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Development of Gazi Functional Vision Assessment Instrument

Pinar Safak*
Gazi University, TURKEY

Salih Cakmak
Gazi University, TURKEY

Tamer Karakoc
Gazi University, TURKEY

Pinar Aydin O'Dwyer
Freelance Ophthalmologist, TURKEY

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Abstract: This study aimed to develop a valid and reliable instrument that measures the functional vision of students with low vision. Thus, an assessment tool and performance activities were developed for three vision skill groups (near vision skills, distance vision skills, and visual field) that include functional vision skills. The universe was 1485 students studying in various primary and middle schools (from 2nd to 7th grades) affiliated to the Ministry of National Education, and simple random sampling was used to select 310 students. The data were collected using the Gazi Functional Vision Assessment Instrument developed by the researchers. Many-facet Rasch model and generalizability theory were used for the rater reliability of the measurements obtained from the instrument, while discriminant analysis was used for the validity of the measurements. The analysis showed that the measurements were reliable, and the inferences based on these measurements were valid. Thus, this instrument can be used to identify and assess the functional vision status of students with low vision.

Keywords: *Distance vision, functional vision assessment, low vision, near vision, visual field.*

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Introduction

According to the World Health Organization (WHO), an individual with low vision has a visual acuity of less than 6/18 m but equal to or better than 3/60 m in the best-sighted eye, or visual impairment with a visual field of less than 10 degrees (Aydın O'Dwyer & Akça Bayar, 2019; Jutai et al., 2009; Lim et al., 2014; World Health Organization [WHO], 2007). Although low-sighted individuals are affected by visual impairment, they still have a residual vision that they can use in their daily life. Corn and Lusk (2010) define the individual with low vision as an individual who has difficulty in achieving vision-required skills even with corrective lenses (such as glasses) but can increase his or her success in these skills by using compensatory visual strategies, low vision tools and other vision tools, and environmental adaptations. However, it is also stated that low vision will not become "normal vision" despite all corrections and treatments. Low vision means that the individual has less visual acuity than required to perform the necessary daily activities efficiently (Ganesh et al., 2013). The visual acuity of individuals with low vision can be at different levels. However, it should be known that, for individuals with low vision regardless of their visual acuity, the existing residual vision should be used, and opportunities should be created for the development of functional vision (Jose, 2004).

For using residual vision and developing functional vision, it is necessary to determine how the individual with low vision sees and what he/she needs to see better. Therefore, functional vision assessment should be considered. Corn (1989) defined functional vision as the visual ability to use visual information in planning or executing a skill that can be performed by sighted individuals. Functional vision refers to how well an individual performs while interacting with the visual environment (Bennett et al., 2019). In other words, it is how vision is used in daily activities (Markowitz, 2006; Webster & Roe, 1998). Many researchers insist that there is no standard format for functional vision assessment (Bishop, 2004; Erin & Topor, 2010; Shaw et al., 2009). On the other hand, some indicate that functional vision assessment should include certain skills. Bennett et al. (2019) advocate that functional vision skills include visual acuity, contrast sensitivity, color vision, depth, and motion perception. Erin and Topor (2010) stated that functional vision assessment should include the physical structure of the eyes and reflexive responses, the use of near and distance vision, eye movements, visual field, color vision, light and contrast sensitivity, figure-ground discrimination and depth perception skills. Provided that functional vision assessment includes all these skills, it should include near vision skills, distance vision skills and visual field skills (Demiryürek, 2016, 2017; Erin & Paul, 2010). Near vision skills refer to vision skills used in things that

* **Corresponding author:**
Pinar Safak, Gazi University, Faculty of Education, Special Education Department, Turkey. ✉ apinar@gazi.edu.tr

require seeing from one or two spans. Distance vision skills are vision skills used in works that require seeing a few steps ahead. The visual field, on the other hand, is defined as the entire area that can be seen when the arms are opened and when eyes are fixed straight at a point (Barraga & Erin, 1992; Erin, 2013).

Many individuals are born with low vision, but the effects and consequences of low vision become evident in childhood and later. While some children born with low vision can use their visual abilities effectively, others may not spontaneously learn to use their low vision effectively. Each student with low vision is unique in terms of how their visual impairment affects them in educational settings (Aydın O'Dwyer, 2011; Kaiser & Herzberg, 2017; Lueck et al., 2011). Individuals with low vision who subsequently lose their sight may need to learn to use their existing vision in daily activities to get used to new vision conditions (Corn et al., 2000). This shows that how people live with low vision is more important than whether they are born with this disability. Therefore, the functional vision of students with visual impairment should be assessed and the results should be interpreted for being used in their daily life and educational environment (Barraga, 1964; Lueck, 2004b). Based on the results of functional vision assessment, it is decided which arrangements and interventions are needed to meet the visual needs of students with visual impairment (Kaiser & Herzberg, 2017; Lueck, 2004a). Besides, in the classroom environment, teachers should benefit from the vision of students with low vision and should know how much students' vision competence is and how to encourage them to use it. Considering the developmental, educational, and social problems that children with low vision may encounter throughout their lives, it is necessary to identify these problems at an early age to ensure that they receive the right interventions at appropriate times (Lennon et al., 2007). The fact that children with low vision do not fall behind their sighted peers in their developmental stages also depends on the development of their functional vision (Corn et al., 2000). It is important for educators to assess functional vision or to measure how a child uses vision in daily tasks (D'Andrea & Farrenkopf, 2000).

Functional vision assessment helps to determine how students use their vision in familiar and unfamiliar environments, the effect of vision on learning, and the factors that help visual function (Koenig et al., 2003). Based on the assessment results, it provides suggestions to the student's family, teachers, and other experts about what needs to be done to use the student's vision more effectively (Corn et al., 2000; Koenig et al., 2003). These recommendations include determining the place where the student with low vision will sit in the classroom, lighting the classroom, determining the background color of the desk, the font size of the reading material to be prepared, adaptations to be made on paper (such as highlighting lines), pen color, and nib thickness (Kaiser & Herzberg, 2017; Koenig et al., 2003; Salisbury, 2008). Also, for children who read very closely, a more comfortable physical posture can be achieved by determining the reading distance and placing them on an inclined platform row. Functional vision assessment results also serve to prepare an intervention program for the development of the student's visual skills. This intervention program includes students' learning to use their visual skills such as monitoring, scanning, and focusing on visual stimuli in daily activities (Corn et al., 2000).

Considering the studies on functional vision assessment, Newcomb (2010) examined the reliability of the CVI Range assessment instrument developed by Roman-Lantzy in 2007 to assess the functional vision of children with Cortical Vision Impairment (CVI). Using CVI, she collected data in three different ways: interviews with family members, observation of the child, and a direct assessment of the child (Roman-Lantzy, 2007). During the interview phase, information about the child's background and visual skills was obtained by interviewing the child's family or service providers. During the observation phase, the assessor observed the child in his/her daily routine as well as during interaction with prominent people and noted visual behaviors. In direct assessment phase, the assessor presented a visual stimulus and recorded the child's reaction. A total of 104 children aged between 6-144 months participated in the study. At the end of the research, the CVI Range was found to have both internal consistency and very high test-retest reliability. The GFVAI differs significantly from the CVI Range. The CVI Range is a tool developed to assess individuals with low vision who are affected by cortical visual impairment. The GFVAI, on the other hand, was not for assessing students with cortical visual impairment. Cortical visual impairment is a neurological disorder (Good, 2001). The cortical visual impairment refers to visual impairment caused by damage to the visual cortex of the brain. Visual conditions differ in cortical visual impairment. Because of this differentiation, functional vision assessment also differentiates. The GFVAI was developed to evaluate the functional vision of individuals with visual impairment due to visual impairments other than cortical visual impairment.

Marks (1990) developed the Marks Functional Vision Assessment (MFVA) and administered it to 30 children with multiple disabilities (students with low vision and additional disabilities). This instrument was compared with the Texas Education Agency Functional Vision Assessment-FVE, which is a different functional vision assessment tool, and the validity of the MFVA was examined. It was stated that 20 items of both instruments were same and similar results were obtained in five skill areas. Besides, it was observed that the MFVA was applicable to children with multiple disabilities. The GFVAI differs significantly from the MFVA in that it was not developed for assessing students with multiple disabilities.

Kaiser and Herzberg (2017) conducted an online questionnaire on the tools and procedures used by teachers in their functional vision assessments, who had 314 students with visual impairment. Most participants reported that they evaluated all students from kindergarten to Grade 12. Also, 131 participants reported that they used Roman-Lantzy's interview form. The procedures and tools used by the participants in functional vision assessments varied according to the student assessed.

Functional vision assessment results are also a variable that affects decision-making about how a student with low vision will receive an education. Although the results of the medical diagnosis of visual impairment made by the ophthalmologist give general information about the vision of children with low vision, they do not provide information about the educational needs of the student, the environment and material adaptations to be made according to their needs, and the vision intervention program (Aslan, 2015; Gürsel, 2011; Koenig et al., 2003). There is not always a relationship between the current vision ratio of children with low vision and their visual performance (Kalloniatis & Johnston, 1990; Klein et al., 2000). Therefore, educational assessments should be included in order to determine how children with low vision use their existing vision in daily life (Gürsel, 2011).

A child with low vision who has been diagnosed medically must apply to the Guidance Research Centers (GRCs) to make an educational assessment. Educational assessment determined in GRCs is made with modules prepared according to disability types. Modules are an online system that includes data about students, where support special education areas are determined, and connects GRCs across Turkey (Çitil, 2012). The modules serve to assess the development of the disabled individual, what they can do in academic fields and their needs, and to decide on supportive education according to the results of the assessment. The results of the educational assessment direct the education by preparing Individualized Education Plans (IEPs). However, the modules currently used in the educational assessment in GRCs do not include the functional vision assessment. In other words, there is no evaluation including functional vision assessment, which is used to determine how a student with low vision (who is affected by visual impairment) uses his/her residual vision in daily life. According to the educational assessment and diagnosis principles of the Ministry of National Education [MoNE] (2006), educational assessment should be carried out in an appropriate environment, with measurement tools suitable for the characteristics of the individual (MoNE, 2006). This reveals the legal justification for functional vision assessment.

In the light of this information, it is important for students with low vision to use their remaining vision. An intervention program should be prepared so that they can use their remaining visions more efficiently. The intervention program can be prepared after determining how much the students can see and what they need to see better. Functional vision assessment is an educational assessment tool that includes the assessment of vision skills and serves to determine how students with low vision use their vision in daily life. Also, functional vision assessment is needed to determine what students with low vision can do in their visual skills and to be placed in the most appropriate educational environments. In Turkey, there is no assessment tool that will serve to evaluate functional vision, and tools used in different countries are also not suitable for adaptation in terms of the group characteristics in which they were developed. Therefore, the comprehensive aim of this study is to ensure that students with low vision can be placed in appropriate educational environments and to prepare the necessary intervention programs so that they can use their low vision more effectively in daily life. The IEPs, which are prepared according to the educational evaluations, should also include the arrangements for the visual needs determined by the functional vision assessment of the student with low vision. Considering the legal requirement of using more than one method and technique and appropriate measurement tools in accordance with the disability of the individual, the lack of a measurement tool for functional vision assessment in Turkey underlines the main reason for conducting this study. Thus, this study aimed to develop a measurement tool that would serve to assess the functional vision of students with low vision validly and reliably. For this purpose, the Gazi Functional Vision Assessment Instrument (GFVAI) was developed.

Methodology

Research Design

The research was carried out descriptively, since the aim was to develop a valid and reliable measurement tool (GFVAI) that could determine the functional vision assessment of students with low vision

Sampling Procedure

The universe was 1485 students with a diagnosis of low vision, studying in various primary and middle schools (from 1st to 7th grades) affiliated to the Ministry of National Education, in 2011, in Turkey. After determining the universe, the sample size to represent the universe was calculated by using the Equation 1 proposed by Büyüköztürk et al. (2012).

$$n = \frac{n_o}{1 + \frac{n_o}{N}}$$

Here, n_o corresponds to a value of approximately 348 (Büyüköztürk et al., 2012). Thus, it was concluded that the sample size representing 1485 students in the universe was at least 305. In this context, the research was carried out with 310 students. Simple random sampling was used to recruit participants. The entire universe was entered into SPSS, and then 310 students were selected randomly. The sample consisted of 120 (38.71%) female students and 190 (61.29%) male students from 47 different provinces. In addition, 141 of these students were studying at schools for the visually impaired, and 169 of them were studying in inclusive classes with their normally developing peers. Since the instrument requires the participants to be literate, students with low vision studying at the first grades were not included in the study. Therefore, students with low vision studying from the 2nd to the 7th grades (including 7th grade) were included in the study.

Permissions were obtained from the Ministry of National Education to carry out the evaluation studies and to video-record these evaluations. Then, before visiting each school, the schools were informed by a phone call, and a copy of the permission letter was sent to them via e-mail. Finally, written permissions were obtained from the students to be studied through the school administration.

Data Collection Tools

Development and Scoring of the GFVAI

During the development of the GFVAI, first, the relevant literature and current functional vision assessment tools were examined. Then, expert opinions were received from academics who are two experts in the field of education of the visually impaired and two ophthalmologists regarding the draft form created for the GFVAI. For the preliminary application, the GFVAI was applied to 30 students at Mitat Enç School for the Visually Impaired in Ankara. After the preliminary application, the GFVAI was finalized.

Table 1 presents the information on the structure of the GFVAI, which was developed to assess the functional vision levels of students with low vision.

Table 1. The structure of the GFVAI

A. NEAR VISION SKILLS	**B. DISTANCE VISION SKILLS**
A1. Focusing	B1. Distance visual field
A2. Maintaining focusing	B1.1. Central distance vision field
A2.1. Maintaining focusing on a single object	B1.2. Right visual field
A2.2. Maintaining focusing on two objects	B1.3. Left visual field
A3. Monitoring-scanning	B2. Distance reading and viewing
A4. Color vision	B3. Object-Person recognition
A5. Light sensitivity	B4. Avoiding Objects/Obstacles
A6. Image Recognition	B5. Avoiding people coming from the opposite direction
A7. Near visual field	B6. Going up and down stairs
A8. Writing tools	

Through the GFVAI, firstly, near vision skills and then distance vision skills are assessed. Table 2 displays a sample scoring of the ability to maintain focusing on a single object, one of the near vision skills.

Table 2. Scoring the Ability to Maintain Focusing on a Single Object

Ability to Maintain Focus on a Single Object	**Distance**		
	20cm	**40cm**	**60cm**
From left to right, the object is moved 4 times at 15 cm intervals.	2 p	4 p	8 p
From top to bottom, the position of the object is changed 4 times at 15 cm intervals.	2 p	4 p	8 p
From the top right to the bottom left, the position of the object is changed 4 times at 15 cm intervals.	2 p	4 p	8 p
From the top left to the bottom right, the position of the object is changed 4 times at 15 cm intervals.	2 p	4 p	8 p

As is seen in Table 2, a student focused on a figure 60 cm away, and then the figure was moved and fixed 4 times at 15 cm intervals. If the student with low vision continued to focus on the figure, he/she got eight points. However, if the student failed to maintain focusing from 60 cm, the process was repeated by bringing the figure closer to 40 cm. If the student made correct visual responses, the score was four. The closer the distance was, the less the score was. Based on the reactions the student with low vision gave in the ability to maintain focusing on a single object, if the score was between 0-13, the ability to focus on a single object was considered weak; if the score was between 14-24, it was considered medium; if the score was between 25-32, it was interpreted as a good level.

Development and Scoring of the GFVAI Performance Activities (PAs)

It is known that the best practices in interventions that increase the use of vision more effectively in daily life are those that are integrated into the student's daily routines or functional activities (Lueck, 2004b). It is important that the functional vision assessment be made by considering what the student's daily activities or routines might be, and that the results of the functional vision assessment reflect how the student will function visually. Thus, while preparing the functional vision assessment tool, the process should include evaluating the individual's visual ability, defining what functional skills are, defining situations that require vision in each functional skill, and determining how the individual performs visual functions in situations that require vision to complete a particular skill.

Figure 1. Development Process of the GFVAI Performance Activities.

The GFVAI was developed to assess the functional vision of children with low vision (aged between 7 and 14 years) (Figure 1). First, the compatibility of the measurement results with the functional use of residual vision in daily life by children with low vision should be determined. Thus, it will be possible to mention that the GFVAI performs a functional vision assessment compatible with daily life. For this purpose, the GFVAI Performance Activities (PA), which is a second measurement tool, was developed. PAs include performance indicators of skills included in the GFVAI. PAs have a total of 93 activities related to near and distance vision skills, prepared based on expert opinions. These activities are compatible with the GFVAI tasks and were selected among the skills used by 7-14 age group in daily life. PAs were applied to 30 students who participated in the pre-trial application of the GFVAI, and then activity instructions that the students did not understand or had difficulty in understanding were arranged. PAs was scored on a five-point scale and compared with the scores of the GFVAI to examine the relationship between the two measurement results.

Each PA follows five different stages, from easy to difficult. For example, Activities Related to Focusing Skills, one of the Near Vision skills, include "seeing the light projected on the wall, finding and pressing the light switch, labeling the required picture/figure in the magazine, labeling the required picture in the newspaper, labeling the product in the market bulletins, recognizing banknotes, and recognizing coins".

Table 3. Scoring the Performance Activity of Seeing the Light Projected on the Wall

1	**2**	**3**	**4**	**5**
is not able to see the light on the wall	expresses that there is light on the wall by approaching and searching for the light.	expresses that there is light by approaching the light on the wall.	indicates that there is light on the wall by noticing the light within 3-5 seconds.	looks at the wall and expresses that there is light.

All other activities included in the focusing were similarly ranked from easy to difficult and scored accordingly. For each sub-factor in near and distance vision skills, the cut-off scores were determined by obtaining the opinions of six experts (two experts of measurement and evaluation, two instructors from the visually impaired department, and two ophthalmologists). Considering all activities in the focusing, a total of 28-35 points referred to the good vision category, 21-27 points represented the medium vision category, and 1-20 points were considered as the weak vision category. A concordance was established between the good, medium and weak vision categories based on the scores obtained from the "focusing" stage of PAs and the good, medium and weak vision categories based on the scores obtained from the "focusing" stage of the GFVAI. The same process was followed for the Activities Related to Focusing Skills, one of the other Near Vision skills. For example, looking at the light projected on the wall was the easiest focusing. Recognizing coins, on the other hand, was the most difficult focusing activity. Thus, attention was paid to include easy or difficult functional vision skills that can be used in daily life and require focus.

Training of GFVAI Practitioners

Practitioners were trained to be able to use GFVAI in 52 provinces (and their districts, towns, villages, etc.). They were seven experts who were doing postgraduate education in the field of education for the visually impaired. A total of 30 hours of GFVAI application training was given to them. The trainings were given by faculty members who were experts in the education of the visually impaired, an ophthalmologist, and a faculty member who was expert in the field of measurement and evaluation.

The GFVAI training was carried out in two stages: theoretical information and application. The theoretical information phase includes issues such as the structure of the eye, how vision occurs? Individuals affected by visual impairment, what is functional vision? Evaluation of functional vision skills and using its results, and assessment-evaluation. During the application phase, the practitioners were given training on the GFVAI and PAs applications. GFVAI and PAs were introduced, and then they were informed about how to make GFVAI and PAs assessments. Practitioners first made GFVAI and PAs assessments under the control of the researchers, and then each expert did it independently with a student with low vision. Researchers provided necessary feedback to them. After the practitioners gained proficiency regarding the GFVAI and PAs applications, they went to their study areas to practice on the sample group

Application Environment of the GFVAI

The GFVAI applications were carried out one-on-one with the students with low vision in the places suggested by the school administration in the schools. For a healthy assessment of distance vision skills, attention was paid to ensure that the size of the assessment environment was at least 12 m^2. It was applied by paying attention to the fact that at least half an hour elapsed between the PAs application and the GFVAI application, and that the student was rested. PAs application was carried out in different natural environments such as school corridors and stairs, as a requirement of the activity, in the environments suggested by the school administration. All applications were video recorded by the practitioners to observe the eye movements of the students with low vision and the materials used. Then, the videos were watched, and thus student's scores of the main and sub-sections of the GFVAI and the PAs results were recorded on the registration forms.

GFVAI Application Reliability

GFVAI practitioners recorded the videos of each GFVAI and PAs application. An Application Reliability Form was created, in which the things that the practitioners should do at each assessment stage and the situations that they should consider at these stages were listed in order. Random samples were selected from the videos brought by the practitioners. Researchers watched these videos and evaluated the practitioners' work. All of the first field applications were included in this evaluation, but in the following applications, 30% of them were randomly selected and evaluated for each practitioner. An average of 80.4% application reliability was calculated, with a minimum of 75% for each practitioner. No application-based problem was encountered during the process.

Inter-Rater Reliability

To provide evidence for the reliability of the measurements obtained from the performance indicators of the GFVAI, Many-facet Rasch model and generalizability theory, which are frequently used in the performance evaluation process, were used.

Many-facet Rasch model can place many sources of variability (such as rater, item, task, person, time) on a single equally spaced scale (Linacre, 1993). The many-facet Rasch model examines group-level rater effects (main effects) and rater-effect interactions like an ANOVA-based approach. Interpretation of main effects becomes difficult as interaction effects are confused with possible main effects in many ANOVA applications. However, this is not the case in the many-facet Rasch model (Myford & Wolfe, 2003). The many-facet Rasch model provides researchers with information that cannot be obtained via models based on classical test theory and generalizability theory (Lunz et al., 1990). For inter-rater reliability, Linacre (2017) proposes a version of the kappa index designed according to the Rasch model. Kappa index designed according to the Rasch model is as follows:

$$Rasch - Kappa = \frac{(\text{observed percent agreement} - \text{expected agreement percent})}{(100 - \text{expected percent agreement})}$$

In the Rasch model, this index should be .000. The Rasch-kappa value is calculated both at the group level and at the individual level. Rasch-kappa values greater than zero indicate a high level of inter-rater agreement, while values less than zero indicate a low level of inter-rater agreement. The many-facet Rasch analysis was performed using the Facets (version 3.80) package program. The inter-rater reliability evidence obtained in the many-facet Rasch analysis was supported by the results obtained with the generalizability theory.

Videos of the GFVAI applications were watched separately by three experts in the research group. The GFVAI scores were obtained by evaluating 110 randomly selected students among the sample group of 310 students. First, the Many-facet Rasch analyzes were applied, then generalizability analyzes were applied to the obtained scores. As a result of the Many-facet Rasch analyzes, the Rasch-Kappa reliability coefficient was calculated for each performance indicator representing the GFVAI skills, and the results were given in Table 4.

Table 4. Rasch-Kappa Values of the GFVAI Performance Indicators.

GFVAI Skills	GFVAI Performance Activities	1.rater Rasch-Kappa	2.rater Rasch-Kappa	3. rater Rasch-Kappa	overall mean	*p*-value for chi-square test
Near Visual Skills	Focusing	0.650	0.727	0.708	0.694	0.78
	Focusing on a single object	0.752	0.751	0.749	0.751	0.59
	Focusing on two objects	0.729	0.736	0.737	0.734	0.86
	Monitoring	0.698	0.703	0.703	0.703	0.93
	Color Vision	0.596	0.586	0.612	0.597	0.65
	Light sensitivity	0.729	0.751	0.746	0.741	0.91
	Image recognition	0.710	0.719	0.740	0.725	0.94
	Near Visual Field	0.777	0.771	0.772	0.768	0.79
	Literacy	0.857	0.869	0.869	0.865	0.97
Distance Vision Skills	Distance Visual Field	0.719	0.717	0.673	0.703	0.82
	Distance Reading and Viewing	0.729	0.731	0.722	0.726	0.92
All Items		0.800	0.796	0.790	0.794	0.74

Table 4 displayed that the Rasch-Kappa values calculated for the performance indicators of the GFVAI skills were greater than .000. Besides, the p-value of the chi-square test was found to be statistically insignificant. In other words, the inter-rater reliability was acceptable. To verify the inter-rater reliability obtained from the many-facet Rasch analysis, the reliability coefficients based on the generalizability theory were calculated with a fully crossed pattern overall performance indicators. The analyzes showed that the G coefficient was .99 and the Phi coefficient was .98. Besides, the G and Phi coefficients calculated for each rater were found to vary between .98 and .99. Considering the amount of variance involved in the measurements, the variance (arising from the main rater effect, the rater-student interaction, and the rater-performance interaction) was 0.00%. In other words, since the scores made by the raters were very similar to each other, no variance was involved in the measurements.

Data Analysis

To analyze the data, confirmatory factor analysis (CFA) was run to determine whether the GFVAI, which consists of two dimensions (near vision and distance vision) and 48 items in 14 sub-dimensions, was empirically confirmed by the data obtained from the students. CFA examines the extent to which the factor structure of a measurement tool, which is determined based on theoretical and/or empirical evidence, agrees with the data. In other words, CFA focuses on investigating the extent to which a predetermined or constructed structure is verified with the collected data (Sümer, 2000).

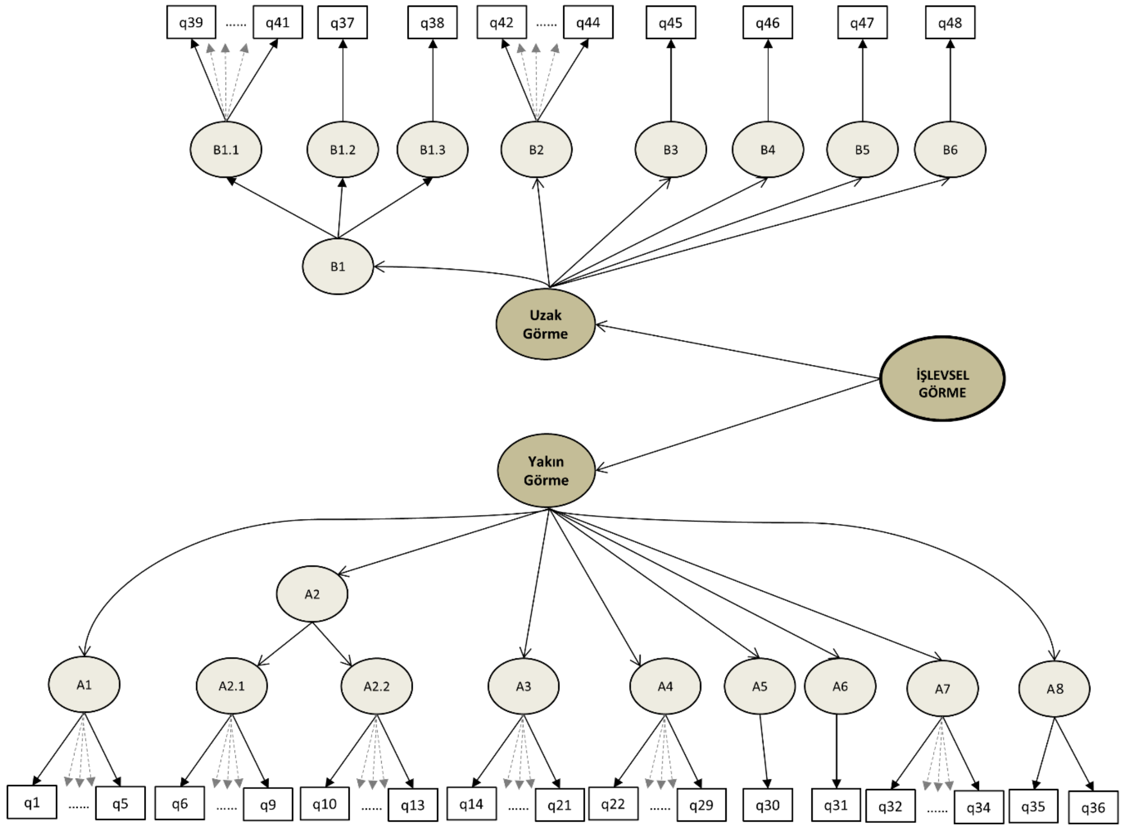
After CFA, students were classified into three categories as “weak-medium-good” in line with their GFVAI scores. Then, by taking students’ performance indicators in PAs as a criterion (defined as the independent variable), discriminant analysis was calculated to determine how accurately the students were classified according to their GFVAI scores. The GFVAI scores of near vision and distance vision were analyzed separately. Also, discriminant analysis was run for all GFVAI scores of students, and the results were interpreted in tables.

Data analysis process included R Studio (lavaan package), Mplus (version 7) (Muthén & Muthén, 2013), Facets (version 3.80), EduG (version 6.1), and SPSS 16.0 programs. Generalizability, Rasch, and discriminant analyses were done via eduG, Facets, and SPSS programs respectively. Generalizability and Rasch analysis were performed to provide evidence for the rater reliability of the measurements obtained from the developed measurement tool, whereas discriminant analysis was performed to gather evidence for the validity (construct validity) of the measurements.

Findings / Results

Findings Related to Testing the GFVAI Model-Data Fit

To assess the functional vision of individuals with low vision who were affected by visual impairment, first, two main factors (latent variable) were determined: near vision and distance vision. Then, a total of 48 items were prepared: The near vision factor consisted of 36 items representing eight sub-factors, and distance vision factor had 12 items representing six sub-factors. CFA was used to identify the extent to which the model, which was created to determine students’ functional vision levels, was confirmed by the results obtained from the students. The path diagram was shown in Figure 2.



Note: İşlevsel Görme: Functional Vision; Uzak Görme: Distance Vision; Yakın Görme: Near Vision.

Figure 2. Confirmatory Factor Analysis Calculated for GFVAI *Items (Theoretical Structure)*

Table 5 presents model-data fit values for the model shown in Figure 2.

Table 5. Analysis results of model-data fit of the GFVAI (Browne & Cudeck, 1992)

Model-Data Fit Criteria	**GFVAI**	**Reference Ranges**
AIC Value	41 002.022	--
BIC Value	41 457.884	--
Adjusted BIC value	41 070.946	--
RMSEA (%90 GA)	0.060 (0.057-0.064)	0.05≤RMSEA≤0.10
Significance value (p) for RMSEA	0.000	--
CFI	0.929	0.90 ≤CFI< 0.95
TLI (NNFI)	0.924	0.90 ≤TLI< 0.95
SRMR	0.072	0.05≤ SRMR ≤0.10

Table 5 showed that the RMSEA value was .06, and the CFI and TLI values were approximately .93. These indices displayed that the model-data fit was at an acceptable level (Brown, 2006; Jöreskog & Sörbom, 1993). According to these results, the theoretical model was validated in practice. In other words, evidence for construct validity was obtained.

Findings Related to Discriminant Analysis

To determine the accuracy of the diagnoses based on the GFVAI discriminant analysis was applied on the data collected by taking the performance indicators defined based on works and procedures related to vision as criteria (independent variables). The dependent variable (criterion variable) consisted of vision levels, while the independent variable was the scores obtained from performance activities. Accordingly, first, the scores obtained from the near vision and distance vision levels were calculated, and then the scores for each dimension at the near and far vision level were calculated separately.

In the analyzes, the group statistics table for each situation and whether the independent variables had a significant variability in the classification decisions were examined. The following statistics were used: the eigenvalues table and the rate of variance explained in the dependent variable, the table of Wilks' Lambda statistics and standardized canonical function coefficients related to the discriminant function, the table of equality of group means and whether group means are similar or there is a difference between groups, the contribution of the independent variable to be used in the prediction of the dependent variable in the table related to the coefficients. Besides, it is aimed to determine the correct classification percentage with the classification statistics table.

Discriminant analysis results related to near vision levels of students

First, descriptive statistics regarding near vision levels of students were calculated and the results were shown in Table 6.

Table 6. Group Statistics of Near Vision Dimension

	Vision Level	N	$\bar{X}$	SD
GFVAI	0 No	0	0	0
	1 Weak	13	67.92	28.92
	2 Medium	47	157.61	50.46
	3 Good	250	248.12	18.70
PA	0 No	0	0	0
	1 Weak	13	126.76	24.95
	2 Medium	47	217.63	54.35
	3 Good	250	285.01	58.59

As is seen in Table 6, considering the near vision dimension, the averages of students with good vision were higher than students with weak or no vision for both GFVAI and Performance Activities.

Table 7. Eigenvalues of Near Vision Dimension

Function	Eigenvalue	Variance	Canonical Correlation
1	3.37	%100	.878

Table 7 presented that the eigenvalue of the function for the GFVAI and Performance values was 3.37. The canonical correlation was found as .878. This value can be interpreted as the function was highly effective in discriminating groups.

Table 8. Wilks' Lambda Statistics for Near Vision Dimension

Function	Wilks' Lambda	Chi-square	df	p
1	0.228	452.69	4	.000

Wilks' Lambda value of the model showed that the discriminant function was significant [$\varkappa^2$=452.69; p<.05]. In other words, the discrimination power of the function was significantly high, or the groups could be discriminated by a discriminant function.

Table 9. Wilks' Lambda Group Means Equality Test for Near Vision Dimension

	Wilks' Lambda	F	df1	df2	p
GFVAI	0.243	478.15	2	307	.000
PA	0.389	240.92	2	307	.000

According to Table 9, all the differences between the groups were significant (p < .05).

Table 10. Standardized and Structure Matrix Coefficient Values for Near Vision Dimension

Scores	Standardized Coefficient	Structural Matrix Coefficient
GFVAI	0.819	0.96
PA	0.313	0.69

Table 10 showed that the most effective variable in discriminating the groups was the GFVAI (.819). When the structural matrix coefficients were examined, it was seen that the variable with the highest correlation with the discriminant function was the GFVAI (.96).

Table 11. Classification Results of Near Vision Dimension

	Vision Level	No	Weak	Medium	Good	Total
N	0 No	0	0	0	0	0
	1 Weak	0	12	1	0	13
	2 Medium	0	6	27	14	47
	3 Good	0	0	8	242	250
%	0 No	0	0	0	0	0
	1 Weak	0	92.3	7.7	0	100
	2 Medium	0	12.8	57.4	29.8	100
	3 Good	0	0	3.2	96.8	100
Total Correct Classification Percentage		%	90.6			

When the classification results presented in Table 11 were examined, 242 of 250 students with good vision (3) were classified correctly; 12 out of 13 students with weak vision (1) were classified correctly. The total percentage of correct classification for the near vision dimension of the discriminant function is 90.6%.

Discriminant analysis results related to distance vision levels of students

First, descriptive statistics were calculated, and then the results were interpreted in the Table.

Table 12. Group Statistics for Distance Vision Dimension

	Vision Level	N	$\bar{X}$	SD
GFVAI	0 No	109	13.78	6.30
	1 Weak	82	35.78	9.46
	2 Medium	57	60.18	14.70
	3 Good	62	96.72	11.58
PA	0 No	109	56.64	14.18
	1 Weak	82	79.72	13.36
	2 Medium	57	91.08	15.37
	3 Good	62	103.38	9.76

The averages of the students with good vision for the distance vision dimension are higher than the students with low or no vision for both the GFVAI and Performance.

Table 13. Eigenvalues of the Distance Vision Dimension

Function	Eigenvalue	Variance	Correlation
1	9.29	%98.1	.950

As is seen in Table 13, the eigenvalue of the function produced for GFVAI and Performance values was 9.29. The canonical correlation was determined as .950. This value can be interpreted as the function was highly effective in discriminating groups.

Table 14. Wilks' Lambda Statistics for Distance Vision Dimension

Function	Wilks' Lambda	Chi-square	df	p
1	0.82	764.98	6	.000

Wilks' Lambda value showed that the discriminant function was significant [x^2 = 764.98; p<.05]. In other words, the discrimination power of the function was significantly high, or the groups could be discriminated by a discriminant function.

Table 15. Wilks' Lambda Group Means Equality Test for Distance Vision Dimension

Function	Wilks' Lambda	F	df1	df2	p
GFVAI	0.98	934.88	3	306	.000
PA	0.357	183.89	3	306	.000

Regarding Table 15, all the differences between the groups were significant (p<.05).

Table 16. Standardized and Structure Matrix Coefficient Values for Distance Vision Dimension

Scores	Standardized Coefficient	Structural Matrix Coefficient
GFVAI	1.066	0.993
PA	-0.138	0.422

Table 16 showed that the most effective variable in discriminating the groups was the GFVAI (1.066). Since the performance variable had a negative value, it had a negative effect on discriminating the groups. Besides, when the structural matrix coefficients were examined, it was seen that the variable with the highest correlation with the discriminant function was the GFVAI (.93).

Table 17. Classification Results of Distance Vision Dimension

	Vision Level	0 No	1 Weak	2 Medium	3 Good	Total
N	0 No	100	9	0	0	109
	1 Weak	9	65	8	0	82
	2 Medium	0	14	38	5	57
	3 Good	0	0	5	57	62
%	0 No	91.7	8.3	0	0	100
	1 Weak	11	79.3	9.8	0	100
	2 Medium	0	24.6	66.7	8.8	100
	3 Good	0	0	8.1	91.9	100
Total Correct Classification Percentage		83.90%				

When the classification results presented in Table 17 were examined, 57 of 62 students with good vision (3) were classified correctly; 100 out of 109 students with no vision (0) were classified correctly. The total percentage of correct classification for the distance vision dimension of the discriminant function is 83.9%.

Discriminant analysis results related to the sub-dimensions of students' near vision and distance vision levels

Discriminant analyzes were also calculated for the sub-dimensions included in both near vision and distance vision levels of the students participating in the study. The total correct classification percentages were given in Table 18.

Table 18. Total Correct Classification Percentages of Sub-Dimensions

Variables	Sub-dimension	Percentages of total correct classification
Near vision	Focusing	99.4%
	Focus on object	97.7%
	Monitoring	94.5%
	Color vision	90.6%
	Light sensitivity	99.0%
	Contrast sensitivity	72.0%
Distance vision	Near visual field	97.4%
	Writing tools	90.6%
	Distance visual field	87.4%
	Distance reading and viewing	82.5%

As is seen in Table 18, the correct classification percentages of all sub-dimensions were high in categorizing the students in terms of the level of near vision as "no, weak, medium, good". The dimensions with the highest classification accuracy were found to be focusing and light sensitivity, while the lowest dimension was found to be contrast sensitivity. Similarly, the correct classification percentages of the sub-dimensions of students' distance vision levels were high. The most accurate classification was made by the near visual field, and the dimension with the lowest percentage of accurate classification was distance reading and viewing.

Discussion

This study aimed to develop a valid and reliable assessment tool for the functional vision assessment of students with low vision. Thus, the GFVAI was developed, which consists of two dimensions (near vision and distance vision) and 48 items in 14 sub-dimensions. Functional vision is how well an individual can perform visually while interacting with the visual environment, that is, how he can use his vision during daily activities (Bennett et al., 2019; Markowitz, 2006; Webster & Roe, 1998). The GFVAI should also measure how individuals with low vision can use their low vision during daily activities. Therefore, PA, a second measurement tool, was developed. PAs include skills related to how students with low vision use their vision during daily activities. According to the results of the research, it is possible to use the measurements of the GFVAI to determine how students with low vision use their functional vision in daily life and what kind of visual performance they exhibit. Based on the results of the functional assessment made with the GFVAI, it will be possible to determine the visual needs of a student with low vision and to decide on the necessary interventions and arrangements accordingly. A vision intervention program can be prepared according to the results of the measurement made with the GFVAI. Thus, the development of functional vision skills will be supported by determining the level of functional vision of students with low vision in the earliest possible period (Corn, et al., 2000). By supporting functional vision skills, it will be possible to increase the functional use of students' vision in daily life, and it will be possible to support them not to fall behind their peers in developmental stages. Based on the results of the functional vision assessment made with the GFVAI, it will be possible to advise the teachers and families regarding the arrangements for the adaptation of the learning environment and materials suitable for the students with low vision. Preparation of materials suitable for the students with low vision, making environmental arrangements and developing vision intervention programs will also increase the quality of the education provided to them.

Therefore, the educational assessment included in the preparation process of IEPs for students with low vision should also involve functional vision assessment. According to the current practice in Turkey, students with low vision are assessed in GRCs via modules of "Support Education Program for Individuals with Visual Impairments". Among these modules, only the "preparation for learning" module includes two skills: "heading towards the light" and "following the light". However, functional vision assessment is necessary for students who are affected by visual impairment to be placed in educational environments appropriately and to develop appropriate educational programs. Based on this requirement, it would be appropriate for the personnel working in the GRCs, who are involved in the educational assessment of students with low vision, to make functional vision assessment using the GFVAI, and to make a placement proposal according to the results of the educational assessment in all areas together with the functional vision assessment made via the GFVAI. Besides, it will be possible to make educational suggestions to the families and teachers regarding the adaptation of the environment and material.

Considering the Turkish context, no study has developed a functional vision assessment measurement tool. The international literature provides a CVI Range measurement tool as a functional vision assessment instrument. CVI Range differs from the GFVAI in that it is a tool developed to assess individuals with low vision affected by cortical visual impairment. In low vision due to cortical visual impairment, visual conditions differ significantly from those in ocular visual impairments (Good, 2001; Newcomb, 2010). Cortical visual impairment is a neurological disorder defined as bilateral loss of central vision (loss of visual acuity) due to damage to the central nervous system (Good, 2001). It is a brain-based processing disorder and shows no ocular abnormalities (an abnormality in the organ of vision) on a typical eye examination, but the child cannot see properly (Chang & Borchert, 2020; Smith, 2007). The term cortical visual impairment refers to visual impairment caused by damage to the visual cortex of the brain. Functional vision assessment of children with cortical visual impairment also differs due to the differentiation of visual conditions. Individuals affected by cortical visual impairment have different low vision characteristics and need different educational arrangements (Şafak, 2018). The GFVAI, on the other hand, was developed to assess the functional vision of individuals with visual impairment due to visual impairments other than cortical visual impairment. In this respect, it is similar to the Functional Vision and Learning Media Assessment-FVLMA Kit developed by Burnett and Sanford (2008) and Individualized Systematic Assessment of Visual Efficiency-ISAVE developed by Langley (1998) (American Printing House [APH], 2013; Mulloy et al., 2014; Newcomb, 2010). ISAVE includes areas such as visual acuity, visual field, and attention test to examine the functional vision of children aged 0-5 years who are visually impaired or have low vision or are blind or at risk of blindness. ISAVE is also a tool designed as a CVI assessment protocol to determine the presence of cortical visual impairment (Langley, 1998). However, the reliability and validity of ISAVE have never been measured (Luijten, 2018). The main purpose of ISAVE is to determine the existing visual performance and develop a program in order to enable even the smallest visual function to be used functionally. The assessment includes nine areas: ecological considerations, structural integrity, minimal sensitivity, alignment and ocular mobility, oculomotor skills, visual acuity, visual fields, cortical visual impairment, and visual perception skills. In terms of the content of the measurement tool, there is a similarity between the GFVAI and the main purpose of ISAVE, but it differs in content. The GFVAI was not developed to assess students with cortical visual impairment and was not tested with participants with cortical visual impairment. It also differs from ISAVE in that it is a valid and reliable tool. The FVLMA, on the other hand, was prepared to systematically assess the level of visual function and adaptation needs of educational materials of a student with low vision. The FVLMA was peer-reviewed by experts in the field of visual impairment and tested with teachers and students (Mulloy et al., 2014). The GFVAI is similar to FVLMA in terms of assessing students with low vision and using the results for adaptations in educational materials. However, no information is available regarding the validity and reliability of the FVLMA (Mulloy, et al., 2014).

Conclusion

As a result, it was found that the GFVAI could measure the functional vision level of students with low vision with a high degree of accuracy in near vision (including sub-dimensions such as focusing, maintaining focusing, monitoring-scanning, color vision, light sensitivity, image recognition, near vision field, and writing tools) and distance vision (including sub-dimensions such as distance visual field, distance reading and viewing, object-person recognition, avoiding objects/obstacles, avoiding people coming from the opposite direction, and going up and down stairs). Besides, it was found to be consistent with the GFVAI Performance Activities. Many-facet Rasch model and generalizability theory were used for the inter-rater reliability, and discriminant analysis was used for the validity of the measurements. It was observed that the inter-rater reliability was high, and the inferences made based on these measurements were valid. This shows that the GFVAI can be used in the functional vision assessment of students with low vision.

Recommendations

It is recommended to include functional vision assessment with GFVAI in GRCs during the educational assessment of students with low vision. Therefore, it is recommended that the educational assessment personnel in the GRCs receive training on the application of the GFVAI. Besides, it is recommended that teachers who work in IEPs units in schools where individuals with low vision are studying, and who are responsible for preparing IEPs, receive training on the application of the GFVAI and the interpretation of its results. The results of functional vision assessment made with the GFVAI will also shed light on families, teachers, and other professionals working with students with low vision.

Future studies can develop a valid and reliable tool that will serve to evaluate the functional vision skills of students with low vision who are affected by visual impairment in the preschool period. A functional vision assessment tool can be developed that will serve to evaluate the functional vision of students with low vision and additional disabilities (students with severe disabilities). Besides, further studies can adapt existing functional vision assessment tools in Turkish for students with cortical visual impairment. Finally, new studies can be designed to test the GFVAI.

Limitations

The current study is limited to students with low vision, who did not have additional disabilities, who were not diagnosed with cortical visual impairment, and who were studying in various primary and middle schools (from 2nd to 7th grades) affiliated to the Ministry of National Education, in 2011, in Turkey.

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Şafak: Concept and design, data acquisition, data analysis, drafting manuscript, securing funding, admin, writing. Çakmak: Concept and design, data acquisition, data analysis, editing/reviewing. Karakoç: Concept and design, data acquisition, data analysis, editing/reviewing. Aydın O'Dwyer: Supervision.

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