Analysis of a digital instrument for multidimensional assessment of the older adults by undergraduate gerontology students

Análise de um instrumento digital de avaliação multidimensional de idosos por alunos de graduação em gerontologia

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ABSTRACT
Introduction: A Multidimensional Assessment of the Elderly (AMI) examines different aspects of the functionality of elderly patients based on scales and quantitative tests. An AMI is performed by health professionals, in particular Gerontologists. The Gerontological Care Plan (PAGe) is an AMI instrument developed by Gerontology researchers at the University of São Paulo. Methods: In this study, under the supervision of a professor, pairs of students conducted the PAGe AMI of an older adult and registered the results in the paper-based instrument first and in the Web system next. The paper-based version demanded that the students calculate the results manually, while the Web system calculates the results automatically. We asked students to answer a questionnaire about their experience with PAGe online. Results: A total of 23 pairs of students

conducted the AMI, of which 11 answered the questionnaire. The students considered that the system corresponds to a complete and correct implementation of the original PAGe AMI. Approximately 63% of the respondents agree that the PAGe online can be used as an alternative to the paper version. Conclusion: The online PAGE system corresponds to the original paper-based instrument, and most students feel confident using the digital system without the support of the physical instrument.

Keywords: older adults, geriatric assessment, electronic health records**.**

RESUMO

Introdução: Uma Avaliação Multidimensional do Idoso (AMI) corresponde ao exame de diferentes aspectos da funcionalidade de pacientes idosos, com base em escalas e testes quantitativos. Uma AMI é realizada por profissionais de Saúde, em particular Gerontólogos. O Plano de Atenção Gerontológica (PAGe) é um instrumento de AMI desenvolvido por pesquisadores de Gerontologia da Universidade de São Paulo. A versão original é empregada como um questionário em papel. Desenvolvemos o PAGe online como um sistema Web como alternativa à versão em papel. Apresentamos o resultado de uma avaliação do sistema PAGe online por alunos de Gerontologia. Métodos: Sob supervisão de um docente, duplas de alunos realizaram a AMI de um idoso e registraram os resultados no instrumento físico e, a seguir, no sistema Web. Os alunos calcularam manualmente os resultados e os compararam com os calculados automaticamente pelo instrumento digital. Solicitamos aos alunos que respondessem a um questionário sobre o PAGe online. Resultados: A atividade foi executada por 23 duplas de alunos das quais 11 responderam ao questionário. Os alunos consideraram que o sistema corresponde a uma implementação completa e correta da AMI PAGe original. Aproximadamente 63% das duplas respondentes concordam que o PAGe online pode ser utilizado como alternativa à versão em papel. Conclusão: O sistema PAGe online corresponde ao instrumento físico original e a maioria dos alunos se sentem confiantes em utilizar o sistema digital sem apoio do instrumento físico.

Palavras-chave: idoso, avaliação geriátrica, registros eletrônicos de saúde.

1 INTRODUCTION

A Comprehensive Geriatric Assessment (AGA), or Multidimensional Assessment of the Elderly (AMI), evaluates various functional aspects of elderly patients using standardized scales and quantitative tests. Saraiva et al. (2017) demonstrate this in their study, and Assis Costa and Monego (2003) note that the

assessment is multidisciplinary and interdisciplinary, aiming to identify impairments, disabilities, and disadvantages in the elderly to plan long-term care and follow-up.

The Gerontological Care Plan (PAGe) is an interactive tool for the multidimensional assessment of the elderly, designed and validated as a paper-based questionnaire. Developed by Gerontology researchers at the University of São Paulo, the PAGe is divided into four modules, with the first corresponding to the AMI instrument. Lima-Silva and Suenaga (2012), Paulo and Neves (2011), and Piovezan and Bestetti (2012) highlight the development and use of PAGe.

The importance of software systems accompanying assessment instruments is widely recognized, especially in the care of the elderly. Devriendt et al. (2013) and Stampa et al. (2018) have observed this. To provide an alternative to the paper-based version, we developed the PAGE online Web system from the four modules of PAGE version 3.0. This work addresses the interface and acceptance tests of the PAGE 3.0 AMI module implemented in the web system.

1.1 GERONTOLOGICAL CARE PLAN - PAGE

According to Cezar (2018), PAGE version 3.0 contains four modules, namely, I) Multidimensional Assessment of the Elderly (AMI); II) Action Planning; III) Coordination and Implementation of Actions; and IV) Control and Reassessment. The AMI module, which is the focus of this study, contains 104 questions and is further divided into four dimensions and 11 domains. The dimensions are Psychological Aspects, Biological Aspects, Socio-environmental Aspects, and Falls. The eleven domains are Attitudes towards aging, Quality of Life, Senses, Malnutrition, Functional Capacity, Depression, Cognition, Cardiovascular Factors, Medication Administration, Environment, Falls, Violence, Social Vulnerability, and Frailties).

A different color represents each dimension in the PAGE instrument. Figure 1 shows a portion of the Biological Aspects dimension, specifically the 'Sensory Deficit' domain. The domain name is on the left, followed by questions

and slots for answers ('yes' or 'no') in the central columns. The rightmost column provides the domain's maximum score, and the evaluator fills in the computed score (the sum of the answers) and indicates whether or not the elderly person requires further investigation in that domain ('yes' or 'no').

Figure 1 – Sample of a dimension and related domains in the PAGE AMI.

BIOLOGICAL ASPECTS				
SENSORY DEFICIT	20. Do you have difficulty seeing? [Note: Even if you already use glasses or other corrective methods]	☐ Yes=0 ☐ No=1	Score (maximum=4)	Need investigation? ( ) Yes ( ) No
	21. Do you have difficulty hearing what people are saying? [Note: Even if you already use a hearing aid]	☐ Yes=0 ☐ No=1		
	22. Do you have difficulty tasting food?	☐ Yes=0 ☐ No=1		
	23. Because of your senses (sight, hearing, taste), do you have difficulty carrying out your daily activities?	☐ Yes=0 ☐ No=1		

Source: Adapted from Cezar's PAGE AMI (2018).

The final portion of the AMI module summarizes the maximum total values by dimension and across the module as a whole (figure 2). In the last line, the professional indicates the risk classification resulting from the assessment as low, moderate, or high.

Figure 2 – Final portion of the PAGE table and AMI module.

SCORE		
SCORE BY DIMENSION	PSYCHOLOGICAL ASPECTS (MAXIMUM = 14 POINTS)	
	BIOLOGICAL ASPECTS (MAXIMUM = 36 POINTS)	
	SOCIAL ASPECTS (MAXIMUM = 32 POINTS)	
	FALLS (MAXIMUM = 16 POINTS)	
SCORE (MAXIMUM = 98 POINTS)		
BIOPSYCHOSOCIAL VULNERABILITY RISK CLASSIFICATION		
( ) GREATER OR EQUAL 70 POINTS = LOW RISK	( ) BETWEEN 69 AND 40 POINTS = MODERATE RISK	( ) LESS OR EQUAL 39 POINTS = HIGH RISK

Source: Adapted from Cezar's PAGE AMI (2018).

Additionally, the module includes a demand map composed of two radar-type graphs (figure 3), which present the evaluation scores by dimension and domain after normalization on a scale of 0 to 100. The left portion of the figure shows the scores by dimension, while the right portion shows the scores by domain. This allows for a visual representation of the patient's strengths and weaknesses in different areas, which can aid in developing a care plan.

Figure 3 – Radar charts used to record percentage-normalized results of dimensions and domains in the PAGE AMI.
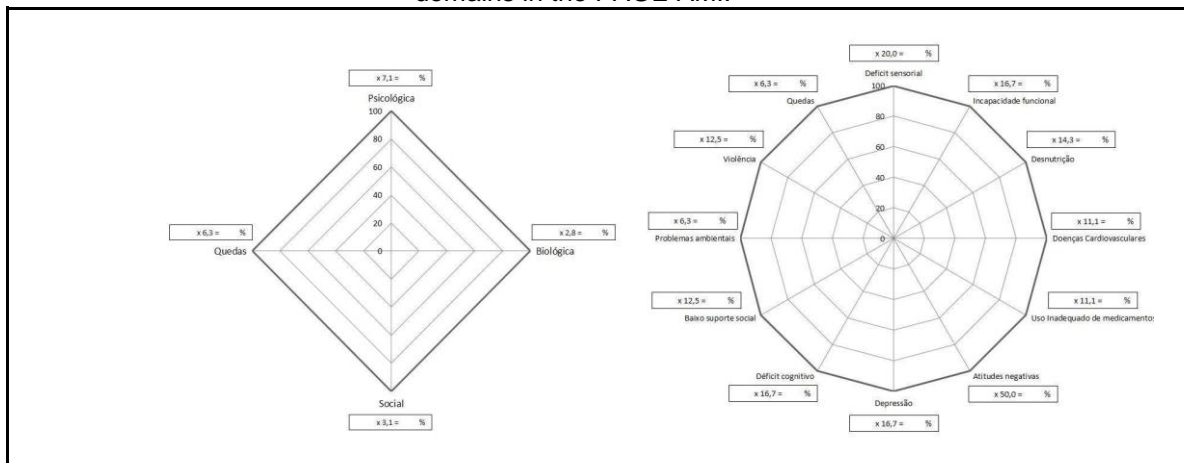
Source: Adapted from Cezar's PAGE AMI (2018).

1.2 PAGE ONLINE SYSTEM

PAGE online is an electronic system designed to replace the paper version of PAGE 3.0. In addition to allowing for the immediate recording of AMI results in an online environment, it also keeps a database that holds the assessment history. PAGE online manages all data and sensitive information per Law 13,787. This law regulates the digitization and use of computerized systems for the custody, storage, and handling of patient records in Brazil (Brasil, 2018a). Additionally, PAGE online complies with Law 13,709, also known as the General Law for the Protection of Personal Data in Brazil (brasil, 2018b).

The online version of PAGE follows User Experience concepts discussed by Benyon (2019) and other authors. The interface of the online version has been designed to be similar to the paper instrument, such as the 'Sensory Deficit' portion (Figure 1) displayed in the online version (figure 4). The design of the online version aims to enable those familiar with the physical instrument to use the online version without any difficulties or confusion. The project has used the "familiarity" principle as the primary interface design principle, as Dix (2016) suggested. The "familiarity" principle relates to the usability heuristics "Correspondence between the system and the real world" and "Consistency and patterns" advocated by Nielsen (2005).

Figure 4 – A section of the PAGE online that corresponds to the part shown in figure 1.

Source: The authors.

At the end of the AMI questions, the PAGE online platform presents the same result elements as those in the physical instrument. Moreover, the system automatically calculates the score table, along with selecting the risk factor range.

The demand map is automatically generated in the PAGE online platform, presenting the assessment scores in the form of a radar chart for each dimension (figure 5) and domain (figure 6). The charts show the percentage score for each category, and the user can zoom in or out to facilitate visualization as needed.

To implement the PAGE Online platform, we followed the current software development standards based on three layers recommended by Pressman and Maxim (2021). The application is divided into two parts, the frontend, which executes in the browser, and the backend, which executes in the server and database. We use HTML5 and CSS standards, which are internationally recommended by the World Wide Web Consortium (2013), as well as Javascript, which is widely used to allow interaction on the web as attested by Wirfs-Brock and Eich (2020). We also use the Angular framework recommended by Fain and Moiseev (2018) on the frontend. On the backend, we use the Django framework, detailed by Forcier et al. (2008), the Django REST framework recommended by

Hillar (2018), and the Postgres database maintained by The PostgreSQL Global Development Group (2022).
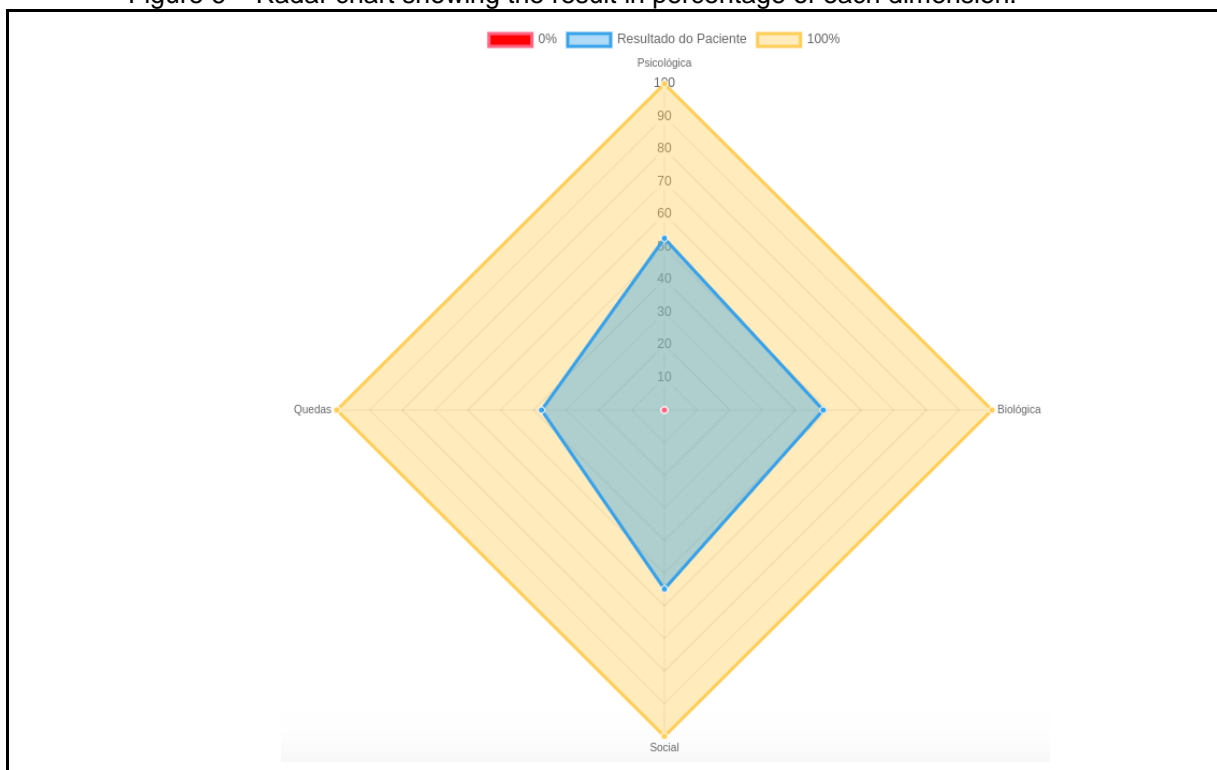
Figure 5 – Radar chart showing the result in percentage of each domain.
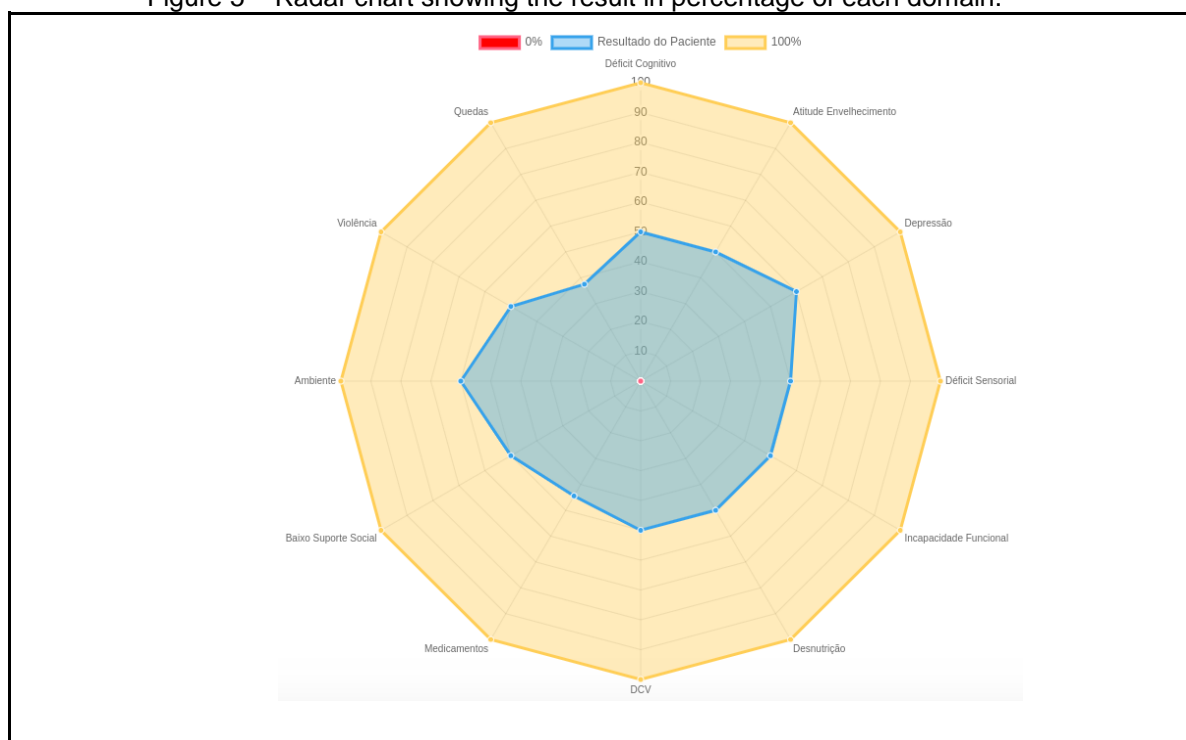
Source: The authors.

Figure 6 – Radar chart showing the result in percentage of each dimension.

Source: The authors.

2 METHODS

The Human Research Ethics Committee of the USP School of Arts, Sciences and Humanities (Registration #1,622,436) approved this study. The evaluation of the AMI of the online PAGE was conducted by students enrolled in the "Broad Gerontological Evaluation" course in the Gerontology program at the University of São Paulo.

We divided the students into pairs, and each pair interviewed an older adult and registered the results in the paper-based instrument first and in the Web system next. During the process, students could choose to fill out the system during the interview or afterward. After completing the digital version, students filled out the evaluation questionnaire. We asked them to manually calculate the results and compare them with those provided by the system.

To evaluate the AMI module of PAGE online, we employed a questionnaire to collect user opinions, as recommended in the Human-Computer Interaction literature by Prates and Barbosa (2003) and others. The questionnaire includes

25 questions designed to evaluate four aspects of PAGE online: whether the online implementation accurately represents the AMI of the physical instrument; whether the system was able to replace the physical instrument during the learning process fully; whether the results presented by the system are equivalent to those manually calculated results; general evaluation of the interface (Textbox 1),

We based the questions for evaluating the interface and implementation on Nielsen's ten usability heuristics (2005). These heuristics are widely known and commonly used in various fields, including health systems evaluations, as noted by Paton et al. (2021) and Khowaja et al. (2020).

To present the questions, we used a five-level Likert scale, as Joshi et al. (2015) suggested. The options on the scale included: strongly agree, partially agree, neither agree nor disagree, partially disagree, and strongly disagree.

Textbox 1 – Questions from the PAGE online AMI assessment questionnaire.

1	Academic title
2	Occupation area
3	Assessment date
4	How long have you been using computerized systems in gerontology or health?
5	The system is simple for those who have already used the paper-based PAGe.
6	The system presents a correct and complete implementation of PAGe.
7	Fields filled in automatically by the system show correct results.
8	The domain scores, automatically calculated by the system, present correct values.
9	The dimension scores, automatically calculated by the system, present correct values.
10	The domain graph data is perfectly visible because it is well distributed.
11	The dimension chart data is perfectly visible because it is well distributed.
12	The domain graph was correct.
13	The dimension chart was correct.
14	The terms used by the system are similar to those found in PAGe.
15	The online system can replace the paper-based multidimensional analysis instrument.
16	It will be very beneficial for the Gerontologist to use computerized systems instead of printed paper documents.
17	The system makes it clear the sequence in which the user must perform the tasks.
18	The system keeps the user informed through feedback on actions taken.
19	The system keeps the user informed about the errors that occur.
20	The system adopts a color pattern similar to that found in PAGe.

| 21	The system interface is very complicated and difficult to understand.
22	The system interface presents a large amount of unnecessary information.
23	Messages displayed by the system are difficult to understand.
24	The fields that must be filled in by the user are evident on the screen.
25	The system makes it very clear the type of data with which the fields must be filled.

Source: The authors.

3 RESULTS

In total, 23 pairs participated in the evaluation and completed both the paper-based and online versions of the PAGE. Of those, 11 pairs completed the evaluation questionnaire. We asked each pair to answer only one questionnaire.

We analyzed the answers to questions 5, 6, 14, and 20 (Figure 7) to determine whether the implementation of the PAGE online AMI accurately represents the physical instrument's AMI. Of the 11 pairs who completed the questionnaire, all agreed with the following statements: the AMI of the online PAGE provides a complete and accurate representation of the AMI of the physical instrument; the system is easy to use for those who have already used the physical instrument; the system's terms are similar to those used in the physical instrument; he color schemes used in the system and the physical instrument are similar.

Figure 7 – Answers to questions 5, 6, 14, and 20.
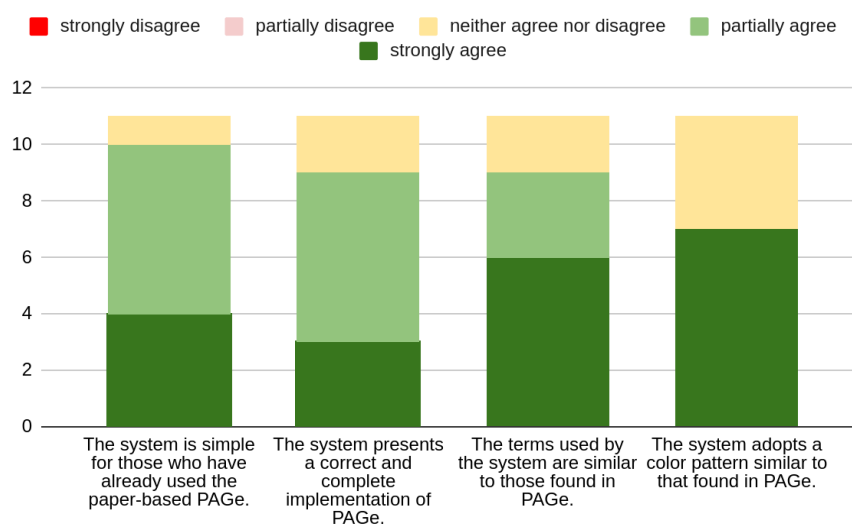
Source: The authors.

We analyzed the answers to questions 15 and 16 of the questionnaire (figure 8) to determine whether the computerized system could fully replace the physical instrument during the learning process. Approximately 37% of the users (four pairs) disagreed with the following: the computerized system can completely replace the multidimensional analysis instrument printed on paper; it will be very beneficial for the gerontologist student to use computerized systems instead of printed paper documents.

Figure 8 – Answers to questions 15 and 16.
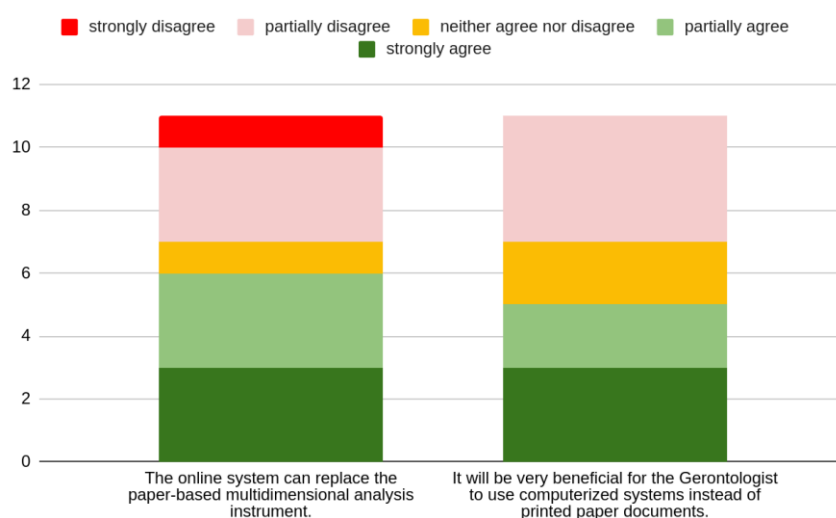
Source: The authors.

We analyzed questions 7 to 13 of the questionnaire (figure 9) to determine the correctness of the results calculated by the system. Approximately 18% of users (two pairs) disagreed that the domain graph data was perfectly visible and well distributed, and one pair disagreed that the domain graph was correct. However, no pair disagreed with the following statements: the fields filled in automatically by the system showed correct results; the domain scores, automatically calculated by the system, present correct values; the scores of the dimensions, automatically calculated by the system, present correct values; the dimension chart data are perfectly visible and well distributed; the dimension chart was correct.

Figure 9 – Answers to questions 7 to 13.
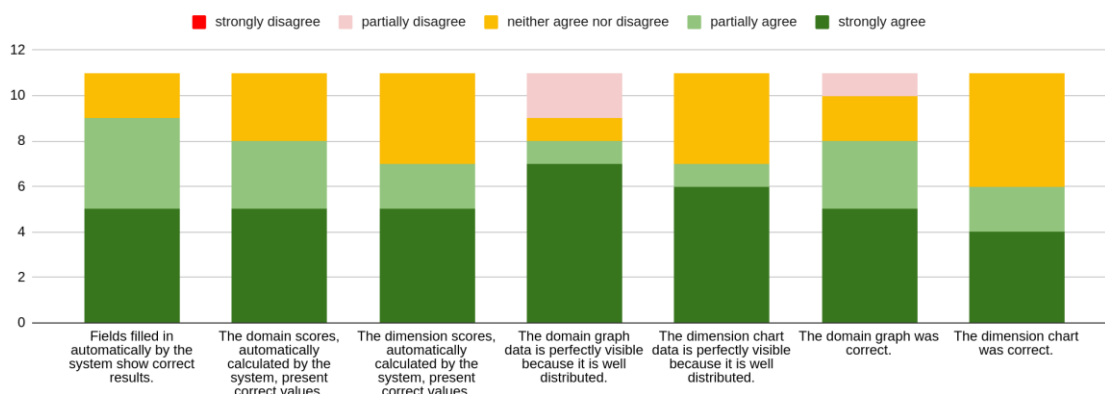
Source: The authors.

We analyzed questions 17 to 19 and 21 to 25 of the questionnaire to gather information on the system's interface (figure 10). According to our findings, approximately 27% of users (three pairs) felt that the sequence of tasks required by the system was unclear. One pair disagreed that the system provides appropriate feedback on user actions and that it clearly indicates the data fields to be filled in. Around 18% of users (two pairs) disagreed that the system provides sufficient information about errors. Similarly, two pairs (approximately 18% of users) agreed that the system interface was complicated and challenging to understand. Three pairs (27% of users) found the messages displayed by the system difficult to comprehend, while five pairs (45% of users) agreed that the messages were hard to understand.

Figure 10 – Answers to questions 17 to 19 and 21 to 25.
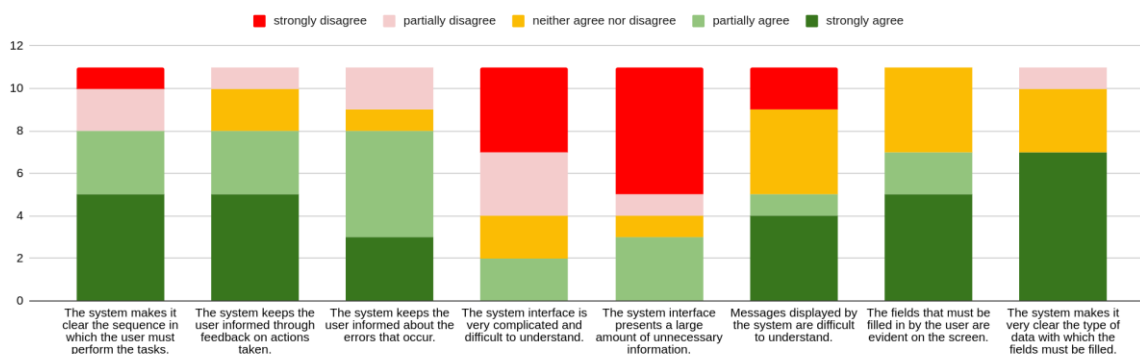
Source: The authors.

4 DISCUSSION

Legris et al. (2003) and other researchers have identified multiple factors influencing the acceptance and adoption of software systems, including those in the health sector. Ahmad and Mozelious (2022) have documented these observations in their literature review, while Singh and Ravi (2022) have discussed specific aspects that affect health professionals' adoption of software systems.

We built PAGe online to explore academic research results to develop effective digital solutions, following the findings by Fakuki et al. (2022). Aiming at the success of PAGe online, we involved a multidisciplinary team after Declerck et al. (2014) recommendations.

4.1 PRINCIPAL RESULTS

The participating students in the survey believe that the implementation and interface of the AMI in the online PAGe accurately represent the AMI of the paper-based instrument. They note that implementing the AMI in a similar way to the physical instrument makes it easier for users who are familiar with it to navigate the system.

The responses indicate that the system generates correct results for fields that are automatically filled, correct scores for domains and dimensions that are automatically calculated, and correct values for the dimension graph data, which is well distributed and visible. Therefore, the system saves professionals time by automatically performing calculations and generating graphs, allowing them to focus more on the actual evaluation process.

Regarding the interface, most users agreed that the system presents a precise sequence in which tasks must be performed, and that it keeps the user informed through feedback on the actions taken, and that it makes it clear what type of data the fields must be filled in. However, a minority of users disagreed with these statements. Similarly, most users agreed that the system keeps the user informed about errors that occurred and that the messages presented by the system are easy to understand, but a minority of users disagreed. On the other

hand, a minority of users found the system's interface too complicated and difficult to understand.

After analyzing the students' responses regarding the interface, we conclude that the visual elements are clearly defined and were easily understood. However, there is a need to revise the vocabulary used in the error messages presented, such as when a mandatory field was not filled in, as five pairs agreed that the system's messages are difficult to understand.

4.2 LIMITATIONS

The survey did not assess the respondents' perspective regarding using a Web system as an alternative to the paper version. Thus, we did not include in the evaluation the positive aspects inherent to the use of software to support the professional's task regarding the collection, analysis, storage of data, as well as visualization and remote access to results, and maintenance of history and versions, among others. On the other hand, aspects such as dependence on the Internet and computing devices may have been considered by respondents who assessed that the system should not be used as a substitute for the paper version.

In future evaluations, we will deploy the Technology Acceptance Model (TAM) questionnaire, proposed by Davis (1989), or the Unified Theory of Acceptance and Use of Technology (UTAUT) questionnaire, proposed by Venkatesh et al. (2003). Both have been used in the health area and have strengths and limitations as predictors of the support needed for adopting new technologies in this area, as highlighted by Ammenwerth (2019).

Another limitation of the research is the fact that participation was restricted to a small number of students in a gerontology course class. Thus, future assessments will involve a larger number of participants, including professionals and students from other courses and institutions, as advocated by Legris et al. (2003).

5 CONCLUSION

Based on our survey conducted with undergraduate gerontology students at USP, the current version of the PAGE online has a complete and accurate implementation of the AMI from the physical instrument PAGE in its version 3.0. Additionally, the digital version is similar to the paper-based version, making it easy for those familiar with the physical instrument to use the online version without difficulty. Future research should expand the scope of the study to include other online PAGE modules with a more diverse audience and other evaluation instruments.

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