

Turkish Online Journal of Educational Technology

Volume 21, Issue 3 July 2022

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TOJET 01.07.2022



THE TURKISH ONLINE JOURNAL OF EDUCATIONAL TECHNOLOGY

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ISSN: 2146 - 7242

Indexed by Education Research Index ERIC EBSCO Online Cabell's Directories Index Copernicus Journal Master List



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Published in TURKEY

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The aim of TOJET is to help students, teachers, school administrators and communities better understand how to use technology for learning and teaching activities. The submitted articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to TOJET. TOJET provides perspectives on topics relevant to the study, implementation, and management of learning with technology.

This journal was initiated in October 2002 to share knowledge with researchers, innovators, practitioners, and administrators of education. We are delighted that more than 693000 researchers, practitioners, administrators, educators, teachers, parents, and students from around the world had visited TOJET for twenty-one years. It means that TOJET has diffused successfully new developments on educational technology around the world. We hope that this volume twenty-one issue three will also successfully accomplish our global educational goal.

I am always honored to be the editor in chief of TOJET. Many persons gave their valuable contributions for this issue. I would like to thank the guest editor and the editorial board of this issue.

July 01, 2022 Editors, Prof. Dr. Aytekin İŞMAN Sakarya University Prof. Dr. Jerry WILLIS Louisiana State University



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An Evaluation on the Human Voice and the Act of Singing

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ABSTRACT

The human voice is an alive, natural instrument belonging to the human body and most beautiful tool for the individual to express himself. When evaluated from a musical point of view; the human voice, the first known musical instrument in the history of music, is the oldest, most natural and most valuable of musical instruments. This privileged instrument bestowed upon man is different for every human being, like a fingerprint. This makes it a single and unique instrument unique to a human being. The human voice, which is used for simpler (primitive) situations (crying, laughing, screaming, etc.), turns into a more complex ability, to speaking and an even more complex ability, to singing. Although all three forms of voice are formed instinctively and/or for a reason arising from necessity, they are also used to express a higher artistic expression. The voice, which is basically used for self-expression and communication, turns into a tool of higher expression in the oral arts and the art of singing. The act of speaking is the basis of the act of singing. Accordingly, it can be said that the act of singing is an enhanced and expanded speaking skill. The correct, beautiful and effective use of the human voice, especially in the art of singing, is based on both technical and artistic skills. Therefore, not only technical skills but also technical skills and artistic skills should be considered together for the development of singing skills in vocal training, and technical skills should support artistic skills. The researches on the human voice and the singing act until today have generally only dealt with the sound from a scientific, biological-acoustic perspective. As far as can be reached, no study has been found in the literature in which voice is considered as a multidimensional phenomenon, in a holistic way, including its biological, spiritual, emotional and aesthetic dimensions. In this context, the aim of this research is to make an evaluation and make suggestions by considering the human voice and the act of singing with its artistic and philosophical aspects. It is hoped that the research will contribute to filling the gap in the literature and set an example for new research to be conducted in this direction. In the research, which is based on the literature review, the domestic and foreign literature on the subject has been tried to be examined. Keywords: Music, Instrument, Human voice, Singing act.

INTRODUCTION

The human voice is a valuable instrument that usually begins with the first cry after birth and is indispensable for human beings until death, except for special cases/exceptions. The fact that it is an alive, natural instrument belonging to the human body and that it is a unique instrument with its own uniqueness like fingerprint, makes it special and important. To understand how special, important and valuable it is for life, it will be enough to think for a moment that this unique instrument has never been given to man.

The voice, which is basically a means of self-expression and communication, turns into a more complex ability, to speech and an even more complex ability, to singing. Therefore, on the one hand, the human voice used for simpler (primitive) situations (sigh, crying, laughing, screaming, etc.) is also used for the expression of a higher artistic expression. In this sense, it can be said to be a surprising and fascinating instrument.

From a musical point of view, it is thought that human beings have been making music by singing or playing an instrument since the beginning of their existence on earth. Music plays a role in almost all important stages of human life (from growing up to marriage, from birth to death). It accompanies work, dance, entertainment and religious rituals. The sound required to make music is produced by the voice of the human mouth or by various musical instruments (Lord and Snelson, 2018, p. 6). The rhythmic dance and musical production types that have characterized music throughout the ages have served as a proof of physical and mental vitality, moreover, higher consciousness and reliability. Because the expertise required to be a musician, requires a special kind of mental focus (Levitin, 2015, p. 289).

It is stated that the earliest sources of music making are probably the "Iliad and Odyssey" (ca. 800 BC), in which epic singers are mentioned. In addition to epic songs, songs that have been sung with a wide variety of vocal forms in almost all areas of life have been included in various sources since Homer. These include business anthems, love songs, and booze songs, and many of them still have. Hymns have been sung to the gods or have been featured



in religious rites such as weddings. There is a certain voice repertoire that is reserved for both gods and humans, or accepted as suitable for both groups (Lord & Snelson, 2018, p. 13).

According to Mark (1982, p. 74), the subject of human voice and singing has occupied the minds of philosophers and musicians throughout history. Martin Luther, in the preface to Georg Rhau's "Symphoniae Incundae" (Sweet Symphony), dated 1538, has said:

Philosophers have tried to explain the marvelous nature of the human voice: How can the air reflected by a slight movement of the tongue and an even lighter movement of the larynx produce such an endless variety of sounds and pronunciations? And how can the sound come out so strong? Despite their best efforts, philosophers can't find an explanation... No one has yet been able to identify or show the original components of the human voice. They are surprised, but they do not understand.

Understanding the human voice in his own way, Luther's questions contain key ideas that modern philosophers, psychologists, and phonologists have focused on to explain the "infinite variety and articulation of voice" and "how a human can sound so powerfully." Luther, defines two forms of movement produced and perceived in singing, "the movement of the throat" and "the movement of the tongue." While making this definition, he emphasizes that the physical movements of the larynx and tongue are important components of the singing sound. Such movements (for example, breathing, vocalization and articulation) can be described separately but are not. "Singing" is the sum of all the movements that compose it. The muscles work together in a continuous cyclical process, and all parts of the voice function as a whole in some special coordination. It is not used for any other purpose (even for speaking). However, ensuring the continuity of such movement and coordination and controlling these movements to produce an aesthetic product depend on another important factor, art, which is a set of skills and understandings.

It can be said that the human voice, which has an important place in the transmission of emotions and thoughts from the first ages to the present, has developed over time and today's singing art has emerged. As a result of prehistoric research, anthropological and sociological findings, various hypotheses have been put forward about how singing emerged, but the most notable of these; it is the use of certain sounds and melodic rhymes in order to increase physical strength and motivate people during joint work in primitive tribes. These rhythmic repetitions are thought to be the basis of speaking and singing. It is assumed that in primitive times, people imitated the sounds of nature by listening and used these sounds to communicate with each other. Primitive music has no artistic or entertaining function. In primitive music, which is predominantly rhythmic and used for magic, every sound or every word has a different rhythm. Expressing the words in accordance with their inner rhythm is called "logogenic", while the music formed by the expression of enthusiasm and emotion without depending on the words is called "pathogenic". In the course of evolution, other sounds have been added to the first melodies that hovered over two voices and in two, three or four intervals. In primitive music, in order to revive monotonous repetitions, the communication between two people or two groups in a choir in turn (question-answer method) is called "antiphony", while a group continues the sound of a song, the other group puts another song on this sound at the same time, it is called "pedal". When everyone sings with different voices, it is "heterophony". Thus, the so-called polyphony is formed. As a result of the development of all these different voices and techniques, today's music has been reached (Ömür, 2001, p. 39, 40).

The act of singing, a fundamental form of musical expression, has played a vital role in ancient forms of ritual and theater in antiquity. Aristotle, who said, "song is the sweetest source of joy for man," and Athenaeus, who said "it is not shameful to admit that one knows nothing, however, his/her refusal to sing among them is shameful" have expressed the importance of singing in human life. The ability to sing well has always been seen as a sign of culture and humanity in the history of western and other civilizations. In general, two basic qualities are always necessary for a singer to be good: correct intonation (intonation) and correct pronunciation. Characteristics of a good singer are; while according to Tinctoris (1481), the a good voice quality and a good sense of voice, correct rhythm and correct pronunciation; according to Giulio Caccini (1601), respiratory control, correct pronunciation and power of expression; according to Sergius Kagen (1950); musical hearing ability, naturalness of voice in singing, proper pronunciation and expressive power (www.grovemusic.com).

Although general information is given above in the context of various sources, most of the research to date on the human voice and the act of singing has focused almost exclusively on voice as a biological phenomenon, not on the voice as a musical instrument. According to Rao (1988, p. 141), while the shape of a musical sentence can be successfully reproduced scientifically with sound synthesizers, it is important and necessary for more phonologists to ask important questions about the aesthetic dimensions of the singing experience. In this context, philosophical, descriptive and experimental perspectives will be required to see the human voice and singing act as a multidimensional phenomenon more holistically rather than a purely biological-acoustic sound source. The act of



singing is a special way of using the voice that embodies a biological, spiritual, emotional and aesthetic nature. The definition of singing as art depends on these aspects of singing. Therefore, the correct, beautiful and effective use of the human voice, especially in the art of singing, is based on both technical and artistic skills. For this reason, not only scientific approach and technical skill, but also artistic skill should be given importance for the development of singing skill in vocal education, technical skill should be considered together with artistic skill and should support artistic skill.

PURPOSE AND IMPORTANCE OF THE RESEARCH

The aim of this research is to make a holistic evaluation and make suggestions about the human voice and singing act in terms of biological, spiritual, emotional and aesthetic aspects. The researches on the human voice and the singing act until today have generally only dealt with the voice from a scientific, biological-acoustic perspective. As far as reached, no study has been found in the literature in which voice is considered as a multidimensional phenomenon in a holistic way, including its biological, spiritual, emotional and aesthetic nature. In this context, it is thought that this research, which deals with voice with its artistic and philosophical aspects, is important in terms of filling this gap in the literature and being an example for new researches to be done in this direction.

METHOD

This research is a compilation study based on literature review. Literature review is the reading, selection and effective critical evaluation of existing knowledge, thoughts, discussions, speculations and findings related to the research area in order to achieve a specific purpose (Ekiz, 2003, p. 173). For the literature review, it is envisaged that a comprehensive review will be carried out in order to reach both the domestic and foreign literature, especially to scan the literature in recent years and reveal the trends in the world (Demirel, 1999, p. 101). In accordance with the purpose of this research, as far as can be reached, the domestic and foreign literature on the subject has been tried to be examined and relevant sources have been utilized as much as possible.

THEORETICAL FRAMEWORK

HUMAN VOICE

The human voice, the first known musical instrument in the history of music, is the oldest, most natural and most valuable of musical instruments. In addition, it is the most beautiful tool for the individual to express himself and communicate. The human voice is capable of producing sounds that are personal and identifiable, even without words. It can be said that it is the most delicate, skillfully made, intelligent and a flexible instrument among musical instruments, and it carries the charm and magic of the art of singing. Because it gives a high expressive power to words. According to Green (1975, p. 3), the human voice is the only unique instrument and its features are:

- This instrument which belong to human and the sound produced are called by the same name.
- Only its owner can produce the human voice.
- Its structure is mostly hidden in the human body.
- It is made of muscle, cartilage and bone.
- It can produce words.
- It can develop good or bad habits.
- It is directly related to a brain.
- Responds to a variety of sounds in a similar and recognizable way with the aid of hearing sense and culturally. In other words, it naturally has the ability to imitate.
- It has two vocal tracts, the oral tract at the bottom, the nasal cavity and sinuses at the top. Other instruments have only one vocal tract.
- Four physical processes, namely "respiration, phonation, resonance and articulation", play a role in the formation of the human voice.

According to Bunch (1994, p. 9), the physiological difference between the human voice and other musical instruments is the articulatory mechanism that creates words.

The term "voice" is understood differently in the varying contexts of science, religion, psychology and aesthetics. In a sense, voice is an expression tool. In the history of religions, voice is considered a form of conscience/belief or a form of God, whereas in psychology, voice is generally defined as a manifestation of emotion. In aesthetics, it is considered as a living form of musical expression. To date, research on the human voice and the act of singing has only considered it from a biological/acoustic perspective. In the literature, there is almost no study in which voice is considered holistically as a multidimensional phenomenon that includes its biological, spiritual, emotional and aesthetic nature (Rao, 1988, p. 144). In this context, the human voice is discussed in different dimensions below.



The Human Voice: An Expression Tool

In life, humans always need expressing themselves more clearly because of a compelling desire for self-expression which comes with existence. The things that people express and tell are their thoughts (Webern, 1998, p. 23). Speech and language are the basic ways of expressing oneself using communication. So the human voice serves as a means of self-expression.

A person could be happy, sad, angry, happy with it, sometimes calms down, relaxes, heals with it and sometimes convinces, influences, is affected by it. The voice that people use in daily life, basically for the need of communication and self-expression, enables them to directly and naturally reflect their feelings and thoughts. A person's voice feature and the style of using it are the factors that determine his quality and respect. On the other hand, the voice that a person uses for simpler (primitive) situations (crying, laughing, sighing, groaning, screaming, etc.) turns into a more complex faculty, to speaking, and an even more complex faculty, to singing. Although all three forms of voice are formed instinctively and/or for a reason arising from necessity, they are also used to express a higher artistic expression. In verbal arts or the art of singing, when the technical and artistic power of the artist is combined with the technical and artistic power of the work, there are magical moments filled with intense and sublime emotions for the listener and the speaker. Thus, the voice that is used in a plain and simple way has the feature of transforming into a fascinating artistic expression.

Human is the unique creative force who transforms voice into letters, letters into language and language into culture. In this context, the sounds that are naturally reflected by the movement of the human larynx and the vocal cords in it are the first basic factors that give life to the art of speech and music. Man has found the first tool of music that shapes his emotional life in his own voice. Interaction between people and nature created music, that is, symbolic language and meaning, thus enabling the emergence of a rich and independent music literature. (Altar, 2013, p. 114, 116).

Vocal cords, concretely, is the organ where the voice is produced and can be thought of as a voice part/structure created in the human larynx for the purpose of speech. Susanne Langer (1953) states that, the voice is a tool of biological response. According to this explanation, voice is the basic tool of human self-expression. Thus, Langer argues that biologically voice is not a musical instrument, but fulfills a practical function. Human voice has a distinctive range of sounds including shouting sounds, crying sounds, speaking sounds, and singing sounds. In all these forms, voice serves a basic human function. According to Langer (1972), early human beings knew the humanizing power of voice because it was used in social rituals. Langer argues that the human voice was originally used in ritual singing, rather than possibly for communication and choral chant lyrics were "gradually reduced to the voice of speaking." Indeed, one anthropological view holds that the primitive use of voice in chorus (singing loud, rhythmic chanting) serves as the original means of mental contact between people, thereby uniting the participants as a whole. Thus, in terms of the evolution of speech, some anthropologists believe there was a time when speech and singing were inseparable (cited by Rao, 1988, p. 144, 145).

In Aristotle's psychological treatise "On the Soul", voice is explained as a point of intersection between body and soul. Using the Greek term resonance (sound), Aristotle speaks of the concept of "voice" as a natural phenomenon. "voice" in nature is defined by Aristotle as the psychic sound emanating from the heart, near the vital center. In addition, there is the pitch or melody of the voice (melos; lyrical quality of singing) and its expression (dialector; the form of articulation that languages have) (Sparshott, 1987, p. 47). Likewise, clear and intelligible speech is another differentiation of voice. Aristotle's definition of voice connects the purely organic or biological dimension of voice to the psychic or spiritual dimension. Similarly, modern science suggests that there is a isomorphism of phonetic and psychic qualities found in the human voice. While science suggests that there is a certain isomorphism between sound and its emotional content, it implies that emotions can be interpreted according to the way voice is used (Rao, 1988, p. 146).

The Human Voice: The Expression of God or Faith

In addition to the general view that the human voice is God's grace, both as a means of self-expression and basic communication in life and as a supreme means of artistic expression; McKinney (1994, p. 150) also states that the human voice is the only musical instrument made by God.

The Oxford English Dictionary that researched for early definitions of the human voice, proposes two forms of voice, "inner voice" and "outer voice." Inner voice can be understood as a form of conscience, soul, or emotion. In ancient moral and theological doctrines, true intelligence is the union of inner voice and outer voice. In other words, what the person thinks (inner voice) and what he says (external voice) must match. From this perspective, external voice is the vocal image of the voice in the mind (spoken by mouth). Huxley says, referring to the



relationship between external voice and inner voice, "voice can exist without speech and speech can exist without voice" (cited by Rao, 1988, p. 146).

In the sixteenth century, the term "voice" was used figuratively and often as an expression of God's will, namely "the voice of God." In Biblical idioms, the term "voice" is regularly referred to as "the voice of eternity" or "the voice of duty". These references imply that there is a voice within us, an inner voice that speaks and guides our actions or as it were a conscience. Today, "inner voice" is generally understood as a form of thought or feeling. External voice, on the contrary, can be perceived as a form of action.

The separation of the biological dimension of voice from the spiritual dimension of voice (i.e. body and mind) contradicts Aristotle's teaching that "soul and body constitute one substance". Aristotle's view combines voice as an organ with voice as soul. According to Aristotle's understanding, voice includes besides musical performance, animal cries and clear, intelligible speech. The significance of this view of his lies in the idea that voice is all these things (cries, screams, speech and musical performance). In other words, he argues that the voice used in singing is never separate from the voice used as both thought and emotion (Rao, 1988, p. 147).

As a natural phenomenon (self-expression through speech), there is intonation and articulation of the voice. When singing, the pitch becomes the melody and the articulation becomes the musical phrase. Of course, these differentiations are partly determined by cultural habits. However, both uses of voice are connected with the vital breath, namely the human body. A cross-cultural proposition by Alan Durant (1984, p. 90) in "Conditions of Music" states that "voice is even as noise produced by the lungs with the power of the breath and modified in different ways as it passes through the vocal tract, becomes the rule of gravitational contour and style" and it becomes an expression of emotion and thought." In musical performance, voice functions as a single phenomenon, inseparable both as body and soul.

When discussed from a phenomenological point of view, all sounds; are "voices" in a broad sense, including "the voices of things, others, Gods and man himself": the voice called "spirit" or "conscience" is phenomenologically referred to as the "otherness" produced by the voice. A voice phenomenology goes towards the concept of voice as "meaning in voice" or "being in voice". Contemporary phenomenologist Don Idhe is careful to distinguish between the meaning of words or language and the meaning of voice. Idhe speaks of words as voice and voices as meaning (Idhe, 1976, p. 152). According to Merleau-Ponty (1967), the meaning in speech sound is limited to ordinary words existing "lazily in the middle of words". In unusually sublime usage (singing voice, acting voice) the human voice magnifies the artistic effect. The voice used in singing or acting exhibits a potential power that raises him above his usual strengths. This voice "convinces, transforms and awakens humanity with the importance of its amplified timbre." The phenomenological account of voice is a theoretical example of "inner voice" that reflects a humanistic, potentially religious or moral perspective on the relationship between sound and the supreme being. In its broadest sense, voice embodies all the richness of human meaning. When the human voice sings the musical text in a narrative form, the interpretation is both vocal and meaningful. This may be one of the foundations of the affective power of voice in music (cited by Rao, 1988, p.149).

The Human Voice: Expression of Emotion

Manfred Clynes defines the movements towards phonation and articulation in the formation of the voice as the expressions of the emotions underlying the structure of the music. "Motions towards phonation and articulation" are manifestations of a common expressive dynamic form that underlies both the perception and production of expression in different ways" (Sundberg, 1982, p. 146). A number of studies on the human voice and emotion show that these gestures or forms of movement reflect the emotional content of musical expression (Rao, 1988, p. 149).

Hungarian scholar Ivan Fonagy (1981, p. 59), who studies the human voice, music and emotion, argues that the act of singing is a "symbolic bodily movement" that carries emotion (and potentially musical meaning) from thought to physical expression. Accordingly, "emotions can be interpreted as gestures or symbolic bodily movements."

Fonagy (1981, p. 69) states that singing and poetic speech are symbolic forms that embody emotion, that is, "expressed emotion is somehow actually present in prosodic expression. Furthermore, singing and poetic speech objectify, reflect or externalize the tension felt in emotion. In this context "emotional intonation (singing or poetry) is expressive only if it relieves tension by throwing out the imaginary (idea) that creates tension." According to Fonagy, voice is used as a form of expression, not communication while objectifying emotion with a symbolic gesture such as singing. In singing or drama, voice expresses the tensions and resolutions inherent in music through sustained pitch and rhythmic articulation.



Fonagy, Sundberg and Clynes argue that independently, but also in consensus; in singing, the pitch and its variability, reveal the emotion conveyed by the music. While measuring the various movements of the vocal system during phonation, it is possible to detect the nature of the emotion that arises in the music transmitted by the singer. Emotions are closely related to the voice as well as the affective content conveyed by the text. Although vocal music is not a language in which something is said, it is closely related to words and with this union, it takes its place among the fine arts. The emotional character of the text or subject depicted in singing, like the emotional character of the subject of a painting (for example, a lonely orphan), is an unaesthetic element in the art symbol (a traditional symbol) which is a song or picture. However, as Fonagy and Clynes argue and Reimer (1970, p. 32) explains, non-aesthetic elements can become part of the aesthetic content of a work of art if they are integrated with the expressive elements of a work of art. From this perspective, the emotional character of a text can be as much an element of the expressive singing tone as its other qualities (cited by Rao, 1988, p. 151).

The Human Voice: A Musical Instrument

The human voice is an alive, biological organ and a form that lives 'philosophically as well as literally'. While the voice can function as a form of human discourse, "the primary means of self-expression or genuine emotion," it can also function artistically as a means of musical expression. Langer (1953 p.142) states that: "Since syllables are fixed to a certain pitch and breathing is sustained, vowels precede consonants and thus voice becomes a remarkable phenomenon rather than discourse" (cited by Rao, 1988, p. 152).

As a musical instrument, the voice conveys the qualities and durations of the pitch (bright voice-dark voice; high voice-low voice; long voice-short voice). Indeed, the transformation of voice from a bodily sound generator to sound as a musical instrument of self-expression depends in part on the formal qualities of the music itself (melody, rhythm, and harmony). Music provides a framework in which the voices produced by the lungs (respiration is the necessary energy source for the formation of voice) and changed as they pass through the vocal tract become an expression of ideas and emotions in music (Durant, 1984, p. 90).

Immediately after the formal features of the music are introduced, the voice becomes the carrier of new ideas and leads to a new order, the sung music. Attention shifts from what is said (what the text means) to what is said (how the text sounds). Rather than shouting in anger or sighing in sadness, the voice as a musical instrument details or expresses the feeling of anger or sadness. While voice as a means of self-expression can describe an event or a mood, voice as a musical instrument cannot. As a musical instrument, the voice finds "metaphors" or "analogues" for real feelings in the melody, rhythm and harmony of the music. In short, voice as emotional expression in music becomes the voice of clear, intelligible musical expression through musical form.

Both the body and the sensory system are the parts that make up the voice as a musical instrument. In singing, the distinction between the physical, emotional and musical aspects of the voice is determined by purposeful human actions, well, the "intended thing." While singing, the voice is deliberately used to sing it musically. As a tool of musical expression, voice is phenomenologically intertwined with human and aesthetic possibilities. As the carrier of musical ideas, the voice has two significance: It remains a means of self-expression, that is, a way of communicating ordinary thoughts and feelings. It also carries the musical idea from thought to physical expression (Rao, 1988, p. 152, 153).

According to Idhe (1976, p. 172), voice has an "all-in-one quality" as a medium of musical expression. When voice is used for musical purposes, its possibilities transform from their usual function to their extraordinary aesthetic potential. At the same time, the voice is both real and unreal. As a musical instrument, the voice is a bodily instrument of human expression and is also a highly skilled bodily movement, that is, a living symbol that carries the lively feel of tone and serves to present the music itself aesthetically. However, the voice retains its relevance to real human emotion, regardless of the complexity of the music or the virtuosity of the vocalism.

Joseph Goddard (1905, p. 87) beautifully expresses the uniqueness of human voice as a musical instrument closely related to human emotion:

When music is produced by the human voice, it ceases to be simple in associations and then takes on the multifaceted unity of humanity. We feel this great change in the transition from abstract sound to sound rich in human associations - from foreign tones to familiar tones - is very striking when human voices enter instrumental music. In vocal music, the mystical properties of musical sound have a human aspect.

Goddard's reference to the human aspects of vocal music supports the holistic thesis that the human voice is a multidimensional phenomenon embodying a biological, spiritual and aesthetic nature. The same reference supports Langer's theory that voice, as a carrier of musical ideas, never loses its relevance to real emotion. Technically



stating, compared to other instruments, the human voice is limited as an instrument. As Langer points out, the human voice is musically constrained by the physiological functions of the lungs, the sensitive delicate constrictions of the throat and the habits of the tongue. Unless the voice is masterfully controlled, these parts of the body cannot accommodate the stylistic features of music and cannot function artistically (cited by Rao, 1988, p. 157).

THE ACT OF SINGING

According to Davran (1997, p. 44), the art of singing; "it is the act of achieving the secrets of the human body and soul by taking control of all the muscles involved in the singing task in our body and using these muscles properly." The New Grove's Dictionary of Music and Musicians defines the act of singing as:

It is a basic form of musical expression and since it is almost always linked to a text, it is more suitable for expressing certain ideas than dancing. The human voice, without words, can give emotional expressions as uniquely personal and identifiable as a baby's cry (to announce itself to its mother). It is indisputably one of the most subtle and flexible of all musical instruments (cited in Rao, 1988, p. 159).

Singing voices originate from vital centers such as the heart and lungs (breath). Also, singing is closely related to true emotion, because voice is often used as a means of self-expression. Langer (1953) defines vocal talent as an interpretative musical talent that enables the production of purposeful and controlled sounds. In her assessment, the singer's interpretive ability is derived from the "natural connection between mind and voice" (cited by Rao, 1988, p.160).

The psychological aspects of singing include perception of the way singing is received or heard by the singer. One's perception of the singing voice directly affects their ability to sing. According to Bunch (1994, p. 7), perception is an important factor in singing. Many factors, including emotion, environment and self-image, affect the singer's perception of voice in singing. Bunch argues that the perception of tone while singing is necessary so that the quality of the produced tone fits the artistic purpose of the composition and does not detract from the meaning of the music. The analysis of the voice (the ability to "hear" and evaluate one's own voice) depends on:

- sound source (sound),
- environment (where sound is produced and heard),
- reception of sound,
- the ability to hear and distinguish.

Bunch also states that perception in singing includes the ability to recognize the aesthetic qualities of music and states that the act of perceiving while singing has three aspects:

- correct hearing without a physical disability,
- actual stimulation of the sensory receptor systems of the ear,
- neurophysiological aspects.

On the other hand, Sundberg (1982, p. 91) says the following about the perceptual effect of singing: "One of the most important things about the act of singing... It is truly remarkable that a performer can use voices to convey musical phrases rather than unrelated tonal sequences to the listener." Sundberg states that the ability to sing and interpret music in a meaningful way depends on the singer's ability to hear, feel and evaluate his own voice to adapt to the characteristics of the music. There are two ways to create a "certain musical effect" when singing. The first is the use of audio signals (the singer's ability to systematically produce and hear sound) to adapt to the structure of the music. Second, the singer "must be consciously or unconsciously aware of the nature of the music."

Since the tone of singing is different from the tone of ordinary speech, the singer must be able to perceive this difference systematically. In his research on the act of singing, Seashore (1936) argues that the singer's interpretation (ability to produce and "hear" vocal tone) is accomplished by what he calls artistic deviations from the mean. So, this happens with the change in vibrato, which is actually the movement of the pitch. Seashore is convinced that the deviations in singing are by no means random. Namely the singing voice and the singer's ability to produce that voice musically are not incidentally. It requires a system that has a way of hearing and evaluating the tone (cited by Rao, 1988, p. 134).

Sundberg (1982, p. 95) agrees with Seashore that "artistic deviations" in tone are not random. They are about a "set of rules" or technique. He argues that the ability to produce "deviation from the mean" or "acceptable" song tone, as distinct from ordinary speaking tone, is the basis of musical performance: "Systematic deviations from the mean cause the performance to come to an artistic agreement with the musical structure." An aesthetically pleasing voice performance is dependent on the ability to produce tones appropriate to the musical structure. That is, technique must be applied to the structure of the music. The act of singing requires picking up or hearing the tone



and making any necessary adjustments to the sound production. According to Sundberg, artistic interpretation is a singer's ability to convey the musical content and emotional atmosphere underlying the text and music through "the emotional information in the musical sounds from the singer's own voice". The use of the term "aesthetics" is theoretically inappropriate unless the singing mechanism and its function are related to the expressive qualities of art and the artist's perception of these qualities.

Vernon A. Howard's book "Artistry: The Work of Artists" is an important example of philosophical research into the artistic aspects of singing. Howard (1982, p. 35) draws attention to the relationship between singing and art in his book. He distinguishes between "function of sound" (the way sound is produced) and "art of the singer" to get a clearer picture of both components. Howard defines singing as a combination of "scientific" knowledge (physiology and acoustics) and "active" management (voice control, projection and flexibility). According to Howard, arriving at a theoretical vision of singing mastery from the first evidence of one's senses and experiences has philosophical as well as physiological and practical dimensions (1982, p. 37). Accordingly, it is very important and essential to develop an understanding of singing as a subtle practical decision governing action. Howard (1982, p. 52) states that singing cannot be reduced to "rote tools to fixed ends," as if it were a mindless routine. While accepting routine in singing, He argues that thought (mind) drives the development of the singing voice and its use in performance.

Meribeth Bunch (1994, p. 1, 2), in her book titled "Dynamics of the Singing Voice", accepts the relationship of the act of singing with art. He sees the act of singing as a sensorimotor phenomenon that requires certain physical skills based on an understanding of the singing processes. At this point, Bunch expresses his thought as follows; "although most people can sing and produce musically acceptable vocal sounds... few could become true artists."Because singing is a common activity, the intricacies of the vocal mechanism are often overlooked. In his book, Bunch identifies coordination and energy as the two most often overlooked components essential to artistic performance. She sees the relationship of the singing voice to the art of music as a "personal and often ... mystical" issue. She tries to relate vocal function to art by explaining in scientific terms how the muscles involved in singing work to produce certain vocal musical qualities. According to Bunch; Knowledge of anatomy, physiology and acoustics is an important aspect of singing. Thus, "a student who understands voice function can develop a more educated perception." Although she claims that the world of science has the most consistent terminology for use in the context of sound teaching, and that scientific terminology provides the most logical basis for constructing a science of vocal pedagogy, Bunch argues that for teaching purposes scientific terminology should be supplemented with images that are descriptive and artistic.

Thelma Merrick's theoretical work on cognitive-emotional processes in vocal pedagogy distinguishes between vocal production and aesthetic perception of voice in singing. Merrick developed a theory of the singing voice called "voice perception". Voice perception is based on the use of images in the analysis of sensations felt during the act of singing. It is an approach to teaching singing that uses the assessment of singing tone sensations as a tool for conceptualizing singing tone.

Through the experience of singing and the analysis of the process, the student develops a concept of singing. In this theory, the ability to sing is acquired through the singer's heightened awareness of the act of singing, this includes the following:

- awareness of vocal functions,
- assessing the changes that have occurred and
- the ability to repeat a modified production if desired.

Merrick distinguishes between vocal sound production and perception of produced sound. Singing is the ability to develop a concept of tone through awareness and evaluation of sensations experienced in tone production.

Russell Hammer (1937) states that the ability to singing is a result of musical development. It can be said that Hammer's book is the only example of an aesthetic-based approach to singing that takes musicality into account. According to Hammer, the following are important for the development of singing ability:

- awareness of a musical problem,
- initiate a response to the musical question,
- distinguishing or recognizing the musical problem, and
- developing more insight.

According to Hammer, the technique of singing "must be learned in the context of the situation in which it will be used." For Hammer, musical literature is the primary way to develop singing. Because literature provides the source from which singing technique can be learned. Hammer distinguishes between pure tone reproduction and the singing experience. Accordingly, the real tone is generated from the respiratory system, larynx/vocal cords and



resonators/mouth and pharynx. Song tone reproduction is based on vowel quality. Through vowel formation, musical qualities such as color, character, and variety are given to singing. Therefore, the "connection" of voice production with musical activity is achieved in the use of vowels and consonants according to the characteristics of the music. The application of vowel to music creates singing as opposed to vocal tone production. Hammer's approach to singing regarding vowel formation is similar to Appleman's work. Appleman's phonetic approach suggests that the singer's focus on the phoneme helps to select the timbre appropriate to the musical purpose. In his phonetic approach to singing, the vowel makes a connection between the "science of singing" and the "art of vocalization" (cited by Rao, 1988, p. 139).

Rogers (2013, p. 4) says that the act of singing is the highest expression of music, as it is a direct expression of spiritual feelings. The human voice is the only instrument that can respond to the will with its absolute spontaneity. When the supremacy of natural law is permitted by the singer, there is nothing between the will and its agent to break or divert the magnetic current. Voice is the only tool that is part of our body and connected to the soul itself. The real urge to singing is the unconscious feeling of the soul that drives the word to sing. It is the spirit that informs the human voice, through the mind, as "transfer my power to the voice so that I can know it". In this way, Rogers states that voicing the silent language of the soul is a marvelous task. The act of singing is discussed in widely below with its various dimensions.

The Act of Singing: Using a Special Tone of Voice

Sparshott (1982, p. 85), defines the act of singing as "an elaborate form of using a particular tone." Sparshott's definition of singing incorporates components of both art and skill, given the distinction between singing as an art (a quality of voice or tone) and singing as a technical skill (a way of producing or forming a tone). If the phrase "a detailed way of using voice..." is taken to suggest a specific type of sound production or a way of making/producing sound, this sentence alone satisfies the technical skill component of singing. The remainder of the expression, namely "a special tone of voice", satisfies the artistic component of singing, referring to the singing tone of the voice. This is an aesthetically recognizable tone as opposed to spoken tone or ordinary voice. When these expressions are used together, it is understood that singing is both a technical skill and an art.

Singing transforms the ordinary voice into an extraordinary special voice, a voice that can be expressed musically. Singing as a special way of producing sound, that is, presenting ideas and sharing the meaning of life with others, serves the basic human inclination of man. In singing, in contrast to speech, emotion precedes meaning, and attention is literally shifted from what is uttered to tonal form, to what is sung with the voice. Verbal expression creates resonances. The concept of singing underlies the aesthetic nature of singing as a specific tone, perceived tone, or musical sound. Indeed, when the act of singing is considered as a special tone, one's understanding of singing as an art deepens.

When someone sings, the voice is recognized as the musical tone. At this point, Sparshott asks a key question, "What is tone?" and he states that musical tone is ordered by pitch and that pitch is a mathematically defined scale in an ideal instrument often determined by frequency ratios or string lengths. Sparshott argues that the music system based on a mathematically defined pitch system may be an artificial system. Such a system, developed from instruments rather than the human voice, has elevated instrumental music to a "pure or absolute" form has leaved vocal music in a less pure (or more distorted) category. Indeed, it is common to hear instrumental music referred to as "absolute music or pure form".

Sparshott (1982, p. 47) advocates a different way of thinking about music, which sees the notion of musical pitch as "voice" (phone) rather than tone (tone). In practice, pitch (such as high or low) is described by the fact that: "People produce different sounds depending on whether we speak, shout, whisper or sing and the time when vocal sounds differ most clearly according to pitch is when we sing."

Sparshott uses the term voice as "voice as faith/conscience". In this sense, the sound in nature is the psychic sound attributed to the body, heart and vital breath. Inner voice (voice of conscience or mind) and external voice (phonation, that is, the act of producing sound) are considered as one voice. Echoing Langer's definition of voice as "passionate expression", Sparshott calls music in which the voice is central "heteronomous music organized by the succession of passions expressed in a spoken text".

Whether the human voice is considered a musical genre or music a type of voice, the act of singing can be considered an aesthetically pleasing musical tone rather than a mathematically defined set of pitches. Although the act of singing is not considered "pure art" due to its relation to the text or irregular pitch frequencies, it can be considered as a distinctive art form embodying meaningful expression in the sung text (Rao, 1988, p. 162).



The Act of Singing: Creating Musical Voice

According to Robert Shaw (1979), the human voice creates a musical tone in the act of singing. The human voice in music art and singing; it is melody, rhythm, harmony and dynamics, not a narrative or expression to explain a story. This view is expressed in slightly different terms by Margaret Hillis (1975) in an interview on the philosophy of choral singing in The Choral Journal. Hillis argues that in singing, the human voice is "just one of many instruments" and that the essence of singing is "the music itself", not diction or expression. By "the music itself" Hillis means that the act of singing begins with an intense musical awareness of the inner life of the art form, not the notes or the elements themselves (cited by Rao, 1988, p.163).

The expression conveyed while singing is never separate from the voice it sounds come to ear. That is, the literary content cannot be perceived separately from the music itself. However, the traditional philosophical view, contrary to the view that evaluates singing as a multidimensional phenomenon with a holistic approach, accepts that the close relationship of purely musical sounds and text in singing interferes with aesthetic perception - the aesthetic response to purely aesthetic qualities. From this point of view, the act of singing is understood as less than an absolute or purely aesthetic experience because of its relation to words.

Although music owes its place within the fine arts to its relationship with literature, expressionist philosophy, which derives from its roots, particularly because of the poetry sung, tends to characterize text in music as less of a primary element. Although Langer mostly adheres to this line of thought, he states the following about the relationship between words and music:

When words enter music, they are no longer prose or poetry but elements of music. The task of words is to help create and develop the primary illusion of virtual time, not of literature, which is another expression; so they renounce their literary status and assume purely musical functions. However, this does not mean that they only have sound value.

What Langer is suggesting in the last sentence of this passage is, although words do not function as elements of the primary illusion of poetry and prose after entering music, this does not mean that they act only as sounds and do not carry any descriptive or associative meaning. On the contrary, any meaning that words convey "meaning of words, enthusiasm of expression, devotional duties, choric responses" also enters directly in the musical structure whether or not it is understood literally. While words are elements of virtual time, the primary illusion of music, they can also have a literal or figurative meaning. In other words, Langer does not exclude the possibility that the true meaning of a text adds something to the emotional experience of the music. He even concedes that "words can suggest emotional centers and ways of connecting to spark a musician's imagination." (cited by Rao, 1988, p.165).

Sparshott offers a different take on the theme of Langer's discussion of the role of text in vocal music:

Music is not a language in which something can be said... What is singing? It is a very specific way of saying something... It conveys how you feel about what you say or how you want others to feel, your attitude towards it (or the attitude you want to evoke) or how you want it to be received (ironic, sarcastic, serious...). So the music of the song tells what the person understands from the text or how one understands it, not what the text means. It doesn't say it, it shows and the word traditionally used for this type of display is "expression".

When Pratt's (1931) famous statement, "the "auditory characters" of music sound only as their mood makes them feel, when considered in more detail, in short, it can be said that singing is "similar" to music in a sense, that is, singing in sensation is like singing of felt emotions (Rao, 1988, p.165, 166).

The Act of Singing: A Way of Hearing Music

While the act of singing can be thought of as a special way of vocalization, it can also be thought of as "a form of listening" (Idhe, 1976, p. 180). At this point, it is important to explain that one's own voice reaches someone's ear in two different ways. One of the ways of hearing is air. The air transmits the sound from the lip opening to the ear canal. It is a sound heard from the outside in. Airborne sound consists of two parts. A section moves from the lip opening to the ears. The other part reaches the ear after to resonator cavity is reflected in one or more times. These reflections can significantly change the voice depending on the resonator cavity.

The other auditory pathway is the one that is heard from the inside out and consists of structures that separate the vocal tract from the inner ear. During vowels is sung, the amplitude of the sound in the vocal tract is very high. The singing voice produces vibrations in the vocal tract (in the resonator cavities: larynx, pharynx, mouth) and these vibrations are transmitted to other parts of the head, including the inner ear. The resulting with bone conduction sound can only be perceived by the singer. This means that bone-conducted sound does not propagate



through the skull efficiently enough to reach the listener or contribute significantly to the sound projected outside the singer. "Only the singer himself perceives his own bone-conducted voice." This describes how singers "hear" to adjust the volume and sing in tone. Vibrations in bone structures caused by bone conduction sound provide the singer with a sense of sound; that is, the sound felt. The frequency characteristics of sound transmitted through bone are converted into skull vibrations. These vibrations can be perceived by the singer in various parts of the body during the phonation of different vowels (Idhe, 1976, p. 81).

The act of singing as a way of hearing can be thought of as a dual form of perception that includes feeling and hearing. Vennard (1967, p. 260) describes the process of hearing and experiencing sensations while singing as the singer's "ear" and states: "sensation-hearing ability is the whole auditory complex following phonation."

- Appleman (1967, p. 141) agrees this view, he says "hearing is interpreting voice" and continues as follows: For the physicist, voice is a form of energy that can be measured and controlled to do work. For the psychologist, voice is a feeling-sensation, something that exists only within ourselves. Such sensations create emotions and change our behavior. Voice is real but abstract. One cannot measure it or see it; one can only feel its effects.
- Victor Fields (1952, p. 52) agrees with these thoughts and states:
 - "Sensation is the mental awareness of some momentary physical stimulus for the body organism." Hearing is the capacity to perceive auditory sensations of voice. Hearing is the function of recognizing, correlating and controlling initial perceptions of acoustic phenomena for vocal expression purposes."

In this multidimensional sense, hearing is at the center of the act of singing. The sensations experienced while singing include auditory hearing (listening to the voice) and awareness of the movements and positions of bodily functions involved in the singing process (listening to the body). In the act of singing, both types of hearing are used, auditory and kinesthetic sense impressions. The importance of physical sensations in singing is emphasized by John Burgin, who defines it as "a change in awareness or a feeling that is the result of a stimulus." Burgin (1973, p. 134) argues that singers "rely heavily on physical sensations for the control of singing intensity". Singers do not generally rely on auditory feedback; that is, the sound that reaches the ear through the air. This principle is confirmed by Sundberg's work, which claims that "singers... rely less on the auditory feedback signal... to control phonation" (cited by Rao, 1988, p. 168).

Descriptions of hearing that involve experiencing sensations show that hearing is a multidimensional, essential and innate aspect of the act of singing. This type of hearing is the primary way a singer interprets the sound and evaluates the results. It is a way of perceiving changing or lack of changing in voice. (Rao, 1988, p. 169). This type of multidimensional hearing accepted in science and aesthetics by researchers is the result of the dynamic process of singing which includes affective, cognitive, psychomotor and aesthetic components.

The Act of Singing: A Way of Musical Performance

Describing musical performance as "the ultimate image/imagination of tone" Langer states that:

This ultimate imagination of the tone itself, as something completely decided by the whole to which it belongs, requires a special symbolic support, a very distinct bodily gesture; obviously, this gesture is the act of producing tone, the expression of it by the performer; physiologically, it is the sense of tone in the muscles tuned to produce it, and is the symbol for imagined tone. Possibly all auditory imagination is somewhat lacking, except for such symbolic action, unless it is based on a vivid memory of the music actually heard.

According to Langer's explanation of musical performance, it is possible to say that the act of singing, which is the act of producing tone, is both a skill used to produce music and a way of understanding music. Remembering in the sense of "imagining" is a way of knowing. Knowing how to produce tone and that the tone supports and complements the musical idea is a way of understanding in itself. Therefore, it makes sense to point out that musical performance ("the ultimate imagination of tone") is a way of producing and perceiving tone. In this sense, the act of singing is a form of bodily knowledge about music.

Dewey (1938), who agrees with this view, characterizes the movements of the body involved in expressive roles or skill-based performances as "motor tendencies". He argues that these movements "make perception... sharper and more intense and add meanings that give it depth". Dewey states that "motor (bodily) preparation is a large part of aesthetic education." Dewey's expression is this way:

A skilled surgeon is someone who appreciates the artistry of another surgeon's performance; he watches it in his own body sympathetically, though not overtly. Anyone who knows something about the relationship



of the piano player's movements to the production of music from the piano will hear something that the layman does not perceive, just as a master performer hears the music 'with his fingers' while reading a note.

Langer argues that musical performance also relies on a "special symbolic support" for the ultimate imagination of tone, including notation and technique. Ultimate imagination requires a "highly distinct bodily movement" in the act of deftly producing the tone and the performer's expression of the tone. The highly articulate bodily gesture is physiologically the "feeling for the tone in the muscles set to produce it," and the means whereby the tone is imagined. In this case, there is a distinction between the experience of cognitive awareness (thinking about something mentally) and being cognitively involved in an experience as a process. In other words, as Jerome Bruner (1968) states, there is a difference between grasping something and applying it (cited by Rao, 1988, p. 170). Sparshott (1982, p. 31) agrees: "A system of grasped facts is not the same as the ability to produce a product." Sparshott continues that: "The joy of doing, of being aware of what one is doing, is the primary kind of aesthetic pleasure, the importance of which no art theorist should ever forget."

Langer states that any form of listening or "auditory imagination" other than the act of producing music is "somewhat lacking." In the case of a very competent musician, it's possible to hear music "purely imaginative" without real tone. In most cases, however, the ability to hear music is helped by the actuality of tone realized in singing or playing: the act of carrying the music from thought to physical expression. According to Langer, the listener imagines music from bodily sensations recalled from the physical act of producing music. Depending on the listener's performance history, the recalled sense impression may vary. Chopin heard the music with the senses of his fingers. Similarly, composer Alan Stout states that he constantly suffered from a sore throat while composing a long choral piece for the Chicago Symphony Orchestra and Chorus. He, too, has "heard" from the "subvocal" (pertaining to or denoting an unexpressed level of speech comparable to thought) senses of the throat. The physical production of music while singing or playing an instrument can be considered a musical imagination or muscle memory that is remembered for the purpose of hearing the music. In Langer's account of musical performance, the act of producing the tone depends on the ability to make "the final decision on what each tone sounds like." The ability to make such decisions is part of the performer's art. When it comes to the art of singing, decision making involves the planned production (or intelligent use) of the body and mind in order to have control over the music itself (cited by Rao, 1988, p. 172).

An artist's art may not require a verbal explanation of everything that is done, but it does require that the produced (voice) be checked, corrected and critiqued by the performer in the light of a purpose, namely the qualities of the music itself. Music provides a context in which sound is produced and controlled. How sound is produced and controlled (how changes and improvements are made) has to do with the qualities and standards of the music itself. Consequently, the act of singing, based on a high-level skill, is a way of hearing music, imagining music, knowing music, and performing music.

CONCLUSION AND RECOMMENDATIONS

The aim of this research is to make an evaluation and make suggestions by considering the human voice and the act of singing with its artistic and philosophical aspects. The human voice is accepted as the oldest, most natural and most valuable instrument among musical instruments in the history of music. In addition to being a living instrument belonging to one's own body, it is also special and valuable because, like fingerprints, each person has their own uniqueness. Vennard (1967, p. 165) states that the human voice is a more romantic instrument than other musical instruments, since it belongs to one's own body and allows emotions to be expressed directly. According to the definition of "man is a walking musical instrument"; his own voice, which is the natural instrument of man, contains his body, soul and environment (Denizoğlu, 2008).

It is generally accepted by all musicologists that the human voice constitutes a category in itself among the sound types with musical quality and has a very different sensitivity. The human voice is distinguished from instrumental music by a very important distinguishing feature. In other words, a person who carries both the feelings and thoughts coming from his inner world and the vocal organ, which is an inseparable part of his body, thus contains the basic elements of the "self-form balance" which is the ideal rule of art (Elmas, 1988, p. 238).

The human voice, which basically helps the individual to express himself and communicate with the outside world, turns into a more complex ability, to speaking and an even more complex ability, to singing. Thus, the voice of the human being, which he/she uses as a result of a necessity for the purpose of being intelligible, is also used for a higher expression artistically. According to Egüz (1980, p. 1), voice has two important functions in human life; talking and making music. The human voice, in addition to containing all the various sound colors that other musical instruments cannot create alone, has increased its effectiveness even more with the power it gets from the language, as well as its unique techniques and methods.



It can be said that the human voice, which has an important place in the transmission of emotions and thoughts from the first ages to the present, has developed over time and today's singing art has emerged. Singing, a fundamental form of musical expression, has played a vital role in ancient forms of ritual and theater in antiquity. The act of singing, which is the sublime and artistic expression of the human voice is a special way of using voice that embodies a biological, spiritual, emotional and aesthetic nature. The definition of singing as art depends on these aspects of singing. Therefore, it is thought that it is important and necessary to evaluate the act of singing together with its technical and artistic/aesthetic aspects. According to Marchesi (undated), "the art of singing, like any art, has a technical/mechanical dimension and an artistic/aesthetic dimension. A singer who cannot overcome technical difficulties will never achieve artistic/aesthetic perfection." It is important to understand this view of Marchesi correctly. Because, as mentioned before, it is seen that in theoretical and practical studies in the literature on voice education and in the voice education process have generally (sometimes only) technical studies focused on. However, the ultimate purpose of technical studies, knowledge and skills in vocal education is to develop the artistic aspect of singing. In this context, technical knowledge and skills are of course important, but it would be correct to consider them together with artistic skills in the vocal training process and to support artistic skills. Kaygisiz (2017, p. 32) also states that aesthetics and technique are the two most important inseparable components of art. Aesthetics is beauty and there can be no art without aesthetics and even if it is, it does not give pleasure. Technique, on the other hand, is the mastery of a job, the realization and application of theoretical knowledge. According to Rock (2005, p. 113), the power of the human voice reaches its peak in the art of singing. In this context, it can be said that in the art of singing, magic for the listener and the singer occurs when technique, words and music are combined with personal style and passion.

Most research to date has focused on the human voice almost exclusively as a biological phenomenon, not as a musical instrument. With a similar approach, according to Rao (1988, p. 116), who argues that the human voice and singing act should be considered as a whole, not only scientifically, but also with artistic and aesthetic dimensions, there is a deficiency in the literature in this respect. As far as can be reached, no study has been found in the literature in which the sound is considered as a multidimensional phenomenon, in a holistic way, including its biological, spiritual, emotional and aesthetic nature. Therefore, this research is considered to be important in this context and it is hoped that it will shed light on new research to be done.

The following can be suggested as a result of the research:

- As far as can be reached, since there is no study on this subject in the field of voice education, new theoretical studies can be made based on this research.
- New researches and postgraduate thesis studies can be made based on qualitative and quantitative research methods on the subject.
- Studies based on qualitative and quantitative research methods can be conducted to determine the approaches of sound artists and voice trainers to the subject and their understanding of education on the subject.
- The use of verbal and pictorial images in order to develop both the technical and artistic aspects of the act of singing can be beneficial in terms of making the education process more effective, efficient and fast.
- In vocal training, not only technical skills, but also technical skills and artistic skills should be considered together for the development of singing skills, and technical skills should support artistic skills.
- It is important and necessary to raise the awareness and education of individuals receiving vocal training about the technical and artistic aspects of singing.
- Individuals receiving vocal training should be provided with a foundation of knowledge, skills and understanding regarding the philosophical aspect of the art of singing. In addition, at the level of theory and practice, about works; composer, period, genre, style of singing, subject, meaning of words (if the works in a foreign language) etc. should be taught. Finally, it should be studied so that the works can be interpreted with an experience in which the feelings of the soul are fully reflected. For this purpose, using the internet, technological tools, visual and audio materials, namely taking advantage of educational technology will contribute to the development of performance skills.

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Designing, Development, Implementation and Assessment of the Accessible Mass Open Learning Platforms for the Visually Impaired Individuals

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ABSTRACT

The aim of this study is to design, develop, implement and evaluate an accessible mass open learning platform for visually impaired individuals. The study group consists of experts in the field who want to contribute to the study voluntarily with the snowball sampling method and have not used the platform before, with or without visual impairment. Thirty-eight visually impaired individuals and ten field experts participated in all stages of the study, a total of forty-eight volunteer users. At the analysis stage, it was tried to reach the features that an open and freely accessible learning platform should have. In this process, interviews were held with visually impaired individuals and subject matter experts. During the implementation phase, usability testing was conducted for the learning platform with visually impaired individuals. Within the scope of the usability test, the effectiveness and efficiency of the learning platform and the satisfaction levels of the participants were revealed. Visually impaired individuals were observed through the observation form for effectiveness and efficiency. In addition, semi-structured interviews were conducted with visually impaired individuals and subject area experts for satisfaction after the completion of the tasks. Content and document analysis was carried out according to the characteristics of the data obtained during the research. In the evaluation phase, the open and freely accessible learning platform developed lastly was evaluated by the automatic test tool. The design principles of the study for an accessible mass open learning platform for visually impaired individuals were revealed.

Keywords: Open and Free Learning Resource, Visually Impaired Individuals, Web Accessibility

INTRODUCTION

The ability to see, which helps to perceive and understand multiple concepts such as shape, color, motion and light (Özçetin, 2003), is very important for the individual from the moment s/he opens his/her eyes to the world. The ability to see allows the individual to first discover and know himself/herself and the environment in which s/he is located, and in the later years of one's life, to perceive and communicate with the objects, beings, events and phenomena around him/her. In other words, the individual integrates with his/her environment thanks to his/her vision.

According to World Health Organization data, while there are approximately 1.3 billion visually impaired individuals worldwide as of 2018, this number reached 2.2 billion in 2019. It is clearly seen that the number of visually impaired individuals is increasing day by day (WHO, 2019). Although the roof is used as a concept for individuals with different visual impairments, this concept is divided into two groups as blind and low vision. While blindness is used for individuals whose vision function cannot be performed by both eyes (Kelly and Clark-Bischke, 2011), it meets individuals whose vision level of both eyes is between 1/10 and 3/10.

When the literature is examined, visual impairment is defined in two different categories as legal and educational; legal definition is used in almost all fields except for the educational field. According to the legal definition, those who do not know the phenomenon of light are defined as blind, while individuals who primarily use vision despite having visual impairment appear as seeing less (Kreuzer, 2007). In the educational definition, in the Regulation on Special Education Services of the Ministry of National Education (2000), the visual disability is defined as "the negative effect on the educational performance and social adaptation of the individual due to the partial or complete inadequacy of vision". Because individuals primarily benefit from the sense of vision in their learning processes. Visually impaired individuals use their hearing and touch senses in the learning process.



Many studies show that visually impaired individuals can use their hearing and touch senses better than individuals without disabilities (Hertrich, Dietrich, Moos, Trouvain and Ackermann, 2009; Goldreich and Kanics, 2003). For example, visually impaired individuals receive help from materials such as screen reading software and Braille. Low vision individuals first benefit from their vision skills in the learning process. Unlike blind individuals, in the teaching environment, writings written with magnifying glass and large fonts are sufficient in this process (WAI 2005; Enç, 2005; Collignon, Voss, Lassonde and Lepore, 2009). As can be seen, there are differences in the learning styles of visually impaired individuals. For this reason, in order not to interrupt and support the education processes of visually impaired individuals, there is a need for some regulations, in other words, to present the education processes specific to these individuals.

There are special purpose schools established for visually impaired individuals in the world and in our country. The aim of these schools is to eliminate the problems and obstacles faced by visually impaired individuals in their education processes and to ensure that they benefit from their education processes at the highest level and acquire a profession with them. Since the 1950s, visually impaired individuals in schools within the scope of the Ministry of National Education in our country (Gündüz, 2004) continue their education day or overnight. In addition, there are special education classes within primary and secondary schools for visually impaired individuals. In this way, visually impaired students have the opportunity to receive education through inclusion with students without disabilities. Primary education curriculum is also taken as a basis in special education classes to reach the achievements in the curricula in question and to organize the education processes in a way that will provide the highest benefit to disabled individuals makes significant contributions.

Auxiliary technologies are instruments developed to solve the problems faced by individuals with any physical disability (Pettersson and Fahlstrom, 2010). When these technologies are selected according to the needs of the visually impaired individual, they can be used actively not only in the daily life of the individual but also in the educational life (Hussin, 2013). Many different systems and applications can be used within the scope of auxiliary technologies that are of such importance in the field of education. Computers, which are an indispensable part of our daily life, constitute an important basis for auxiliary technologies used for individuals with disabilities, because computers allow visually impaired individuals to easily access information while at the same time enabling them to reuse information (Emiroğlu, 2008). Thanks to the software, applications and content developed for the visually impaired within the scope of computer technologies, disabled individuals can manage their learning processes autonomously. The open educational resources in these applications offer an enriched content to support the education of disabled individuals.

Open Educational Resources are teaching, learning, and research resources that are publicly available or that have been released under an intellectual property license that allows free use or reprocessing by others. Today, the main purpose of these resources, which have turned into a platform where open and free resource philosophy and course materials are shared (Çağıltay and Göktaş, 2016), offers a deep range of potential and opportunities especially for visually impaired individuals (Okur and Demir, 2019). In other words, in terms of eliminating the problems experienced in information sharing (Taylor, 2007), open and free education resources offer equal opportunities for the education of disabled individuals. Because these resources enable individuals with disabilities to access learning opportunities wherever and whenever they want, just like individuals who do not have visual impairment.

As can be seen, it is very important to benefit from technological opportunities in eliminating the problems and difficulties faced by disabled individuals in their education processes. Undoubtedly, this situation brings along critical contributions in terms of their participation in society. Websites, which are among the technological possibilities, act as a bridge between users and institutions. Web accessibility is the preparation of the elements and content of a web page for the needs of users. Thus, it is aimed to reach the largest user audience (Şerefoğlu and Henkoğlu, 2019).

Based on the reasons stated in this study, a platform with open and free education resources has been developed for visually impaired individuals (who do not see total and see less). In the developed platform, web accessibility, which is of great importance when using on web pages for visually impaired individuals, was taken into consideration and thus, it was aimed to leave an equal effect on every student using the platform (Güven and Sözer, 2007) and to serve the concept of mass with the designed pages. The platform designed for the study was evaluated according to the findings obtained in the application and suggestions that would benefit policy makers, education leaders, academicians and subject area experts were presented. Since this developed platform was carried out within the scope of W3C standards, it was aimed that the results obtained would be a reference study in the literature.



METHOD

Research Model

In this study, design-based research method, which is one of the quantitative research methods, was preferred. Quantitative research design is a study that aims to measure events with experiments and bring them to reality in the light of events (Arıkan, 2011). Design-based research is a systematic research design carried out by the study group and the researcher to develop the design with real tasks in a cyclical way (Wang and Hannafin 2005).

Design researches are classified into two categories as Type 1 and Type 2 in line with the purpose of the study. While Type 1 is based on the design, development and evaluation steps of the product, Type 2 takes into account the model development and evaluation process (Richey and Klein, 2005). In this study, the Type 1 category was preferred because it includes many working groups as well as product design, development and evaluation steps.

Study group

There are many different study groups in the study. The study group, which was determined on a voluntary basis by the snowball sampling method, consisted of experts who had not used the platform before, had visual impairment, had no visual impairment and were experts in the subject area. Based on the research question in the snowball sampling method, the participants direct the researcher to other participants who have similar characteristics after the interview of the researcher (Yıldırım and Şimşek, 2016).

In the need analysis phase of the study, 10 visually impaired individuals and 5 subject area experts were included. In the first cycle of the application phase, six visually impaired individuals were studied for usability test. In addition, the opinions of two subject area experts were consulted for the evaluation of the platform. In other cycles, the number of participants is higher. In the second cycle, eight visually impaired individuals were studied for usability test. In the third cycle, 14 visually impaired individuals, 5 non-visually impaired individuals and 1 subject area expert were included.

Developing an Accessible Open and Free Learning Platform for Visually Impaired Individuals

In the study, design development design stages were followed and the said stages and the actions taken within the scope of these stages are as follows;

Identification of the Problem: After defining the research problem and defining the problem, possible solutions and theoretical framework literature review were conducted.

Problem Analysis: Studies on the subject have been examined with the literature review. Needs analysis was made and the needs of visually impaired individuals were taken into consideration and in addition, subject area experts were interviewed. Thus, the purpose of the study and the characteristics of the platform to be developed were determined.

Generating Solutions: Solutions have been developed on the subject based on the interviews made during the problem analysis phase and the results obtained from the literature review.

Development: At this stage, it was first decided that the platform to be developed should include traditional mass open online courses, which are among the MOOC types. It is designed as a teacher-centered platform where information is transferred. While developing an open and free learning platform, the needs determined during the design phase were arranged in line with the characteristics of the target audience.

Directions, emphasizing connections, ground-shape contrast, font selection, writing size, plain language use, offering alternative materials, compatible with auxiliary technologies, access with keyboard and predictability of menus in cross-page transitions were taken into consideration for individuals with low vision and visually impaired in total. An accessibility menu has been developed for visually impaired individuals by integrating with the platform. The accessibility menu can be activated with the combination of "Ctrl+B" and closed with the "Esc key", allowing the menu to be used only when needed.

The accessibility menu includes keyboard navigation, voiceover, color contrast, text size, link contents, zoom, issue reporting, and reset settings. All activated buttons are designed to be disabled with the "Reset Settings" button. When the page is opened, it is arranged to be active by default with "keyboard navigation" and "open reader" options.

Both in the accessibility menu and across the page, the Web Content Accessibility Guide is designed to ensure an open navigation mechanism based on compatibility principles. Thus, the links were made detectable and



understandable. In addition, some combinations of keys were used to quickly navigate between pages. Because shortcut keys make it easier to move around the website without using a mouse.

Voiceover with the features in the accessibility menu, color contrast section, text size, link contents, zoom and Course Evaluation Exams sections, a more functional and practical content for visually impaired individuals has been tried to be designed. Apart from the sections listed in the accessibility menu, "Help, Report Problems and Reset Settings" features have been added. A help page has been created based on the principle of correct marking of the Web Content Accessibility Guide.

As a result of the analyzes, fixed menus were preferred by avoiding the drop-down menus in the design of the page. Instead of presenting the contents to users as sliders, six popular and recently added courses are shown sequentially. Links, buttons, titles on the home page are designed according to accessibility principles. Accordingly, it is possible to stop, advance, rewind, full screen and switch between segments from the keyboard of the videos on the page containing the course contents.

Considering the principle of consistency and reliability, which is one of the basic principles of web page designs, attention has been paid to use the items, buttons and menus used on the page in the same place on each page.

Content containing information equivalent to video elements has been prepared for visually impaired individuals. Adobe Reader was preferred for alternative digital documents. These equivalent contents serve the same purpose as the content in the video.

After the course was completed, the end-of-process evaluation and measurement and evaluation process were added. During the measurement and evaluation process, multiple-choice questions were prepared according to the objectives of the content; traditional objective tests, which are among the techniques used in mass open and free measurement and evaluation, were preferred. After the completion of the exam, it was ensured that the students' results were evaluated by computers and feedback was provided.

Application: In order to detect possible problems that may be encountered in the main application of the open and free learning platform and to produce solutions in advance, a pilot application was carried out. The pilot study was conducted by a volunteer participant. Improvements deemed necessary before the actual application were made in line with the data obtained.

Evaluation: It was aimed to find answers to the questions about how to improve the design process of the open and free learning platform more effectively and efficiently. Accordingly, open and free learning platform usability test results and interviews were analyzed. The places where the participants were not satisfied and seen as incomplete and the tasks that were failed and the parts where the most performance was spent were determined. The improvements were made within the scope of three cycles and the open and free education platform was given its final form used in the application.

Data Collection Process

Observation, interview and document analysis methods were used in the data collection process of the study. Accordingly, an observation form has been developed for the evaluation of the accessible open and free education platform. Throughout the observation, notes were taken using this form and the participants were recorded on video and the status and behaviors of the participants were monitored in the usability test.

In the analysis phase of the design-based research, it conducted interviews with subject area experts, software developers and visually impaired individuals. Four different interview forms were used in these interviews. Interviews were conducted with the participants for the satisfaction stage of the evaluation step. In addition, subject area experts were asked to evaluate the accessible, open and free education platform developed by considering the usability criteria.

Steinbach (2020) emphasizes that it is not possible to determine whether a website is accessible as a result of evaluation only with automated testing tools. Therefore, in the design development research of this study, observations and interviews were made in all three cycles. After the improvements ended, the platform was evaluated with the selected automated test tools. Within the scope of this study, AChechker test instrument was preferred. According to Ahmi and Mohamod (2016), these two instruments are among the most preferred web accessibility controllers in terms of accessibility and usefulness.



Validity and Reliability

Additional methods are used to control the results of the data found by the researcher about the situation or event investigated (Yıldırım and Şimşek, 2016). The use of different methods in the studies increases the validity and reliability of the data. Within the scope of this study, the actions taken to increase validity and reliability are as follows:

• In order to report the obtained data in detail (Çokluk, Yılmaz and Oğuz, 2011), the opinions of the participants were presented as direct quotations.

• During the study process, the opinions of different participants and subject area experts were consulted and various data collection tools were used.

• In addition to the literature review conducted by the researcher, the pilot application of the interview form prepared by taking the opinion of an expert was made.

• In the process of determining the tasks included in the observation form, two subject area experts were consulted, who were graduates of CIS and accessibility experts.

• In this study, different data collection methods, which are among the types of triangulation strategy, were preferred and the data were collected by observation, interview and document analysis methods.

• The researcher took an active role in the data collection process.

• Interview data were analyzed in detail and descriptions were included in the findings section.

• After the data obtained from the participants were transcribed, the opinions of the individuals participating in the study were taken and confirmed. The codes and themes obtained were also examined by other experts.

• During the evaluation process of the platform, the opinion of more than one expert was taken.

• In order to ensure data diversity, data from various sources were collected with different participants in each cycle.

Data Collection Process and Analysis

During the analysis phase of the study, the participants were first contacted by phone and stated the purpose of the study. The audio recordings obtained as a result of the interviews made on a voluntary basis were transcribed. The created transcripts have started to be read and analyzed several times. First of all, transcripts were tried to be interpreted as a whole. Then, the data were converted into codes and themes.

During the implementation phase, interviews were held with the participants in July 2021 for the first cycle, October 2021 for the second cycle and November 2021 for the third cycle. Information, observation and interview forms were applied to the volunteers, respectively. Participants were asked to give their consent for the audio recording. Then, the observation form prepared for the use of the learning platform was applied. Through the observation form, notes were taken about the interaction of the participants' learning platform. With the completion of all tasks, the interview process was started.

For the effectiveness dimension, the successful completion of the tasks requested from the participants was taken into account. The number of movements required by the person who developed the system to perform the operation in the tasks requested from the participants was determined for the efficiency dimension. An individual without visual impairment was asked to complete the same tasks and the average time spent was tried to be determined. Finally, for the satisfaction dimension, interviews were held with five visually impaired participants and two subject area experts who participated in the application. The data recorded by voice recording in the interviews were transcribed and read several times. First of all, transcripts were tried to be interpreted as a whole. Then, the data were converted into codes and themes. The themes created in the findings section are emphasized.

FINDINGS

Findings on the Design Features of an Accessible Open and Free Learning Platform for Visually Impaired Individuals

In order to reveal the design features, in the analysis phase, ten visually impaired individuals and five subject area experts were interviewed together with the literature review. As a result of the interviews, 5 themes were determined as "problems, suggestions, exam screen design, text elements, audio and video elements" (Table 1).



Table 1 Themes Related to Design Features

Themes	Codes	Participants
Recommendations	Shortcut identification	TG1, KAU1, KAU2, KAU3, KAU5
	Keyboard access	TG1, TG2, TG4, TG8, KAU1,
		KAU3
	Resizing the display	TG5, KAU1, KAU2, KAU3
	Error prevention	TG2, TG5, KAU1, KAU3
Exam Screen	Single page design	TG3, TG6, AG1, TG7, KAU4
Design	Voice feedback	TG7, TG8, KAU5
	Keyboard usage	TG1, TG6, TG9, KAU4
Text Items	Resizing texts	TG3, AG1, TG9
	Shape-ground contrast in texts	TG1, TG2, AG1, TG7, TG9
	Highlighting the content on the page	TG3, TG5, TG9
Audio and Video	Alternate content	KAU1, KAU2, KAU3
Items	User control	TG4, TG6, TG8, KAU2
Challenges	Describe the images	TG5, TG6, KAU1, KAU2, KAU4
encountered	Shape-ground contrast in images	TG3, AG1, TG9, K11, K13
	Suitable title	TG2, TG4, KAU1, KAU2, KAU3
	Labeling	TG4, KAU1, KAU2, KAU3, KAU5

According to the theme of the problems encountered, it has been observed that there are mostly visual elements and software problems in terms of accessibility on the existing web pages. Since no explanations were added to the images on the web pages, it was determined that the users could not access the elements such as graphics, pictures or tables added to the pages. In addition to the fact that the visual elements were not explained, it was determined that the shape and ground contrast used in the images was not taken into consideration, however, there were problems with the titling and labeling. The statements of some of the participants related to this theme are as follows:

"Of course, pictures are used on the pages. We try to see the writings in here by enlarging and reading them. But what makes my work here difficult is the colors used. We cannot read when the same colors are used." (AG1)

"It is important to make the right headings. There are pages developed as direct h2, h3 starting without h1 in the pages we examined. This accessibility problem is in a software problem as well. Heads provide great convenience when navigating with the keyboard. We can make effective pages with simple solutions." (KAU2)

According to the theme of suggestions, it was determined that it was important to determine keyboard access and shortcuts for individuals with total visual impairment; and to resize the screen for individuals with low vision since they mostly used magnifying glass technology on their web pages. However, it has been determined that the use of voice feedback regarding the errors made by the users may be useful in order to minimize the occurrence of errors. The statements of some of the participants related to this theme are as follows:

"Some of my friends can use mice, but I do not prefer to use mice very much. The keyboard is easier for me. On some pages, I can navigate comfortably with the keyboard, while on others I can experience difficulties." (TG8)

"I use it in the screen reader. And a magnifying glass. Since some places are sufficiently large, I may not need a voice-over program." (TG9)

It is seen that in the online measurement and evaluation screen designs related to the exam screen design theme, each of the questions are on different pages, the use of keyboards is not allowed in the question transitions or in answering the questions, and the lack of voice feedback is among the problems encountered. It was determined that the biggest problem in the online measurement and evaluation screen design was that each exam question was included on different pages. The statements of some of the participants related to these situations are as follows:

"In distance education exams, we took the exams with a lot of panic and experienced difficulties. The more problems such as page transitions and descriptions are minimized on the exam screens, the easier it will be for us." (TG4)

"The most difficult point when taking the online exam was that each question was on a different page." (TG7)



"Voiceover on the exam screen will also help to reduce exam anxiety." (KAU5)

It has been observed that features such as resizing texts according to the theme of text elements, shape-ground contrast and emphasizing the titles or links on the page draw attention. Some of the opinions related to this theme are as follows;

"It is important to present the content on the page in different dimensions, or it is better when the individual can intervene in these dimensions when individual wants. It is a great convenience for us to be able to intervene on the page when we want." (TG9)

"We can read well when there are black texts on the white page. But sometimes neon colors are used. The place and duration of these are important, so I think they should not be missed." (TG7)

It was determined that it was important to have alternative content in the theme related to audio and video elements and to allow user control in the elements. Regarding the subject in the audio and video elements, it is important to include the summary or the whole subject on the page with different options; it has been observed that it is appropriate to leave the features such as stopping, starting or fast-forwarding in the audio and video elements to the user. The statements of some of the participants related to these situations are as follows:

"The disabled individual is looking for something, for example, that information is included in the video. However, it facilitates the process if not only that information is given by video but also as text, for example." (KAU2)

"We should be able to intervene in the videos on the web page as we wish." (TG6)

"It can be animated on one page; it can be video. When they move constantly, we can experience distraction. That is why it is important for us to start or stop them at any time." (TG4) Findings on the Availability Level of an Accessible Open and Free Learning Platform for Visually Impaired Individuals

Within the scope of the second research question of the study, the usability level of the accessible open and free learning platform developed for visually impaired individuals was tested in the context of the effectiveness, efficiency and user satisfaction levels of the platform.

Findings on the level of effectiveness of the platform during the first cycle

During the application phase, evaluations were made with six visually impaired individuals, three non-visually impaired individuals and two subject area experts and the level of effectiveness was evaluated according to the success of the participants in completing 11 tasks. Accordingly, it was determined that all participants completed the task with success (100%) in 1, 2, 3, 4, 5, 6, 9, 10 of them. Task 11 had the lowest success rate with 33.3% task success rate.

Findings on the level of productivity of the platform during the first cycle

The efficiency level of the platform was evaluated according to the time spent and the number of movements while completing the tasks with the same difficulty requested from the participants; however, the average duration of the participants with and without visual impairment was compared. When calculating, only the participants who completed the task were taken into account in Tasks 7, 8 and 11. Accordingly, it was determined that the task that the visually impaired participants spent the most time on was task 9 (38.0 seconds) and the task that they spent the least time on was task 1 (2.7 seconds). Considering the number of movements of the participants during the tasks, it was determined that all the participants completed the same number of tasks as the number of steps required while performing the process.

When the average time spent by the participants with and without visual impairment while completing the task was compared, the task with the most difference was determined as 11 (36.9 seconds/6.71 seconds) while the task with the least time was determined as 9 (38 seconds/33.6 seconds).

Findings on the level of satisfaction of visually impaired individuals and experts using the platform during the first cycle

At this stage, as a result of the experiences of the participants, interviews were held with visually impaired individuals and subject matter experts, and as a result of the interviews, 3 themes were determined as "liked features, disliked features and suggestions" (Table 2).



Themes	Codes	Participants
Liked properties	Accessibility menu	TG10, TG11, TG12, TG13, AG2, KAU6,
		KAU7
	Exam screen	TG10, TG11, TG12, TG13, AG3, KAU6,
		KAU7
	Features of video elements	TG10, TG11, TG12, TG13, AG2, KAU6,
		KAU7
	Voice feedback	TG10, TG11, TG12, TG13, AG2, AG3,
		KAU6, KAU7
Disliked features	Labeling	TG10, KAU6, KAU7
	Opening message.	TG11, TG12, TG13, KAU6, KAU7
Recommendations	Acceskey feature	TG1, KAU6, KAU7
	Skip to content feature	TG12, KAU6, KAU7
	Readership feature	TG10, TG11, TG12, TG13, KAU6, KAU7
	Region feature	KAU6, KAU7
	Headings	KAU6, KAU7
	Certificate	TG11, KAU6, KAU7
	Changing items as buttons	TG10, TG11, TG12

Table 2. Themes Related to the Satisfaction Level of the Participants

It has been observed that accessibility menu, exam screen design, features assigned to videos and audio feedback draw attention regarding the liked features theme. It was determined that providing personal feedback or providing voice feedback in case of possible problems was among the favorite features of the page. These features increased the satisfaction levels of the users and their desire to stay on the page. The statements of some of the participants related to this theme are as follows:

"The most striking feature was the accessibility menu. I think there seems to be no need for anything extra as it contains a lot of things." (TG10)

"When we leave it blank, giving feedback will prevent us from skipping questions or I think it is a great convenience to say when we mark it. It is one of my favorite parts. Because it is not pleasant to experience these stresses with the stress of the exam." (TG11)

It is seen that there are opening message and labeling problems in the theme of disliked features. Thanks to the auxiliary technologies, it was determined that the opening message was not liked because it was easily understood whether the web pages were accessible or not, and that it was not understood what these elements were because there were elements that were not labeled on the page. The statements of some of the participants related to this theme are as follows:

"I think there was a pop-up message at the opening, as soon as the page opened, I missed it and my mind stayed there to see what he said, I could not understand what happened." (TG11)

"Voice-over programs did not understand what was happening in some items on the inner pages. I think it is because it looks unlabeled." (KAU6)

Suggestions theme was created from certificate, some items being buttons, skip content, accesskey, region and reader feature codes. While all pages of the platform were designed as accessible, it was determined that a design contrary to accessibility was made due to the downloading of the certificate as an image in the certificate section at the last stage; some links on the page were perceived as buttons. At the top of the platform, it was determined that browsing the menus such as logo, search menu, member login, sign up, help and my profile in order prevented efficiency in reaching the desired content. On the developed learning platform, shortcut definitions were made for pages or items, but this information was not liked because it was presented on the help page. In addition, it was emphasized that the status of whether the reader feature is active or passive should be left to the user. Some of the related opinions are as follows;

"The alternative content item was not a button; I think specific situations such as a link may be a button. Because I did not think it was a link." (TG12)

"Accesskey is a feature that we want to have on the pages but we do not encounter very much. I think it is not necessary for the accessibility of this page, but it can be added." (TG10)



Findings on the level of effectiveness of the platform during the second cycle

In the second cycle of the application phase, evaluations were made with eight visually impaired individuals, four non-visually impaired individuals and two subject area experts. The level of effectiveness of the platform was evaluated according to the success of the participants in completing the task. Accordingly, all participants completed the task with success (100%) in 1, 2, 3, 4, 5 and 10 of them. While the success rate for the tasks 7, 8, 9 and 11 was 87.5%, the task success rate of task 6 was found to be 75%.

Findings on the level of productivity of the platform during the second cycle

In the second cycle, the efficiency level of the learning platform was evaluated in the same way as the first cycle. Accordingly, the tasks completed by the visually impaired participants in the longest and shortest average time were determined as task 3 (66.8 seconds) and task 1 (2.3 seconds), respectively. It was determined that Tasks 1, 2, and 10 were completed jointly by 7 participants with the same number of steps as the number of steps required for the process.

When the average duration of the participants with and without visual impairment was compared, it was seen that the task with the most difference between these periods was 11 (22.0 seconds/5.2 seconds). The task with the lowest difference was task 5 (32.8 sec/28.6 sec).

Findings on the level of satisfaction of visually impaired individuals and experts using the platform during the second cycle

In order to determine the level of satisfaction, 3 themes were determined as "positive aspects, negative aspects and suggestions" in line with the data obtained from the interviews with visually impaired individuals and subject matter experts. The themes and codes created are shown in Table 3.

	Table 3. Themes Related to the Satisfaction Level of the Participants	
Themes	Codes	Participants
Positive	Accessibility menu	AG4, TG14, TG15, TG16, TG17, AG5,
aspects		AG6, KAU8
	Shortcuts to items	AG4, TG14, TG15, TG16, TG17, AG6,
		KAU8, KAU9
	Personalized notices	AG4, TG14, TG15, TG16, AG5
	Labeling items	TG14, TG15, TG16, TG17, KAU8, KAU9
	Exam page	TG14, TG16, TG17, TG18, KAU8, KAU9
Negative	Not being uniform of the items	TG16, TG18, KAU8, KAU9
aspects	Message screen	TG15, TG16, KAU8
Recommendati	Personalizing the exam screen	KAU8
ons	Identifying star elements	TG15, KAU8, KAU9
	Description of videos	KAU8, KAU9

Accessibility menu, shortcuts defined for items, personalized feedback, tagging of items and exam screen codes were determined regarding the positive aspects theme. The accessibility menu was liked by the participants as it was suitable for both the visually impaired and the visually impaired. In the first cycle, a shortcut was defined for certain items on the pages, but as a result of the improvements, the screen reader was able to read these shortcuts. It was determined that each visually impaired participant was satisfied with the voice or written feedback he received as a result of being a member or making mistakes and the identification of almost all items on the page. In the questions and options on the exam screen, the screen reader does not have any difficulties, there are feedbacks, and the participants can easily access the complete exam button and request approval. Some of the example statements related to this theme are as follows:

"The accessibility menu was the part that I was satisfied with because I could perform many operations from one place." (TG17)

"It is good that the questions are on a single page. Because when we reach each question by saying forward, we lose time in the exam." (TG16)

In the theme of negative aspects, the elements are not uniform and the message screen codes are included. The fact that the items were not uniform was expressed by visually impaired individuals and subject matter experts. It was thought that some participants focused directly on the message writing area on the message screen, so it would be appropriate to add an explanation about this situation on the message screen. Some of the statements related to this theme are as follows:



"Defining items differently when browsing web pages is a challenge for people who do not see them. Because according to the features of the screen reader, those items are scanned differently." (KAU8)

"In addition to finding the My Messages screen difficult, it had slipped my mind in the part I had to choose." (TG16)

In the theme of suggestions, the codes of personalizing the exam screen, defining the stars and describing the videos are included. It was determined that the voice feedback given in the process of answering the questions should be improved on the exam screen. Although the labels on the pages are liked, it is emphasized that the evaluation stars should also be made accessible. In addition, it was said that videos should be described by subject area experts, and a video should be described in order to show at least how video descriptions are within the scope of this study. The statements of some of the participants are as follows:

"There was an unlabeled item on the course content page. I learned this by asking you. Since visually impaired people may want to evaluate this course, these star images should be presented differently. This is quite easy." (KAU8)

"The fact that the video content is described in the videos on the pages where it is located is a situation that motivates the visually impaired and helps them to come to life." (KAU9)

Findings on the level of effectiveness of the platform during the third cycle

In the third cycle of the application phase, evaluations were made with 14 visually impaired individuals, five non-visually impaired individuals and one subject area expert. As in other cycles, task completion situations are discussed first in determining the effectiveness level of the platform. Accordingly, it was determined that the success of tasks 1,2,3,4,5,7,8 and 10 was 100%, and that task 9 had the lowest success rate with 86%. The tasks in which the visually impaired participants spend the least and the most average time are task 10 (3.6 seconds) and task 5 (35.5 seconds), respectively.

Findings on the level of effectiveness of the platform during the third cycle

When the average number of steps of the visually impaired participants who successfully completed the task at the stage of determining the efficiency level of the platform was examined, it was seen that Task 1 was completed with the same number of steps as the number of steps required while performing the process by the other participants except for 3 participants, and Task 2 was completed by the other participants except for 2 participants. When the average time spent by the participants with and without visual impairment while completing the tasks was compared, it was determined that task 3 was completed in a shorter time by the visually impaired participants (26.8 seconds/ 33.2 seconds).

Findings on the level of satisfaction of visually impaired individuals and experts using the platform during the third cycle

For the level of satisfaction, 3 themes were determined as "satisfaction, difficulties and suggestions" in line with the data obtained from the interviews with visually impaired individuals and subject matter experts. The themes and codes created are shown in Table 4.

Tuble 4. Themes Related to the Sullsfullion Level of the Tuble pullis		
Themes	Codes	Participants
Satisfaction	Being accessible	TG20, TG22, TG23, TG24, AG8, TG25, TG26,
		TG28, GT29, TG30, KAU10
	Shortcuts to navigation	TG22, TG24, TG26, TG27, TG28, TG30
	Voice guidance	TG21, TG23, TG26
	Accessibility menu	TG19, TG20, TG22, TG24, AG8, TG29,
	-	AG9
	Lack of space in the page structure	TG21, TG22, TG25
	Ease of navigation in form field	s TG22, TG23, TG24, TG26, TG30
	Video controls	TG22, TG24, TG25, TG28, TG30
	Distinguishability of connection	AG8, AG9
	Consistency of pages	TG20, TG22, TG24, AG8, TG29
	Exam page	TG20, TG21, TG22, TG25, TG26, TG27,
		TG30
Problems experienced	Language issue on video control buttons	1 TG21, TG28, TG30

Table 4. Themes Related to the Satisfaction Level of the Participants



Recommendation	Images used unnecessarily	TG19, TG20
S	Improvement in accessibility menu	TG20, TG22, TG25
	Unread texts Heading	AG8, AG9 KAU10

Codes such as page accessibility, ability to navigate through shortcuts, voice guidance, accessibility menu, lack of space in the page structure, ease of navigation in form areas, video shortcut controls, distinctiveness of links, consistency of the page and exam page were determined regarding the satisfaction theme. At the end of this cycle, it can be said that the accessibility of the page is one of the most liked features by almost all participants. When the platform started to be designed according to accessibility standards, individuals with low vision and total visual impairment were taken into consideration as the target audience. Since the options in the accessibility menu consider both groups of participants, it can be said that the menu was liked and found functional by the participants. The statements of some of the participants related to this theme are as follows:

"The accessibility of the page is very good. I did not have any difficulties while navigating." (TG22)

"When I entered the exam, the transition of the questions, the ability to complete the exam directly, and the feedback provided were very easy. That page was very comfortable to use." (TG25)

"Based on the feedback you have received so far; it has made great progress and reached a successful level in terms of accessibility." (KAU10)

Although video controls were made on the keyboard in the theme of the problems experienced, it was expressed as a difficulty encountered by the participants to voice the button in English. Therefore, it can be said that some participants have language problems. The example statements related to this theme are as follows:

"Those voice overs were in English while the buttons were on the keyboard in the videos. It bothers me. At first, I could not understand." (TG28)

"While everything was being performed in Turkish, the video player was performed in English. I ran the word "full screen" and found it. It is not much of a problem, but it can be changed." (TG30)

Codes such as unnecessary visual use, improvement in accessibility menu and unreadable texts were determined regarding the theme of suggestions. Unnecessary visual use is another problem in the accessibility menu. Therefore, it can be said that improvements should be made in the options of the accessibility menu. In addition, it was suggested that the sections should be written in different colors and emphasis, and that they should increase readability. The statements of some of the participants related to this theme are as follows:

"In the accessibility menu, the screen reader does not read some places. I think they are visual. It can be removed in terms of being simple." (TG19)

"The fact that there are faint texts on the pages makes my job difficult because we see so little. I am having trouble finding it. Therefore, the section articles were not read for me." (AG8)

Findings on the results of the level of accessibility when the accessible open and free learning platform developed for visually impaired individuals is tested by the automated testing tool

Improvements were made in line with the feedback received from the participants at the end of the third cycle. Although evaluation tools are useful in the accessibility tests process, it is emphasized that user testing should definitely be done. Considering this situation, first of all, user test was performed in this study and evaluations were taken from the subject matter expert. The learning platform, which was developed as a result of the feedback received, was finally tested with an automatic evaluation tool. Thus, every error that may be encountered has been evaluated with all accessibility methods. For this study, AChecker, which is one of the web accessibility assessment tools, was selected. In addition, it was evaluated according to WCAG 2.0 Level AAA.

According to the results of the AChecker evaluation, the number of known errors was determined as zero. When looking at the potential errors, generally shape-ground contrast contrast errors were detected. Since potential errors are an error type that requires manual examination of the page, no negative feedback was received from visually impaired users about this color contrast. Therefore, necessary arrangements were made by paying attention to W3C and design principles. In addition, it can be said that the presence of different options for color in the accessibility menu minimizes this negative situation. Another problem encountered other than the color contrast is the codes written with the script. The reason for this is that the script codes cannot be changed because it is desired to make the existing page accessible. However, it was observed that the script codes shown as errors



did not pose any problems during the observation process with visually impaired individuals. One of the problems encountered as a potential problem is the lack of a sitemap on the platform. In line with the results of the automatic evaluation tools, a sitemap was created on the main page and added as a link.

	AC HECKER®
Checker Web Accessibility Checker	Web Accessibility Chee
Check Accessibility By:	
URL Upload Markup	
Address: https://open.bau.edu.tr/v2/	
Check It	
Options	
Accessibility Review	
Accessibility Review (Guidelines: WCAG 2.0 (Level AA))	
Known Problems(0) Likely Problems (0) Potential Problems (174) HTM	Validation CSS Validation
@ Congratulational No known problems	

As a result, the results of the automatic evaluation tool were corrected. In some warnings, user test and evaluations of the subject area expert were prioritized.

DISCUSSION AND CONCLUSION

In this study, which aims to develop an open and free accessible learning platform for visually impaired individuals (who do not see total and see less), firstly, a literature review was conducted within the scope of the design phase and the opinions of visually impaired individuals and subject matter experts were taken. According to the findings, the first design of an open and free accessible learning platform was made.

In the design process of an accessible, open and free learning platform for visually impaired individuals, six topics were focused on: text, visual, audio, video, keyboard usage and technical design principles. As a result of the interviews with the participants, the explanation of the images on the internet pages, the figure-ground contrast of the pages, the titling hierarchy, the labeling of the elements on the page, the definition of shortcuts to page transitions, keyboard access, resizing the screen, minimizing errors, audio feedback, providing alternative content and it has been concluded that the features such as leaving the page to the user's control should be included.

It has been determined that one of the most common problems in terms of accessibility on internet pages is visual elements. The reason for this is that these items cannot be read by screen readers unless explanations are added to the images on the web pages. In other words, since the visually impaired individuals can navigate the pages with the help of screen reader programs, it has been determined as the biggest difficulty to include the items on the page that do not have text equivalents. Similar results have been obtained in many studies on web accessibility (Aydın, 2011; Olive, 2009; Kurt, 2011; Emiroğlu, 2008; Chilson, 2002; Kubuş and Çağıltay, 2006; Perisa, Perakovic, & Remenar, 2012; Kaygısız, Keskin and Oğuz, 2011; Menzi and Çetin, 2015). In his study, Arık (2011) emphasizes the concept of text conjugation in images or videos so that the items on the internet pages can be accessed by screen reader programs to support this study. In other words, he focused on tagging items with the "alt" parameter in HTML codes. As can be seen, it can be said that the lack of text conjugates on accessibility is also a problem in previous studies. In addition, it has been concluded that alternative options should be offered for the content on the pages for the visually impaired individuals, and the use of the keyboard should be an alternative for page transitions or redirections. For example, it has been determined that defining specific navigation shortcuts for the internet page may provide convenience, in addition to making page transitions with the shortcuts supported by screen reader programs. In addition, the pages designed with web accessibility in mind work in harmony with screen readers. Thus, it has been seen that access to information on the site is easily provided through the shortcuts supported by the programs. For example, all links can be made easily navigable


with the letters "k" or "l" while browsing through the links. When Kurt (2011) evaluated the web pages of 10 universities in Turkey in terms of accessibility in his study, he stated that the lack of keyboard accessibility of the pages is among the striking mistakes. In addition to in-page navigation, attention should be paid to transitions between sub-pages. In addition, it was emphasized that the links on the pages work correctly. When the literature is examined, it has been observed that there are parallel problems in orientation and navigation between pages (Andronico, 2006; Menzi and Çetin, 2015; Yerlikaya and Durdu, 2020; Providenti and Zai, 2007; Aksoy and Şengel, 2018; Airplane and Çakmak, 2009). Instead of keyboard control, Kusumaningayu and Ayu (2017) developed a web access tool with talk and listen feature. In this web access tool, there are operations such as going to the web page, highlighting the information, repeating and stopping. There are different studies in the literature for web accessibility.

It has been concluded that audible feedback should be given for the problems encountered for individuals with total visual impairment. Yıldırım, Gül, Yurdagül, and Arslantaş (2016) reached a similar conclusion in their study. It has been seen that giving feedback audibly is more understandable and faster for users with total vision impairment. For individuals with total vision impairment, repeated voice-over of written feedback by screen reader programs can be considered a problem. Thus, it can be said that appropriate designs are not made for the use of the internet pages of visually impaired individuals. It has been observed that automatic completion should be allowed as well as warning notifications for errors made in the form entries on the internet pages for individuals with total visual impairment. In order to facilitate access to information, it has been determined that the title and location information of the current page should be given in a way that screen reader programs can detect. However, studies in the literature emphasize that many internet pages do not meet this requirement and cause access problems (Erkmen, Kılıç, & Holly, 2020). In line with the findings, it was concluded that alternative content should be provided to audio and video contents. In their study, Reed and Curtis (2012) emphasize the problems of visually impaired individuals in accessing digital materials and the difficulties experienced in the process of following them. For this, it can be said that it would be useful to leave the visuals such as audio or video on the web page to the user's control, but also to be presented as text. Perisa, Perakovic, and Remenar (2012), in their study, identified the lack of alternative content for videos as a major problem in terms of accessibility and reached similar results.

It has been observed that visually impaired individuals also benefit from the titles of the contents on the internet in the process of accessing information. For example, it has been determined that visually impaired individuals can navigate within the page with the help of the "h" shortcut. If proper titles are not provided on the website, it can be said that the participants have problems while browsing the page. When the literature is examined, there are many studies that give parallel results for titling (Kubuş and Çağıltay, 2006; Hassouna, Sahari, and İsmail, 2017; Yerlikaya and Durdu, 2020; Şerefoğlu and Henkoğlu, 2019). It has been concluded that for individuals with low vision, it is necessary to offer options that can interfere with screen size, color contrasts, text sizes and spaces between texts while browsing internet pages. In addition to these, it has been determined that the links and titles on the web page should be highlighted by the user at any time. He concluded that at the beginning of all the findings, attention should be paid to color and contrast for individuals with low vision, design features such as synthesized reading programs and keyboard access to pages. Individual differences (Kalac, Telli, & Erönal, 2020) should not be ignored in the universal design process. When the literature was examined, it was seen that parallel results were obtained (Dolunay & Akkan, 2019; Şerefoğlu & Henkoğlu, 2019). The reason for these results is that individuals with low vision experience great problems in the internet environment and designers still do not pay attention to these issues. It can be said that designers focus on visuals instead of thinking about universal design when designing a website. As a result of the evaluations made, it has been seen that the school website management panel, developed by Hebebci and Alan (2017), is a successful design in terms of color use. In the study conducted by Allan and Stiteley (2010), it is emphasized that interface preferences such as providing high-contrast options and adjusting the font size should be presented to the user so that individuals with low vision can use web pages easily. Michalska, You and Nicolin (2014) found similar results in their study. In this study, suggestions were made such as the use of Arial and Helvetica fonts, resizing the screen size to 200%, and a font size of 12. Arasid et al. (2018) have seen that there are many similar problems such as the use of color, media usage and structuring of page titles on web pages. Arslantürk (2021) identified the problem of insufficient color contrast in the web pages of the ministry he examined. Teymen and Özdemir (2015) concluded that the font increase feature provided for individuals with low vision on internet pages has a positive effect on increasing their reading speed. In addition to obtaining parallel results in all studies, the guidelines of the guidelines developed for internet accessibility were also developed. When the study of Yerlikaya and Durdu (2020) is examined, it is seen that the design is made with very few mistakes for individuals with low vision. Despite all these results and the design principles put forward, it is thought that the issue is ignored by the web page developers. For this reason, Durdu and Altuntas (2020) focused on the website accessibility perceptions of



software developers in their research on Turkish software experts. As a result of the study, it was emphasized that studies should be carried out on web accessibility legislation.

In the open and freely accessible learning platform developed for visually impaired individuals, there is an online measurement and evaluation screen in addition to the course contents. After the findings obtained from the participants during the design process of these screens, the problems encountered were that the questions were not included in a single page, the keyboard was not allowed to be used in question transitions or answering the questions, and the voice feedback was not included. Tsironis, Katsanos and Xenos (2017) The most striking problem in the Udacity platform is that users have difficulties on the exam screens. It has been determined that the text boxes and radio buttons on the exam page are not accessible. When the literature is examined, it has been seen that there are accessibility problems in online measurement and evaluation screens, even in widely used learning platforms.

In the application phase, a pilot study was conducted with the visually impaired individual, and after the pilot study, the design development process was completed in three cycles. The usability level of the platform developed as a result of each cycle is discussed within the scope of effectiveness, efficiency and satisfaction levels. It was aimed to ensure that the learning platform complied with the principles of universal design and accordingly, seven principles of universal design were taken into consideration (Connell et al., 1997) with the improvements made in line with the opinions obtained as a result of the cycles.

The following results were obtained for an open and free accessible learning platform developed in the light of universal design principles: (1) Drop-down messages or drop-down menus should not be included in the platform; if there is a drop-down menu, there should be options to access the relevant section. (2) Different color contrast options should be offered in order to increase readability for individuals with low vision. (3) In order to increase readability, individuals with low vision should be given the opportunity to enlarge the texts on the page as much as they want as well as magnifying technology and to increase text gaps (5). Links should be easily emphasized on the learning platform and the contents on the page should be emphasized in different colors. (6) In order to increase the distinctiveness of the titles, individuals with low vision should be able to emphasize the titles in underlined red at any time. (7) For individuals who do not see total, all titles should be written in a certain hierarchy. (8) Explanations of the visuals on the learning platform should be added. Low vision individuals should be able to see the explanations with a single click, and all explanations should be added with the "sub" parameter for individuals who do not see total. (9) Each feature applied to the learning platform should be able to be reset with a single option. (10) Access to actively used help and message pages should be provided with different options. (11) If specific feedback is to be provided to the learning platform, a screen reader synthesized on the platform should be preferred. (12) Shortcuts should be defined for in-page and inter-page transitions. (13) Learning platform design should be consistent, simple and understandable; fixed menus should be preferred; the sitemap should be on the page. (14) Links and titles should be written appropriately according to HTML tags. (15) Both voice guidance and written warnings should be made about the problems experienced in the forms on the learning platform; written warnings should be written in red for individuals with low vision. (16) The page titles of the learning platform should be defined appropriately; users should be able to read the names of the page they are on with "Insert+F7". (17) Keyboard control should be provided for video items; when the videos are completed, they should provide voice guidance. (18) Content containing information equivalent to video elements should be prepared for visually impaired individuals; Adobe Reader should be preferred for alternative digital documents. (19) In the pages deemed necessary, the elements that the cursor will focus on should be determined. (20) The measurement and evaluation should be designed in such a way that the questions on the web pages are displayed on a single page, and the questions are read as a., b., c., while the options are read with the reader tool. (21) At the beginning and end of the exam, the routing, which can be interacted via the popup message and voiceover keyboard, should be submitted to the user for approval. The duration of the exam should be expressed aloud as soon as the exam starts and at certain intervals; when the user wants to know the remaining time, the user should be given feedback about the remaining time with the combination of "Ctrl+ Z". (22) When the correct answer is desired to be marked on the measurement and evaluation screen, it should be possible to mark with the "Enter" button as well as the mouse. Voice guidance should be made when the option is checked; feedback should be given when the question is left blank. (23) Region feature should be defined as the beginning of the page, the middle of the page and the end of the page in the sections on the learning platform. (24) If there is a screen reader specific to the page, it should be activated according to the user's own request. (25) The certificates to be given to the users who are successful in the course on the learning platform should be presented with a QR code.

When the learning platform, which was developed with the AChecker automatic evaluation tool in line with the design principles set out within the scope of the study, was tested, no known error was encountered. When the



literature was examined, it was seen that the web pages selected using the AChechker test tool were evaluated (Delen and Abdüsselam, 2015; Çelik, 2014; Akgül and Vatansever, 2016b; Karaim and Inal, 2017; Acosta-Vargas et al., 2018; Aksoy and Şengel, 2018; Ataç, Beyazgül and Cengiz, 2020). Unlike the open and free learning platform developed, the most common error is the lack of text explanations of the pictures. Unlike the study of Shubina (2016), it was observed that although there were technical errors on the Udacity platform, there were no technical errors on the open and free learning platform developed. Because the platform is designed with W3C standards in mind. The open and free accessible learning platform, which does not have any known mistakes, also helps visually impaired individuals to adopt an uninterrupted learning approach in their daily lives with its user-friendly interface (Kishore and Raghunath, 2015). Thus, like individuals who do not have visual impairment, individuals with visual impairment can have the opportunity to learn at any time and anywhere (Wong and Looi, 2011). In this context, one of the biggest advantages of the open and free accessible learning platform developed as a result of this study is that it is accessible and offers lifelong learning.

When the results obtained in the study are evaluated holistically, it is clearly seen that the most important issue in Web accessibility is that the software developers who design the websites should have sufficient knowledge about the concept of universal design and accessibility. For this reason, it is important for these people to be involved in educational processes that will increase their awareness about learning platforms and the accessibility of digital materials. It is thought that showing accessible design examples in practice within the scope of these training processes will be a guide for software developers.

In order for visually impaired individuals to benefit effectively from the applications developed in the field of information technologies, in other words, the needs of disabled users should be taken into consideration. The developed internet-based software should be subjected to automated test tools and user test and necessary corrections and improvements should be made in line with the opinions obtained. It is thought that the results obtained in this study also contain important feedback in the development of new designs, and it is predicted that it will make significant contributions to the desired quality of these contents by considering the design principles.

In this study, entrepreneurship course was selected as the demo course. In line with the design principles, it is thought that the research of the effectiveness and efficiency of the learning platform by preparing numerical course contents will contribute to the literature. Apart from this, the contribution of open learning platforms to lifelong learning skills in visually impaired individuals can be investigated with the studies to be carried out with different age groups; experimental studies can be conducted to investigate the effect of this platform on success; and the attitude scale regarding accessible mass open learning platforms can be developed by taking into account the themes and interview expressions obtained from the opinions of the participants.

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Examination of Mathematics Teachers' Opinions on the Future of Distance Education*

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ABSTRACT

In this study, it is aimed to reveal the opinions of mathematics teachers about the future use of distance education. This study, which was designed in accordance with the case study, which is one of the qualitative research designs, was carried out with 42 mathematics teachers in the spring term of the 2020-2021 academic year. The data of the study were obtained from the answers given to the semi-structured interview form made with mathematics teachers. The data obtained from the research were analyzed using content analysis. As a result of the research, it is seen that teachers want to continue distance education for different purposes. Mathematics teachers who want to continue distance education mostly in order to be able to solve questions, to eliminate the deficiencies of the students and to repeat the subject. Teachers also stated that distance education can be used in online meetings, in communicating with parents who cannot come to school, in eliminating deficiencies that may occur due to disruptions in face-to-face education. In the study, it was seen that teachers who think that distance education and that a classroom atmosphere cannot be created in these lessons. As a result, the majority of teachers who have experienced distance education want to continue the new normal and later distance education in order to support face-to-face education.

Keywords: Distance education, mathematics teaching, mathematics teachers, lesson model

INTRODUCTION

Distance education has created remarkable effects in the field of education by using various communication technologies since the 19th century and has become an important topic of interest in the field. In this context, various definitions have been made in the literature about what distance education is and what it includes. For example, Holmberg (1989, p.168) defined distance education as a concept that covers all learning-teaching activities where learners and instructors are separate in space and time. According to Moore (1994), distance education is teaching methods in which teaching behaviors are carried out separately from learning behaviors, so that communication between teacher and student is facilitated by printed, electronic, mechanical or other devices. Simonson (2003) defines it as an institutional-based, formal education in which interactive telecommunication tools are used to connect learners, instructors and course contents, in which the learning group is separated. This definition of Simonson highlighted four main components of distance education as seen in Figure 1.

^{*} A part of this article was presented as a summary paper at UFBMEK2021.





Figure 1. Basic Components of Distance Education (Simonson, 2003)

The first of these components is the conduct of distance education by institutions. Second, it provides flexibility to students and instructors in terms of time and space. This distinctive feature of distance education makes distance education attractive by overcoming the problems such as space and time management brought by traditional face-to-face education (Of, Kahraman, & Kudu, 2018). Third, distance education allows individuals in the learning group to communicate with various telecommunication tools. The last component is distance education, which provides students with the opportunity to gain different learning experiences through various educational resources.

In distance education, the classroom environment where teachers and students communicate face-to-face is replaced by a technological environment. This allows technological developments to shape the distance education process and to continue this process in accordance with today's conditions. This process, which is defined as the new generation distance education, is explained by Zhou et al. (2020) as a method of rapid learning and dissemination of content through the use of information and internet technologies. In other words, it is a teaching process in which enriched learning environments are developed in which learning processes are carried out through instructional technologies. Saykili (2018) states that in this process, when the effect of technology on learning reached its peak, previous learning models began to lag behind, and thus new models that allow multi-faceted communication and interaction came to the fore. Therefore, new generation distance education; aims to use synchronous, asynchronous and mixed education models effectively.

Distance education has gained a special importance, especially with the onset of the Covid-19 global epidemic, and has been seen as the only way to continue education activities in many countries around the world (Moreno & Gortazar, 2020). Due to the Covid-19 epidemic, face-to-face education was suspended in most countries and various restrictions were introduced, and distance education activities, which provide flexibility to students and teachers in terms of time and space, have begun to be carried out rapidly. Thus, as in most countries, in order not to disrupt education and training activities, Turkey has adopted and started to implement the new generation distance education method. With the distance education activities developed day by day, teachers tried to keep up with these studies, which they encountered for the first time, and to make distance education as efficient as possible by combining technology and education (Ozdemir Baki & Celik, 2021). In this context, teachers gained various experiences in the distance education process and continued their educational activities by combining these experiences.

When the relevant literature is examined, there are studies that show that distance education has many advantages and that it is as effective as traditional education when appropriate methods and technologies are used (Kiryakova, 2009; Ward et al., 2010). Some of these advantages are; distance education is economical in terms of cost (Bijeesh, 2017; Brown, 2017; İsman, 2011), being easy in terms of accessibility (Moore & Kearsley, 1996; Traxler, 2018), being independent of space and time management (Erfidan, 2019; Fidan, 2020) ; Horspol & Lange, 2012; Kirik, 2014; Nagrale, 2013; Of et al., 2018) the use of various educational resources (Arat & Minister, 2014), the replayability of the content (Duman, 2020; Yolcu, 2020), the use of technology in education. (De Paepe et al., 2018), aiming at lifelong learning, and most importantly, meeting the need for education during the pandemic period (Almaghaslah & Alsayari, 2020; Kaden, 2020). In addition, Simonson et al. (2011) emphasized the



importance of the design and quality of distance education and revealed a significant relationship between welldesigned online courses and student satisfaction and learning outcomes. Whereas, some studies suggest that rapid growth due to technological developments, along with the increase in online learning opportunities in distance education, brings along various problems (Ferguson, 2020). For example, Murphy (2020) stated that distance education practices limit face-to-face classroom interactions during the Covid-19 epidemic. Stillman (2019), on the other hand, stated that the interaction between the student and the instructor is insufficient in distance education and argued that online courses limit the opportunity of following the students' work. Basaran et al. (2020), on the other hand, revealed that students and teachers do not find online lessons productive. On the other hand, most research findings show that digital technology opportunities in distance education vary according to individuals with different economic conditions, and therefore, schools in rural areas and individuals living in places without internet infrastructure are negatively affected by this situation (Alpago & Oduncu Alpago, 2020; Ozdemir Baki & Celik, 2021; Zhou et al., 2020). As a matter of fact, conducting online courses, which are compulsory due to the pandemic, requires internet infrastructure. This also applies to mathematics education.

When the studies on distance mathematics teaching are examined, it is seen that there are two different opinions regarding the online realization of mathematics lessons. While the first view argues that conducting mathematics courses completely online is as effectual as face-to-face teaching, the second view argues that it is not possible to conduct mathematics courses completely online in an effectual teaching process (Trenholm et al., 2019). Xu and Jaggars (2014) concluded in their study that students are more successful in face-to-face mathematics lessons rather than online mathematics lessons. Similarly, Smith and Ferguson (2005) concluded in their qualitative research that teaching mathematics in online courses is difficult and not effective enough. Moliner and Alegre (2022) found a statistically significant difference between the academic achievements of high school students in their study in which they compared mathematics achievements before and after Covid-19. In the study, decreases were detected in the mathematics achievement of students with Covid-19 restrictions. In particular, it was determined that the main factor explaining this decrease was the changes in peer support. Although the results of the research comparing face-to-face and online mathematics teaching revealed that there was no significant difference between the two applications in terms of learning, Trenholm et al. (2019) argued that this claim is incomplete, the success achieved as a result of the tests is not obviously expressed, and the data collection tools used are not reliable and valid enough. For this reason, the researchers stated that this is not enough to compare the effectiveness of faceto-face and online teaching, and online courses should only be used to support face-to-face teaching.

Studies examining the distance education experiences of mathematics teachers, their views and attitudes towards distance education also draw attention during the pandemic process. For example, Ozdemir Baki and Celik (2021), in their study investigating teachers' experiences of teaching mathematics remotely during the pandemic process, revealed that teachers experienced difficulties due to instructors (student, teacher and mathematics-specific), technology and external factors, and that they took various measures depending on environmental factors. In the study conducted by Kilit and Guner (2021) with mathematics teachers, it was concluded that teachers did not find web-based distance education effective and efficient for teaching mathematics. It is possible to encounter similar findings in the studies of Tican and Toksoy Gokoglu (2021). In the study conducted by the researchers with the teachers, most of the participating teachers stated that they did not find mathematics lessons useful in distance education. Unlike other studies, Cassibba et al. (2021) stated in their study that most of the professors consider writing tablets, mathematical software and e-learning platforms they use in distance education to be limited. On the other hand, Ozcakir Sumen (2021), who stated that teachers adopted positive views on distance education, revealed that in this process, teachers planned the operation of mathematics lessons before the lesson and used technological materials more. In addition to these studies, when the results of the study examining the attitudes of students and teachers towards distance mathematics education were evaluated, Demir, Kaleli Yilmaz and Sert Celik (2021) examined about distance mathematics education the attitudes of teachers working at primary, secondary, high school. Research findings showed that teachers' attitudes towards distance mathematics lessons were undecided but negative. In this direction, Wijaya (2021) examined students' attitudes towards mathematics during the pandemic. In the study, it was concluded that the use of video through dynamic mathematics software affects students' attitudes towards mathematics teaching positively.

In general, researches clearly reveal that distance education, which was started because of the epidemic, is an effective method for teaching and learning. On the other hand, studies on mathematics teaching more specifically show that this situation is not the same. As a matter of fact, considering the general course of the Covid-19 epidemic, it would be correct to say that its effects in the field of education will not be short-lived, and therefore distance education may turn into a permanent teaching method rather than an alternative solution used during the epidemic period. For this reason, distance mathematics teaching activities should be structured as well as possible in the new normal and subsequent period when the epidemic continues. This makes the experiences and observations of mathematics teachers who carry out distance education activities important under the emergency



conditions of the global epidemic. Although studies have been carried out to determine the views of mathematics teachers on distance education during the pandemic period, no study has been found that reflects the perspectives of teachers on using distance education in the new normal and the following period. It is very important to reveal the opinions of the teachers who train the individuals of the future about the role of distance education in the new normal and the following process, in order to raise students with the necessary competencies and needs of the age. In this study, it is aimed to reveal the views of mathematics teachers on the future of distance education. In this context, the research problem of the study is as follows:

• What are the opinions of mathematics teachers about using distance education in the future?

METHOD

Research Model

This study was designed in accordance with the phenomenology approach, one of the qualitative research designs. Phenomenological research focuses on making sense of the lived experiences of individuals related to a phenomenon (van Manen, 2007). Therefore, the main purpose of phenomenological research is to reflect individuals' understandings, feelings and perspectives towards the phenomenon, based on how they experience a phenomenon. In this study, it was found appropriate to use the phenomenological research method as it will reveal the perspectives of mathematics teachers towards using new normal and later distance education in line with their experiences in distance education.

Ethics committee approval was obtained for this study from Atatürk University Social and Human Sciences Ethics Committee with the number E-56785782-050.02.04-2200007986.

Study Group

This study was carried out with 42 mathematics teachers working in different provinces of Turkey. In phenomenological studies, the study group is chosen for the purpose, since it is aimed to collect information from individuals who have experiences with the phenomenon that the study focuses on and who will reflect this phenomenon. For this reason, multi-stage sampling method was preferred in determining the participants. In the first stage, criterion sampling, one of the purposeful sampling methods, was used. In this method, it was taken as a criterion for teachers to have mathematics teaching experience in the distance education process. In the next step, snowball sampling, one of the purposeful sampling methods, was used. Snowball sampling consists of subjects added as research continues. This sample begins with one or more known and available subjects. Just as a snowball expands and grows when it rolls, snowball sampling can lead the researcher to more events or subjects with one or more types of events or subjects that are initially desired to be studied. In this way, more events or subjects than expected can be reached (Ozen & Gul, 2007). From this point of view, a mathematics teacher, who is well known by the researchers, was determined as the key person. Then, four resource people were reached from the mathematics teacher who was the key person, who volunteered to be interviewed, who were suitable for the purpose of the research and the criteria determined in the research. With the help and suggestions of these teachers, a total of 42 mathematics teachers, 33 of whom work in secondary schools and 9 of which work in high schools, were reached. The descriptive characteristics of the participant teachers are given in Table 1.

	Table 1. Information on the descriptive characteristics of participant teachers					
Sahaal	~ .	Teaching Experience (years)				
Levels	Gender	0-5	6-10	11-15	16 and	
					over	
Secondary	Woman	5	7	4	5	
	Man	2	4	5	1	
High	Woman	1	1	1	1	
	Man	1	1	1	2	

Table 1. Information on the descriptive characteristics of participant teachers

Data Collection

One of the most frequently used data collection techniques by qualitative researchers in education and social sciences is semi-structured interview. The data of the study were obtained through semi-structured interviews with mathematics teachers. The first question in the semi-structured interview form prepared by the researchers was prepared to determine the opinions of the teachers participating in the interview about whether distance education should continue or not. According to the answers given by the teachers, the sub-questions were directed in two different ways. Teachers who did not want distance education to continue during and after the new normal were asked to explain why they did not want it to continue. Teachers who wanted to continue distance education were asked for what purposes they wanted to use distance education activities. It was tried to determine whether there



was any change in their perceptions of using distance education by interviewing the interviewers twice at different times. The interviews were conducted online. The first interview was held in the spring term of the 2020-2021 academic year, and the second interview was held in the fall term of the 2021-2022 academic year. Thus, by reconsidering the feelings, thoughts and experiences of mathematics teachers towards distance education at different times, it has been tried to reflect the different perspectives of teachers towards using distance education.

Data Analysis

Oualitative data analysis was used in this study. Qualitative data analysis is a collection of activities in which the data obtained by data collection methods and techniques such as observation and interview are organized, categorized, themes are discovered, and ultimately the whole process is transferred to the report (Özdemir, 2010). The data obtained from the research were analyzed using content analysis. In this process, firstly, the questions in the interview form were determined and the answers of the teachers who participated in the interview were evaluated in detail. While the answers given by the teachers were analyzed, the data were coded by dividing them into small meaningful parts with the help of an excel table. The codes were revised after each interview. While the codes were being created, it was determined how often a code was used in the interviews and where to pay attention in the next interview. Then the frequencies of each code were determined. Thus, while determining how many teachers the determined codes were effective on, it was also tried to reach the exceptional situations experienced by the teachers. A table was created by giving names to the codes according to the explanations. Afterwards, a literature review was made and the codes were revised. By examining the generated codes, the relevant codes were brought together and categories were created. In order to increase the reliability of the coding, the collected data were examined by both researchers. The agreement between researchers was calculated by using Miles and Huberman's (1994) percent agreement formula. In this study, the agreement between the two encoders was found to be 94%. Accordingly, the coding process provided a desired level of reliability. In addition, the relationships and explanations between the codes were explained descriptively in the research. In order to increase the validity and reliability of the research, the accuracy of the interview transcriptions of the participants was confirmed by the participants. In addition, direct quotations from the interviews with the teachers were included and the study was presented in detail through dense and rich descriptions.

RESULTS

In the interviews, the first question was asked to the teachers, "Do you want distance education activities to continue when the new normal and then face-to-face education is started? question was posed. In this context, teachers who wanted to continue distance education were asked for what purposes they wanted to carry out distance education activities. The codes created in line with the answers given by the teachers are given in Table 1.

Theme	Category	Codes	f
		Flexible lecture hours	2
	T. 1	Being able to communicate easily outside of school	4
	reacher-oriented purposes	Reaching more students at the same time	1
		Carrying out professional development activities	3
		Using interest in technology	2
Distance	Student-oriented purposes	Considering individual differences	1
Distance		Giving guidance	2
should		Conducting special education lessons	1
continue		Providing weekend courses	3
continue		Conducting online parent meetings	3
		Solving the question	11
	Taaahing amantad	Repetition of the topic	2
	numperson	Conducting the discussions	1
	purposes	Making/completing activities	4
		Elimination/support of subject deficiencies	7

Table 1.

Teachers' Opinions on Continuation of Distance Education

As seen in Table 1, teachers who think that distance education should continue in the future; It has been determined that they want distance education to continue with the aim of contributing to the development of students, reaching the purpose of teaching and contributing to the personal development of the teacher. The category that teachers who want to continue distance education think to develop the least is the goals for the teacher. According to Table 1, it is noteworthy that the frequencies of the four codes of the category created for these purposes are not very high. When the categories are examined, it is seen that the teachers mostly want the distance education to continue



by highlighting the aims of the teaching. In this context, teachers; They stated that they want to continue distance education for purposes such as repeating the subject, conducting discussions, completing the activities in the lesson or doing new activities, eliminating the deficiencies of the subjects covered in the lesson and solving questions.

Mathematics teachers who want distance education to continue when the new normal and then face-to-face education is introduced stated that live lessons should be conducted in distance education in order to be able to solve the most questions. In this context, T2 "Live lessons can be continued to solve problems." expressed his opinion. T15 said, "Teachers can solve questions that students cannot do with distance education. Additional questions can be resolved." expressed his thoughts on this subject with his statements. One of the teachers who thinks that distance education should continue in order to make up for the deficiencies of the students, T1 said, "The subjects of the mathematics course are interconnected and do not accept any deficiency. For this reason, I would like distance education to continue in order to complete the deficiencies." expressed as. T17 said, "A more effective course can be created by supporting the subjects that students are stuck on with distance education, especially apart from face-to-face education." He stated that distance education can be used to support the subjects. Similarly, T7 said, "In order to use the time efficiently, support lessons can be taught by conducting distance education with students who do not understand the same subject. In fact, by developing distance education, the lectures can be recorded and students who do not understand can be given the opportunity to watch it over and over again", he stated that distance education can be used to support the subjects. T14, on the other hand, stated that distance education can be used both to support the subjects and to eliminate the deficiencies that may occur due to disruptions in face-to-face education:

"Distance education can be used to support the topics we cover in face-to-face education, especially in order to discuss the subject or problem that is not understood after the lesson... When we get sick and get a report, it can be used to make up for the lesson."

In this direction, T9 stated that distance education should continue in order to repeat the topics covered. In addition, T9 mentioned that since some students are interested in technology, it is possible to support mathematics teaching by using technology. T9 "Some students can better understand this method because they are interested in technology. In this way, we also take into account student differences." used expressions. Stating that distance education has become a part of the education system, T10 emphasized that distance education can be used in online meetings with the following statements: "We can communicate with the parents who could not attend the school, organize a parent meeting in the evening with the participation of the parents, and exchange views about the students. We can also hold online meetings, such as group meetings, with branch teachers at school." Similarly, T7 stated that teachers had improved themselves in online education in this process and emphasized that this situation should be used beneficially in the field of education in the following periods. T7 also said, "We can hold meetings with parents who can't come to school using online meetings and who have limited time. Thus, we can make school, family and student communication more active, and we can cooperate with parents so that students can use the time they spend at home efficiently. Also, as math teachers, we can exchange ideas with each other using these remote online meetings." made statements. T4, who is in favor of using face-to-face education on weekdays, said that distance education should continue for weekend courses, "I think auestion solving can be done in distance education in the courses that exist on the weekend. We can continue by solving questions and explaining the subject by using the smart board application in the courses. We will save time and children can attend courses at home." expressed in his words. In parallel, T18, who works in a regional boarding school, said, "Weekend courses can continue as live lessons, not as lessons. It may not be possible for every student to attend the courses at the school. These students can attend courses with distance education." used expressions. T18 also stated that he wants his students, who live in different villages, who have problems in transportation, but stay at the school as boarders and attend classes on weekdays, to attend the courses held at the weekends as distance education. Ö15, a village teacher, also stated that weekend courses can be continued with distance education. Four teachers stated that distance education can be used to carry out and complete the activities. Stating that it is not predictable how long the pandemic will last, and therefore we need to improve ourselves in the distance education process, T10 said, "We can use these programs to improve ourselves in the profession. We can attend online meetings related to mathematics teaching organized by some university professors. We can meet with our online math teacher friends and exchange information, so we can perform a better mathematics teaching." made statements. Stating that they do not know what life will bring even in the end of the pandemic process, and therefore teachers should be prepared for many difficult conditions, T26 said, "It is impossible to break away from this completely experienced, tried and gained distance education." made statements. However, T7 mentioned that it is necessary to continue distance education in order to carry out professional development activities as follows:

"... Also, as math teachers, we can exchange ideas with each other using these remote meetings. We can discuss how we can teach mathematics better and share different mathematics problems with our branch colleagues through this platform. We can inform each other about current teaching methods and



techniques in mathematics and share what we have done in our productive lessons. We can exchange ideas to diversify the materials we use." Drawing attention to a different point, T13 stated that distance education can be effective for students who need to be educated at home.

In the interviews, he said to the teachers who do not want distance education to continue, "Why do not you want to continue distance education activities in the new normal and afterwards? question was posed. The codes created in line with the answers given by the teachers are given in Table 2.

Table 2 Teachers' Opinions on the Discontinuation of Distance Education				
Theme	Category	Codes	f	
		Not suitable for village schools	1	
Distance		Virtual learning environment	4	
	In terms of the structure of	Insufficient interaction	7	
	distance education	İnequality of opportunity	6	
		Lack of face-to-face lecture	3	
education		Not suitable for math class	8	
shouldn't		Boredom of students	2	
continue	In terms of students	Students have problems taking responsibility	2	
		Difficult to measure and evaluate	3	
	In terms of teaching	Not efficient	7	
		Insufficient class participation	3	
		Lesson time is limited	2	

As seen in Table 2, teachers who think that distance education should not continue in the future: It has been determined that they do not want distance education in the future due to the negative effects on the development of students, the inability of the education to achieve its purpose, and the unsuitability of the structure of distance education. The situations that the teachers who do not want to continue the distance education think that they have the least problems are the problems related to the "In terms of students" category. It is noteworthy that the frequencies of both codes of this category created according to Table 2 are not very high. From this point of view, it can be thought that teachers do not have enough knowledge about the problems experienced by students in distance education. When the categories were examined, it was determined that the teachers had various concerns about the structure of distance education. Teachers, who think that distance education should not continue, have generally argued that the interaction in live lessons is insufficient and live lessons are not efficient for teaching mathematics. For this reason, they argued that distance education should not continue when face-to-face education is introduced. On this subject, T23 said, "Distance education is insufficient in the narration and interaction of the subject. Since the interaction with the student has decreased, the necessary intervention cannot be made on time, and therefore the deficiency continues exponentially. After a while, the student loses all interest. Since the interaction of students with each other is minimized, it is not an enjoyable process for the student." used expressions. T6 stated that distance education is not suitable for village schools without internet infrastructure and argued that face-to-face interaction is necessary for mathematics teaching. Sections of teachers' statements in this regard are presented below:

"... If possible, I would like a complete transition to face-to-face training. Because I believe that face-to-face training will be more beneficial due to our branch. Mathematics is a lesson that students can only understand with face-to-face education." (T28)

"We have seen that distance education is not as beneficial as face-to-face education. Not all students can attend remote courses. Since the subjects of mathematics lesson are related to each other, it is necessary to know the previous subjects in order to learn each subject. Students who cannot attend one lesson do not understand the other lesson. In addition, I think that it affects the learning of the course badly because there is a lack of communication." (T30)

"...Because I think that even facial expressions are helpful in class. It is difficult for students to understand mathematics in distance education. We mathematicians use our bodies a lot, especially in figure or graphic questions." (T36)

T3 and T22, on the other hand, stated that the lecture should be face-to-face and stated that distance education should not continue. T3 explained this situation as "Because I love education and teaching as a whole, I want to make eye contact with my students and be together with them in my lessons." explained as. In addition, T5 argued that live lessons should not continue due to the virtual nature of distance education. Stating that he had difficulties



in doing live lessons in distance education, T8 stated that not all students could benefit from distance education because of the inequality of opportunity and stated that distance education should not continue. In addition, T27, T31, T30 and T41, on the other hand, stated that adequate opportunities could not be provided to everyone and stated that distance education should not continue. Similarly, T13, who works in a rural school and tries to offer live lessons with students living in villages, emphasized the inequality of opportunity in distance education and stated that distance education should not continue. Ö22, on the other hand, stated that he did not want distance education to continue on the grounds that a classroom environment could not be created in distance education.

In the first interviews, it was seen that the teachers had concerns about teaching such as the difficulty of measuring and evaluation in distance education, the limited duration of the lesson, the insufficient participation in the lesson and the ineffectiveness of the live lessons. In this context, T5 said, "Since the time is very limited in live lessons, we can only teach here, but we are disrupting the education part of education and training. Therefore, face-to-face training would be better." He talked about the limited time with his statements. On the other hand, it has been determined that some teachers do not want distance education to continue due to student-related reasons such as students getting tired of live lessons and having problems in taking responsibility in lessons.

During the meetings held with the teachers in the spring term of 2021, their opinions on using the new normal and then distance education were taken. When the opinions of the teachers were examined, it was determined that there were three lesson models they wanted to use in mathematics lessons. The lesson models preferred by the teachers are shown in Figure 2.



Figure 2. Preference Ethics of Mathematics Teachers Lesson Models

Teachers who want to use the distance education model completely stated that some deficiencies should be eliminated in order to carry out mathematics lessons efficiently in distance education, but they emphasized that the flexibility of the lessons is quite advantageous. Teachers who think that mathematics lessons should only be continued face-to-face, stated that they could not provide enough classroom order in virtual environments and that they encountered negative effects during the operation of distance education. In addition, it has been determined that teachers working in rural areas argue that distance education should not continue due to inequality of opportunity and they only want to continue face-to-face education. The teachers who agreed that distance education is a new achievement for teachers and that the deficiencies experienced in live lessons can be largely corrected in the new normal and afterwards, and that success in distance education can be achieved, stated that distance education.

When face-to-face education was introduced in the fall semester of 2021, interviews were conducted again to determine whether there was a change in teachers' thoughts on using the new normal and then distance education. In repeated interviews, it was determined that there were changes in the use of distance education by some teachers. In this direction, the lesson models that teachers want to use in mathematics lessons in the spring and fall semesters of 2021 are compared in Figure 3.





Figure 3. Preferred Ethics of Mathematics Teachers, Lesson Models by Term

As seen in Figure 3, in the spring term of 2021, 16 teachers preferred face-to-face education only, while 13 teachers preferred face-to-face education in the fall semester of 2021, when face-to-face education was introduced. During this time, three teachers decided that "distance education should support face-to-face education" instead of "only face-to-face education". For example, "... I don't want to continue with distance education only in the future, faceto-face education is more effective. But they can be together. I would like to do live lessons remotely from home at certain times a week. I would like to use distance education for the purposes of repeating the subject, solving questions and informing the students about the instant developments in the lesson, not to teach new subjects in mathematics." T11, who preferred only face-to-face education in the first interview, stated that distance education and face-to-face education should be combined in the second interview. Despite this, a teacher who preferred only distance education stated that there was no change in his ideas. Contrary to this situation, T3 who stated that distance education is not beneficial in the spring semester and he wanted to meet and be together with the students as a reason and preferred only face-to-face education; in the interviews held in the fall semester, he stated that he preferred face-to-face learning more decisively. T3 justified this situation by saying, "... Only my views on distance education have definitely not changed, they have even been consolidated and strengthened. When it comes to supporting face-to-face education with distance education, school already takes children's time. Also, I don't want to make children sit in front of the computer at home. I am one of those who think that the computer makes children more passive than necessary. ..." used the expressions. In parallel with this situation, T30, who preferred only face-to-face learning in the spring semester, stated that the students could not attend the live lessons sufficiently, and that the students who could not attend a lesson because the mathematics subjects were related to each other could not fully understand other mathematics subjects. T30 also stated that there was no change in his ideas during the interviews held in the fall semester. T30 explains this situation as follows;

"... Last year, I thought that students who could not attend my live lessons in distance education for various reasons did not understand the lessons. In fact, I saw this semester that even some students, who only interrupted some lessons and tried to attend live classes as much as possible, did not fully understand the subjects due to the disconnections in the lessons. Since distance education is not efficient enough, when I switched to face-to-face education this year, I found that children could not acquire the gains they should have in distance education. Due to the nature of the mathematics course, students cannot understand new topics this semester, as there are deficiencies in the topics of the previous semester. I think we should just continue with face-to-face training."

However, it was observed that there was no change in the opinions of 24 teachers who preferred the supportive distance education model in the spring term when distance education was started. These teachers think that face-to-face education supported by distance education will be more beneficial for students in both conditions. Parallel to this situation, the statements of T11, who is considering using distance education to support a subject that the student does not understand, are given below:



"I would like to use distance education together with face-to-face education in the future. It can be used to supplement topics that students do not understand. In fact, the lessons can be recorded and students who do not understand can be given the opportunity to watch it again and again. I am seriously considering using distance education as a support. I will even start distance education myself in this process. I don't have enough time for face-to-face training. Some math subjects that were supposed to be finished according to the plan did not catch up. Considering that my students have completed their deficiencies such as internet and computer in distance education and that they have learned how distance education should be by experience, we can think that we will not have a problem in this regard. I talked to the children and we will do online lessons together. We both complete the missing topics and solve a lot of questions."

Similarly, many teachers think that distance education can be used to support face-to-face education with live lessons that can be held at flexible hours. For example, T10 said, "I think we can provide education outside of school because of the flexible course hours in distance education. We can communicate with our students even during the summer holidays. Even as teachers, we can participate in professional development courses to improve ourselves by reducing costs without paying for travel and hotel expenses." In both interviews, she stated that she preferred supportive distance education.

When the interviews held in the spring and fall terms are compared, a significant increase has been observed in the number of teachers who prefer supportive distance education. It was determined that three teachers who preferred only face-to-face education in the first interviews and one teacher who preferred only distance education preferred supportive distance education in the second interviews. Ö25, who prefers distance education completely in both interviews, emphasized the importance of distance education by stating that more audiences can be reached at the same time with live lessons at a lower cost. T25 also stated that due to the flexibility of distance education hours, students can be given more education during the day and stated that distance education should be used completely in the future. It is understood from the interviews that most of the teachers care about the gains they have gained in distance education, and they want to provide positive developments in education for the future by transferring these gains and experiences to face-to-face education.

Conclusion

The present study reveals the opinions of mathematics teachers who have distance education experience on the new normal and later on using distance education. It was observed that the teachers gave three disjointed opinions on the use of distance education and explained these opinions by presenting various reasons. In this context, some of the teachers stated that only face-to-face education is suitable for mathematics teaching, while others claimed that distance education can be used to support face-to-face education. On the other hand, some teachers stated that distance education is a effective as face-to-face education and stated that mathematics lessons can be conducted with distance education. As a result, it has been concluded that there are three lesson models that teachers want to use based on their views on the future of distance education.

In the spring semester of 2021, some of the teachers who wanted only face-to-face education changed their minds by stating that face-to-face education was not sufficient in the fall semester of 2021, when face-to-face education was started. It was observed that teachers who changed their minds in this direction claimed that a distance education model that supports face-to-face education would be more beneficial for students. However, all of the teachers who want to use the new normal and later distance education together with face-to-face education in the spring term in which distance education is held, showed that they agreed by choosing the supportive distance education model in the fall period when face-to-face education was given. In both conditions, teachers who prefer supportive distance education in interviews; They emphasized that face-to-face education should be supported by stating that it has various deficiencies. At this point, they stated that face-to-face education can be supported by reaching more students at the same time with less cost and by providing more education to the students during the day thanks to the flexible education hours, with the distance education activities developed at this point, the deficiencies of which are identified and eliminated.

When the interviews made in the spring and fall terms are compared, it is observed that the number of teachers who prefer supportive distance education has increased. Although there are differences of opinion on the subject, it can be said that most of the teachers tend to use the supportive distance education model. Teachers who want to use the distance education model completely claimed that mathematics lessons can be carried out effectively in a well-planned distance education process where the deficiencies are eliminated. Similarly, the study results of Simonson et al. (2011) show that well-designed distance education is an effective method for teaching and learning. However, Ward et al. (2010) revealed that distance education is as effective as face-to-face education when appropriate methods and technologies are used. In addition, the teachers who support the conduct of mathematics courses entirely with distance education emphasized that distance education provides flexibility in terms of time



and space. They stated that it is possible to reach more students at the same time thanks to distance education. In line with this result, Duman (2020) in her research evaluating distance education, showed that distance education is independent from the environment, being able to take distance lessons by phone, and the absence of absenteeism problems as the advantages of distance education.

In the study, it was seen that teachers who think that distance education should not continue in the new normal and afterwards, generally think that live lessons are not efficient, that distance education is virtual and that a classroom environment cannot be created. There are studies showing similar results in the related literature (Aksu, 2021; Smith and Ferguson, 2005; Kilit and Güner, 2021; Ozdemir Baki and Celik, 2021). In this direction, Basaran et al. (2020) stated that the most important shortcoming of distance education is its inability to provide the educationteaching spirit created by the school environment, and stated that it is very difficult to provide education in a virtual environment. Therefore, these results support the findings of the present study. In addition, it has been determined that teachers who work in suburban schools or try to conduct live lessons with students living in villages argue that distance education should not continue due to the inequality of opportunity in distance education. In parallel with this research result, Can (2020) emphasized that everyone's access to distance education opportunities at all education levels should be strengthened. Similarly Aksu (2021); Stating that students who do not have opportunities such as internet and computer at home in distance education cannot attend the classes, he stated that the lessons given in distance education should be recorded and delivered to every student in order to provide equal opportunities in education. In the study, some of the teachers who thought that distance education should not continue, brought up the issue of insufficient interaction. In parallel with this study, Ferri, Grifoni and Guzzo (2020) stated that students lack motivation and interaction in distance education and stated that there are various social difficulties in distance education, among students themselves and between teachers and students. On the other hand, in the interviews conducted within the scope of the research, it was determined that secondary school mathematics teachers generally wanted distance education and face-to-face education to be used together, whereas high school mathematics teachers wanted to use only face-to-face education model. The teachers, who said that distance education is not suitable for the mathematics course, stated that they found that the students could not apply the knowledge they learned after listening to the lesson to the problem solving stages in order to support their views. Similarly, Akyurek (2020) argued that distance education can work in theoretical courses, but it cannot work effectively in practical courses. The situations that the teachers who do not want to continue the distance education think that they have the least problems are the problems related to the "In terms of students" category. From this point of view, it can be thought that teachers do not have enough knowledge about the problems experienced by students in distance education.

Teachers, who agree that distance education can be provided to a large extent in the new normal and afterwards, find it appropriate to use the distance education model in order to support face-to-face education. In this context, it has been determined that teachers want to use distance education to solve more questions, eliminate the deficiencies of students, repeat the subject, conduct weekend courses and conduct special education lessons. In line with these findings, Trenholm et al. (2019) stated that distance education should only be used to support face-to-face education. Watson (2008), on the other hand, stated that both models have strengths and drew attention to the blended education model in which face-to-face education and distance education are used together. As a matter of fact, most of the teachers emphasized that they have gained experience of distance education during the pandemic process and that they have improved themselves considerably and emphasized that they want to benefit from this experience in the future.

As a result, although the current study reveals that mathematics teachers mostly prefer the distance education model that supports face-to-face education, the future of distance education will continue to be a topic that teachers all over the world discuss and make evaluations about.

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Exploring Students' Engagement in Distance Learning During the Pandemic of COVID-19: A Correlational Exploratory Design

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ABSTRACT

This study aims to examine the students' level of engagement in distance learning during the pandemic of COVID-19. Among all learning models, students' engagement is considering a challenging factor, however this is particularly true in a remote learning environment. To obtain the research aims, a quantitative method, precisely Correlational Exploratory Design is conducted. Thus, a questionnaire is designed to collect the essential data from students. A total of (359) participants from Taibah University across different departments and programs were participated and completed self-report measures. The questionnaire consists of two main parts: first demographic questions, second different types of engagements (cognitive, behavioral, emotional, and social engagement) in distance learning. Making sense of these variables, enables reconsidering the decision-making regarding improving how distance learning is practiced for more successful and meaningful delivery. The result demonstrated that social engagement domain has been the only indicators of differences between gender in which female were more socially engaged than male, thus enhancing students' social engagement is a critical area to be considered. Moreover, the participants in this study measured cognitive engagement with 'strongly agreed' measure. While behavioral and social engagement were just agreed. However, emotional engagement was reported by them as natural. This finding indicated that the students were ready to shift to distance learning during COVID-19 and they need emotional support during this time. This study suggests recommendations on how to improve students' engagement.

Keywords: Students' engagement. Distance Learning. COVID-19, Quantitative method.

1. Context of Research: Distance Learning in Saudi Higher Education

The coronavirus (COVID-19) was first identified as a contagious disease in January 2020 (Sahu, 2020). For this purpose, the health authorities recommended that educational institutions to be closed (Moawad, 2020). However, "the implementation of distance education became the only choice for educational institutions to continue their academic activities during the COVID-19 pandemic" (Hassan et al., 2021, p. 2). Distance learning platforms have been used to facilitate learning during this COVID-19 crisis. There were many challenges for these platforms to be succussed (Moawad, 2020). Therefore, it is important to understand how students learn and interact with the new learning experience.

Saudi Arabia was one of the recognized countries that provide online resources and training for educational institutions and families to use distance learning during this difficult time. There are many Saudi studies conducted to understand how students perceive the experience of fully adopting distance learning during the COVID-19 crisis. A study by (Al-Nofaie, 2020) showed that the students had high motivation levels towards using distance learning since they were aware of the importance of completing their degrees even though they may prefer in-class learning. (Bahanshal & Khan, 2021) studied the effect of COVID-19 on Education in Saudi Arabia and E-Learning Strategies. The result showed that most participants had positive attitudes toward E-learning and they were prepared to shift to online mode. Moreover, (Alshahrani, 2021) studied the readiness of using e-learning during the COVID-19 Pandemic. The study showed that the students were ready to shift to e-learning systems. The study also indicated that there was clear evidence that "universities originally adopting a blending learning system are more ready than their peers." (p.159). However, (Mahyoob, 2020) showed that students could not effectively interact with teachers during virtual classes.

1. Demographic Characteristics Impacts on Distance Learning

Demographic characteristics refer to attributes that describe the status of people or a person such as age, gender, ethnicity, or income. Prior studies have explored students' differences in distance learning among other factors



affecting academic performance. (Yu, Huang, Han, He, & Li, 2020) concludes that demographic information such as gender, level of study, and age has been a subject study in many research aimed to explore its impact in distance learning practice. Similarly (Ismail, Mahmood, & Abdelmaboud, 2018) reveals that students' demographic characteristics are among the most significant factors affecting the level of students' academic performance in distance learning. Subsequently, the need to ensure that learners are effectively and adequately engaged in the distance learning, exploring the impact of demographic characteristics impacts on students' engagement towards distance learning is a fundamental part of this study.

2. Students' Engagement in Distance Learning

Student engagement is defined as "the student's psychological investment in an effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (Lamborn, Newmann, & Wehlage, 1992, p. 12). Because online students have fewer opportunities to engage with the school, it is critical to understand their engagement in distance learning. According to (Martin & Bolliger, 2018), Students' engagement in online courses improves their motivation and performance, as well as their sense of isolation. In this paper, we adopt Balwant's definition which is defining engagement as the involvement in academic activities that are highly motivated and enjoyable on emotional, behavioral, and cognitive levels (Balwant, 2018). There are various types of engagement (Cognitive engagement, behavioral engagement, emotional engagement, and social engagement), that will be reviewed to understand how students can achieve success in distance learning.

1.1 Cognitive Engagement in Distance Learning

Cognitive engagement refers to making all the necessary efforts to comprehend difficult ideologies. Cognitive engagement can be defined as "the integration and utilization of students' motivations and strategies in the course of their learning" (Richardson & Newby, 2006) p. 23). According to (Yundayani, Abdullah, Tandiana, & Sutrisno, 2021), research on cognitive engagement and distance learning examined students' cognitive abilities, motivations, and experiences. The finding of their study also showed that the students were taking more ownership of their education in distance learning environments. Moreover, one study showed that higher-level thinking is encouraged by distance learning when students write reflections using asynchronous technology (Erdoğdu & Çakıroğlu, 2021). In a study to identify the role cognitive engagement played in distance learning, the researchers suggest that online course instructors, tutors, and designers should offer students tailored motivational scaffolding depending on their motivational profiles (Riaz, Batool, Naeem, & Qayyum, 2021). The demands of each student must be examined in order to determine the learning tactics and motivations used by the learners in the distance learning platforms (Park & Yun, 2018).

Cognitive engagement affects how much time and effort one puts into their schoolwork and is a useful indicator of what motivates them. Park and Yun (2018) described self-regulation learning as a top type of cognitive engagement because students develop their learning solutions. According to this study, students had different strategies that enabled them to succeed in their online classes. Additionally, the study aimed to determine whether the students were enrolled in online courses from various programs that used differentiated learning and motivational tactics. The researchers concluded that there was a substantial variation in the students' strategies based on their programs. According to (Cho, Cheon, & Lim, 2021), self-regulated learning considers the pinnacle of cognitive engagement, in which students discover their answers. Interacting with the subject, students, and instructors has a favorable impact on students' progress in distance learning. Students' cognitive engagement would rise because of a well-designed distance course.

1.2 Behavioral Engagement in Distance Learning

Behavioral engagement is termed as the participation, attention, persistence, effort, and positive conduct of students in there learning activities (Kokoç, 2019). Behavioral engagement denotes the efforts and participation an individual exerts to participate in the distance learning platform such as attending the class and asking instructors to expound where they have not understood. According to (Riaz, Batool, Naeem, & Qayyum, 2021), behavioral engagement explains that many elements are present in student engagement in the classroom setting. Collaborative learning with peers is also a right way of improving the behavioral engagement of learners as they get to share their knowledge.

Technology tools may also affect the student's distance learning platforms. A study by (Tang & Hew, 2022) founded that using asynchronous technology tools promoted reflection. The researchers also indicated that online classes made students collaborate more with their peers. (Kokoç, 2019) implied that more interaction with online discussion positively impacted the performance of students learning through the online platform. The study's findings established that the flexibility in distance learning is expected to encourage students to engage more with learning content in their own pace, leading to high learning performance. The study deduced that for distance learning to work, the stakeholders had to come together and assist each other. Furthermore, students, in distance



courses, can participate step by step in the learning process. They are in the position of learning by doing. Students would use the online resources, which would push them to analyze and integrate the content of their work and share their personal views. This develops their ability to construct their own knowledge and share their thoughts, experiences, and cultures with their peers (Milman, 2020).

1.1 Emotional Engagement in Distance Learning

Emotional engagement is termed to involve affective reactions such as enjoyment, rejection, sense of belonging, interest, joy, satisfaction, attitude, anxiety, boredom, and frustration to students (Henritius, Löfström, & Hannula, 2019). The socio-emotional communication that establishes the social presence in distance learning is essential for the engagement of students. The use of humor in distance learning can positively impact reducing the levels of stress and increasing further the students' attention. During this COVID-19 pandemic, most students have difficulties in their distance learning process due to their emotional engagements in studies. The punctuation marks can express emotions on the students' keyboard during their interactions in online lessons. These emotions can be used to create a more social atmosphere in the distance learning classroom and create connections with fellow students (You, 2022).

Emotional engagement denotes the reaction of students towards their peers, instructors, and other academicians. Emotional engagement is all about making the distance learning programs interesting through participation in group discussions. (Hughes, Wickersham, Ryan-Jones, & Smith, 2002) state that distance learning can fail due to many issues that may limit the students' success and instructors in the online platform. To improve student performance and engagement, instructors must ensure students engage in collaborative learning with their peers.

Emotional engagement is the right way of ensuring students are engaging with the course material as more time spent interacting with the course material increases students' performance (Salta, Paschalidou, Tsetseri, & Koulougliotis, 2022). Instructors need to ensure all students do not feel isolated or left out of the online platform classes. By encouraging group work and participation in all classes, students can get emotional engagement with their peers as they have been availed with a grading rubric which enables them to engage in collaborative learning (Hughes et al., 2002).

1.2 Social Engagement in Distance Learning

Social Engagement denotes the process of engaging or getting involved in interactive online activities. Students who engage in distance learning are more likely to be socially active with their peers, instructors, and academicians (Bernard et al., 2009). According (Martin & Bolliger, 2018), "engagement strategies are aimed at providing positive learner experiences including active learning opportunities, such as participating in collaborative group work, having students facilitate presentations and discussions, sharing resources actively, creating course assignments with hands- on components, and integrating case studies and reflections" (p. 206). To boost social engagement in distance learning, there are three basic engagement techniques that have been identified: student-content, student- instructor, and student-student. These techniques help students become active and more engaged in their online courses (Bernard et al., 2009).

(Salta et al., 2022) study showed that students mostly engaged in student–faculty interaction. The study also found that most students in online classes collaborated at least sometimes. The study suggested future studies to find out what promotes engagement in the online environment. (von Goble, 2022) study indicated that instructors should consider designing interactive online assignments where students can engage with the content and with each other. The study also showed when instructors create multiple channels such as e-mails to students and discussion forums in which the instructor interacts, students have higher engagement in the course. (Dumford & Miller, 2018) study indicated that students "were less likely to engage in collaborative learning, student-faculty interactions, and discussions with diverse others, compared to their more traditional classroom counterparts" (p. 452). The study suggested that faculty should find ways to encourage student engagement across a variety of delivery types. (Martin & Bolliger, 2018) found that instructor's presence is the most important element in online courses. The study concludes that instructors who were responsive and supportive and who listened and communicated with students were very appreciated by the students.

RESEARCH AIMS AND QUESTIONS

There has been little known how higher education students in Taibah University in Saudi Arabia interacted and engaged with their online courses during the coronavirus crisis. Hence, this research will address gaps in the literature by examining students' engagements in distance learning in higher education in Saudi Arabia. As such, this study and its results may provide implications for designing best practices in online environment and provide suggestions for future studies. Therefore, this study was designed to first determine the significant relationship between student engagement in distance learning and their demographic characteristics. Second to investigate the



extent of which students are engaged with the experience of distance education based on (Behavioural, cognitive, emotional, and social) influences during the COVID-19 pandemic in the one Saudi university.

RQ1: what determents Saudi university students' (Behavioural, cognitive, emotional and social) engagement in distance learning based on their demographic characteristics?

H1: there is a significant difference in students level of engagement in distance learning and their gender H2: there is a significant difference in students level of engagement in distance learning and their name of college H3: there is a significant difference in students level of engagement in distance learning and their level of study

RQ2: To what extent Saudi university students are engaged with the experience of distance learning based on (Behavioural, cognitive, emotional, and social) influences?

H4: distance learning has a positive effect in students' behavioural engagement

H5: distance learning has a positive effect in students' cognitive engagement

H6: distance learning has a positive effect in students' emotional engagement

H7: distance learning has a positive effect in students' social engagement

Research framework



3.1 Methodology

To test the previous hypotheses and answer the research main questions, quantitative methodology has been found a constructive method. It is statistical representation of data that is collected and analyzed in numerical methods. It is useful when studying large group of people and thus generalize the finding to larger group (Swanson & Holton, 2005). Particularly, quantitative, correlational exploratory design is approached which is "a procedure in which the researchers hypothesizes a causal model and then empirically tests the model to determine how well the model fits the data" (Johnson & Christensen, 2013, p. 368), p.368). Therefore, it is a suitable method to test the relationship among the study's variables and their degree of association (Creswell, 2002). Creswell, 2002 asserts that "a correlational design in which the researcher is interested in the extent to which two variables co-vary" (p. 363). As a result, it is an appropriate design that aligns with the research fundamentals.

3.2 data collection: The tool of the study

The researchers used the anonymous questionnaire as a tool to collect data, due to its suitability of the study aims, its curriculum, and its society, and to answer its questions. The questionnaire is considered one of the most important means of collecting data and codified information, and the most reliable. Participation was voluntary, and all responses were anonymous. After reviewing the educational literature and previous studies related to the subject of the current study and considering the data and questions of the study and its objectives, the tool (the questionnaire) was designed, and it organized into two parts. The following is a presentation of how it was constructed, and the procedures used to verify its authenticity and reliability: The first section: It contains an introductory introduction to the aims of the study, and the type of data and information that researchers want to



collect from members of the study sample, while providing guarantees of confidentiality of the information provided, and pledging to use it for scientific research purposes only. The second section: It consists of (12) items, divided into four main axes, the following table clarifies the number of expressions of the questionnaire, and how they are distributed among the axes.

Table (1)	axes and	terms	of the	questionnaire
1 4010 (- /	and the second		01 0110	questionnente

Axis	Number of items
Behavioural engagement	3 items
Cognitive engagement.	3 items
Emotional engagement	3 items
Social engagement	3 items
Questionnaire	12 items

Validity for the tool of the study

Truthfulness of the study tool means making sure that it measures what was prepared as intended to include the questionnaire for all the elements that are included in the analysis on the one hand, and the clarity of its expressions on the other hand, so that it is understandable to everyone who uses it. The researchers have made sure the study tool is validated by:

Validate the internal consistency of the tool

To verify the validity of the internal consistency of the questionnaire, the Spearman's Correlation Coefficient was calculated to determine the degree of correlation of each of the questionnaire expressions to the overall degree of the axis to which the item belongs, and the following tables show the correlation coefficients for each of the axes including their terms.

(Behavioural	engagement)		
Item	Item	correlation	Sig.
number		coefficient	
1	I set aside a regular time each week to work on Blackboard.	.801**	< 0.01
2	I took notes while studying the Blackboard.	.857**	< 0.01
3	I revisited my notes when preparing for Blackboard assessment tasks.	.889**	< 0.01
(Cognitive eng	gagement.)		
Item number	Item	correlation coefficient	Sig.
1	I often searched for further information when I encountered something in the Blackboard that puzzled me.	.684**	< 0.01
2	When I had trouble understanding a concept or an example, I went over it again until I under- stood it.	.800**	< 0.01
3	If I watched a video lecture that I did not understand at first, I would watch it again to make sure I understood the content.	.779**	< 0.01
(Cognitive eng	gagement.)		
Item number	Item	correlation coefficient	Sig.
1	I often searched for further information when I encountered something in the Blackboard that puzzled me.	.684**	< 0.01
2	When I had trouble understanding a concept or an example, I went over it again until I under- stood it.	.800**	< 0.01
3	If I watched a video lecture that I did not understand at first, I would watch it again to make sure I understood the content.	.779**	< 0.01
(Emotional en	gagement)		

Table No. (2) Spearman correlation coefficients for first-axis expressions with the overall grade of the axis



Item	Item	correlation	Sig.
number		coefficient	
1	I was inspired to expand my knowledge in the Blackboard.	.831**	< 0.01
2	I found the Blackboard interesting.	.892**	< 0.01
3	I enjoyed watching video lectures in the Blackboard.	.895**	< 0.01
(Social engage	ement)		
Item	Item	correlation	Sig.
number		coefficient	
1	I often responded to other learners' questions.	.827**	< 0.01
2	I contributed regularly to course discussions.	.876**	< 0.01
3	I shared learning materials (eg, notes, multimedia,	.710**	< 0.01
	links) with other classmates in the Blackboard.		

**Significant at 0.01

It is clear from the previous table that the values of the correlation coefficient for each of the items with their dimension are positive, and statistically significant at the level of significance (0.01) or less, which indicates the validity of the internal consistency between the statements of the first axis, and their suitability to measure what was prepared to measure it.

The validity of the study tool:

The validity of the study instrument was confirmed by using the validity factor of Cronbach's Alpha (α), the next table shows the values of the parameters of the validity of each of the questionnaire axes.

Table No. (3) Alpha Cronbach coefficient to measure the validity of the study instrument

Axes of the questionnaire	Ν	constancy
Behavioural engagement	3	0.824
Cognitive engagement	3	0.659
Emotional engagement	3	0.845
Social engagement	3	0.773
General constancy	12	0.877

It is clear from the previous table that the general validity coefficient is high as it reached (0.877), and this indicates that the questionnaire has a high degree of validity reliable. that can be relied upon in the field application of the study.

3.3 Quantitative data analysis

Quantitative analysis was performed whereas descriptive correlational technique employed to the collected data. Correlational research means to the discovery of relationships between variables. "Investigators use a correlation statistical technique to describe and measure the degree of associationbetween two or more variables" (Creswell, 2002, p. 361). To check the significant difference that found in factors that determines Saudi university students' engagement based on their demographic information, Mann-Whitney and Kruskal-Wallis tests have been used. To know the extent of Saudi university students engagement with distance education based on (Behavioural, cognitive, emotional, and social), iterations, percentages, arithmetic mean, standard deviations, and ranks for the responses of the members of the participants have been calculated on the terms of Saudi university students are actually engaged with the experience of distance education based on (Behavioural, cognitive, emotional, and social)

3.4 Research participants

The sample consisted of online students at Taibah university cross various courses and study level. A random technique was used for recruiting participants to ensure the generalizability of the research. A "simple random sample" was used to select a representative sample whereby the selection of the population's members was done equally; thus, the chance of being selected was equal across the target population (Johnson & Christensen, 2013). A total of (359) participants completed the online survey.



		Count	%
Gender	Female	260	72.4%
	Male	99	27.6%
Name of	College of Computer Science and Engineering	108	30.1%
college	College of Business administration	7	1.9%
	College of arts and Humanities	67	18.7%
	college of sceince	9	2.5%
	College of education	58	16.2%
	college of family sceince	2	0.6%
	College of applied Medical Science	63	17.5%
	college of law	18	5.0%
	other	27	7.5%
Level of study	Diploma	5	1.4%
	Bachelor	333	92.8%
	High studies	21	5.8%

Characteristics of the individuals in the study sample:

The previous table indicate that 72.4% of the sample study were females. 30.1% of them study at Computer Science and Engineering college. 92.8% of them have a Bachelor. as indicated in the following figures:





Findings: hypothesis testing

• H1: there is a significant difference in students level of engagement in distance learning and their gender

Gender		N	Mean Rank	Mann- Whitney	Sig.
Behavioural	Female	260	186.44	11196.000	0.054
engagement	Male	99	163.09		
Cognitive engagement	Female	260	177.30	12167.000	0.416
	Male	99	187.10		
Emotional	Female	260	180.30	12791.500	0.929
engagement	Male	99	179.21		
Social engagement	Female	260	189.15	10491.500	0.006
	Male	99	155.97		
		0.05	-		

 $\alpha = 0.05$

No significant difference in **behavioral engagement, cognitive engagement, emotional engagement** because the sig. value of Mann-Whitney test (0.054, 0.416, 0.929) frequently greater than 0.05, so we accept the null hypothesis which refer to no significant difference in **engagement** with level of confidence 95%. However, there was found a significant difference in **social engagement** because the sig. value of Mann-Whitney test (0.0006) less than 0.05, so we reject the null hypothesis and accept the alternative one which refer to there was found a significant difference in **social engagement** with level of confidence 95%.

• H2: there is a significant difference in students level of engagement in distance learning and their name of college

Name of college		N	Mean Rank	Kruskal- Wallis	Sig.
Behavioural	College of Computer Science and Engineering	108	154.89	15.448	0.051
engagement	College of Business administration	7	191.43		
	College of arts and Humanities	67	190.30		
	college of sceince	9	175.61		
	College of education	58	174.41		
	college of family sceince	2	117.75		
	College of applied Medical Science	63	214.20		
	college of law	18	178.50		
	other	27	191.22		
Cognitive	College of Computer Science and Engineering	108	185.36	4.496	0.810
engagement	College of Business administration	7	156.71		
	College of arts and Humanities	67	184.93		
	college of sceince	9	155.83		
	College of education	58	168.39		
	college of family sceince	2	91.50		
	College of applied Medical Science	63	176.50		
	college of law	18	200.69		
	other	27	186.31		
Emotional	College of Computer Science and Engineering	108	164.37	11.766	0.162
engagement	College of Business administration	7	142.29		
	College of arts and Humanities	67	172.32		
	college of sceince	9	147.11		
	College of education	58	199.41		
	college of family sceince	2	154.00		



	College of applied Medical Science	63	193.49		
	college of law	18	227.72		
	other	27	179.26		
Social	College of Computer Science and Engineering	108	148.25	30.173	0.000
engagement	College of Business administration	7	130.07		
	College of arts and Humanities	67	212.60		
	college of sceince	9	148.06		
	College of education	58	211.70		
	college of family sceince	2	108.25		
	College of applied Medical Science	63	167.37		
	college of law	18	222.19		
	other	27	188.30		

 $\alpha = 0.05$

No significant difference in behavioural engagement because the sig. value of Kruskal-Wallis test (0.051) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in behavioural engagement with level of confidence 95%. No significant difference in cognitive engagement because the sig. value of Kruskal-Wallis test (0.810) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in cognitive engagement with level of confidence 95%. No significant difference in emotional engagement because the sig. value of Kruskal-Wallis test (0.162) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in emotional engagement because the sig. value of Kruskal-Wallis test (0.162) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in emotional engagement with level of confidence 95%. There was found a significant difference in social engagement because the sig. value of Kruskal-Wallis test (0.000) less than 0.05, so we reject the null hypothesis and accept the alternative one which refer to there was found a significant difference in social engagement with level of confidence 95%.

level of study					
Level of study		Ν	Mean Rank	Kruskal- Wallis	Sig.
Behavioural	Diploma	5	196 30	1 889	0 389
engagement	Dipioniu	<i></i>	177.05	1.009	0.507
engagement	Bachelor	333	177.95		
	High	21	208.62		
	studies				
Cognitive engagement	Diploma	5	152.30	0.471	0.790
	Bachelor	333	179.97		
	High	21	187.12		
	studies				
Emotional engagement	Diploma	5	205.10	4.262	0.119
	Bachelor	333	176.90		
	High	21	223.19		
	studies				
Social engagement	Diploma	5	200.80	12.719	0.002
	Bachelor	333	174.85	1	
	High	21	256.71]	
	studies				
		0 0 -			

• H3: there is a significant difference in students level of engagement in distance learning and their level of study

$\alpha = 0.05$

No significant difference in **behavioural engagement** because the sig. value of Kruskal-Wallis test (0.389) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in **behavioural engagement** with level of confidence 95%. No significant difference in **cognitive engagement** because the sig. value of Kruskal-Wallis test (0.790) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in **cognitive engagement** because the significant difference in **cognitive engagement** with level of confidence 95%. No significant difference in **emotional engagement** because the sig. value of Kruskal-Wallis test (0.119) greater than 0.05, so we accept the null hypothesis which refer to no significant difference in **emotional engagement** with level of confidence 95%. There was found a significant difference in **social engagement** because the sig. value of Kruskal-Wallis



test (0.002) less than 0.05, so we reject the null hypothesis and accept the alternative one which refer to there was found a significant difference in **social engagement** with level of confidence 95%.

RQ2: To what extent Saudi university students are actually engaged with the experience of distance learning based on (behavioural, cognitive, emotional and social) influences?

• H4: distance learning has a positive effect in students' behavioural engagement

Table No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance learning based on behavioural, descending according to the Means of approval.

N 0.	Item	Strongl y Disagre e		Disagree Neutral			utral	Agro	ee	Stro Agr	ngly ee	Mea n	Std. Devi ation	Exte nt	O r d
		C o u nt	%	C o u nt	%	C o u nt	%	Co unt	%	Co unt	%				e r
1	I set aside a regular time each week to work on Blackboard.	1 1	3.1 %	2 9	8.1%	5 5	15.3 %	12 2	34.0 %	14 2	39.6 %	3.99	1.07	Agre e	1
2	I took notes while studying the Blackboard.	1 2	3.3 %	4 5	12.5 %	4 5	12.5 %	12 5	34.8 %	13 2	36.8 %	3.89	1.13	Agre e	2
3	I revisited my notes when preparing for Blackboard assessment tasks.	1 0	2.8 %	5 7	15.9 %	4 9	13.6 %	12 9	35.9 %	11 4	31.8 %	3.78	1.14	Agre e	3
Beł	Behavioural engagement												.959 54	Agree	

In the previous Table it is clear that the participants agree with the behavioural engagement with an average of (3.88 from 5.00), an average that falls in the fourth category of fifth scale categories (from 3.4 to 4.2). It is clear that the participants agree on all features of behavioural engagement, which was arranged in descending order according to the approval of the participants as follows: The item No. (1), which is: "I set aside a regular time each week to work on Blackboard." come first in terms of approval of the participants with an average of (3.99 out of 5). The item No. (2) came: "I took notes while studying the Blackboard.", in the second place in terms of approval of the participants with an average of (3.89 out of 5). The item No. (3): "I revisited my notes when preparing for Blackboard assessment tasks." came third in terms of approval of the participants with an average of (3.78 out of 5), as indicated in the following figure:





Figure No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance education based on behavioural, descending according to the Means of approval.

• H5: distance learning has a positive effect in students' cognitive engagement

Table No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance education based on congnitive, descending according to the Means of approval.

Ν	Item	Strongly		Disagree		Neutral		Ag	Agree		Strongly				
о.		Disagree									Agree		Std.	Exte	0
		Co	%	С	%	С	%	С	%	Co	%	n	Deviation	nt	rd
		un		0		0		0		un					er
		t		u		u		u		t					
				nt		nt		nt							
1	I often searched for	6	1.7%	1	4.2	2	7.5	1	38.	17	48.2	4.27	0.90	Stron	1
	further information when			5	%	7	%	3	4%	3	%			gly	
	I encountered something							8						Agre	
	in the Blackboard that													e	
	puzzled me.														
2	When I had trouble	4	1.1%	1	4.7	2	7.8	1	41.	16	45.1	4.25	0.87	Stron	2
	understanding a concept			7	%	8	%	4	2%	2	%			gly	
	or an example, I went							8						Agre	
	over it again until I under-													e	
	stood it.														
3	If I watched a video	12	3.3%	3	9.2	3	9.2	9	25.	19	52.9	4.15	1.13	Agre	3
	lecture that I did not			3	%	3	%	1	3%	0	%			e	
	understand at first, I														
	would watch it again to														
	make sure I understood														
	the content.														
cor	ngnitive engagement											4.22	.74935	Strong	ly
1												38		Agree	

In the previous Table it is clear that the participants strongly agree with the congnitive engagement with an average of (4.22 from 5.00), an average that falls in the fifth category of fifth scale categories (from 4.2 to 5). It is clear that the participants strongly agree on most features of congnitive engagement, which was arranged in descending order according to the approval of the participants as follows: The item No. (1), which is: "I often searched for further information when I encountered something in the Blackboard that puzzled me." come first in terms of approval of the participants with an average of (4.27 out of 5). The item No. (2) came: "When I had trouble understanding a concept or an example, I went over it again until I under- stood it..", in the second place in terms of approval of the participants with an average of (4.25 out of 5). The item No. (3): "If I watched a video lecture



that I did not understand at first, I would watch it again to make sure I understood the content." came third in terms of approval of the participants with an average of (4.15 out of 5), as indicated in the following figure:



Figure No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance learning based on congnitive, descending according to the Means of approval.

• H6: distance learning has a positive effect in students' emotional engagement

Table No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance education based on emotional, descending according to the Means of approval.

N o	Item	Stro Disa	Strongly Disagree		Disagre e		Neutral		Agree		Strongly Agree		Std.	Ext	Or
•		С	%	С	%	С	%	С	%	С	%	an	Deviatio	ent	der
		ou		о		0		0		ou			n		
		nt		u		u		u		nt					
				nt		nt		nt							
1	I was inspired to expand	37	10.3	5	15.	7	22.	1	29.	82	22.8	3.3	1.27	Ne	2
	my knowledge in the		0%	5	30	9	00	0	50		0%	9		utra	
	Blackboard.				%		%	6	%					1	
2	I found the Blackboard	51	14.2	5	15.	6	16.	8	23.	10	30.4	3.4	1.42	Ne	1
	interesting.		0%	6	60	0	70	3	10	9	0%			utra	
					%		%		%					1	
3	I enjoyed watching	85	23.7	6	18.	4	13.	4	13.	10	30.1	3.0	1.57	Ne	3
	video lectures in the		0%	8	90	9	60	9	60	8	0%	8		utra	
	Blackboard.				%		%		%					1	
En	Emotional engagement													Neut	ral
												888			
1													1		

In the previous table it is clear that the participants Neutral with the emotional engagement with an average of (3.28 from 5.00), an average that falls in the third category of fifth scale categories (from 4.2 to 5). It is clear that the participants Neutral on most features of emotional engagement, which was arranged in descending order according to the approval of the participants as follows: The item No. (2), which is: " I found the Blackboard interesting." come first in terms of approval of the participants with an average of (3.4 out of 5). The item No. (1) came: " I was inspired to expand my knowledge in the Blackboard.", in the second place in terms of approval of the participants with an average of (3.08 out of 5), as indicated in the Blackboard." came third in terms of approval of the participants with an average of (3.08 out of 5), as indicated in the following figure:





Figure No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance education based on emotional, descending according to the Means of approval.

• H7: distance learning has a positive effect in students' social engagement

Table No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance education based on social, descending according to the Means of approval.

N 0	Item	Strongly Disagree		Disagre e		Neutral		Agree		Strongly Agree		Me an	Std. Deviation	Ext ent	Or der
		ou nt	%	o u nt	%0	o u nt	%0	o u nt	%0	ou nt	%				
1	I often responded to other learners' questions.	20	5.6%	4 8	13. 4%	7 5	20. 9%	1 4 4	40. 1%	72	20.1 %	3.5 6	1.12	Agr ee	2
2	I contributed regularly to course discussions.	30	8.4%	4 6	12. 8%	7 2	20. 1%	1 1 4	31. 8%	97	27.0 %	3.5 6	1.24	Agr ee	3
3	I shared learning materials (eg, notes, multimedia, links) with other classmates in the Blackboard.	16	4.5%	2 5	7.0 %	4 9	13. 6%	1 4 1	39. 3%	12 8	35.7 %	3.9 5	1.08	Agr ee	1
So	Social engagement													Agre	e

In the previous table it is clear that the participants agree with the social engagement with an average of (3.68 from 5.00), an average that falls in the fourth category of fifth scale categories (from 4.2 to 5). It is clear that the participants agree on most features of social engagement, which was arranged in descending order according to the approval of the participants as follows:

The item No. (3), which is: "I shared learning materials (eg, notes, multimedia, links) with other classmates in the Blackboard." come first in terms of approval of the participants with an average of (3.95 out of 5). The item No.



(1) came: "I often responded to other learners' questions.", in the second place in terms of approval of the participants with an average of (3.56 out of 5). The item No. (2): "I contributed regularly to course discussions." came third in terms of approval of the participants with an average of (3.56 out of 5), as indicated in the following figure:



Figure No. () Responses of the participants about the extent of Saudi university students are actually engaged with the experience of distance learning based on social, descending according to the Means of approval.

Discussion

RQ1: what determents Saudi university students' (Behavioural, cognitive, emotional and social) engagement in distance learning based on their demographic characteristics?

The main observable trend within the findings tied social engagement domain as the main indicator with a significant difference cross all categories of gender, subject of study and level of education. Whereas other engagement domains (behavioral, cognitive, emotional) showed slight differences based on demographic variables. Regarding gender female students showed higher level of social engagement than in their male fellow students. In line with previous studies showing Female socially more engaged than male in distance learning, (Nistor, 2013) asserts that males were more stable in attitudes, while females performed well in engagement. (Alghamdi, Karpinski, Lepp, & Barkley, 2020) study conclude that gender differences in overall engagement of distance learning have led to more positive online learning outcomes of females than males due to the females' stronger self-regulation than males. It is evident that students were able to build self-learning strategies that would enables behavior, cognitive and emotional engagement, however, they were not able to approach social one. Hence, indicating that social engagement has a huge consequence on students' level of general engagement leads to the importance of developing students' social experience on distance education. This finding aligns with (Altuwairesh, 2021) (Alawajee, 2021) studies indicates students' negatively experienced low-interaction and communication level in distance learning. In line with (Alawajee, 2021) findings which indicates distance learning supports students learning process by becoming more like self-educated and self-learner, thus, becoming more independent learners. Such absence of face-to-face interaction hinder students' motivation in distance learning, in which both above-mentioned studies suggested that building positive students-instructors, students-students, and studentscontent interactions is a vital requirement for distance learning improvement. Distance learning platforms offer many social interactions opportunities synchronously and asynchronously, such as video conferencing, online forum discussions and much more. In which communities can be constructed, sense of belonging can be shaped, relationships can be developed, and trust can be established within a safe environment. However, this study findings stated that these opportunities found to be challenging to put into practice which might be related to the fact that distance learning in Saudi higher education grew suddenly with lack of groundwork (Aladsani, 2021). (Venton & Pompano, 2021) study reveals that student's level of engagement is greater in distance class where active learning is a central component of instruction. Unquestionably, promoting student engagement is heavily associated with the instructor's role and this role is a continues one throughout the course duration and it could be taking a place in different forms such as guide, feedback, learning activities (Yu et al., 2020).



RQ2: To what extent Saudi university students are actually engaged with the experience of distance learning based on (Behavioural, cognitive, emotional and social) influences?

The second research question attempted to explore the following: To what extent Saudi university students are actually engaged with the experience of distance learning based on (Behavioural, cognitive, emotional and social) influences? In response to this question, students expressed positive agreement about behavioural, cognitive, emotional, and social engagements in distance learning. The result showed that the students enjoyed the experience of distance learning. The findings are in line with the previous studies reported by (Al-Nofaie, 2020) (Bahanshal & Khan, 2021) (Alshahrani, 2021) (Ta'amneh, 2021) who found that the students had positive attitudes towards Elearning and they were prepared to shift to online mode. It is important to note that, Taibah University has been using the Blackboard system as eLearning tool since 2008 (Taibah University, n.d.). This indicate that faculty members and the students were ready to adopt the Distance learning during the COVID-19 crisis and the finding of this study are not surprising. Therefore, it seems that the participants enjoyed and engaged in distance learning during the COVID-19 pandemic due to existence of eLearning tools and prior experience. The participants in this study agreed on all features of behavioral engagement and strongly agreed on most features of cognitive engagement. The participants expressed Neutral on most features of emotional engagement and agreed on most features of social engagement.

The result showed that the highest engagement that students agreed with was the cognitive engagement. This indicate that students could take more responsibility for their own learning in distance environments. Also, students could have Self-regulation learning strategies that enabled them to succeed in their online classes as (Park & Yun, 2018) mentioned in their study. The study also showed that the second engagement that students had were behavioral engagement and social engagement which showed that the students are able to participate and contract their own knowledge, share their thoughts, and participate in online discussion. This finding is in line with previous study reported by (Tang & Hew, 2022) who found that the distance learning promotes reflection and interaction. Moreover, Students expressed Neutral when asked about their emotional engagement with the experience of adopting distance learning. This revealed that the students were incretin and maybe they were stress due to the first experience of fully incorporating the distance learning and they could be worried about their grades and tests. This finding is in line with previous study reported by (Mahyoob, 2020) who found that students were not satisfied with distance learning due to many obstacles including testing.

Conclusion

Due to COVID-19 crisis our life has changed including the way we teach and learn. Integrating Distance learning has had both positive and negative impacts on students. In order to understand how students engaged in this new environment, this study has attempted to investigate how students are engaged with the experience of distance education based on behavioural, cognitive, emotional, and social influences. The result showed that fully implementing distance learning at Taibah University was effective and successful solution for the students during the COVID-19 crisis. Distance learning may face different challenges, but it has the potential to replace traditional classrooms in the future. The finding of the study showed four different students' engagements towards the distance learning during the COVID-19 period. The finding indicated that there was significant different between students' social engagement. The study also revealed that students had the lowest emotional engagement.

Therefore, the distance learning is bound to succeed if the stakeholders take the necessary steps. Institutions need to invest more in distance learning platform to ensure all students can access this platform. It is also important to conduct a needs assessment for students and faculty members during remote and hybrid learning to provide resources during these challenging times of anxiety and uncertainty. The role of instructors is to create purposeful course designs that increase students' interaction and engagements. Faculty members should be advised on the way to incorporate new teaching and assessment experience to engage students during the online courses. It is essential for instructors to listen to students' concerns and offer them the opportunity to have a one-to-one conversation to reconnect and discuss any distresses that might have arisen during the adoption of distance learning. Extensive training must be provided to instructors to equipped them with the know-how necessities to enhance students' social engagement in distance education. Especially in how to incorporate social learning theories into the design of online courses that would enables the active learning. It recommended that the four level of engagement to be part of the instructional design.

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Technostress in Medical Students During Pandemic-Prompted Distance Education: Adaptation of Technostress Scale Based on Person-Environment Misfit Theory

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Declaration of Interest: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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All the authors contributed to the critical review of the manuscript and agreed on the final layout for submission.

Ethics:

Approval for the study was granted by Niğde Ömer Halisdemir University Ethics Committee (11.02.2021; 2021/26). The permission to adopt the survey was granted form Prof. Dr. Wang via 02.01.2021 dated e-mail.

Data Availability Statement:

The data that support the findings of this study are openly available in figshare.com at https://doi.org/10.6084/m9.figshare.16635118.v1.

ABSTRACT

This paper investigates the phenomenon of technostress in medical students and its predictors during pandemicprompted distance education. From a sample of 259 students in a school of medicine at a public university in Turkey, the data were collected using convenience sampling through an online questionnaire based on personenvironment misfit theory and were analyzed by means of descriptive and inferential statistics. Descriptively, the participant students reported experiencing relatively mild level of technostress. As a result of the multiple regression analysis, regular attendance and participation, adequate learning environment, perceived negativity of distance education, perceived need for psychological support, and year at medical school were all found to be significant predictors of technostress in medical students. This is the first study evaluating technostress on medical students. Students who do not attend classes regularly, do not have an adequate learning environment, have higher degree of perceived negativity of distance education, have need for psychological support and are at higher grade levels experience more technostress. Finally, according to the person-environment misfit theory the major component of technostress in medical students originated from the tool-related component. Although the level of technostress was relatively low, technological tools generate pressure even on the digital native generation. **Keywords:** technostress, medical education, distance education, technology-enhanced learning, Personenvironment misfit theory

INTRODUCTION

As the whole world has undergone a kind of 'reset' driven by the imperatives of the current global pandemic, there has been almost no single area where technology has not reached or been used. While digital technologies have become a part of our lives more than ever before, they have also brought or forced structural changes in education systems, as well. Having dominated the last two years, the Covid-19 crisis has been very effective in accelerating this transformation. Closing schools has been one of the primary measures taken by almost all countries around the world, which has influenced the learning process of millions of students from pre-school to higher education. With the closure of educational institutions and the interruption of face-to-face education, 1.6 billion students, which means approximately half of the student population from all levels of education, have been influenced negatively (UN, 2020). Educational conditions created by the pandemic have revealed the necessity of digital transformation to be applied to the entire system of education, in particular higher education. With the need to reduce human interaction to prevent the spread of the pandemic, digital connections have increased, and a lot of educational processes have largely moved to online environments. As in all educational contexts, medical education has also been transformed by the pandemic. Considering the transformational effects of the pandemicprompted conditions on medical schools as well as challenges, limitations and emerging concerns placed upon by distance education, this paper investigates the phenomenon of technostress and its predictors in a sample of medical students.

Technology-enhanced learning (TEL) is comprised of any form of learning that is catalyzed via the integration of information and computer technology (ICT) in educational practices (Wang et al., 2020). Investments concerning TEL are increasingly demanded by many universities worldwide as transformation of conventional learning, especially in higher education, becomes inevitable (Dunn & Kennedy, 2019). Postmodernism and the digital era accelerated the course of time tremendously, thus Industry Revolution 4.0 along with Internet of Things enabled various robotic devices and artificial intelligence integrated technologies as parts of everyday life (Romli et al., 2020). Consequently, a digital native generation has grown up in close contact with technology, not only in their social life but also in all educational settings including higher education. Therefore, these circumstances ineluctably lead to the evolution of conventional learning characterized by traditional face-to-face lessons, rote learning, compulsory attendance and manual practice methods into technology-enhanced, dynamic, and interactive



learning forms that ease the activity of learning (Bond et al., 2019). By all odds, TEL provides flexibility, convenience and the opportunity to high quality resources for students (Wang et al., 2020). Meanwhile, these modalities might give rise to some degree of technostress in students. This is mainly because individual needs and personal expectations require more effort and consume more time. Additionally varying skills in dealing with time management and personal abilities in accession, validation and internalization of information put pressure on vulnerable individuals, which might be expressed as technostress (Qi, 2019).

The American Psychological Association defines technostress as a form of occupational stress that is associated with information and communication technologies such as the Internet, mobile devices, and social media (https://dictionary.apa.org/technostress). In previous studies, technostress was studied in employees in different job sectors and both creators and inhibitors of technostress were defined accordingly (Ahmad et al., 2012; Ragu-Nathan et al., 2008). Ahmed et al., examined technostress in a sample of academic librarians and Tarafdar et al., investigated employees in different public-sector organizations (Ahmad et al., 2012; Ragu-Nathan et al., 2008). Repeated research on various populations identified and validated 5 technostress generators which can be sorted as techno-overload, techno-invasion, techno-complexity, techno-insecurity and techno-uncertainty (Ahmad et al., 2012; Hassan et al., 2019; Ragu-Nathan et al., 2008). Techno-overload is referred to the extra workload and necessity for working faster, harder and longer (Tarafdar et al., 2011). Techno-invasion is referred to the invasion of personal life by demands of technology and technology itself (Oi, 2019). The perception of 'being continuously on-line' results in feeling of imprisonment with fiber chains of technology as well as a sensation of interference in personal grounds. Techno-complexity is referred to the feeling of inadequacy while dealing with various forms of technological equipment. More time and effort is required to deal with complex and sophisticated digital systems, and in this way individuals get stressed or even exhausted while trying to understand, learn and execute high technology programs or devices (Peiris-John et al., 2020). Techno-insecurity refers to the fear of losing one's job to ICT-related devices, programs or someone better in technology manipulation (Ahmad et al., 2012). Technouncertainty is described as the lack of confidence toward the perpetual evolution of technology (Ragu-Nathan et al., 2008). Individuals with technostress related to techno-uncertainty hardly catch up with continuous changes, upgrades, and extremely short half-life time of ICT systems.

The determination of technostress creators in various populations and in different context has assisted researchers in understanding the dimensions and different aspects of ICT effects on employees.(Fuglseth & Sørebø, 2014; Hwang & Cha, 2018; Jena, 2015; Lee et al., 2016; Ragu-Nathan et al., 2008; Tarafdar et al., 2011).

Although technostress and adverse effects of technostress are both recognized, studies on this issue, especially in higher education is insufficient (Al-Fudail & Mellar, 2008; Jena, 2015; Joo et al., 2016). The identification of the students with phrases such as 'net generation' or 'digital native', resulted in an assumption that the preferences of the students in development and adaptation of TEL modalities consisted solely of 'more technology demand' (Echenique, 2014; Yu & Suny, 2020). Accordingly, the presumption that these students are techy and free of technostress evoked the neglect of the psychological reaction and adaptation of the students who play a key role in the success of TEL (Qi, 2019).

Technostress is a component of overall stress which inextricably hinder the academic performance of students (Penado Abilleira et al., 2020). Although there are dimensions overlapping with technostress creators described in employees, different causal factors should be researched in students. The identification of technostress creators is essential because it will assist students suffering from technostress and therefore enhance their academic performance. Furthermore, it will provide educators guidance with how to effectively deal with technostress(Upadhyaya & Vrinda, 2021). It is also important to consider individual differences in levels of technostress and types of technostress creators experienced in students(Krishnan, 2017). For instance, age, gender, year and level of experience were studied to some extent (Barrick & Mount, 1991; Bono & Judge, 2004; Krishnan, 2017; Wilkins & Ouchi, 1983). Demographic factors are superficial in nature, rather personality and adopted cultural beliefs would exert deeper effects on overall performance, behavior and academic achievement (Krishnan, 2017). It was postulated that individuals might have positive or negative consequences of the same independent factor depending on the individual character properties and cultural adaptation (Krishnan, 2017). The situation is similar in stress. Low level of stress provokes and enhances learning as well as achievement of both practical and theoretical grounds whereas high level of stress downregulates learning abilities and demonstration of previously acquired skills (Krishnan, 2017; Qi, 2019).

Person-environment (P-E) misfit theory was proposed as the basis of research on technostress that is assumed as a psychological answer to the inconsistency between the environment and the individual (Al-Fudail & Mellar, 2008). P-E misfit theory argues that all types of stress, including technostress, demonstrates complex features and hence is not originated from the individual or the environment only, rather from the interactions of both (Chuang et al.,



2016). Furthermore, environmental factor is multidimensional and affected by the organization of the individual, the culture of the organization, terms of task description and others surrounding the individual (Edwards & Billsberry, 2010). P-E misfit theory-based technostress scale was developed by Wang et al., and aimed to evaluate the dimensions involving person-organization (P-O), person-TEL (P-TEL), person-other people's (P-P) interactions. Furthermore, exhaustion of the students, continuity on TEL, and individual performance perceptions were other items evaluated in the scale (Wang et al., 2020).

The integration of TEL into medical and nursing education is grounded on the same rationale and is realized in a similar manner (Hampton et al., 2020). Particularly in medical education, as integration, transformation and evaluation process of TEL was prosecuted globally, Covid-19 pandemic compelled a premature and absolute transition which, for sure, has had a wide variety of psychological, sociological, individual, and communal effects other than urging learning and teaching to be maintained through distance education. The concept of 'distance' at this juncture emphasizes not only the physical one, but also the interactional and the psychological distance (Bozkurt, 2020). In this context, such a type of distance eliminates all the dialectical elements and networks of human communication and interaction, and the learning naturally resulting from interactive or communicative flow of information in face-to-face education. This transformation largely influences the emotional and psychological state of the learners by placing new or emerging challenges, limitations and concerns driven by technology. Therefore, this study aimed to identify specify the predictors of medical students' technostress level changed as a result of particular variables.

THE STUDY

This study was designed and performed as a prospective cross-sectional web-based survey study and was reported according to Consensus-Based Checklist for Reporting of Survey Studies (CROSS) guidelines for both web- and non-web-based surveys (Sharma et al., 2021). All the procedures in this study were in compliance with the institutional and national research committee ethical standards and the 1964 Helsinki Declaration and its later amendments. Approval for the study was granted by XXXXXXX University Ethics Committee (11.02.2021; 2021/26). The permission to adopt the survey was granted form XXXX via 02.01.2021 dated e-mail.

Designed as a survey, the study is principally a correlational study exploring the relationship between certain variables and technostress. To this end, the following research question was formed to answer:

• How well do the variables including (1) regular attendance and participation, (2) adequate learning environment, (3) perceived negativity of distance education, (4) perceived need for psychological support, and (5) grade level predict medical students' technostress?

Based on the research question, there main hypotheses were constructed to test:

- H0: None of the variables included in the model predicts medical students' technostress.
- H1: At least one of the variables included in the model predicts medical students' technostress.
- H2: All the variables included in the model predict medical students' technostress.

Using convenience sampling, 259 medical students from the Faculty of Medicine at XXXXXX University, Turkey were included in the study as the participants. Ranging from 18 to 29, the average age of the participants was twenty (M=20.3). Table 1 presents the background information about the participants. Accordingly, 57% of the participants were female while the rest (43%) were male. Since the current program started to accept students four years ago, only the students from 1st to 4th grades were represented in the study (34% 1st graders, 32% 2nd graders, 19% 3rd graders, and 14% 4th graders). Almost half (48%) of the participants were the graduates of Anatolian High Schools, which was followed by Science High Schools (39%) and other types of high schools (13%). A great majority of the participants were living in the city (60%), while the rest were living either in a district (31%) or a small town/village (9%).

Table 1.1 articipant Students' Dackground information					
Background factors	Groups	Ν	%		
Gender	Female	148	57		
	Male	111	43		
Grade Level	1 st	88	34		
	2^{nd}	85	32		
	3 rd	49	19		
	4 th	36	14		
Type of High School	Anatolian High School	124	48		

Table 1. Participant Students' Background Information



	Science High School	101	39
	Other Types of High Schools	34	13
Place of Living	City	156	60
	District	80	31
	Small Town/Village	23	9

The data were collected through an online questionnaire which was adapted from Wang et al., (2020) (Wang et al., 2020). After taking the necessary permissions from the scale developers, the instrument was translated into Turkish and the translated version was peer-examined by two language experts who are proficient in both Turkish and English. As a further step, a back-translation procedure was carried out to make sure that there were minimal differences between the English and the Turkish versions of the scale. The data collection instrument used in the current study included three main sections. In the first section, demographic information about the participants was inquired through items on gender, age, grade level, type of high school graduated from, and place of living. Not all of them were used as variables in the analyses, though. The second section comprised of 10 items to cover possible internal or external independent variables that were assumed to be significant predictors of the participants' technostress level. These items were grouped into four dimensions as the predictor variables: regular attendance and participation (RAP), adequate learning environment (ALE), perceived negativity of distance education (NDE), and perceived need for psychological support (NPS). The dimensions of RAP, ALE, and NDE were measured in a scale from 1 to 5 through three items in each, and all three sets formed a reliable scale, .70, .69, and .77 respectively (Table 2).

Table 2. Reliability Analyses of the Dimensions as Predictor Variables

Predictor Variables	Cronbach's Alpha	Number of Items
Regular Attendance and Participation (RAP)	.703	3
Adequate Learning Environment (ALE)	.691	3
Perceived Negativity of Distance Education (NDE)	.767	3
Perceived Need for Psychological Support (NPS)	-	1

The NPS dimension was measured with only one item asking about how often the participant students feel the need for psychological support during distance education. The third section, as the main body of the instrument, consisted of 30 items aiming to measure the participant students' technostress level. The *Cronbach* alpha for the 30 items was calculated as .97, which was considered to have a high level of internal consistency (Table 3).

Outcome Variables	Current St	Wang et al. (2020)		
	Cronbach's Alpha	Number of Items	Cronbach's Alpha	Number of Items
1. Institution-related Technostress	.913	9	.95	9
2. Tool-related Technostress	.941	9	.94	9
3. Human-related Technostress	.936	12	.85	4
3.1. Peer-related	.873	4	.85	4
3.2. Family-related	.899	4	-	-
3.3. Instructor-related	.882	4	-	-
Overall Scale	.970	30	.93	22

Table 3. Reliability Analyses of the Dimensions as Outcome Variables

The first 22 of the items were taken from the original scale and used as suggested by Wang et al., (2020). Two additional sets of items (8 items in total) were added to the scale with two new sub-dimensions under the human aspect of the original scale. In the original scale, the human aspect was measured through 4 items focusing only on 'peers.' In the Turkish version of the scale, the human aspect was measured through 12 items focusing on 'parent's/family members' and 'instructors' in addition to 'peers.' While forming the wording of the additional items on 'parent's/family members' and 'instructors,' the same patterns of statements were used as in the items on 'peers.' In this line, the dependent (outcome) variable, the medical students' technostress, was measured in a rating scale from 1 (*never*) to 5 (*always*) through 30 items representing three dimensions: (a) institution-related, (b) tool-related, and (c) human-related technostress. The *Cronbach* alpha for each dimension was calculated as .91, .94, and .93, respectively (Table 3).

Within the third dimension (human aspect), three sub-dimensions were included in the study as peers, parent's/family members, and instructors. The rationale behind this step was based on the observations of the researchers during distance education. The students were in need of support, not only from their peers but also



from other people around. Especially during the pandemic, the role of family and instructors in motivating, encouraging, and supporting the students was undeniable. Therefore, adding two new sub-dimensions into the human-related technostress was considered to be critical. The Cronbach alpha values of the three sub-dimensions were .87, .89, and .88, respectively (Table 3).

In order to answer the research question, a multiple regression analysis was run to predict the participant students' technostress level by means the software *IBM SPSS 23*. Based on the design, five independent (predictor) variables were included in the model: regular attendance and participation, adequate learning environment, perceived negativity of distance education, perceived need for psychological support, and grade level. On the other hand, technostress was the dependent (outcome) variable to be predicted from a combination of those five variables. The simultaneous regression (the *SPSS Enter*) method was employed to consider all the variables at the same time. Before interpreting the regression model, the necessary assumptions were checked to ensure that the analysis was independent of possible violations. Considering the *Correlation Matrix* depicted in Table 4, there were no higher intercorrelations than .43 among the predictor variables and all the values were below .60, which ensured that the multicollinearity assumption was not violated.

Table 4. Correlations Matrix of Predictor Variables

Predictor Variables	2. ALE	3. NDE	4. NPS	5. GL
1. regular attendance and participation (RAP)	292	.252	182	031
2. adequate learning environment (ALE)		263	.316	.204
3. perceived negativity of distance education (NDE)			430	108
4. perceived need for psychological support (NPS)				.101
5. grade level (GL)				

Furthermore, other collinearity statistics such as Tolerance and VIF were checked and none of the values regarding any variable indicated a problematic case for multicollinearity. The relationship between each of the predictor variables and the dependent variable was linear and the errors, the residual, were normally distributed and uncorrelated with the predictors. As observed, all the independent variables were significantly correlated with the dependent variable (Table 5).

Fable 5. Pearson Correlation	ations between the P	redictor Variables and	d the Outcome Variable
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Predictor Variables	technostress
1. regular attendance and participation (RAP)	342*
2. adequate learning environment (ALE)	440*
3. perceived negativity of distance education (NDE)	.567*
4. perceived need for psychological support (NPS)	.489*
5. grade level (GL)	.245*

*Correlation is significant at the .001 level (2-tailed).

To control the extreme values, the residual statistics were checked for the maximum values in *Mahalanobis Distance*, *Cook's Distance* and *Centered Leverage* and the extreme cases were deleted. A *Scatterplot Matrix* was created to check the assumption of linear relationship of each predictor with the dependent variable and a scatterplot between the predictive equation and the residual was checked for the assumption that these are uncorrelated. Normal distribution of the errors was assumed by checking the *histogram* and *P-P plot*. Homoscedasticity was also checked through *Scatterplot* and no violation was observed.

FINDINGS

The data that support the findings of this study are openly available in figshare.com at https://doi.org/XXXXXXX

The overall mean value of the scale (M=2.19) indicated a relatively low level of technostress among the participants, which could be interpreted that the participant medical students were able to cope with the stress placed on them by distance education. Table 6 presents the results of descriptive statistics regarding all dimensions within the scale. Considering the mean value of each dimension, the participants had a slightly higher level of technostress resulting from the technological tool used in their distance education (M=2.28) compared to human-related (M=2.13) and institution-related (M=2.20) technostress. Looking into the human aspect comparatively, the



instructor-related technostress (M=2.24) seemed to be a little higher than the family-related (M=2.01) or peer-related (M=2.14) technostress despite all being fairly low.

Table 6. Descriptive Results					
Dimensions of Technostress	M	SD	Ν		
1. Institution-related Technostress	2.20	.85	259		
2. Tool-related Technostress	2.28	.98	259		
3. Human-related Technostress	2.13	.90	259		
3.1. Peer-related	2.14	.92	259		
3.2. Family-related	2.01	.94	259		
3.3. Instructor-related	2.24	.93	259		
Overall Technostress	2.19	.85	259		

The highest level of technostress was measured for the items about meeting the high demands of the university's distance education policies and decisions (M=2.88); feeling uncomfortable with the pervasive invasion of distance education in all aspects of a student's life (M=2.60); and meeting the expectations of the instructors during distance education (M=2.51). On the other hand, the lowest level of technostress was measured for the items about being not encouraged by the parent's/family members (M=1.78); not having the relevant tutorials provided by the university (M=1.80); and not receiving sufficient incentives for distance education by the university (M=1.83).

A multiple regression was calculated to predict the medical students' technostress based on (1) regular attendance and participation, (2) adequate learning environment, (3) perceived negativity of distance education, (4) perceived need for psychological support, and (5) grade level. The model summary indicated that multiple correlation coefficient (*R*), using all the predictors simultaneously, is .70. In this five-IV model, a significant regression equation was found, *F* (5,253)=48.56, *p*<.001, with an R^2 =.48, which means the model accounted for 48% of the variance in the outcome variable. Accordingly, the medical students' technostress is equal to 2.85 + (-.07*RAP) + (-.31*ALE) + (.25*NDE) + (.19*NPS) + (.11*GL) and could be predicted from those five independent variables combined (Table 7).

		Table	7. Mulupi	e Regiessi	on Summe	այ			
								Adjusted	
Variables	В	SE	β	t	p	R	R^2	R^2	F
Model					.000	.70	.49	.48	48.56
Constant	2.85	.39		7.16	.000				
RAP	067	.02	146	-3.05	.003				
ALE	.307	.07	.202	4.03	.000				
NDE	254	.03	364	-7.14	.000				
NPS	.194	.04	.228	4.45	.000				
GL	.112	.03	.136	2.96	.003				

Table 7. Multiple Regression Summary

B=unstandardized coefficients, SE=standard error of the estimate, β =standardized coefficients

All the independent variables included in the model were found to be significant predictors of technostress. In this framework, RAP was a significant negative predictor of technostress, β =-.15, t(253)=-3.05, p<.005, pr^2 =.04, which could mean that an increase in the frequency of regular attendance and participation in (synchronous/asynchronous) classes and learning tasks (such as assignments, exams, projects, and so on) would lead to a decrease in the students' technostress level. Similarly, ALE was also a significant negative predictor of technostress, β =-.20, t(253)=4.03, p<.001, pr^2 =.06, which could be interpreted that the students having a better learning environment for distance education would reflect a lower level of technostress. On the other hand, NDE happened to be a significant positive predictor, β =.36, t(253)=7.14, p<.001, pr^2 =.17, as having a more negative perception about the influence of distance education on the students' academic, social, and daily life would result in an increase in their technostress level. Likewise, NPS was found to be a significant positive predictor of technostress, β =.23, t(253)=4.45, p<.001, pr^2 =.07, which could imply that the students who need more psychological support during distance education would also reflect a higher level of technostress. Finally, the students' grade level tended to be another significant positive predictor of technostress, β =.11, t(253)=2.96, p<.001, pr^2 =.03, which indicates that the higher the grade level was, the more techno-stressed the students were.

The same model of the multiple regression was run for each of the dimensions within the scale and all the independent variables combined were found to be significant predictors of each dimension (Table 8).



Dimensions	р	R	R^2	Adjusted R ²	F
1. Institution-related Technostress	.000	.61	.37	.36	30.26
2. Tool-related Technostress	.000	.71	.50	.49	52.32
3. Human-related Technostress	.000	.67	.44	.43	40.37

Table 8. Multiple Regression Models for Each Dimension

Accordingly, the model combining all of the independent variables accounted for:

- 36% of the variance in the institution-related technostress, F(5,253)=30.26, p<.001, $R^2=.36$;
- 49% of the variance in the tool-related technostress, F(5,253)=52.32, p<.001, $R^2=.49$; and
- 43% of the variance in the human-related technostress, F(5,253)=40.37, p<.001, $R^2=.43$.

The values obtained in the model run for each dimension confirm the overall scale and indicate that the students who:

- attend and participate in the classes and learning tasks less regularly,
- have an inadequate learning environment for distance education,
- perceive the influence of distance education on their life from a negative perspective,
- need psychological support during distance education,
- are in an upper grade,

are more likely to have a higher level of overall technostress as well as institution-related, tool-related, or human-related technostress (Figure 1).

DISCUSSION

In this study, the presumption was that the technology-dependent distance education, imperatively driven by the Covid-19 lockdown period, in a field requiring attainments of intensive operative skills like medicine might cause technostress, even on a digitally native generation composed of medical students who are in the first percentile of academic achievement. To test this presumption, the technostress scale developed by Wang et al. (2020) was translated into Turkish language and conducted at a medical school with students from different grade levels (Wang et al., 2020). All the participant students had been mandatorily attending the lessons in a home environment where their family were the closest human source of interaction while their instructors were the most frequently consulted official and academic representatives of the organization. This fact made it necessary to interpolate further dimensions to the P-P interactions of P-E misfit theory, which was tested in the original scale through only the peer dimension as relevant to P-P technostress. In this adaptation, parents/family and instructors were integrated into the scale and this integration performed well with the scale revealing high reliability and internal consistency values throughout the validation of the modified scale. The adapted version of the scale demonstrated that RAP, ALE, NDE, GL and NPS were significant predictor variables of technostress, which was mild in medical students but not negligible though. The most powerful predictor was ALE and the weakest predictor was RAP.

ALE where students feel physically and emotionally safe and secure is considered to be one of the most critical components of learning. Debating on how physical environments shape learning as well as psychological and emotional welfare of learners, the current study defines ALE as physical surroundings that are enriched with digital and adaptive devices that promote better and faster learning during distance education. In this framework, ALE is thought to be related to the techno-security, which, in other words, implies that having inadequate physical surroundings during technology-enhanced learning could lead to techno-insecurity among students as a sub-dimension of technostress (Ahmad et al., 2012; Hassan et al., 2019; Ragu-Nathan et al., 2008). In this line, the positive impact of ALE on learning would also demonstrate significant outcomes in students' psychological wellbeing, because students who study in a technologically safe and secure environment would be more motivated and engaged and therefore they tend to reflect a lower level of technostress.

Interpretation of RAP as an independent technostress creator involves the dimensions of both techno-overload and techno-invasion. In a study examining different aspects of academic stress, researchers concluded that maintaining regular class attendance as a minimum requirement of the course and fulfilling the obligatory tasks were among the major factors of academic stress caused by the programmatic aspects (Nandamuri & Ch, 2009). Among 12 causative factors of academic stress, 60% of the students reported RAP as the first or second choice of preference (Nandamuri & Ch, 2009). Nevertheless, in a research held with medical students, RAP was not reported as a source of stress (Abdulghani et al., 2011). In the present study, RAP was only a minor component of overall technostress. It is possible that failure to meet required attendance and participation evoked technostress in a couple of ways. First, as students missed more classes, the amount of incomplete course work increased. Secondly, additional occupations or personal preferences might converge with timing of the lectures which might result in the perception of techno-invasion. This was solidified in a study investigating the reasons for not attending classes in university students (Kottasz, 2005). During face-to-face education, 50% of the students stated that timing of the lessons was



not right, 38% stated that they were able to access the lesson content without attending the lesson. Additionally, %61 had some other occupation convergent with the timing of the lesson. Illness and transportation issues were also stated as reasons of non-attendance (Kottasz, 2005).

Negative perception on distance education stems from personal attitudes. As with all applied sciences, in medical education master-apprentice relationship is a long-established tradition. Although it seems like a challenging requirement that students are supposed to attend practical lectures and learn specifically by both observing the mentor and executing the procedures, collaborative teaching methods and TEL are still in progress in medical education contexts. Moreover, surveys undertaken recently revealed that both students and teachers were in favorable attitudes towards distance education (Çokyaman & Ünal, 2021). Nevertheless, it is a fact that obligatory distance education due to Covid-19 lockdown resulted in numerous mistakes, deficiencies, and inadequate applications worldwide. This inevitably and adversely effected the attitudes of most of the students, teachers and parents, as well (Çokyaman & Ünal, 2021). Moreover, negative reactions depend on affections, private standards of judgement and personality traits (Krishnan, 2017). The major component of negative attitudes demonstrate positive correlation with the distance of the hometown (Upadhayaya et al., 2021). Negative attitudes demonstrate positive correlation with the distance of the hometown from the city center (Upadhayaya et al., 2021). Naturally, the difficulties in accessing the Internet and infrastructural problems disable individuals and cause exhaustion while dealing with timely and bulky lectures.

Increasing technostress by increasing grade level is probably related to work overload along with technocomplexity. Medical students feel the heavy responsibility of dealing with 'someone's life' after 3rd grade. Bedside lectures, clinic visits and internship in in-patient clinics constitute the mainstay of medical education. During the obligatory lockdown period most of the universities were caught unprepared or half-prepared although some degree of TEL was a part of curriculum. Video demonstrations and controlled laboratory dummy studies fell short in satisfying students. Perception of self-confidence in technical and applicable skills were deficient in students.

Need for psychological support is an indicator of overall stress and is the result of an inability to deal with existing stressors and non-adaptation. Technostress was investigated in medical freshmen (Madaan et al., 2020). Distinctly authors identified technostress as 'stress related to technology being a part of everyday life' rather than stress originating from TEL (Madaan et al., 2020). Technology utilization in areas other than education is an important part of the lives of university students. Nearly 90% of medical freshmen reported using the Internet for entertainment purposes and nearly half of them reported feeling distressed if they were not able to access the internet for 1 day (Madaan et al., 2020). Therefore, as a double-edged sword, ICT utilization in everyday life eventually leads to vicious circle of cause and effect relations for psychological conditions (Qi, 2019).

The P-E misfit theory stands on three cornerstones as described previously. It is not surprising that the most prominent component estimated in the present study was the tool-related technostress. Everyday new advancements are realized in ICT and technological tools like computer integrated systems, multiple complicated databases are source of great amount of strain on individuals (Jena, 2015). Technostress, as emphasized in the term itself, is primarily associated with technology utilization, which is realized through use of electronic devices, software, and hardware as well as every day evolving intelligent machines. The results of this study revealed that the rapid and ever-changing nature of technological tools generate pressure even on the digital native generation. Human-related technostress was the weakest component of technostress in the present survey. Neither family members nor peers were a source of remarkable technostress on medical students. On the other hand, instructors evoked technostress level nearly as much as the technological tool did. It is a fact that most of the teachers and academicians experience reputable amount of technostress during teaching within the context of TEL (Jena, 2015). Additionally it has been demonstrated that individuals experiencing technostress have negative impacts on job performance, gradually end up with job dissatisfaction and induce negative affectivity depending on personal characteristics (Jena, 2015; Ragu-Nathan et al., 2008; Tarafdar et al., 2007, 2011). Academicians deal with technostress by either struggling to accept or by over-identifying with collaborative teaching methods (Jena, 2015). In the last instance, these collaborative technologies consisting of e-mails, spreadsheets, presentations, interpretation of statistical outcomes and using multimedia soft wares all promote the techno-overload on the students (Groves & Zemel, 2000; Jena, 2015).

The results of this study is limited to 259 medical students at a single institution of a public university in Turkey, and more diverse settings to be included into future studies would definitely add to the validity and to the interpretations of the findings. Health hazards like pandemics are enormously effective environmental agents. Besides, they function as powerful personal stressors. Inevitably, both P and E components of P-E misfit theory were adversely affected from the presence of Covid-19. Therefore, the results should be interpreted from that point of view. False positive rate or higher than real values might have exerted from this study. The number of the



participants in the present study was sufficient for factor and statistical analysis. However, results from a larger population would be a better guidance. Also, using only one item to measure NPS was another limitation of the scale which might either have over-estimated or under-estimated its relationship to technostress. Finally, creators and inhibitors might be more reliably determined in a population with inertly higher technostress rather than a digital native generation.

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CONCLUSIONS

- Validation of technostress scale of Wang based on P-E misfit theory was elicited for Turkish language.
- This is the first study evaluating technostress on medical students. In medical students, though stress was known and strategies managing stress were studied, the technostress levels were not evaluated before. The level of technostress in medical students were relatively low and nearly half of the generated technostress was explained by 5 creative factors.
- The technostress creator factors determined in this study were NPS, RAP, ALE, NDE and GL. If these factors can be controlled or eliminated, technostress of medical students would be nearly undetectable.
- The major component of technostress originated from the tool-related component. All the factors significantly and independently predicted all the dimensions of technostress. The highest predictive values were detected in tool-related technostress and the lowest predictive values were for the organization-related technostress.

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The Discovery of Knowledge in Educational Databases: A Literature Review with Emphasis on Preprocessing and Postprocessing

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ABSTRACT

In educational data mining (EDM), preprocessing is an arduous and complex task and must promote an appropriate treatment of data to solve each specific educational problem. In the same way, the parameters used in the evaluation of postprocessing results are decisive in the interpretation of the results and decision-making in the future. These two steps have as much influence on obtaining good results in EDM as the algorithms used. However, in the dissemination of the results of studies on this topic, emphasis is placed only on the evaluation of the algorithms used. Thus, the present study sought to carry out a systematic review of the literature on this topic, focusing on the exploration of the preprocessing performed and on the metrics for evaluating the results. It is observed in many studies that the description and evaluation of the preprocessing and the use of several metrics to evaluate the algorithms used are negligible. However, without a proper explanation of the meaning of each metric to reach the proposed objective

INTRODUCTION

The higher education educational system comes from a long and continuous expansion of its access places, favoring social equity through education. According to the Organization for Economic Co-operation and Development (OECD), higher education drives the growth of economies by promoting the acquisition of specific skills and competences, qualifying academics for various job functions (OECD, 2019). This prerogative is foreseen in the Law of Directives and Bases of Brazilian Education, which, in article 2nd, defines the principles and purposes of national education: "Education, a duty of the family and the State, inspired by the principles of freedom and the ideals of human solidarity, aims at the full development of the student, his preparation for the exercise of citizenship and his qualification for work" (LDB, 1996). However, just providing access is not enough, as there are difficulties faced by higher education institutions that impact their efficiency in graduating professionals. The most prominent difficulties include low academic performance, evasion, and retention, which make it impossible or delay graduation (ACKCAPINAR, 2019).

Considering this, institutions and researchers have tried to understand these phenomena to support the creation of effective policies to face and resolve these problems. Thus, as in the commercial and business area, where innovative technologies have been incorporated into the management and decision-making process, in the educational area, initiatives that aim to use data analysis technologies to support educational actions in the educational process have been considered promising. In the same way, the business sector exploits the abundance of data generated continuously by systems that computerize all its processes. The educational system reveals this same potential, revealed through the vast amount of data generated by academic systems, educational platforms, exam results and activities, inside and outside virtual learning environments.



In this context, the educational data mining (EDM) approach appears, which comprises a field of research aimed at the application of data mining whose origins are inherent to the educational context, with the main intention of producing a reliable understanding of learning patterns of students and identifying their study processes and behaviors to enhance educational outcomes (ANOOPKUMAR, 2018; SOKKHEY, 2020). As a result of this deepening of information, it is believed that student performance can be improved more effectively through strategic programs (MENGASH, 2020).

In this conjecture of several possible applications and the availability of many techniques, a single EDM method that works best in all contexts and applications has not yet been identified. Often, more than one technique is explored to determine which technique leads to better results in a particular case (ALTURKI, 2021). It stands out that these techniques comprise not only the algorithms used but also the process of data collection, data processing and evaluation of results. In this sense, systematically exploring works that present studies in EDM can contribute to the identification of good practices, the recognition of varied techniques and their application potential and the signaling of gaps to be filled.

Thus, this article presents a systematic literature review (SLR) about the use of EDM in higher education in predictive approaches. Considering that there is a predominance of SLR on this topic that addresses the main algorithms used (SHAHIRI 2015, PEÑA-AYALA 2014 ALTURKI 2020) and considering that works in EDM tend to apply several algorithms in the same study, this work has the main objectives of investigating which attribute selection methods, preprocessing, and evaluation metrics are being used the most. With the assumption that these steps, in addition to the algorithms used, are fundamental to define good results in an EDM enterprise, they are reliable and potentially generalizable.

In the next section, a discussion is undertaken that seeks to compose a theoretical framework on the EDM theme, highlighting the approach carried out in some studies. Then, the proposal of the systematic review is described, along with its respective methodological details. Subsequently, the results and discussions are presented. Finally, final considerations are made, resuming and evaluating the objectives achieved.

EDUCATIONAL DATA MINING

The term "educational data mining" first appeared in 2005 during the annual conference of the Association for the Advancement of Artificial Intelligence in the city of Pittsburgh, United States (USA) (SADIQ, 2019). Since then, this technique has become popular among researchers in the technological and educational area, building a consensus that there are many benefits that EDM can bring to education (AKMEŞE, 2021; SOKKHEY, 2020; HELAL, 2018; MIGUÉIS, 2018; ASIF, 2017; SADIQ, 2019; MAGBAG, 2020; COSTA, 2017; ALTURKI, 2021; URBINA-NÁJERA, 2020; PABREJA, 2017). The purpose of educational data mining is to obtain meaningful information from data from the educational environment, with the expectation that it can provide an in-depth understanding of educational phenomena and provide substantial support for decision-making. To this end, strategies from the field of computational intelligence are employed, which involve statistical methods and data analysis, composing the data mining techniques already widely disseminated in other areas.

In data mining, approaches can be divided into two main categories: descriptive and predictive methods. Descriptive methods allow identifying patterns in the data, recognizing possible rules of cause and effect. Predictive methods aim to make inferences about the future, enabling predictions of occurrences through induction based on previous occurrences (AKMEŞE, 2021). Both approaches have numerous potential applicabilities. However, predictive methods applied to the prediction of academic performance have stood out as the most popular (MIGUÉIS, 2018; SOKKHEY, 2020; ALTURKI, 2021). Early identification of the results that students may have during or after an educational process allows teachers or managers to intervene in a timely manner and reverse an unsatisfactory academic trajectory. Alturki et al. (2021) describe three types of predictions in higher education: (i) performance prediction of student results in specific subjects. With the early identification of these trends, it may be possible to guard against possible malfunctions in the education process. Armed with this information, instructors can monitor students' progress and intervene early on academic problems, negotiate alternative routes and discerning strategies to fill gaps or overcome vulnerabilities (AKMEŞE, 2021).

It is important to emphasize that the use of EDM is not limited to the application of algorithms that implement mining techniques. It encompasses a rigorous process of data collection and treatment, which directly interferes with the results achieved. Sokkhey (2020) describes the EDM process in 5 steps: (i) first, it is necessary to obtain the desired data, which can be generated by academic systems, virtual learning environments, digital educational objects or collected through observation or questionnaires; (ii) the second stage comprises the processing of data, since they are hardly found "clean", that is, and in appropriate formats, requiring preparation; (iii) in the third step,



the data are submitted to data mining algorithms, which may vary according to the objective to be achieved. In the same way, several algorithms can be used, evaluating the best performance obtained for the desired objectives; (iv) in the fourth stage, the results need to be interpreted to guide decision-making; and (v), finally, the fifth stage comprises modifying the educational processes according to the identified trends, the predictions obtained, and decisions formulated to direct them. This step can be postponed if the results are inconclusive: the process can be readjusted, and the first 4 steps can be repeated.

Several academic studies make important contributions to this area, exploring and presenting different methods of implementing each step of the EDM process. In this context, literature reviews seek to explore the methodologies used, highlighting the most commonly used procedures or those of recognized effectiveness. Shahiri et al. (2015), for example, explored which attributes are most influential in academic performance and which algorithms are most used. Their results showed that the cumulative grade average is the most commonly used attribute in EDM. This is a more common metric in American institutions, called the Grade Point Average (GPA) in English, and represents the average of your grades in each period. In Brazil, its use is not common in academic systems, but it can be easily calculated.

Peña-Ayala (2014) focused his review on mining approaches, concluding that 60% of the articles in his review used predictive methods, while 40% used descriptive methods. The author also indicated the predominance in the implementation of Bayesian network techniques, decision trees and instance-based learning. Saa et al. (2019) investigated the most influential factors in academic performance by grouping them into 4 categories, namely, students' past grades and class performance, students' e-learning activities, student demographics, and student social information. In this survey, the techniques of decision trees, naïve Bayes classifiers and artificial neural networks stood out as the most used.

It is noted that there are many aspects to be explored when carrying out a substantial analysis of one or some educational data mining processes. Although some approaches may be repeated, carrying out studies such as these will always be important due to the emergence of new works. There is a tendency to use multiple techniques and algorithms to highlight, at the end, which of them presented better results. In this sense, limiting it to only one algorithm or restricting it to a few techniques in the testing phase are not necessary when it is possible to explore several techniques until an acceptable performance is obtained. Thus, this review does not focus on examining the algorithms used, but on the preprocessing, activities carried out and how they promoted improvements or not in the results, considering that these activities are highly influential in the final performance, capable of making a data source irregular in a promising dataset, providing good results.

PROPOSAL AND METHODOLOGY

In this study, it is proposed to carry out an investigation of the literature related to the mining of educational data in higher education, specifically in works with a predictive approach, and to identify the most used preprocessing procedures and which performance improvements. At the same time, it seeks to examine which performance metrics are being used to assess the results achieved. To this end, a systematic literature review (SLR) methodology will be used, using the guidelines proposed by Kitchenham et al. (2009), which determine three main steps: planning, conducting, and reporting.

Planning

Planning is the first step of SLR and is subdivided into five other subcategories:

Identification of the research objective and questions: The aim of this study is to conduct an investigation of the literature on the use of educational data mining in higher education using the guidelines for systematic review by Kitchenham et al. (2009). To achieve all adjacent purposes, the questions were defined as follows:

- Question 1: What preprocessing procedures are described?
- Question 2: What attribute selection techniques are described?
- Question 3: Which evaluation metrics of the models generated in educational data mining are described?

Identification of keywords: The construction of the search string was elaborated with the concern of properly delimiting the search results without increasing the amount returned in a way that makes the review impossible but also without restricting it too much. In this way, we sought to restrict specific educational data mining jobs used in higher education in the search string. More specific delimitations were carried out in conducting the research through the inclusion and exclusion criteria. The search string used was "Educational Data Mining" AND ("higher education "OR "under graduation courses").



Identify the sources: The databases used were chosen according to their range of indexing and recognized reliability, delimiting the search to the Scopus, Science Direct and Web of Science databases.

Identify the inclusion/exclusion criteria: Table 1 presents the exclusion and inclusion criteria. It is reiterated that failure to meet the inclusion criteria also excludes the study.

INCLUSION	EXCLUSION			
Only articles published in journals	Duplicate articles			
Published from 2016 to 2021	Articles that present systematic reviews and systematic mappings			
Only in English language	Articles that do not have open access			
Peer-reviewed iournals	Not considering the context of higher education			
Explain about all the information inherent to the research questions	Articles not available in PDF format			
Studies that implement predictive methods	Articles that do not describe the information inherent to the research questions			

Identify the data extraction strategy: in the first step, all articles returned by the search were collected. Second, a transversal reading of the articles was carried out, comprising the title, abstract, methodology and results, excluding those identified within the exclusion criteria and identifying duplicate articles. The remaining articles were read in full, examining eligibility criteria that included meeting the inclusion criteria and a complete description of the study's methodological processes.

CONDUCTING THE REVIEW

It consists of the second stage of the review, subdivided into 5 other stages:

Identify the Search: Currently, searches were carried out in the selected libraries with the search string created. As a result, 95 articles from the Web of Science database, 65 from the Scopus database and 61 from the Science Direct database were obtained, totaling 221 articles.

Selection of studies: As a protocol for examining the collected articles, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol was used (PAGE et al., 2021). With this, it was possible to structure the information flow of the review process, mapping the number of articles identified, included, excluded and the reasons for exclusions. Figure 1 depicts the details of the process of selecting works based on the PRISMA protocol.

Assess the quality of the study: although provided separately in the guidelines of Kitchenham et al. (2009), in this study, the quality was based on the requirements stipulated in the step "Identify the data extraction strategy" and apply it in the PRISMA protocol.

Data extraction: In this step, the data necessary to answer the research questions are extracted, as well as important data to characterize the sample of selected articles. These data are presented and discussed in the results section. *Synthesizing the Data*: In this step, the congruence between the analyzed studies and the divergences are highlighted. It mainly seeks to explain the contributions that the studies add to the preprocessing procedures in educational data mining and to the performance metrics used.





Figure 1: Systematic review protocol based on PRISMA.

RESULTS AND DISCUSSIONS

At this stage, the results are presented both relating to the stipulated research questions and other relevant aspects found in the review. Although specific objectives to be achieved are defined, which lead to an emphasis on preprocessing and metrics, during the full examination of the selected studies, several pieces of information were categorized as a way of characterizing the sample. Regarding the objectives of the studies, there was a predominance of studies on predicting performance in the course, with 10 works on this topic (AKMEŞE, 2021; ANOOPKUMAR, 2018; HELAL, 2018; MIGUÉIS, 2018; ASIF, 2017; SADIQ, 2019; MAGBAG, 2020; COSTA, 2017; ALTURKI, 2021; SULTANA, 2019), one of the works addressing performance in a specific programming discipline (SUNDAY, 2020). Another three works address the prediction of dropout and graduation in courses (AGRUSTI, 2020; MENGASH, 2020; NIETO, 2019; URBINA-NÁJERA, 2020). Two works with purposes that are not so frequent stand out, such as Mengash (2020), who proposes the use of educational data mining to support the university admission process based on the profile and performance obtained in high school, and Pabreja (2017), who used data from every degree to predict the employability potential of its graduates. Regarding the sources for obtaining data for mining, the hegemony of academic systems remains as providers of data for analysis, being indicated by 12 works in the sample of this study, while another three used data from virtual learning environments, and 1 used data from the national education system. However, although several works use the academic system to collect data, it does not mean that the predictor attributes used are the same, as this depends on the researcher's decision or methodology and on the type of information stored in the academic systems of each institution.

When exploring the attributes used in the reviewed studies, classifications were used in categories based on the segmentation performed by Shahiri et al. (2015). Table 2 presents the categories and the description of the attributes that compose them, correlated with the respective works that use attributes of the category.

Categories	Category Attributes	Works	The amount
External evaluation	High School Score, Credits from Other Institutions, Admission Score, Subject Specific Entrance Exam Score, GPA High School	(AGRUSTI, 2020), (AKMEŞE, 2021), (MENGASH, 2020), (MIGUÉIS, 2018), (ASIF, 2017),	7

Table	2:	Predictive	Attributes
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		(MAGBAG, 2020), (ALTURKI, 2021)	
Internal Assessment	Academic Phase, Exam Name, Credits Completed, Maximum Score of an Exam, Academic Phase of the Exam, Result (Pass, Fail), Attendance (Attendance), Average by Academic Phase, Frequency by Academic Phase, Academic Year of Enrollment, Grades in specific subjects, Subjects that failed, Subjects that passed, Maximum Grade, Minimum Grade, Median Grade, Number of Enrollments per term, Grades in Specific Exams, Laboratory Grades, Grade Point Average (GPA), GPA per term, Percentage of Grade Use per academic period.	(PABREJA, 2017), (SUNDAY, 2020), (ALTURKI, 2021), (MAGBAG, 2020), (SADIQ, 2019), (NIETO, 2019), (ASIF, 2017), (MIGUÉIS, 2018), (HELAL, 2018)	9
Demographic data	Age, Gender, Family Income, High School Origin, Parents' Education, Employment Status, Parents' Occupation, Disability, Dependence on Parents or Guardians, Marital Status, Number of Children, Education and Occupation of an Elder Brother	(AGRUSTI, 2020), (AKMEŞE, 2021), (ANOOPKUMAR, 2018), (HELAL, 2018), (MIGUÉIS, 2018), (COSTA, 2017), (URBINA-NÁJERA, 2020), (PABREJA, 2017)	8
Psychometric	Parent Response Survey, Parent School Satisfaction	(SULTANA, 2019)	1
Interaction Data	Book View, Activity View, Course Page View, Forum Post, Start Forum Discussion, Review Forum View, Lesson View, Quiz View, Quiz Take, Quiz Review, Wiki View, Edit wiki, view resource files	(HELAL, 2018), (SADIQ, 2019), (COSTA, 2017)	3

There is a great diversification of attributes, which requires expertise for the analyst on the topic to be addressed to select the attributes, as well as the use of attribute selection techniques that support them. The predominance of the use of all student performance records to make future predictions, considering previous scores, during and after admission to higher education stands out. It may be intuitive that it is expected that a certain performance that the student has at some point will be repeated in future situations. However, it must be considered that, regardless of the level of performance presented by an individual in high school, it was enough for him to pass the subjects and complete this training stage. The same perspective is repeated for the entrance exam because he was approved and joined the institution. What is now discussed is how these performances, which were satisfactory, can now indicate future academic performance. In this context, data mining algorithms may be able to capture the nuances of these relationships. Furthermore, it is possible to combine attribute categories. As shown in Table 2, there are works that describe using attributes from more than one of the categories.



Research Question: What preprocessing procedures are implemented?

Traditional data mining algorithms are rarely applied directly to raw source data, requiring specific preprocessing for the mining methods to be applied (DUTT, 2017). Schmidhuber (2015) argues that preprocessing and data transformations are a byproduct of the data mining strategy, contributing to the representation of data to explore the advantages of the algorithms and minimize the disadvantages. In Han et al. (2011), preprocessing is defined as the process of manipulating, enriching, reducing, or transforming the original data to make them more easily accessible. Urbina-Nájera (2020) complements this understanding by describing that transformation may involve combining data from different sources to provide a unified view. These concepts of preprocessing and data transformation are part of the well-known knowledge discovery process in a database (KDD), comprising as distinct steps the selection of attributes, preprocessing (such as data cleaning) and transformation, all of which are predecessors to the application phase of mining algorithms. In this study, the approach of Sokkhey (2020) is used, considering as preprocessing all the treatments performed on the data before the application of the algorithms, except for the use of specific techniques for selecting attributes that, by composing a research question, will be addressed in a specific section.

All papers reviewed, at some level, described preprocessing. First, regarding data cleaning, although it is presumable that it is a step present in any EDM enterprise, only half of the reviewed works described performing this activity (AGRUSTI, 2020; AKMEŞE, 2021; ANOOPKUMAR, 2018; MENGASH, 2020; NIETO, 2020; 2019; MAGBAG, 2020; COSTA, 2017; SULTANA, 2019), basically reporting noise elimination, removal of instances with missing data, removal of students who did not fit into any of the predictive classes, removal of duplicates, and fits in this step, the removal of visibly irrelevant attributes such as address, ID, email, number of documents, among others of this nature.

In addition to mandatory data cleaning, the most declared preprocessing procedure is data transformation, also described in 8 works. Regarding performance-related attributes, the need to categorize scores into concepts such as A, B, C, Bad, Good, and Excellent, among others, was demonstrated (ANOOPKUMAR, 2018; MENGASH, 2020; HELAL, 2018; MIGUÉIS, 2018; SUNDAY, 2020; PABREJA, 2017). Age is also an attribute that is usually transformed, especially in age groups. Among the works reviewed, three performed discretization of student ages (AGRUSTI, 2020; HELAL, 2018; PABREJA, 2017). Additionally, in terms of transforming continuous data into discrete data, binarization is also a resource for data transformations and was implemented by Agrusti (2020) in all its attributes. However, the author does not specify exactly the advantages he intended to achieve, only citing "better adequacy of the algorithms" and does not discuss in the results whether advantages were obtained, since there was no comparative dataset (without making the values binary), as it was not an object of study, but only an aspect methodological.

Regarding the transformation, the procedures found and presented here do not have innovative characteristics that aim to advance the mining process. Standard procedures were shown, almost mandatory, to be performed in data preparation for EDM. Two aspects can be highlighted about the methodologies found: first, the approach of transforming scores into concepts. Seven works described carrying out this transformation under the approach of "categorization", while one of them approached this activity as "discretization", which leads us to the second aspect to be highlighted. Although discretization is a common procedure to be performed in data preparation, it is not a random action and, depending on how it is performed, it can negatively influence the prediction. In short, discretization is the division of something into smaller, less complex parts. For this, statistical principles are used so that the new parts faithfully represent the original data.

That said, it appears that the works that described the transformation of scores as categorization did not report using any discretization method. Thus, it is assumed that this was carried out based on the experience of the researchers or on some standard of concepts of the institution. Only Miguéis (2018) used the binning algorithm (equal width binning) to establish five levels of academic performance (A, B, C, D and E) and thus described this transformation as discretization. The importance of formalizing this process with a methodology is highlighted, as generating intervals without observing the amplitude of the sample that one has can generate irregular intervals. It is possible to accumulate, for example, empty age ranges rather than others with more than 60% of individuals in your sample. Table 2 shows that half of the studies used demographic data such as age and salary income range (individual or family). These types of data can have an entirely different amplitude in each context. Therefore, they would need a statistical evaluation for their discretization; however, none of the studies reported using any formal methodology for these attributes.

Still in critical observance of the nonuse of statistical formalization in data processing in preprocessing. It should be noted that several studies report using external scores (high school grades and entrance exam grades) and



internal scores (semester grades, grades in subjects or exams and activities) in the same dataset for data mining. Only Magbag (2020) reported the concern and need to perform data normalization. This aspect is relevant, as the scoring scales may differ from one data source to another.

A very common situation in data mining is unbalanced databases, that is, the number of instances for each predictive class is too discrepant. This is a very plausible scenario to occur for several reasons in educational databases. In exact science courses, for example, the number of students who drop out or fail may be much higher than in other possible situations for students. The same scenario can be repeated in courses or disciplines, traditionally with few failures or dropouts. In addition to harming the construction of the prediction model, this situation can lead to a misinterpretation of the results and the effectiveness of the algorithm. Take as an example a subject in which the approval rate is 90% (in the training group, 90% are approved), if this algorithm correctly classifies the prediction of approved students at 90% (the tendency is to print a predominance of correct answers in the majority class) and miss 100% in the prediction of students at risk of failing, the accuracy of this algorithm will still be 81%, which is a good success rate, but, in practice, this prediction model is useless, since that the objective is to highlight students at risk of failing so that it is possible to carry out some form of intervention, but in this case, the minority class will always be misclassified.

Only three works reported the observation of this problem and implemented some load balancing technique, namely, MAGBAG (2020), COSTA (2017), and ASIF (2017). Of these, only Magbag (2020) and Costa (2017) specified which technique they used; both works used the Synthetic Minority Oversampling Technique (SMOTE) algorithm that works by creating synthetic minority class data based on existing neighbors. Assif (2017) does not describe which load balancing technique was used, but compares the results with the unbalanced base, reporting that there were no improvements in classification rates, but does not discuss the confusion matrix, so it is not known if there were any changes in the classification of minority classes.

Are attribute selection techniques being used? What techniques?

As shown in Table 2, there is a significant diversification of attributes present in the consulted databases. However, not all of them may be relevant to the characterization of the desired prediction state. In fact, using all available attributes can be harmful. As described by Urbina-Nájera (2020), many attributes represent a large dimensional space, and it is necessary to perform a dimensionality reduction, selecting only a few attributes in a way that retains as much information as possible to describe the training instances.

In some cases, only the researcher's expertise around analysis, experience in data mining or knowledge of the algorithmic techniques to be applied are used in the selection of attributes. However, there are techniques whose objective is to select the most relevant factors to be used as input variables for forecast models (ALBÁN, 2019). Among the works examined, seven reported using some procedure for selecting attributes (AKMEŞE, 2021; ANOOPKUMAR, 2018; MENGASH, 2020; MAGBAG, 2020; COSTA, 2017; ALTURKI, 2021; URBINA-NÁJERA, 2020). With emphasis on the use of the GainRatioAttributeEval method, which evaluates each attribute by measuring its proportion of influence related to the class, and the InfoGainAttributeEval method, which estimates the attributes by measuring the information gain provided by each attribute related to its class, implemented by 4 works (MAGBAG, 2020; COSTA, 2017; ALTURKI, 2021; URBINA-NÁJERA, 2020). The other methods used were the chi-squared method (AKMEŞE, 2021) and the correlation coefficient method (MENGASH, 2020). Anoopkumar (2018) does not report which technique was used but states that an attribute selection process was carried out.

Among the results obtained with the selection of attributes, Alturki (2021) shows that the student's cumulative average (GPA) for each semester, the number of courses failed in the 1st and 2nd year, his grade in the 'Fundamentals of the Database' and 'Basic programming courses 1' are the most influential attributes for predicting academic performance, while English skills and high school cumulative average have not been shown to influence the prediction. Urbina-Nájera (2020) reduced its attributes from 56 to 27 after using the selection method, and Akmeşe (2021) reduced it from 12 to 6 attributes. In both cases, the attributes of gender and age were waived. Alturki (2020) reported in his investigation that gender and age did not show significant impacts in his reviewed studies, but they are among the attributes most used by most studies. Table 2 corroborates this finding. Alban (2019) attributes the recurrence of the use of these attributes because they are internal data that are simple to define and measure; that is, they are easily found in academic systems, teaching platforms or sources of demographic data. In this way, gender and age are trivial information that arise in any collection performed.

What evaluation metrics are being used to evaluate results in educational data mining studies?

It is part of the analysis of results in data mining to evaluate the classification model, which allows the researcher to determine the level of confidence in the prediction model, which supports the interpretation of the results and,



if necessary, guides the adjustments and repetition of the preprocessing. Souza (2021) argues that to verify the results of a classification model, it is necessary to define the evaluation methods and the interpretation metrics because together they can determine whether a model is effective or not. A diverse set of metrics are available to researchers, but in general, the confusion matrix is the dominant measure, and its components are used in the calculation of many metrics (SHUQFA, 2019).

Usually, cross validation is predominant as an evaluation method. This method performs the random division of the dataset for the algorithm evaluation in N equally distributed data subsets. After the division, the tests are performed by sending one of the subsets for the algorithm to classify (test set), and the others act as a training set. The process is repeated until all subsets have been used as a test set and a training set. In this survey, this was the method used in 13 studies. Only Agrusti (2020), Sunday (2020) and Anoopkumar (2018) did not specify which evaluation method was used.

For the metrics used, a variety of 8 metrics were found. Table 3 presents the studies examined and the metrics used to evaluate the results. The greater use of the metrics of accuracy, precision, and F measure was reported in 10 works, followed by recall, which was reported in 9 works.

Studies	Metrics							
	Accuracy	Precision	F	Recall	Specificity	Kappa	AUC	ROC
(AGRUSTI, 2020)		Х	Х	Х				
(AKMESE, 2021)	Х							
(ALTURKI, 2021)		Х	Х					
(ANOOPKUMAR	Х	Х	Х	Х	Х			
(ASIF, 2017)	Х					X		
(COSTA, 2017)			Х					
(PABREJA, 2017)		Х						
(HELAL, 2018)		Х	Х	Х		X	Х	
(MAGBAG, 2020)	Х	Х	Х	Х			Х	
(MENGASH.	Х	Х	Х	Х				
(MIGUÉIS, 2018)	Х	Х		Х				
(NIETO, 2019)							Х	
(SADIO, 2019)	Х		Х	Х				
(SULTANA,	Х				X	X		X
(SUNDAY, 2020)	X	X	Х	X		X		
(URBINA-	X	X	X	X				

Table 3: Evaluation Metrics

In addition to the diversity of metrics, the survey shows that, except for Nieto (2019) and Pabreja (2017), all other works employ more than one metric. However, it is essential to understand to what extent the characteristics of each of these metrics are being considered for interpreting the results and evaluating the forecast model. Table 4 displays the description of each of the metrics recorded.



Metrics	Description
Accuracy	Proportion of samples correctly estimated in relation to the number of all samples. That is, the test is the rate of total correct diagnoses.
Precision	Ratio between true positives and all values classified as positive.
Recall	Corresponds to the success rate of positive examples correctly classified among all positive examples in the base.
F Measure	It represents the harmonic mean between recall and precision.
Specificity	It is the true negative rate, that is, it is the number of instances of the negative class that were predicted to be negative.
Kappa	It compares the overall accuracy of the classification model with the expected accuracy for the same if the classification is performed at random.
ROC	It consists of a two-dimensional graph, where the y-axis refers to Precision or Recall and the x-axis to specificity.
AUC	Synthesizes the ROC curve into a single value, aggregating all ROC thresholds, calculating the "area under the curve".

It is evident that although some metrics complement each other, others deal with specific results of the classification. The finding made in this investigation about the lack of description or omission of the criteria to use each metric, and how they were used to interpret the results or evaluate the forecast model, is worrisome. Although they use different metrics, when presenting the results of the best forecasting techniques, the result obtained by accuracy and, lacking it, precision is used. Only Helal (2018) considers the best forecast model based on the F-measure metric.

As described in Table 4, the accuracy represents the overall performance of the forecast model. Although it is the most commonly used metric in data mining studies, it must be used and interpreted carefully. Otherwise, it can lead to a mistake in the evaluation of the model, especially in cases of unbalanced classes. A high accuracy rate may be based on the hits of the majority classes, neglecting minority classes. Regarding educational data, the bases are likely to be unbalanced in different ways, depending on the institution, course, discipline, etc. Thus, the need to explore additional metrics is evident.

The Kappa coefficient is a metric whose approach seeks to mitigate this situation, printing a more reliable performance metric, regardless of the base imbalance. With these characteristics, it is widely used to determine the confidence level of forecast models. However, the objectives and context of the problem to be addressed with educational data mining may require more specific metrics, which can support the analyst and obtain more satisfactory results. The Precision, Recall, and Specificity metrics are highlighted here, as they are metrics through which it is possible to separately assess the performance of the specific forecast for each class.

The objective of all 16 works reviewed using educational data mining was to build a predictive model of the results of students in courses or subjects that can be interpreted as positive or negative situations. Positive, for example, in cases of graduation, approval or performance concepts Good, Excellent, A or B. Negative, in cases of evasion, retention, failure, or performance concepts Bad, Terrible, C, D or E. Even the objectives of Pabreja (2017) about the employability or not of graduates fit into predictions of positive cases (in case of the possibility of getting a

¹ For a better understanding of the descriptions in this table, consider: True Positive Rate (TP): the number of instances that are correctly predicted as positive; False Positive Rate (FP): The number of occurrences that are incorrectly predicted to be positive; True Negative Rate (TN): the number of instances that are correctly predicted to be negative; False Negative Rate (FN): The number of instances that are incorrectly predicted to be negative.



job) and negative cases (in case of not getting a job). With this, it is evident that the benefits of predicting these results lie in the possibility of carrying out an early intervention in students at risk of negative results to change their trajectories, transforming possible negative trends into positive results.

In this way, it is preferable that the prediction models have an excellent performance in identifying students at risk (with prediction of dropout, retention, failure, low performance, or unemployment) so that they can be contemplated by some intervention action. Wrongly predicting a student who would be approved as a student at risk of failing will cause him to receive some pedagogical intervention to improve his performance, which will not cause him any harm; at most, this situation can lead to an unnecessary allocation of resources. However, a student who is truly at risk of failing and is classified as a student expected to perform well and pass will not receive any intervention and may continue his tendency to fail.

Results obtained by the classification techniques used

Although it is not part of the research questions of this work, the results achieved by the data mining techniques used were extracted during the examination in full of the studies. A total of 21 different algorithms were identified; however, the predominance of decision tree techniques (used in 15 works), naïve Bayes (used in 14 works), forests and neural networks (both used in 7 works) stands out.

In addition to the predominance in its implementation, these techniques presented the best performances. The decision tree technique presented the best performance in 6 works, followed by Forests, which stood out in 5 works. Naïve Bayes had the best performance in 3 works, and finally, Neural Networks obtained the best results in 2 works. Only in Helal (2018) was the best result presented by a technique outside this group, using rule-based mining, specifically the JRIP algorithm.

CONCLUSIONS

The present study carried out a systematic review of the literature on educational data mining used in predictive approaches, covering only higher education. Within the delimited specifications, the superiority of studies aimed at building a model for predicting academic performance was evidenced. However, other forecasting possibilities were implemented, demonstrating that there is flexibility for the use of EDM if the necessary information is available. In this regard, the feasibility of performing educational data mining is confirmed since institutions already produce some daily information that can be processed and mined. Most studies reported using data from academic systems and teaching platforms.

This study had an initial premise that EDM studies tend to use several algorithms in the same research, comparing the results at the end. This was confirmed, and 21 different algorithms were identified, distributed in studies that implemented 3 to 10 algorithms at the same time. This justifies the objectives of this work and seeks to bring a new contribution, examining the preprocessing procedures performed, understanding that the preprocessing and selection of attributes have as much influence on obtaining good results in EDM as the algorithms used.

After the review is carried out, first, the analyses demonstrate that more requirements must be added to the work of the researcher who employs EDM, and the need to use several formal and statistical methods in the selection of attributes and preprocessing of the data is recommended. However, it should be borne in mind that, in the same way that the use of different algorithms can occur due to the ease offered by the tools that researchers have at their disposal, this could reflect on preprocessing activities. All works reported using support tools, namely, Weka, RapidMinder, Pentaho and libraries of Python and R languages. These same tools have resources available for attribute selection, balancing, normalization, discretization, among other features. All reported preprocessing methods can be performed by the same tools that were used to apply the algorithms.

The examination, carried out to answer the research question relating to metrics, clarified that this topic needs to be discussed in more depth. Several studies reported using 1 to 5 metrics, but it was not appreciated to what extent each of them would be suitable for each scenario. This finding shows that, in the same way that the tools bring many algorithms, they generate many metrics as results, and all of them are brought as "search results". However, the purposes for the use of each metric specifically are absent in the studies.

As future aspirations, the need for studies to compare or validate preprocessing techniques and understand the results that metrics can represent in educational data mining is considered. It is considered that the results of studies in this sense are likely to be generalized or extended, as there is an equivalence of data sources as well as the attributes used by studies on this topic.



Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The Use of Arduino in Physics Laboratories

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ABSTRACT

Arduino is easy to use because it is a simple system. In addition, since Arduino has an open source code system, it is a system that is open to everyone's use, can be developed and can be easily implemented. Anyone who wants to use Arduino can buy and use the necessary parts for their application. It is a platform that can be very useful in the physics lab due to its low price and wide availability of sensors and transducers. In this article, the Arduino platform is briefly introduced, and by installing an RC circuit, the charge-discharge curve of the capacitor has been drawn on the serial plotter. In addition, distance measurement was calculated by using an ultrasonic distance sensor and time measurement between two sensor events was calculated with two infrared obstacle sensors. The measurement results are given in the serial monitor. As a result, several examples of what can be done in laboratories in physics experiments using Arduino and some sensors have been shown.

Keywords: Arduino, physics laboratory, RC charge and discharge, voltage measurement, distance measurement

INTRODUCTION

In education, especially in physics education, new trends in active learning are emerging. These trends are aimed at ensuring student-oriented learning. "Problem-Based Learning", "Project-Based Learning", "Collaborative Learning" and "Inquiry-Based Learning" are the most important strategies used to ensure that learners actively participate in the learning process (Celik, Senocak, Bayrakceken, Tashkesenligil, & Doymus, 2005, p. 1). The teacher can facilitate the learning of physics by using one or more of these strategies according to the attitudes of the students in the classroom towards physics classes, their readiness, and their interest in physics class.

Laboratory activities are important in physics teaching, because by arousing students' interest and by putting emphasis on the learning of physics, they teach individuals to ask questions, identify problems and seek out solutions by working in collaboration with those around them. Laboratory experiences enable students to understand the laws of physics, recognize and understand physics concepts, and improve their scientific skills (Darrah, Humbert, Finstein, Simon, & Hopkins, 2014, p. 1; Sari, Pektas, Celik, & Kirindi, 2019, p. 3). The limited number of tools used in the laboratory does not allow every student to conduct experiments at the same time. In this respect, the physics laboratory can be enriched by designing measurement tools and experimental setups with Arduino (Gungor Babaoglu, Durmaz, & Oztekin, 2020, p. 93; Organtini, 2018, p. 1). In this study, several practical examples are given of how teachers can use the Arduino platform in the physics experiments they will be conducting in the lab.

ARDUINO'S PLATFORM

The Arduino development team consists of Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino and David Mellis. The Arduino platform is an open-source system consisting of electronic cards, expansion cards, sensors and software development environment (Tasdemir, 2015, p. 5; Cobanoglu, 2017, p. 1). Its hardware and software are open source, and its cost is preferred and prevalent by large audiences due to its benefits, such as the redundancy of code samples. In addition, thanks to the Arduino compatible shield and sensor diversity, the application is very user-friendly with many advanced technologies (Wi-Fi, GSM, GPS, etc.) (Cobanoglu, 2017, p. 23).

Arduino has different boards with various features. The simplest and most widely used is Arduino Uno. All boards share the same programming environment and may differ in board size, memory size, number of ports, type, and speed. The use of Arduino UNO board as a physics laboratory tool is an excellent solution (Organtini, 2018, p. 2).

The Arduino UNO board (Figure 1) is a microcontroller board based on the Atmega328 family of microcontrollers. It has a total of 14 digital input output ports and 6 of them are used as Pulse Width Modulation (PWM) outputs.





Figure 1: The Arduino UNO board.

Arduino Uno uses serial communication protocols such as UART, SPI, to communicate with environmental interfaces. ATmega328 UART TTL (5V) provides serial communication with RX and TX (pins 0 and 1). You can understand when the communication takes place from the blinking of the Rx, Tx leds on the Arduino board (Cobanoglu, 2017, p. 34).

ARDUINO PROGRAMMING

It is a platform that uses the C/C++ and Java grammar structure. Due to the programming environment, no indepth object-oriented programming knowledge is required. Unlike computers, microcontrollers do not run an operating system, but only perform the only tasks that have been loaded into their memory (Organtini, 2018, p. 3).

The user can use the Integrated Development Environment or the Arduino Software (IDE), available free on the Arduino website, easily on a computer, to write a computer program. The IDE includes a text editor for writing code, a message box, a text console, a toolbar with buttons for commonly used functions, and a set of menus. Arduino platforms can easily be connected to any computer with Windows, MAC or Linux operation systems thanks to the USB interface, which can quickly be programmed and tested (Cobanoglu, 2017, p. 23). When the IDE is launched, it appears as in Figure 2.



Figure 2: The Arduino IDE window.

Void setup() and void loop(), which are included in the Arduino code display in Figure 2, are the two main functions of the workspace. The void setup() part of the program is the part where the input – output pin modes are set, the task / variable definition taken from the library in the program is defined, and the first values of the defined variables are assigned. After the program is installed on the board, this part runs once, and then transfers the task to the void loop() section. In the void loop() section, the codes that your application wants to run continuously/indefinitely are written.

After the IDE is started, the codes of the work to be implemented are written in the void setup() and void loop() code area, compilation/checking is done, and if there are any errors or mistakes in the subsequent operations, the program reports errors in the error section at the bottom. This will continue until the code software errors are



fixed. After the arrangements are made, the necessary connections are made on the circuit and the program is installed on the board.

Serial Monitor

The Serial Monitor is a tool that we can view data sent via the serial port from the Arduino to the computer. The serial monitor is used to retrieve data from Arduino, view data for debugging, and send data (command) from PC to Arduino.

The PC and Arduino must be connected to each other with a USB cable for the serial monitor to function.



Figure 3: Arduino IDE window. Click the Serial Monitor Icon to open the Serial Monitor.

Items on the serial monitor



Figure 4: Serial Monitor Window.

- 1. Output console: Displays the data received from the Arduino.
- 2. Autoscroll checkbox: The option to choose between auto-scrolling and not scrolling.
- 3. Show timestamp: Option to view the time stamp before displaying the data on the serial monitor
- 4. Clear output: Clears all text in the output console.
- 5. Baud rate selection: The speed of the serial communication between Arduino and PC is selected.
- 6. Textbox: The user can enter the characters they want to send to the Arduino.
- 7. End selection: The ending character added to the data sent to the Arduino is selected.

8. Send button: When this button is clicked, the serial monitor sends the data in the text box and the ending character to the Arduino (Arduino-Serial Monitor, n.d.).

Serial Plotter

The Serial Plotter is a tool that can plot graphs of the data sent over the serial port of Arduino. The Serial Plotter can read temperature, pressure, humidity or any sensor data connected to Arduino analog input and visualize them as waveforms. It can plot graphs of the data it receives from more than one sensor at the same time.

Data communication between the serial plotter and Arduino is done with a USB cable. Therefore, Arduino and PC must be connected to each other with this cable. The baud rate of the Serial Plotter must be selected to be the same as the Arduino code.



x axis: Represents time. The axis has 500 sample points. The time between each point is usually equal to the time it takes to execute the code in the void loop() function section.

y-axis: Represents the values obtained from the sensor output. The y-axis automatically adjusts itself according to the increase or decrease of the value read from the sensor (Arduino-Serial Plotter, n.d.).

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Figure 5: Opening the Serial Plotter.

Line charts

A line chart is used to show the changes in the current data that occur over a certain time period. It is possible to present these emerging data changes in an easier and more understandable form visually with the help of line graphs.

• Drawing a single line graph

Printing a single chart can be done by sending the data and ending it with the character " $r\n$ ". When writing code for it, the Serial.println (variable) function must be used. Serial.println() adds the characters " $r\n$ " automatically after the data (Arduino-Serial Plotter, n.d.).



Figure 6: Drawing a single line graph of the values received from the analog pin A0 in the serial plotter.



• Drawing multiple lines on the graph

When we want to plot multiple variables, we must separate the variables with the character "t" or " ". The last value must be terminated with the character " $r\n$ " (Arduino-Serial Plotter, n.d.).



Figure 7: Plotting a multi-line graph of the values read from analog input pins A0, A1, A2, A3 and A4 on the serial plotter.

Using Analog Ports

Arduino Uno has six analog inputs from A0 to A5. Since each of these analog inputs has a resolution of 10 bits, it converts the input voltage into numbers from 0 to 1023. When the grounds of the circuit to be measured with the Arduino are connected to each other, the analog input pin allows electrical measurement with a resolution of $5/1024 \approx 5$ mV. (Cobanoglu, 2017, p. 216). Voltage values greater than 5V can also be measured using voltage divider resistors.

Using Digital Ports

Each of the 14 digital pins on the Arduino Uno can be used as both an input and an output. Each works with 5V and draws 40mA current. Digital ports can be used for various operations, such as control and measurement. For example, interesting measurements in mechanics (one-dimensional position and time etc) can be made using ultrasonic sensors.

Digital pins can be used to represent data in binary form or for complex measurements using existing sensor modules (Organtini, 2018, p. 6).

ARDUINO SHIELDS AND SENSORS

Shield (Plug-in) cards are plug-ins that are installed on the Arduino board and provide special functions. With these add-ons, the capacity or functionality of the card can be increased. There are many low-cost shields, and their libraries are available. For example, the current capacities of the digital outputs on the Arduino microcontroller board are usually not enough to drive a servo or stepper motor, so a motor driver shield can be added to the Arduino board (Tasdemir, 2015, p. 15; Cobanoglu, 2017, p. 9). Physical values in the outside world can easily be detected using sensors with Arduino. Temperature, current, humidity, voltage, pressure, force, light, sound, acceleration, magnetic field, etc. sensors are available. These sensors allow the performance of many physics experiments. In addition, data collected using Arduino and sensors can be transferred to excel via the Parallax data Acquisition Tool (PLX-DAQ) program and easily graphed (Gungor Babaoglu, Durmaz, & Oztekin, 2020, p. 97).

MEASUREMENT EXAMPLES WITH ARDUINO

The Arduino pins are designed to measure voltages from 0 (zero) to 5V. Many measurements can be made provided that the physical changes obtained from the sensors are converted into voltage. When measuring with sensors, it is necessary to know the operating principles and limits of the sensors in order to prevent incorrect measurements or to keep the measurement errors under control.



Voltage Measurement

To obtain the value of the voltage in Volts, it is necessary to multiply the read value by a conversion factor, which is given as $C = 5/1023 \approx 0.00489$. When writing code, it should be taken into account that the value returned by analogRead() is an integer and a line with int value = analogRead(A5)* 5/1023; (Organtini, 2016, p. 46). This type of measurement can be useful for all converters that provide voltage as their output, or for electrical measurements. Using this technique, for example, the time constant of an RC circuit can easily be measured. An RC circuit is a series of capacitors with capacitance C and a resistor with a resistance of R.



Figure 8: An RC measuring circuit.

The circuit in Figure 8 is connected. First of all, the Arduino's 8th digital pin is set to HIGH. The 470 μ F capacitor is charged via a 10K Ω resistor. When the capacitor is charged, the voltage reaches its final value exponentially, and this is indicated as $Vc(t) = Vo(1 - e^{-\frac{t}{Rc}})$. The RC time constant indicates the fill rate.

Arduino's 8th digital pin is set to LOW and is ensured that the capacitor is discharged through the 10K Ω resistor. As the current flows, the voltage at the capacitor ends decreases. The Q charge is exhausted, and as a result, the circuit is also de-energized. This process creates an exponentially decreasing voltage, and this situation is denoted as $Vc(t) = Vo(1 - e^{-\frac{t}{RC}})$. As the RC time constant indicates the fill rate, here the discharge rate is indicated.

The charge and discharge voltage at the capacitor ends are obtained from the Arduino's analog pin A0 with 71 measurements at intervals of 30ms. Arduino Codes (Organtini, 2018, p. 5; Morresi & Piermarteri, 2020) and charge-discharge curves are shown in Figure 9.



Figure 9: Plotting the charge and discharge curve of a capacitor with Arduino codes.



Distance Measurement

Distance measurement is a basic type of measurement. Converting a distance to a voltage is not such an easy task. But interesting measurements can be made in the field of mechanics with sensors that are easily available on the market, for example, ultrasonic sensors. Distance can be measured using an existing module consisting of two piezoelectric devices (such as the HC-SR04), one consisting of a transmitter and the other a receiver. Most of these devices use sound waves. They use ultrasound, which is a very short wave (or very high frequency) sound, to avoid false measurements and not harm people nearby. Sound waves move in air at a constant speed of about $c \approx 340$ m/s. Ultrasonic sensors consist of a transmitter (speaker) and a receiver (microphone) for ultrasonic waves. The transmitter produces a series of waves that are reflected by any obstacle in front of it (if it is large enough) (Arun Francis, Arulselvan, Elangkumaran, Keerthivarman, & Vijaya Kumar, 2019, p. 207; Gabriel & Kuria, 2020, p. 937).

The time it takes for the reflected sound to reach the receiver,

$$t = 2\frac{d}{c}$$

t is the time taken for the reflected wave sequence to be detected by the receiver.

d, the distance between the receiver and the obstacle.

c, the speed of propagation of sound in the air.

2 the coefficient set for the pulses going from the transmitter to the obstacle and back to the receiver.

The sensor has an electronic circuit which measures the time and generates a pulse whose duration is proportional to the time. You can then trigger the device with the digital pins and read the duration of the measuring pulse with the pulseIn() function. The value read is proportional to t. It can be used to get the distance by reversing the above equation (Organtini, 2018, p. 6; Abdulkhaleq, Hasan, & Salih, 2020, p. 3).

$$d = \frac{c * t}{2}$$

There are two kinds of sensors on the market with three pins and four pins. See the datasheets for these sensors for details on how they work.



Figure 10: Three-and four-pin ultrasonic distance sensor.

You can easily measure distances with the ultrasonic distance sensor HC-SR04. In Figure 11, the pin labeled GND should be connected to the Arduino ground, the pin labeled Vcc should be connected to the Arduino's 5V pin, and the Trig and Echo should be connected to the digital and PWM pins, respectively. Also, the trigger pin should be defined as an output pin and the echo pin should be defined as an input pin.





Figure 11: Connection diagram of HC-SR04 with Arduino.



Figure 12: The result of a measurement performed with the HC-SR04



distance measurement circuit.

<pre>#include <ultrasonic.h> const int TrigPin = 9; const int EchoPin = 8; long Duration; int DistanceCm;</ultrasonic.h></pre>	delayMicroseconds(2); digitalWrite(TrigPin, HIGH); delayMicroseconds(10); digitalWrite(TrigPin, LOW); Duration = pulseIn(EchoPin, HIGH); DistanceCm = Duration * 0.034 / 2;
<pre>void setup() { Serial.begin(9600); pinMode(TrigPin, OUTPUT); pinMode(EchoPin, INPUT); } void loop() { digitalWrite(TrigPin, LOW);</pre>	<pre>Serial.print("Distance: "); Serial.print(DistanceCm); // Write the distance</pre>

Figure 13: Arduino codes of distance measurement with HC-SR04 ultrasonic sensor.

The laws of physics are expressed in terms of elementary quantities with clear definitions. There are three basic quantities used in mechanics. These are length, time and mass. All other physical quantities, for example, velocity, acceleration, force, kinetic energy, etc. are expressed in terms of these basic quantities (Sarı, 2008, p.2). Time is one of the most precisely measurable quantities in physics. This quantity can be easily measured using the digital pins of the Arduino platform. For this, the millis() function of Arduino can be used. This function gives the time elapsed in milliseconds from the moment the current program starts running on the Arduino platform. Therefore, to calculate the time that a transaction takes, millis() can be called before and after the transaction and the difference of the two values can be taken. Sample application codes are given in figure 14.

void setup() {
 // Enter your setup code here to run once:
 Serial.begin(9600);
 long int t1 = millis();
 //task_whose_time_is_to_be_measured();
 delay(1000); // processing time 1000 ms
 long int t2 = millis();
 Serial.print("Time range: "); Serial.print(t2-t1); Serial.println(" milliseconds");
 }
 void loop() {
 // Enter your main code here to run it repeatedly:
 }



As mentioned above, the time between two sensor events can easily be measured. For this purpose, two infrared obstacle detection sensor (Obstacle detection IR sensor) modules can be used. The + pin of the sensors is connected to the 5V pin of the Arduino, the GND pin is connected to the GND pin of the Arduino, the out pin of the first infrared obstacle-detecting sensor module is connected to the 2nd pin of the Arduino and the out pin of the second infrared obstacle detecting sensor module must be connected to the 3rd pin of the Arduino. Also the 2nd pin and the 3rd pin must be defined as the input.



Figure 15: Keyes IR Obstacle Avoidance Sensor Module for Arduino.



This sensor is called Keyes, KeyesIR or Keyestudio KY-032. The sensor uses a four-pin connector with the pins labeled as follows: EN (Enable), Output (Out), + (Power), and GND (Ground). When the sensor detects an obstacle, its OUT output is LOW, and when no obstacle is detected, its output is HIGH. So, there is no need to install sensor related libraries. There are also two small potentiometers (variable resistors) and a jumper on the board. R6 is used to tune the 555 oscillator to exactly 38kHz. On the other hand, R5 limits and reduces the IR LED current when turned counter clockwise. These two settings together affect the sensitivity and range of the device. If you do not have an oscilloscope or frequency counter, it's best to keep the R6 as it's from the manufacturer or mid-range. Turning R5 clockwise will overload the 555 and end the process. Leaving the R5 in a full clockwise direction can lead to overheating and, eventually, to the device breaking down (IR Sensor for Obstacle Avoidance KY-032 (AD-032), n.d.).

Two key KeyesIR sensors are positioned so that there are 20 cm between them. The circuit measuring the time it takes for a toy car to cross a distance of 20 cm is shown in Figure 16.



Figure 16: A circuit measuring the time interval with two IR sensors.

When the toy car comes in front of the 1st sensor, the time (t1) from the moment the program in Arduino starts running is measured as ms. When the toy car passes in front of the second sensor, the time passed is measured as (t2). The time (Δt =t2-t1) of the toy car to travel the distance between the two sensors is determined. This time is on the serial monitor in milliseconds and printed in the format of hours, minutes, seconds, and milliseconds. The codes to be loaded into the Arduino are given in Figure 17.

/* Measuring the time interval */	Serial.println(elapsed);
	Serial.print("Elapsed time: ");
unsigned long t1, t2, elapsed;	Serial.print(h,0);
	Serial.print("h ");
void setup()	Serial.print(m.0);
{	Serial.print("m "):
Serial begin(9600).	Serial print(s.0):
pinMode(2, INPUT); // 1st sensor	Serial.print("s ");
pinMode(3, INPUT); // 2nd sensor	Serial.print(ms,0);
Serial.println("start the task to be	Serial.println("ms");
timed");	Serial.println();
}	}
void displayResult()	void loop()
{	{
float h,m,s,ms;	if (digitalRead(2)==LOW)
unsigned long over;	{
elapsed=t2-t1;	t1=millis();
h=int(elapsed/3600000);//convert	delay(200); // for debounce
milliseconds to	Serial.println("Started");
//hours	}
$a_{1}a_{2}a_{1}a_{2}a_{2}a_{1}a_{2}a_{2}a_{2}a_{2}a_{2}a_{2}a_{2}a_{2$	

Figure 17: Arduino codes of time interval measurement (Boxall, 2013, p. 181).





Figure 18: The result of a time interval measurement performed using two KeyesIR sensor modules.

CONCLUSIONS

In order to facilitate learning, a number of physical technologies are used in the field of educational technologies, such as computer hardware, software, a graphing calculator, sensor interfaces (LabQuest, Go!Link, Vernier Arduino Interface Shield, etc.), digital cameras, interactive whiteboard tools, and LCD projectors. Additionally, there are also technologies such as blogs, collaborative software, e-portfolios and virtual classes which consist of these technologies used together differently. (Wikipedia. (n.d.); Vernier. (n.d.)).

In a study conducted in recent years, it has been noted that the Arduino has been used primarily in physics education but also in areas such as chemistry, engineering, robotics, electronics and education. It has been stated that the Arduino has made application development possible in various fields from education to engineering. Moreover, it was emphasized that it contributes to students' learning of physics topics, concepts and principles by having them apply basic electrical and electronic knowledge, and to their practical realization of meaningful and permanent learning, through conducting experiments (Duman, 2019, p. 494).

Arduino can be used as an alternative for conducting experiments in physics, taking measurements and collecting data. Therefore, the physics laboratory can be enriched by designing measurement tools and experimental devices with Arduino. There are various studies with an introduction of sensors that can be used with Arduino along with the sizes to be measured. (Fisher & Gould, 2012, p. 8; Organtini, 2016, p. 45-46).

Likewise, there are studies related to the reorganization of electrical experiments carried out in physics laboratories with Arduino (Kirikkaya & Basaran, 2017, p. 351). In this context, it has been noted that projects could be developed to determine the electrical, mechanical and magnetic properties of substances (Bouquet, Bobroff, Fuchs-Gallezot, & Maurines, 2017, p. 3; Huang, 2015, p. 26.1205.2).

In relation to the use of Arduino in physics education; temperature dependency of electrical resistance (Sari & Kirindi, 2019, p. 688), investigation of simple harmonic motions within the scope of kinematic measurements (Music, 2017, p. 1; Tong-on, Saphet & Thepnurat, 2017, p. 1), have shown in various studies that magnetic field measurements can be performed (Organtini, 2016, p. 57).

In one of his studies, Nichols contributed to the development of measurement tools that can be used in the laboratory by showing that the data received from Arduino Uno could be transferred to programs such as Excel, LabVIEW, MATLAB (Nichols, 2017, p. 226).

In another study, a free fall experiment was examined by designing an Arduino-based experiment. This study showed that the gravitational acceleration of an object released from a certain height could be calculated using location and time data with the HC-SR04 ultrasonic distance sensor and Arduino (Moya, 2018, p. 1).

In this study, real-time monitoring of the values for physical quantities is provided with the voltage, distance and time interval measurements performed. The variety of sensors (acceleration, temperature, light, sound, magnetic field sensors, etc.) that can be used on the Arduino platform can provide many and interesting experiments in the


fields of Mechanics, Thermodynamics, Electromagnetism and Optics (Bouquet et al., 2017, p. 2; Oprea, 2018, p. 99).

As a result, due to the inexpensiveness of Arduino and its sensors, the variety of sensors to be used in physics experiments, and the ease of accessing various resources on this subject from the internet, it is thought that the use of Arduino in physics course laboratory activities will be beneficial to teachers, students and those who work as amateurs or professionals on this subject. In addition, since it is possible to design many measuring devices that can be used in physics laboratories with Arduino, it can be made easier and more enjoyable to learn physics in depth with these measuring tools.

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Validity and Reliability Studies of the Uskudar Benevolence and Malevolence Scale (USBEMA) in the Digital Age

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ABSTRACT

This study aimed to study the validity and reliability of the Uskudar Benevolence and Malevolency Scale (USBEMA). The sample consists of 1028 people from all over Turkey. The analysis made revealed that the scale consists of two factors. The first factor "Purpose Oriented" explains 35.2% of the variance and the second factor "Process Oriented" 7.9% of the variance. The two-factor structure, consisting of a total of 35 items in total, explained 50,6% of the total variance. In addition, two factors confirmed the USBEMA in the confirmatory factor analysis (Chi-square/degrees of freedom: 4.09; RMSEA: 0.079; NFI: 0.80; NNFI: 0.81; CFI: 0.84; GFI: 0.86; AGFI: 0.83). The internal consistency coefficient (α) of the scale was found to be 0.92. As a result of the study, it was understood that the scale is valid and reliable. Thus, A valid and reliable USBEMA Scale emerged, which was rated as "I do not accept", "I accept", "I accept but I cannot do it, I'll feel regret", and "I believe and implement with a sense of responsibility by planning" and "I always believe and implement with love" that psychometrically measures the benevolence/malevolence attitudes and perceptions of individuals. **Keywords:** Benevolence, Malevolence, Scale Development, Validity, Reliability.

INTRODUCTION

Well-being is a phenomenon that is examined within the scope of behavioral sciences with psychology aimed at prevention, which not only affects the definition of health but also leads to the development of well-being models that combine the basic principles of positive psychology. Benevolence, on the other hand, is considered a scientific category within the scope of the "Science of Goodness", which recommends a holistic, healthy, that is, a positive functioning.

Well-being has been a popular concept in the field of psychological counseling since the 1990s and has been defined as a product of the modern world's efforts to find answers about how to live better and healthier by reviewing one's way of life (Oğuz-Duran, 2006). Benevolence or malevolence is about how people behave in the face of an event, situation, personal relationships, and how behaviors are organized. Thus, benevolence, as a guide to malevolence behaviors, plays a decisive role in organizing people's lives, while well-being forms the basis of positive psychology.

Howard Gardner's theory of Multiple Intelligences has a potential to change all of our conceptions about the abilities of human beings from top to bottom. Gardner's main aim in this theory is to prove that intelligence is not a single construct and human beings possess at least seven distinct intelligences independent from each other. Gardner (1999) in his work of Intelligence Reframed: Multiple Intelligences for the 21st Century emphasizes that one of our aims in the new century will not only bring these different intelligences together and use in harmony but also to question how to bring intelligence and the morality together in order to help different people come together to live in happiness and peace to create a better world.

However, character strengths; It is the whole of the features that can be called positive for the individual that emerge with thoughts, feelings and behaviors. In order to reveal a holistic character structure, the definition of character strengths has emerged. In order to be called character strengths, more than one positive character trait must be found together. Virtue, on the other hand, are positive traits that are considered valuable. These characteristics, which differ from person to person, may also differ from culture to culture (USPP, 2022).

Many character strengths are interconnected. For example, the link between the character strengths of "kindness" and "fairness" is very strong. No matter how much a person is careful not to be "deserved", he will be referred to



as "kind-hearted". In this context, having one of the character strengths indicates that the others can also exist. Character strengths can show itself even before the age of 1 and can be called a feature that is possessed at the age of 3 years. This sentence does not apply to every character strength. For example, character strengths such as "social intelligence" and "persistence" can be acquired near adolescence, while character strengths such as "curiosity" and "loving and being loved" can be acquired at very early ages (USPP, 2022). The virtues mentioned and the character strengths they contain are as follows:

- 1- Wisdom; It is not related to one's intelligence capacity, but to what extent one shares knowledge with others. In this context, the 5 character strengths it contains are related to one's self-renewal and being open to innovation: (1) Originality, (2) Curiosity, (3) Openness to Learning, (4) Open-mindedness, (5) Broad Perspective.
- 2- Courage; Despite possible obstacles, it has the ability to move forward depending on both internal and external forces to reach the targeted end: (6) Integrity, (7) Courage, (8) Dexterity, (9) Enjoyment.
- 3- Humanity; It is the virtue that indicates the value and dignity of a human being, and that makes people approach without prejudice because they are human. It is related to the effective maintenance of human relations: (10) Compassion, (11) Capacity to Love and Be Loved, (12) Social Intelligence.
- 4- Fairness; It is a virtue that emphasizes equality and fairness. While shifting to individual life rather than social life in the changing world, it also includes being ahead without ignoring other people's efforts to exist: (13) Justice, (14) Leadership, (15) Citizenship.
- 5- Temperance; It is the dimension of virtue that shows resistance to the extreme. It involves a self-sacrificing approach to one's self and others: (16) Forgiveness, (17) Humility, (18) Attention, (19) Self-Control.
- 6- Transcendence; It means believing in the transcendent and connecting to the extent necessary. It includes quality of life and having satisfying social lives: (20) Appreciating Beauty, (21) Gratitude, (22) Hope, (23) Humor, (24) Spirituality.

According to Seligman (2007), positive psychology gives people skills that allow them to live their lives in a fulfilling way. In this direction, it focuses on the abilities and capacities of people. With this positive approach, the exploration of some concepts such as happiness, hope, optimism, art, aesthetic sensitivity, altruism, morality, kindness, tolerance, responsibility, perseverance, inspiration, and spirituality has gained momentum, and thus, the science of positive psychology has begun to spread all over the world (Seligman & Csikszentmihalyi, 2000). The World Health Organization (WHO) has developed an optimal definition of health by making the definition of health "not only as a state of absence of disease and disability, but also as a state of complete well-being in physical, mental and social aspects", and this definition was later added to spiritual well-being (Kasapoglu, 2013; Witmer & Sweeney, 1992). After being first described by Dunn (1961), well-being has taken its place in the literature with its models, programs, and scales. Nowadays, positive psychology has started to take its place in education programs in higher education by aiming to increase the abilities and life capacities of people based on their benevolent aspects.

With positive psychology, the life purpose skills of the person are also reconstructed and based on benevolence (Tarhan, 2019). Accordingly, one of the important criteria for reaching a decision is moral reasoning, and there are three levels to it. When a person takes into account his immediate interests, enthusiasm, and comfort, to save the day when making decisions in the face of a situation, he thinks just about the short-term consequences. This is the most primitive level and is rated below the average. In average moral reasoning, abstract values such as social order, sense of duty, and thinking about the future are also taken into account. In highly moral reasoning, on the other hand, equitable thinking comes to the fore, including not succumbing to instincts, altruism, suffering, sensitivity to the feelings of others such as responsibility, justice and not harming anyone (Tarhan, 2015). People who have acquired advanced moral reasoning skills are expected to have a higher level of benevolence orientation.

The need to be able to scientifically examine benevolence and malevolence tendencies, understand the benevolent and malevolent forces of individuals, and advance moral reasoning skills with psychometric measurements and quantitatively in terms of purpose and process has brought about the need for a valid and reliable measurement tool. The development of a valid and reliable measurement tool that can measure the benevolent and malevolent powers of individuals in many ways within the scope of dimensions such as *"honesty, fidelity, accountability, a refuge in a transcendent power, empathy, unrequited love and ability to do good, patience, suffering, virtuousness, just and fair sharing anxiety"* is considered important as it will allow research to be done by filling the gap in the literature (Gardner, 2011)

In this study, it is thought that the scale of goodness and malevolence in the valid and reliable dimensional structure developed within the scope of the science of goodness will meet the need in terms of including current



perspectives in measurement tools and conducting current research. Thus, this study, it is aimed to develop a dimensional scale of benevolence and malevolence that can be used to understand the moral reasoning level and benevolent and malevolent attitudes and perceptions of people in a purpose- and process-oriented manner, which is thought to contribute to the science of goodness.

METHOD

This study is a validity and reliability study designed with the aim to develop a scale of benevolence and malevolence.

Research Group

Uskudar Benevolence and Malevolence Scale (USBEMA) validity and reliability studies were carried out with 1028 participants across Turkey. When the literature is examined, there are various opinions about the sample size that should be reached in the validity and reliability studies to be carried out for the development of a scale (Büyüköztürk, 2011; Preacher & MacCallum, 2002; Tavşancıl, 2002). When these opinions are examined, it is reported that the least study group may vary between 100 and 250 and that the amount of expression in the measurement tool may be at least five times or ten times. the workgroup size in this study is greater than 20 times the number of expressions. Thus, it was decided that it was proper because it was well above the minimum sample number required.

The research group consisted of 765 women (74.4%), and 258 men (25.1%), a total of 1028 participants from different regions of Turkey. They range in age from 15 to 69 years and have an average age of 32. When the participant characteristics were examined, it was figured out that 55.9% of the education level was university, 22.8% were graduate, 8.8% were high school, and 12.1% were high school and below. In addition, when marital status was questioned, it was found that 41% of the participants were married, 53.3% were single, and 4% were separate.

Data Collection Tool

Uskudar Life Meaning and Goals Scale (USLIFE): Uskudar Life Meaning and Goals Scale (USLIFE), developed by Tarhan and Tutgun-Unal (2022), is a valid and reliable scale in the 5-point Likert type consisting of 28 items and 7 dimensions. Accordingly, the scale, which includes seven dimensions named Tangible Meaning Skills, Belief in Death, Skill to Delay of Gratification, Intangible Meaning Skills, Internal Control Skill, Medium- and Long-Term Planning Skill, and Perception of Ego Ideal, is used to determine the level of the skills of the person concerning the life meaning and goals. The explained variance rate by the scale was found to be 52.28%, and the internal consistency coefficient Cronbach Alpha value was .73. Since it is thought to be related to the scale developed in the research, it has been included in the convergent validity stage.

Uskudar Benevolence and Malevolence Scale (USBEMA): Content validity, structure validity, discrimination validity, convergent validity stages, and internal consistency reliability studies were carried out for the validity and reliability studies of the Uskudar Benevolence and Malevolence Scale (USBEMA). Accordingly, in the content validity studies, the item pool of the scale was formed from 37 statements in the first case. The scale was formed as a Likert-type scale graded to 5 and the participation in the statements was determined as "I do not accept", "I accept", "I accept but I can't do it, I'll feel regret", "I believe and implement with a sense of responsibility by planning" and "I always believe and apply with pleasure" in order to determine the degree to which the person agrees with the item in question. Thus, a high score to be obtained from the USBEMA scale shows that the person's behaviors are above the average in terms of benevolence and malevolence in the face of an event or situation, that he uses his benevolent forces, and that he gets peace. A low score shows that the person is dominant in malevolence and that awareness does not occur.

After the statements and contents of the articles were arranged by taking expert opinions, the draft scale was applied to a pilot group consisting of 10 people and it was decided that the draft scale could be applied with 37 items.

In exploratory factor analysis studies, items related to each dimension were examined in terms of item-total analysis and their relation to internal consistency, and statements were excluded from the measurement tool if there was a low correlation or if removing the statement increased internal consistency. However, to determine the structural validity of the dimensions or factors, Explanatory Factor Analysis was investigated with the contribution of the Varimax Rotation Technique.

Bartlett Sphericity test was performed with Kaiser Meyer Olkin (KMO) coefficient to determine the suitability of the data for basic components analysis, or in other words, factor analysis (Kalaycı, 2009; Tavşancıl, 2002). There are several opinions regarding the evaluation of KMO value. The KMO value of 0.90 and more is considered



"excellent", a case between 0.80 and 0.89 is considered "very good", a status between 0.70 and 0.79 is considered "good", a status between 0.60 and 0.69 is considered "medium", a case between 0.50 and 0.59 is considered "weak" and a lower than 0.50 value is considered "unacceptable" (Sharma, 1996). In general, a value above 0.70 is considered "good" in the case of a study group size, while 0.80 and above is considered "excellent" (Can, 2013; Sipahi, Yurtkoru & Cinko, 2008). On the other hand, the Bartlett Sphericity value is expected to be p<0.05 for factorization analysis with the data set.

However, as a result of factor analysis, the appropriateness is decided when the variance rate described by the scale is evaluated between 40%-60% in terms of social sciences (Tavşancıl, 2002). 50% of the research obtained is evaluated as appropriate in social sciences.

Structural validity of the scale looked at the correlation values in the calculations of the relationship between the dimensions or factors themselves and between the scaled sum for the analysis stages. In the evaluation of the correlation results, the relationship value between 0.30 and 0.70 is medium; The value above 0.70 was considered a high relationship (Büyüköztürk, 2002:32).

In validity examinations, the discrimination validity of each expression, scale sum, and subscales was examined for the discrimination validity of the scale. The item discrimination index value (D) reveals the level at which expressions are distinguished concerning the feature to be measured. In other words, it is the potential to distinguish between individuals who are more than suitable for the situation that the measurement tool aims to put forward and people who are suitable to a lesser extent. The value or index used to distinguish expressions may differ between -1 and +1. The negativity of the index values in question can be said to indicate that the expression can distinguish people in the opposite direction in terms of the situation. Thus, it is appropriate to remove such expressions from the measuring instrument (Büyüköztürk et.al. 2011). After scoring the scale, the scores were sorted and the lower and upper groups were divided according to the lower quarter and upper quarter of 27% and the independent group t-test was performed.

In the reliability stages of the scale, internal consistency (Cronbach α) coefficient values were examined by item analysis. The fact that the coefficient of Cronbach's α is above 0.70 shows the reliability of the scale (Sipahi, Yurtkoru & Çinko, 2008). In this study, the internal consistency value of Cronbach α was evaluated by this criterion.

Process

The study was approved by Uskudar University Non-Interventional Research Ethics Committee with the number 61351342/JANUARY2022-61 (January 31, 2022) in terms of ethics. Data acquisition was conducted voluntarily through an online survey between February 10 and 25, 2022. The study group consists of people aged 15 years and older through randomly selected sampling. Uskudar Benevolence and Malevolence Scale were applied to the participants through an online survey. An average of 15 minutes was sufficient for the questionnaire to be filled.

Data Analysis

The data set for USBEMA Scale validity and reliability studies were divided into two explanatory factor analyses (AFA), discrimination calculations, and reliability studies were carried out on 528 people within the scope of structure validity. Confirmatory factor analysis was applied to 500 people. In the Validity of discrimination studies, 27% of the upper group and lower group in the AFA study set were taken and the difference between the two groups was examined by an independent group t-test. The relationship between the total score of the scales used for convergent validity was revealed by the Pearson correlation coefficient calculation. The reliability coefficient of the scales was determined by Cronbach's Alpha value. SPSS 26.0 statistical program was used for all validity and reliability analyzes. In addition, with the AMOS program, modeling was done for the relationship and harmony of the dimensions with each other and the Goodness-of-Fit Indexes (Chi-square/releasing value, RMSEA, NFI, NNFI, CFI, GFI, AGFI) were calculated.

FINDINGS

In this part of the study, evaluations were made for Uskudar Benevolence and Malevolence Scale (USBEMA). Following expert opinions, data were collected with the scale form created with 37 items, and basic components analysis was applied within the scope of structure validity. Thus, at this stage, where it was decided that the data were suitable for factor calculations, the Kaiser-Meyer-Olkin (KMO) result was calculated as 0.959. This test reveals the suitability of the data for factor analysis. Taking into account the literature reviews of the KMO value, it is concluded that it is "excellent". In addition, the Bartlett test applied to the data set is meaningful (X^2 =21701,419, sd:595, p=0,000). It was concluded that the results in question showed a high correlation between the variables and that the data were suitable for factor analysis.



When revealing the number of factors or dimensions, Eigenvalue calculations are used. According to the results of calculations, factors greater than 1 are considered proper for dimension build-up. If these values are below 1, it is evaluated that it does not form a factor. In the first stage of the study, the dimensions obtained above 1 as a result of Eigenvalue were taken into consideration and it was seen that the five-dimensional structure was formed. When the substances were examined, it was seen that the items distributed in values together with the overlapping items did not provide a meaningful coexistence. The explained variance ratios were observed that the two dimensions received Eigenvalue as 12.54 and 5.74 and explained the high degree of variance ratio (33.09%; 15.51%), and after the second dimension, Eigenvalue took values around 1 and explained the variance in the 2% to 3% slices. In this case, when the Eigenvalue value is manually set to 1.5, the 2D structure is obtained. However, since it is seen that 2 items have low values, as a result of the factor analysis repeated by subtracting these items, the variances of the 35-item structure explained by the Eigenvalue results are shown in Table 1.

Table 1. Number of Dimensions and Explained Variance Ratios								
Dimensions	Eigenvalue	Variance	Cumulative Variance					
1 st Dimension	12,331	35,231	35,231					
2 nd Dimension	5,392	15,407	50,638					

According to Table 1, the ratio of variance explained by the first dimension, whose Eigenvalue result is 12,331, is 35,231%; The ratio of variance explained by the other dimension obtained from the Eigenvalue result of 5,392 was found to be 15,407%. The total ratios of variance explained by the structure was obtained at 50.638%. Scree Plot test was also performed as a different technique applied to determine the dimensions. In the line chart, which is the technique in question, the size is determined by the amount of the breakage where the slope begins to become uncertain. The Scree Plot Chart for the dimensions is given in Figure 1.



Figure 1. USBEMA Line Chart

When the line chart in Figure 1 is examined, a break is observed around the second factor. Accordingly, the high acceleration and rapid declines in the chart were effective in determining the number of factors. In the next stage, the rotation of the factors was made with the Varimax Rotation technique to correlate the items and the factors. Accordingly, which items are included under the two factors obtained in the study, and the factor loads of the items are given in Table 2.

The factor load values seen in Table 2 are listed from largest to smallest under each dimension. The charge quantities here are coefficient values that show the relationship between factors and expressions, and they are guiding in determining the dimensional structure. In the study, the lower cutting value was decided as 0.50. Thus, items that exhibit a load value below this value have been removed from the scale. Thus, 2 items were eliminated, and it was seen that the scale of 37 expressions before the factor analysis decreased to 35 expressions.



	Items	Dimen. 1	Dimen. 2
M2 7	What is not to be done to oneself, one should not do to others.	,833	
M2 5	You need to try to be happy with the little things.	,809	
M2 4	Giving things that you don't need to those in need is a virtue, it should be practiced often.	,804	
M2 3	Life is helping the other, being generous is a high value, and it should be done often.	,803	
M3 1	To say first my right and then justice is the error of the age, I pay attention to this, I say justice first.	,801	
M2 8	Having good intentions and good efforts brings both success and happiness.	,798	
M1 4	The truly religious one knows the meaning of death, and what he says and does is compatible with his deeds.	,791	
M1 3	We will be held accountable to the creator who knows and controls everything, we must not forget that.	,763	
M3 0	Imposing one's own opinion, and trying to change everyone, is not the right and proper method.	,757	
M8	The statement: "Whatever the circumstances are, my priority is just my interest" is wrong.	,750	
M1 8	I try very hard to be patient and tolerant.	,750	
M3	What is right should be done, even if it is against our interests.	,734	
M9	The idea that "it is good to be moral, but it is not valid in this era" is a modern misconception.	,715	
M7	The most sacred value should not be money, the position of authority, and fame.	,709	
M1 5	In my weak, helpless, and powerless times, I take refuge in spirituality and practice it.	,709	
M1 1	The idea that "It is a comfort to live without accountability" prepares us for the end of humanity, and hidden evils increase.	,701	
M4	The sense of responsibility and accountability is the most important principle in our lives.	,681	
M1	Being honest and keeping one's word is an indispensable principle in all circumstances.	,676	
M2	Lying is a common trait of bad people, I hate that.	,666	
M3 4	It is necessary to forgive someone who did wrong to you or to accept the event as it is and look forward.	,623	
M5	I have to be accountable to my family, and my relatives.	,545	
M3 6	I want to do gratuitous kindness, but I know it is hard to do it.	,518	
M2 1	Modesty and humility undermine self-confidence, it is what the strong say in this age becomes.		,721
M3 7	I think the view of "Though I did good deeds, the hand you fed bite you!" is very correct.		,677
M2 2	Life is a struggle; being strong is more important than being virtuous.		,667
M2 0	Unrequited love without expectations, compassion, and kindness are nice, but such people are used at this time, you should have priority		,664
M2 6	It is not right to resort to fraudulent means to achieve the goal, but nowadays it is often necessary.		,662

Table 2. Loads of USBEMA Scale Expressions by Dimensions

	Items	Dimen. 1	Dimen. 2
M3 3	It's nice to win by hard-working, but it's not the method of the era.		,628
M2 9	Fair sharing is a beautiful thing, but it is not possible in this era.		,616
M6	The only measure we believe in is our interest, such as this age.		,611
M3 5	Getting revenge is often necessary.		,589
M1 6	Enduring hardships and ordeals for our ideals is not the right thing in this era, comfort comes first.		,582
M1 7	Asceticism is the old understanding; you come once to the world.		,563
M1 2	In this age, we have to be selfish and live in luxury.		,543
M3 2	Man's wealth is not in assets, property, or money, but in the character, he carries, but the character does not put the feed bag on.		,540

When Table 2 is examined, it is observed that the items load values of the first dimension consisting of 22 expressions differ between .833 and .518, and the item load values of the second dimension consisting of 13 expressions differ between .721 and .540. Item 10 and 19, their dimensional loads were below .50, and were removed from the measuring instrument.

After the discovery of the factor load values, the dimensions were named according to the explained variance ratio before the item discrimination studies were started, and the contents of the items were taken into account when naming the dimensions. While building up the 22 items in the first dimension; "honesty, to abide by his word, accountability, a refuge in a transcendent power, empathy, unrequited love and ability to do good" were taken into account. And while building up the second-dimension articles, "patience and suffering, virtuousness, and the concern for fair and equitable sharing" were taken into consideration. Thus, when the items in the measurement tool were examined, it was decided that two main headings were suitable for the dimensions. Accordingly, the first dimension is called "Purpose-Oriented", and the second dimension is called "Process-Oriented."

After the explanatory factor analysis studies carried out within the scope of construct validity, 2 items (Items 10 and 19) have been removed from the scale and the final form of the scale consists of 2 dimensions with 35 expressions formed by lining the items from small to large according to the item number is given in Annex-1. Accordingly, the dimensional structure of the Uskudar Benevolence and Malevolence Scale (USBEMA) was determined and the relationship between the dimensions was examined. The resulting relationships are given in Table 3.

Table 5. The Relationship of Dimensions with USBEMA								
Subscale/Scale	Purpose-Oriented	Process-Oriented						
Purpose-Oriented	1	0,226						
Process-Oriented	0,226	1						
USBEMA	0,943	0,147						

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1.

When Table 3 is examined, the USBEMA sum and the relationship of the items were found to be related at the significance level of 0.001. Thus, it is understood that the relationship of dimensions to the sum varies between low and high (r: 0,147 ve r: 0,943). In the discrimination validity stage of the Uskudar Benevolence and Malevolence Scale (USBEMA), the discrimination of the expressions, dimensions, and the sum of the scale was examined and given in Table 4.

As it can be seen in Table 4, after the scores were sorted from high to low within the scope of discrimination validity, an independent group t-test was performed for the lower and upper quartile sections consisting of 195 people as groups of 27% in the dataset of 528 people. The distinctiveness of the scale expressions at the degree of p<0.01 was determined and it was decided that the expressions measured what was wanted to be measured.



Table 4. The Distinctiveness of Dimensions with USBEMA								
USBEMA and the Dimensions	Group	Ν	X	SS	Sd	t	р	
Purpose-	Upper Group	195	75,5	6,3	200	101 5	000	
Oriented	Lower Group	195	16,0	5,1	388	101,5	,000	
Process-	Upper Group	195	51,8	0,3	200	20.7	000	
Oriented	Lower Group	195	33,5	8,5	300	29,1	,000	
UCDEMA	Upper Group	195	120,6	8,57	200	74.0	000	
USDEMA	Lower Group	195	59,6	7,45	288	74,9	,000	

On the other hand, the 2-factor scale with 35 expressions is rated in the 5-points Likert type. It was revealed that the highest score value that can be obtained from the Uskudar Benevolence and Malevolence Scale is 140, the lowest score value is 0, and the average score indicated by the scaled sum (n=1028) is 84.7 for this study. In the evaluation of the scale, the lowest "0 points" and the highest "4" points can be given to the item. At a later stage, the relationship of USBEMA with the Uskudar Life Meanings and Goals Scale (USLIFE), which is thought to be related to USBEMA's convergent validity, was tested. A positive and significant relationship was obtained as shown below.

Table 5. USBEMA's Convergent Validity					
Scales	USLI				
Scales USBEMA —	r	,72			
	р	,000			



Figure 2. USBEMA's Confirmatory Factor Analysis



Confirmatory factor analysis was also applied in the AMOS program with 500 participants to test whether the scale that emerged after the studies on the construct validity of USBEMA, the relationship of factors with each other, the validity of the distinctiveness of the items and factors, and the validity of the criteria were verified in terms of items and factors. Accordingly, the resulting model is located in Figure 2.

When Figure 2 is examined, it is seen that the structure revealed in the structure validity studies is confirmed by confirmatory factor analysis. Accordingly, the dimensions revealed by explanatory factor analysis were statistically verified and the results are shown in Table 6.

]	Table 6. USBEMA Goodness of Fit Index Values							
Goodness of	Acceptable Goodness of Fit	USBEMA's Goodness of						
Fit Index	Index Values	Fit Index Values						
X ² /sd	<5	2290,662/559=4,098						
RMSEA	<0,08	0,079						
NFI	>0,90	0,80						
NNFI	>0,95	0,81						
CFI	>0,95	0,84						
GFI	>0,90	0,86						
AGFI	>0,85	0,83						

Table 6 shows the goodness of Fit index values of USBEMA. In the confirmatory factor analysis calculations, Chi-square/freedom value; df: 4.09; RMSEA: 0.079; NFI: 0.80; NNFI: 0.81; CFI: 0.84; GFI: 0.86 and AGFI: 0.83. First of all, the "df" goodness of fit and "RMSEA" values were found in the appropriate range, and the close presence of other values showed that the model generally met the acceptable goodness of fit values and that it needed to be retried in different groups.

In addition, within the scope of reliability studies, internal consistency coefficient values of USBEMA and dimensions were calculated α Cronbach. The internal consistency coefficient values of the Cronbach α made by considering the variance of the items are given in Table 7.

Table 7. Internal Consistency Coefficients of USBEMA and Factors									
Factors/USBEMA	Number of Items	Cronbach Alpha Coefficient							
Purpose-Oriented	22	,959							
Process-Oriented	13	,889							
Uskudar Benevolence and Malevolence Scale (USBEMA)	35	,920							

 Table 7. Internal Consistency Coefficients of USBEMA and Factors

As can be seen in Table 7, it is seen that the α value of .920 Cronbach Alpha obtained from the sum of the Uskudar Benevolence and Malevolence Scale reveals a very high level of reliability.

In the calculations made in the factors of the scale, it was seen that the Cronbach α value was the smallest at .889 and the largest at .959. It was concluded that the USBEMA sum and dimensions provide reliability.

CONCLUSION AND DISCUSSION

Uskudar Benevolence and Malevolence Scale (USBEMA) is a psychometric scale developed by researchers to measure people's benevolent and malevolent attitudes and perceptions. Following the validity and reliability studies of USBEMA, it was seen that it consisted of two dimensions with 35 expressions.

USBEMA is a 5-point Likert type scale, graded as "I do not accept", "I accept", "I accept but I cannot do it, I'll feel regret", "I believe and implement with a sense of responsibility by planning" and "I always believe and implement with love", and it turned out that the highest score that can be obtained from the sum of the scale is 140 and the lowest score is 0. Thus, the increase in the score to be obtained from USBEMA means an increase in peace with the preference for distance from malevolent and benevolent behavior. To evaluate the scores to be obtained from USBEMA, the difference between the top and bottom scores that can be obtained from the scale was calculated, and the range coefficients were formed according to the 5-point Likert scale. The total score taken from the scale is evaluated in the range of 0-35 as "Malevolence is dominant, moral blindness has become normal", in the range of 36-70 as "Awareness has been built-up in malevolence but you are below the average", in the range of 71-105 as "You have entered the positive path, behavior reinforcement is needed", and in the



range of 106-140 as "You are using your benevolent powers above the average, you have achieved peace, do not forget that every event is a new test for you".

The fact that the total variance explained by USBEMA is 50% has shown its appropriateness in terms of social sciences. However, the Cronbach α value of the scale was calculated as .92. The consistency of the factors among themselves has taken appropriate values. In the confirmatory factor analysis, the goodness of fit values of the scale with the factors were found to be at an acceptable level. Although a positive conclusion has been reached on the acceptability of the model due to the conformity of the two values (df and RMSEA) that are considered to be the most important of the acceptance goodness of fit values, other acceptance goodness of fit values need to be re-validated with different groups in other studies. As a result of all the studies carried out, it was decided that USBEMA can be considered a valid and reliable scale. Thus, it is thought that the developed scale will contribute to the measurement of people's benevolent and malevolent attitudes and perceptions by eliminating the lack of measurement tools.

The dimensions of the two-dimensional scale structure that emerged to understand the benevolent and malevolent attitudes and perceptions of the people were named "Purpose-Oriented" and "Process-Oriented". Thus, to measure the benevolent and malevolent attitudes and perceptions towards the purpose, *"honesty, keeping one's word, accountability, a refuge in a transcendent power, empathy, unrequited love and ability to do good"* is measured with 22 items on the scale. With the 13 items in this dimension for the benevolent and malevolent tendencies towards the process, *"patience and suffering, virtuousness, concern for fair and just sharing"* are measured.

In the literature, although the increase in satisfaction from life is related to the attachment of people to a certain purpose and believing that they can realize their purpose, it is stated that not every goal of the individual contributes to the satisfaction of his psychological needs and subjective well-being at the same level (Brunstein, 1993; Emmons, 1986; İlhan & Özbay, 2010). However, it was concluded that the purpose- and process-oriented measurement approach discussed in this study would provide a more comprehensive and innovative perspective in determining the tendency to benevolence and malevolence together with moral reasoning skills. It is thought that the USBEMA scale developed in this direction can be used to determine benevolent and malevolent attitudes and perceptions.

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Annex-1: Uskudar Benevolence and Malevolence Scale (USBEMA)

Item No.	Items	I do not accept	I accept	I accept but I cannot do it, I'll feel regret	I believe and implement with a sense of responsibility by planning	I always believe and implement with love
1	Being honest and keeping one's word is an indispensable principle in all circumstances.					
2	Lying is a common trait of bad people, I hate that.					
3	What is right should be done, even if it is against our interests.					
4	A sense of responsibility and accountability is the most important principle in our lives.					
5	I have to be accountable to my family, and my relatives.					
6	The only measure we believe in is our interest, such as this age.					
7	The most sacred value should not be money, the position of authority, and fame.					
8	The statement: "Whatever the circumstances are, my priority is just my interest" is wrong.					
9	The idea that "It is good to be moral, but it is not valid in this era" is a modern misconception					
10	The idea that "It is a comfort to live without accountability" prepares us for the end of humanity, and hidden evils increase.					
11	In this age, we have to be selfish and live in luxury.					
12	We will be held accountable to the creator who knows and controls everything, we must not forget that.					
13	The truly religious one knows the meaning of death, and what he says and does is compatible with his deeds.					
14	In my weak, helpless, and powerless times, I take refuge in spirituality and practice it.					
15	Enduring hardships and ordeals for our ideals is not the right thing in this era, comfort comes first.					
16	Asceticism is the old understanding; you come once to the world.					
17	I try very hard to be patient and tolerant.					
18	Unrequited love without expectations, compassion, and kindness are nice, but such people are used at this time, you should have priority.					
19	Modesty and humility undermine self-confidence, it is what the strong say in this age becomes.					
20	Life is a struggle; being strong is more important than being virtuous					
21	Life is helping the other, being generous is a high value, and it should be done often					
22	Giving things that you don't need to those in need is a virtue, it should be practiced often.					
23	You need to try to be happy with the little things.					



24	It is not right to resort to fraudulent means to achieve the goal, but nowadays it is often necessary.		
25	What is not to be done to oneself, one should not do to others.		
26	Having good intentions and good efforts brings both success and happiness.		
27	Fair sharing is a beautiful thing, but it is not possible in this era.		
28	Imposing one's own opinion, and trying to change everyone, is not the right and proper method.		
29	To say first my right and then justice is the error of the age, I pay attention to this, I say justice first.		
30	Man's wealth is not in assets, property, or money, but in the character, he carries, but the character does not put the feed bag on.		
31	It's nice to win by hard-working, but it's not the method of the era.		
32	It is necessary to forgive someone who did wrong to you or to accept the event as it is and look forward.		
33	Getting revenge is often necessary.		
34	I want to do gratuitous kindness, but I know it is hard to do it.		
35	I think the view of "Though I did good deeds, the hand you fed bite you!" is very correct.		

Uskudar Benevolence and Malevolence Scale (USBEMA) is a psychometric scale that measures people's benevolent and malevolent attitudes and perceptions. USBEMA consists of 35 items and 2 dimensions. First dimension: Is called "**Purpose-Oriented**" (Measures the attitudes and perceptions of honesty, keeping one's word, accountability, a refuge in a transcendent power, empathy, unrequited love, and ability to do good). Items 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 17, 21, 22, 23, 25, 26, 28, 29, 32, 34 in the scale measure the first dimension.

Second dimension: Is called **"Process-Oriented"** (Measures the attitudes and perceptions of patience and suffering, virtuousness, and concern for fair and just sharing). Items 6, 11, 15, 16, 18, 19, 20, 24, 27, 30, 31, 33, 35 in the scale measure the second dimension.

NOTICE: Items 6, 11, 15, 16, 18, 19, 20, 24, 27, 30, 31, 33, 35 must be reverse-encoded.

Evaluation: A score between 0 and 140 can be obtained from the scale.0-35: Malevolence is dominant, and moral blindness has become normal.36-70: Awareness has been built-up in malevolence, but you are below the average.71-105: You have entered the positive path; behavior reinforcement is needed.106-140 : You are using your benevolent powers above the average, you have achieved peace, do not forget that every event is a new test for you.