	Recording the result, we observed with the microscope	83
			Recording melting, freezing temperatures Note in a notebook what flavors the tongue takes	
			Transferring the weights of some substances at different heights to the table	
Estimating/ Hypothesizing	Asking questions about the factors affecting the dissolution rate, about each variable, to predict the result with the data at hand.	3	Estimating the weights of objects	77
	The situation where the force gain is dependent on the force arm in the levers		Predicting how a mixture of iron and sand can separate	
	Hypotheses given within the scope of the activity		Predicting an explosion as a result of mixing two chemicals	
			Estimating how fast the car is moving relative to the ground	
			Predicting which colors would appear before trying to refract the light	
Using Data and Modeling	Energy pyramid example	5	Building the model of the planets	81
	Digestive system model		Making a cell model	
	Images given before or after the experiment		Construction of electrical circuits according to the given data	
	Designing a model based on the conversion of electrical energy into heat, light or motion energy		Modeling of electrical circuit	
	By giving experimental examples and asking students to create models in this context		Modeling of the skeletal system	
Changing and Controlling Variables	Keeping the number of batteries constant and changing the number of bulbs in a simple electrical circuit	6	Changing the amount of heat to find out how quickly a sugar cube dissolves in tea	72
	Keeping the factors other than the desired situation constant to repeat the experiment with a different situation		Replacing the number of bulbs and batteries and checking the circuit	
	Changing the independent variable as the amount of water or the wavelength of light when determining the factors that affect the rate of photosynthesis		Observing the change while applying the opposite force to a car	
	The subject of dependent independent variable is reinforced by giving examples from daily life on the factors affecting the dissolution rate.		Observation of the dissolution rate of 10 grams of sugar in hot and cold water	
	Explaining that the force gain increases with the increase of the path loss, not the increase in the force arm		Using both plastic and cardboard cups and changing the lengths of the strings when making a simple phone call	

Experimenting	Experiment to see if photosynthesis takes place in artificial light	7	Separation of salt and water by evaporation	99
	Reagents for determining the pH of substances		Parachute experiment on air resistance	
	Kidney and heart dissection experiments on systems topics		Mixing and straining sand and water to separate mixtures	
	Determination of specific heat		Acid and base experiment	
	Separation of light into colors and image formation in mirrors		Olive oil and water experiment	
	Experimenting with variables and constants		Sound propagation experiment	
	Giving an experiment and asking students to do it			

Teachers mostly gave examples of "observing" skills (*n*=15) regarding the use of SPS in science lessons. The examples related to the observing skill were followed by "experimenting" (*n*=7), "measuring" (*n*=6), "changing and controlling variables" (*n*=6), "classifying" (*n*=5), "using data and modeling" (*n*=5), "estimating/hypothesizing" (*n*=3) and "recording data" (*n*=3) skills, respectively. Similarly, studentsgave examples related to the SPS of "observing" (*n*=113), "experimenting" (*n*=99), "measuring" (*n*=98), "classifying" (*n*=92), "recording data" (*n*=83), "using data and modeling" (*n*=81), "estimating/hypothesizing" (*n*=77), "changing and controlling variables" (*n*=72) (Table 8).

DEVELOPMENT OF STUDENTS' SPS IN TECHNOLOGY-ENHANCED LEARNING ENVIRONMENTS

While 86.1% (*n*=31) of the teachers thought that the SPS of the students learning with technology-enhanced learning environments would improve, 13.9% (*n*=5) of them did not agree with this view. The frequency values and some justifications of the answers given by the teachers who think that the SPS of the students who learn through technology-supported learning environments will develop regarding which of these skills will be developed are given in Table 8.

Table 9 Development of Students' SPS in Technology-Enhanced Learning Environments

SPS	Justification(s)	f
Observing	Provide detailed observation opportunity	20
	Observing hard-to-observe events/experiments	
	Offer time flexibility	
Experimenting	Providing the opportunity to conduct experiments in a virtual environment	20
	Provide the opportunity to perform dangerous/difficult-to-do experiments	
	Providing the opportunity to experiment more	
Classifying	Easy classification/grouping	16
	Distinguish similarities/differences more easily	
Using data and modeling	Creating models in a digital environment	15
	Ability to create models with less material	
	Easier visualization	
Recording data	Saving data to digital media	14
	Saving data correctly	
	Easy save data	

Measuring	Develops measurement skills	13
Estimating/Hypothesizing	Improves estimation skills	13
	Improves the ability to use data correctly	
	Develops independent testing skills	
Changing and controlling variables	Observing the effects of changing variables	12

Teachers thought that students' "observing" (*n*=20) and "experimenting" (*n*=20) skills would be improved the most in technology-enhanced learning environments. These skills are followed by "classifying" (*n*=16), "using data and modeling" (*n*=15), "recording data" (*n*=14), "estimating/ hypothesizing" (*n*=13), "measuring" (*n*=13), and "changing and controlling variables" skills (*n*=12) (Table 9).

BENEFITS OF DEVELOPING STUDENTS' SPS IN REAL LIFE

Teachers were asked whether the development of students' SPS would benefit them in real life. While 91.7% (*n*=33) of the teachers who participated in the study stated that the development of students' SPS would benefit them in real life, 8.3% (*n*=3) of them stated that it would not. Teachers who believed that improving the SPS would benefit students in real life were presented with some alternatives regarding the possible real-life benefits it can provide to students. The frequency values of the answers given by the teachers to these alternatives are given in Table 10.

Table 10 Benefits of Developing Students' SPS in Real Life

Benefits of developing students' SPS in real life	f
Gaining a scientific perspective on events	29
Awareness of the problem(s) around them	29
Science literacy	28
To enable the student to access the information himself/herself	28
Expanding perspectives on events	27
To be able to solve the problems they encounter more easily	25
Other (to increase students' level of relating between events and phenomena)	1

Teachers stated that the benefits of developing students' SPS in real life would be "gaining a scientific perspective on events" (*n*=29), "awareness of the problem(s) around them" (*n*=29), "science literacy" (*n*=28), "enabling the student to access the information himself/herself" (*n*=28), "expanding perspectives on events" (*n*=27), "able to solve the problems they encounter more easily" (*n*=25) (Table 10).

CONCLUSION AND DISCUSSION

The views of teachers and students have consulted within the scope of needs analysis studies for the development of design elements of a web-based learning system that would help the development of students' SPS to be used in science lessons. According to Cook and Dupras (2004), there are basic steps to developing an effective educational website. These are conducting a needs analysis and setting goals and objectives, identifying technical resources and needs, promoting active learning as the methodology, planning to facilitate and encourage learner use (making the website accessible and user-friendly, dedicating time to learning and motivating students), evaluating students and the course; piloting the website before full implementation, planning to monitor and maintain online communication by resolving technical issues, verifying hyperlinks periodically, and updating content regularly. A web-based active learning systemhas been designed to develop students' SPSconsidering the teacher and student needs identified in the current study.

According to Poon et al. (2004), behaviors of students, characteristics of faculty lecturers, interactive application, technology or systems, and institutions are the factors that affect the effectiveness of the online learning process. In addition, there is a need to improve the quality of web-based learning due to the variations in the adaptation styles of the learners in the process. In such learning systems, teachers should be able to constantly control the interaction of students with learning resources, respond easily to feedback, easily upload learning content to the system, and analyze student interactions on the content. Therefore, it is

important to define students' and teachers' needs and characteristics to develop an online learning environment.

While determining student needs, it was also asked whether students had difficulties in learning science subjects, and if they had difficulties, why they could not learn science subjects. Middle school students stated that they had difficulty in learning science subjects due to the reasons of inability to visualize topics/concepts/events, inability to do math operations very well, inability to memorize formulas, not finding topics interesting, being indifferent to science class, inadequate technological tools and equipment, inadequate laboratory, and equipment, finding less time allocated to science lessons, respectively. Moreover, students thought that they can learn the subjects in the science course better with their individual efforts, technological and educational support, and various teaching activities. While some of the students who learn with individual effort thought that they can learn by solving tests/ questions and repeating the subjects, working, writing, and listening well, some of them thought that they could learn better with technological and educational support. In addition to these, some students stated that they could learn better by experimenting, through face-to-face lessons, applied lessons, detailed/intensive/well-education, increased course hours/numbers, fun lessons, and observation. Furthermore,most of teachers and students thought that science subjects could be taught with technological tools such as computers, smartphones, and tablets. Apart from these, there were also teachers and students who thought that science can be learnt better with different technological tools such as multimedia technologies, AR/VR glasses, 3D devices, and virtual labs.Barbour et al. (2008) found that secondary school students perceived web-based learning environments as useful and challenging. They emphasized the need to ensure that students should be provided with well-designed and organized content, as well as with an efficient time management and motivational skills so that they can work effectively in this independent environment. Most of the students stated that they liked learning science more after using the website tutorial and theinteractive content that included a game as teaching materials. The website tutorial motivated students werefun and helped them learn about the levers of the human body (Astuti et al., 2020). It is obvious that the technical system quality, information quality, education system quality, and service quality positively affect students' intention and satisfaction to use web-based learning management systems (Mehroliaet al., 2021).

Students gave positive feedback on the features of web-based learning tools such as visual aids, learning benefits, ease of use, animations, graphics, and engagement. Although some students were concerned about the speed, difficulty level, and quality of the help features when using web-based learning tools, it has been observed that the generally used web-based learning tools have a positive effect on teacher and student attitudes and student learning performance (Kay, 2014). The features of a web-based learning environment that support students' needs in the learning process were an online discussion forum, lecture notes, assignments, portfolio, and chat. Many students also agree that an online discussion forum is the highest requirement, as the tool can provide a space for students and teachers to share knowledge and experiences related to teaching and learning (Hamzah et al., 2017).Students with different learning patterns and experiences learned equally well in web-based courses. Students enjoyed the ease and self-controlled learning speed of web-based learning and were motivated by competition and high expectations (Gamon, 2001).

Both teachers and students found the web-based learning tools easy to use. They were positive about the learning impact and engagement value that web-based learning tools bring to the classroom. Web-based learning tools have the potential to improve students' understanding of both basic and higher-level concepts. Carefully planned lessons seem to increase the learning impact of web-based learning tools–these tools are often not designed for independent learning. Teachers need to be aware of possible problems with going too fast, level of difficulty, and amount of text. While web-based learning tools are easy to use, the concepts presented can be challenging especially when the learning speed is too fast or there is too much text to read (Kay, 2014).

Teachers define SPS of observing as perceiving, experiencing with our sense organs; measuring as comparing, finding value, calculating in units, expressing numerically, measuring with a measuring tool; classifying as grouping, classifying, classification according to similarities or differences; recording data as recording results/measured values, taking notes, processing; estimating/hypothesizing as hypothesizing/predicting the outcome of the predicted subject or event, speculating; using data and modeling as creating a product suitable for the data (model, design, mock-up, etc.); changing and controlling variables as a controlled experiment; experimenting as testing the hypothesis, testing the problem, experimenting, observing, preparing the mechanism. On the other hand, students stated that activities in science lessons improve the SPS of observing, experimenting, measuring, classifying, recording data, using data and modeling, estimating/hypothesizing, changing and controlling variables, respectively. Many of the teachers and students both stated that using technology in science teaching would improve the SPS of observing and experimenting. This result is consistent with the representation of lower and upper-secondary school science textbooks' science activities in terms of SPS(Yalçınkaya-Önder et al., 2022). In addition to these skills, teachers stated that other skills such as interpreting/inferring, development in cognitive and affective areas, analyzing/synthesizing, critical and creative thinking, and problem-solving skills can be improved by using technology in science teaching. Besides, teachers thought that students' observing and experimenting skills would be improved at most in technology-supported learning environments. These skills are followed by classifying, using data and modeling, recording data, estimating/hypothesizing, measuring, and changing and controlling variables skills. Furthermore, they stated that the benefits of developing students' SPS in real life would be gaining a scientific perspective on events, awareness of the problem(s) around them, science literacy, enabling the student to access the information himself/herself, expanding perspectives on events, and able to solve the problems they encounter more easily. Online integrative teaching strategies improve the integrated SPS (interpreting data, defining, hypothesizing, and experimenting skills) of the students (pReyes &Aliazas, 2021).

Teachers stated that the features of a web-based teaching system should be simple and understandable, related to real/daily life, diverse in terms of content, rich/good in visual terms,interactive as a system, and include multimedia technologies such as 3D materials, simulations, and animations. According to the results, SPS seems to have improved when students learned with computer simulations and animations. Computer simulations and animations have been suggested as a suitable alternative teaching method in chemistry learning in secondary schools (Beichumila et al., 2022). Computer simulations used in the social constructivist learning environments have important pedagogical consequences. Biology students and primary school students stated that this experience was beneficial for learning science. It was emphasized that students overlooked the importance of identifying variables in an experiment, as computer simulation provides rapid results of the experiment. In spite of the efficiency of computer simulations, it was stated that instructors should be guided in using and learning SPS. Since computer simulations imitate the problems in real life, it has been stated that this teaching tool is also powerful in improving problem-solving and decision-making skills in biology subjects (Lee et al., 2002).

In addition, according to teachers, the features of activities that should be in a web-based active learning environment are interesting/fun, associated with daily life, game-based, tutorial on the subject, assessment, and evaluation, encourage repetition, and preparation for exams. On the other hand, many students pointed out that a website that would help them learn the subjects in the science course should include lecture videos (tutorial videos), test/solved/sample questions, practice exams, accurate and reliable information;be simple, understandable, and easy; have rich and interactive content, and a good technical infrastructure. Perceived usefulness as the most important factor affecting the intention and actual use of the system, perceived ease of use, and system quality increase the instructors' intention to use web-basedlearning systems (Motaghian et al., 2013).Teachers had very positive opinions on the learning benefits, design, and engagement value

of web-based learning tools. Although being more critical, the students were still positive about the same characteristics. Students appreciated the visual scaffolding, ease of use, engagement, and use of technology. Student performance in five knowledge categories (remembering, understanding, applying, analyzing, and evaluating) enhanced significantly when web-based learning tools were used. Although middle school students had similar attitudes towards web-based learning tools, older students showed higher learning performance gains (Kay, 2011). System quality, service quality, and self-efficacy are the factors that increase perceived ease of use. Increases in perceived usefulness increased teachers' intention to use the web-based active learning system more (Wang & Wang, 2009).

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CONFLICTS OF INTEREST

No potential conflict of interest was reported by the author(s).

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