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DOSE FÁCIL: A LEARNING TOOL FOR VETERINARY STUDENTS

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ABSTRACT

The administration of drugs is essential in veterinary practice, acting as an ally in the recovery and maintenance of animal health. Often, errors in the preparation and administration of drugs are attributed to the professionals' difficulty in dealing with mathematical calculations. In this context, it is important to highlight the role of information technology in veterinary medicine, which provides tools for scientific and technological advances in both clinical practice and the academic environment. Therefore, in this study, a mobile tool called Dose Fácil was developed, capable of calculating the infusion rate of medications, assisting veterinary students, focusing on syringe and drip infusion methods. Based on the Kotlin programming language and developed in Android Studio, the tool has an intuitive interface, with interactive buttons and editable text options. With the approval of the Ethics Committee of the University of Mogi das Cruzes (CAAE: 78751924.5.0000.5497), usability tests revealed a high acceptance of the tool, with average scores of 97.5, indicating a positive experience. Additionally, a test conducted with 89 veterinary medicine undergraduates demonstrated variations in participants' approaches. Statistical analysis indicated that the volunteers' responses were similar to those of the tool in several questions, both the median and mode coincided with the values provided by the tool. The data collected highlighted the high acceptance rate of Dose Fácil, with 78% of students expressing enthusiasm for the tool. Therefore, according to the hypothesis of this study, it is concluded that the tool has potential benefit in the learning of undergraduate veterinary students.

Keywords: Kotlin. Tool. Infusion rate. Veterinary. Graduation students.

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INTRODUCTION

The administration of drugs is essential in veterinary practice, acting as an ally in the recovery and maintenance of animal health. Even so, both the effectiveness of the treatment and the incidence of adverse effects are directly related to the way in which the drug is administered [1]. Adverse effects are undesirable responses that arise as a result of the administration of a drug and may be intrinsic to its pharmacological action or result from errors during its administration [2].

To determine the appropriate dose of a drug, it is essential to consider several variables, such as the mass and volume of the drug, the weight of the animal and the route of administration. Errors in the preparation and administration of drugs are often attributed to the difficulty of health professionals in dealing with mathematical calculations [3].

In this context, it is important to highlight the growing presence of information technology in veterinary medicine, which drives scientific and technological advances in both clinical practice and the academic environment. However, most existing research focuses predominantly on the development of software for the management of veterinary clinics and hospitals, as well as on the printing of 3D anatomical models [4]. Therefore, despite the availability of more than 40 tools focused on this area, there is a notable shortage of articles and mobile tools that explore this topic, especially in the educational context [5].

Thus, the need was identified to develop tools that integrate different areas of veterinary medicine, including the calculation of the drug infusion rate. Such tools not only assist professionals in performing complex mathematical calculations, but also act as training and qualification instruments for undergraduates in the field. The use of tools with easy-to-interact interfaces in the academic environment has proven to be an effective strategy for optimizing the learning process and improving understanding of the calculations involved. This approach not only promotes students' academic development, but also prepares them to meet the increasing demands associated with veterinary practice.

Thus, the development of a mobile tool with an interactive and intuitive interface to calculate the rate of drug infusion in animals with tool directed to veterinary medicine was proposed. Also with the hypothesis that the tool ideally meets both the clinical and academic context, to facilitate the calculation process and contribute to the training and qualification of students in the area.

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METHODS

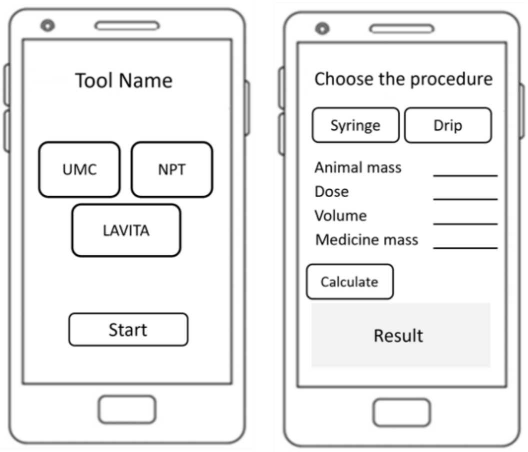
This section describes the development and validation procedure of the proposed tool. To this end, the Kotlin programming language was used to develop the essential structures and features of the tool, using the Android Studio software. This in turn is an integrated development environment (IDE) with several visual resources that facilitate creation, debugging and structural testing.

REQUIREMENTS ENGINEERING

To address all the necessary requirements, the requirements for the tool were clarified, understood and identified, based on the possible needs of users (veterinary students). From this, the requirements were documented descriptively, in detail, including their origin, priority and any dependencies on other requirements. Finally, the requirements were validated to ensure that they met the needs and expectations of users through prototyping of the screens. Thus, the name *Dose Fácil* was given to the tool, which means an easy way to get the result of the drug dose.

During the prototyping of the interface, the first screen, called the splash screen, was created. It displays the name of the tool and the logos of the institutions involved in the development, including the University of Mogi das Cruzes (UMC), the Laboratory of Virtual Environments and Assisted Technology (LAVITA) and the Center for Technological Research (NPT). This screen also features a button to launch the tool. On the second screen, the user is directed to select the procedure (syringe or drip) and fill in the data. At this stage, fields are available for entering the animal's mass, dose, volume and mass of the drug, followed by a button to activate the calculation of the drug infusion rate (Figure 1).

Fig. 1 Screen prototypes



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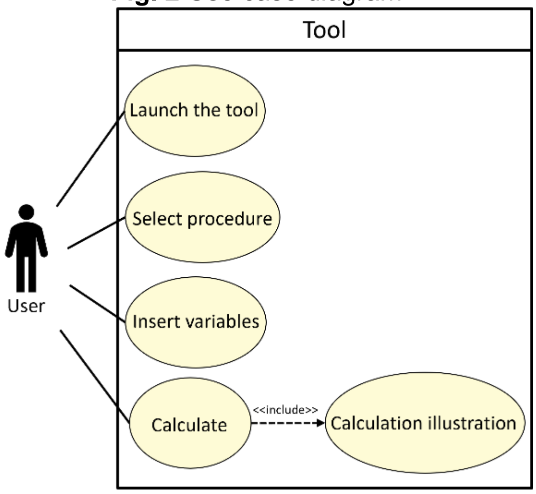
The use case for this project (Figure 2) involves a user interacting with the tool. After launching the tool, the user is presented with a choice between two distinct procedures: syringe or drip, both of which are documented in the literature. After choosing the desired procedure, the tool displays the interface for calculating the infusion rate. At this point, the user is prompted to provide information including the volume of drug in milliliters (mL), the mass of the animal in kilograms (kg), the mass of drug in milligrams (mg), the dose of drug in milligrams per kilogram per hour (mg/kg/h), and the drip factor in drops per milliliter (gtt/mL) for the drip procedure.

Once all the information has been entered, the user confirms the entry and the tool performs the calculation. To do this, a mathematical equation implemented in the algorithm, determined by the previously selected procedure, is used to calculate the infusion rate. Finally, the tool displays the formula used in the calculation and executes the mathematical model, providing a visual representation of the process.

Fig. 2 Use case diagram



For the tool to calculate the infusion rate, two calculations described in the literature were provided, referring to the two types of procedure (syringe and drip) [6]. The first mathematical model refers to the syringe procedure and uses the variables: m for the animal mass (kg), d for the drug dose (mg/kg/h), M for the drug mass (mg) e V for the volume (mL). Therefore, the final value of the infusion rate (Tx_s) is given by mL/h, as shown in Equation (1).

$$Tx_s = \frac{m \times d}{M} \times V, \qquad (1)$$

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The second mathematical model, presented in Equation (2), refers to the drip procedure, where F_{gt} is added to the drip factor (gtt/mL), which is the number of drops in 1 mL of solution, and the conversion to minutes. Therefore, the final value of the infusion rate (Tx_{gt}) is given by ggt/min.

$$Tx_{gt} = \frac{m \times d}{M} \times V \times F_{gt} \times \frac{1}{60}, \qquad (2)$$

TESTING THE TOOL

To verify the functionality and usability of the developed tool, software tests and usability tests were carried out with volunteers. For the structural test, the Basic Path Method, developed by Thomas McCabe, was used, whose objective was to use the smallest number of paths to resolve from the input to the output of the algorithm. In this way, the input values were simulated and the expected outputs were awaited. For the functional test, the Android Studio development software resource was used, which indicates and alerts errors in the algorithm.

To evaluate the usability of the tool, two tests were carried out with volunteers, the first is a usability test called the SUS scale (System Usability Scale), this method was created by John Brooke and consists of a questionnaire with 10 questions, where a specialized evaluator must respond on a scale of 1 to 5, where 1 means “completely disagree” and 5 means “completely agree”. Therefore, a questionnaire with 10 questions was developed, intended for validation by 10 experts (5 software developers and 5 veterinarians).

The second usability test was conducted with a focus on the veterinary academic environment, involving three questions related to the calculation of the infusion rate in clinical situations. Initially, volunteers were asked to solve the calculations manually in a discursive way and then to perform the same calculations using the tool.

With the approval of the Ethics Committee of the University of Mogi das Cruzes (CAAE: 78751924.5.0000.5497), volunteers were screened according to the inclusion and exclusion criteria, focusing on undergraduate students of the University of Mogi das Cruzes, selected based on their previous knowledge about calculations in the administration of compounds (liquids) in animals. The volunteers who participated in the study signed the informed consent form.

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The sample size (n) was set to 100 since internationally recognized guidance suggests that the number of assessors should be equal to or greater than 60 and for a statistical estimate the minimum sample size should be at least 100 individuals. Then, three fictitious clinical cases were presented, in which the volunteers responded discursively based on their knowledge, and then solved the same cases using the *Dose Fácil* tool. Afterwards, they evaluated the tool based on their personal experience through a facial hedonic scale.

To prepare each hypothetical clinical case, different medications and different clinical objectives were selected. In addition, the variables used in the calculations, such as the volume of the drug, the weight of the animal and the mass of the drug, were adjusted for each case, aiming to provide a wide diversity of clinical situations and treatment scenarios in veterinary practice. Finally, the volunteer's feedback is based on the answer to the question "What is your impression of the usefulness of this tool in your professional practice?", which should be answered using the hedonic scale.

DATA ANALYSIS

The analysis of the results of the SUS scale was done by calculating the result of each question. For odd answers (1, 3, 5, 7, 9) 1 point was subtracted from the score assigned by the evaluator. For even answers (2, 4, 6, 8, 10) 5 points were subtracted from the value assigned by the evaluator. Then, all the scores for the ten questions are added together and multiplied by 2.5. This result can range from 0 to 100. The total score for all evaluators was assessed as: less than or equal to 20.5 (worst imaginable); 21 to 38.5 (poor); 39 to 52.5 (average); 53 to 73.5 (good); 74 to 85.5 (excellent); 86 to 100 (best imaginable).

The volunteers' discursive responses were interpreted with the aim of verifying the number of resolutions of mathematical problems without the help of the tool. Initially, the absolute values of the resolutions were computed. These absolute values were then converted into percentages to allow a proportional analysis of the volunteers' performance. To convert to percentages, the number of resolutions presented was divided by the total number of participants and the result was multiplied by 100.

For the statistical analysis of the discursive responses compared to the tool result, the Shapiro-Wilk Test was applied to verify the normality of the responses, that is, whether the results follow a normal distribution. If normality is confirmed, the parametric t-test for

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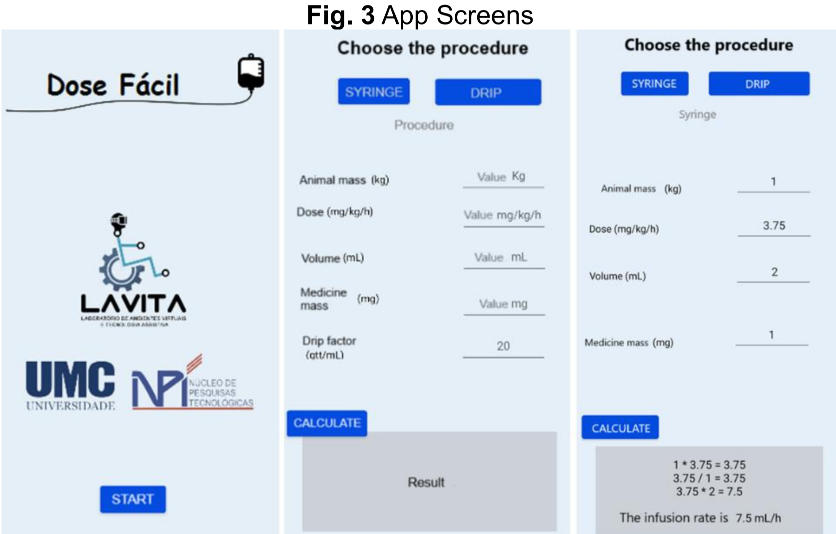
related samples will be used, which compares two samples to check whether their means differ significantly. If the data does not follow a normal distribution, the nonparametric Wilcoxon test will be applied, which compares a sample of results with a reference value. This test is suitable for non-normally distributed data and assesses whether the measurements tend to be higher or lower than the control.

In addition, the app feedback, collected through a hedonic scale, was analyzed by computing the absolute frequency of responses. Absolute frequency refers to the total number of times each specific response was selected by the volunteers. To obtain the relative distribution of each response category, these absolute values were converted to percentages. This was done by dividing the frequency of each response by the total number of responses and multiplying the result by 100.

RESULTS

The mobile tool was developed using Android Studio software (Figure 3), using a Kotlin-based programming language. The screen design was designed with buttons with intuitive commands and editable text views for inserting variables. The algorithm also performs the necessary calculations and provides visual representations of the mathematical models, helping the user to understand and interact with the tool.

Fig. 3 App Screens



Structural and functional tests were performed directly in Android Studio, without detecting structural errors or logic problems in the tool's back-end programming. After this testing phase, the *Dose Fácil* tool was registered with the National Institute of Industrial

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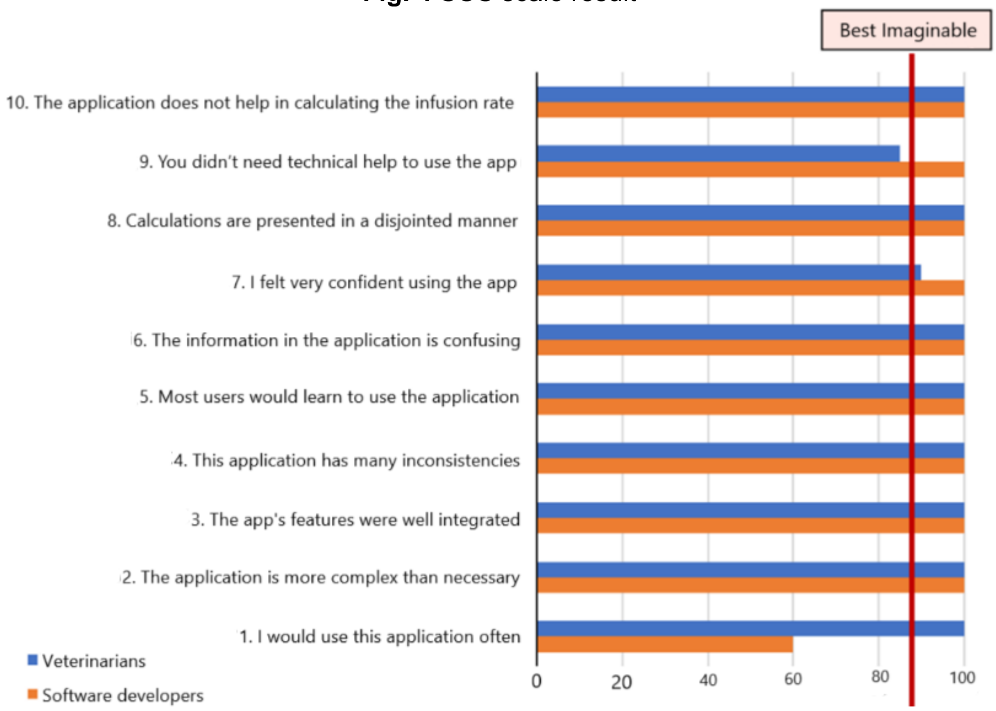
Property (INPI), under the Directorate of Patents, Computer Programs and Circuit Topographies, with process number BR512023001179-7, issued in May 2023.

The first usability test, SUS scale (System Usability Scale), involved 5 software developers and 5 veterinarians working in the Alto Tietê region (São Paulo - BR), aged between 23 and 40 years old. The average score obtained was 97.5 by veterinarians and 96 by software developers, being between 86 and 100 and, therefore, interpreted as "Best Imaginable". Thus, according to the criteria for applying and measuring the data, the tool exceeded the expectations imagined for a positive experience (Figure 4).

Fig. 4 SUS scale result



The second usability test was conducted with the voluntary participation of 89 undergraduate veterinary medicine students. The questionnaire developed to evaluate the tool presented three distinct situations, which were answered by all 89 volunteers. However, the analysis of the volunteers' discursive responses revealed significant variations in the way the participants approached the questions.

Only 32 volunteers demonstrated all the calculations made in the first stage (36%). On the other hand, 39 volunteers presented the calculations for one or two of the proposed situations (44%), which may indicate partial understanding or difficulty in completing all the necessary steps. Finally, 18 volunteers did not demonstrate any calculations (20%), limiting themselves to providing only the final answers (Figure 5).

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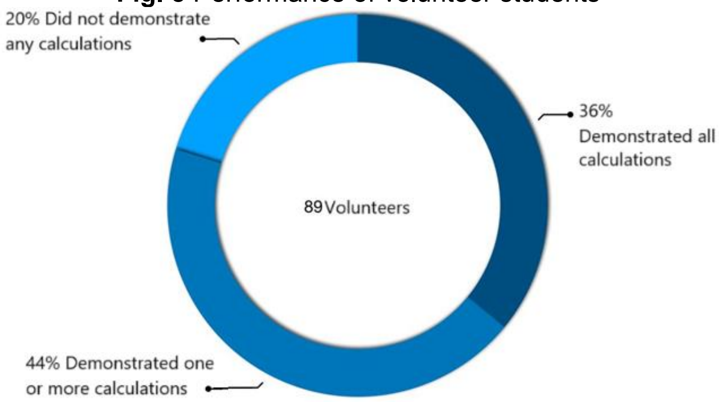
Fig. 5 Performance of volunteer students



To verify the normality of the responses, the Shapiro-Wilk test was applied. It was observed that the responses did not follow a normal distribution, since the p-value for all questions was less than 0.05. Therefore, the nonparametric Wilcoxon test was used, which compared each response with the reference given by the tool. The hypothesis tested was that the volunteers' response is different from the tool's response. In addition, the median and mode of the results were calculated (Table 1).

Based on the results, questions 1-1 and 2-1 had p = 1.000, indicating that the volunteers' answers were the same as those in the app. Questions 2-2 and 3-2 had p = 0.743 and p = 0.927, respectively, suggesting that more than half of the answers were similar to those in the app. Questions 1-2 and 3-1 had p = 0.006 and p = 0.581, respectively, indicating that half or almost none of the answers were similar to those in the app.

Both the median and mode matched the values provided by the app, suggesting that these central tendency results reflect the typical or most representative value, similar to that of the app.

Table. 1 Result of statistical analysis

	Q.1-1	Q.1-2	Q.2-1	Q.2-2	Q.3-1	Q.3-2
Median	0.200	0.032	0.300	0.096	0.300	0.048
Mode	0.200	0.032	0.300	0.096	0.300	0.048
Shapiro-Wilk p	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
T. Wilcoxon p	1.000	0.006	1.000	0.743	0.581	0.927

Of the 89 volunteers, 69 rated the option "I loved it" as the emotion that best represented their feedback (78%), 18 chose "I liked it" (20%), while 2 volunteers classified their impression as "Indifferent" (2%). The options "I hated it" and "I didn't like it" were not marked.

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DISCUSSION

The implementation of tools and software in veterinary practice reveals several advantages, as evidenced by the study by García (2020), where he presents the implementation of medical history software in a veterinary clinic, optimizing the professional's activity and increasing productivity in the clinical environment [7].

The implementation of tools in the academic environment is called mobile learning, as it refers to the learning process that is carried out with the support of mobile devices, allowing learning to take place anywhere. In the educational field, software and tools are widely accepted, especially among young people, who demonstrate a greater affinity with technology [8]. These factors indicate that the integration of mobile learning can improve the quality and accessibility of education in the area, benefiting both students and professionals.

In view of these issues, a mobile tool was developed with the aim of improving clarity and precision in drug administration, focusing on two infusion methods: drip and syringe, to optimize the drug administration process, and assist in the learning of undergraduate students.

A list of recommendations was drawn up by Mol (2011) related to the necessary requirements in an tool interface for smartphones. Among the items on this list, the *Dose Fácil* tool allows autonomous use by the user [9]. In addition, the tool has text alignment to the left, buttons with interaction with visual feedback when pressed, and dimensions greater than 62 pixels. An animation is also present in the tool to highlight the transitions between screens, according to Lima et al. (2019), this method facilitates the user's perception in changing the context and operation of the tool [10].

When a tool is designed with ease of use in mind, it has a significant impact on its audience [9]. This impact was evident as the experts' high score (Best imaginable) reflected their positive impressions of the tool. However, question 1 – "I would use this tool frequently" – scored below 70 for software developers. This type of result can be circumvented by developing two questionnaires covering each area of knowledge or by applying more software validation tests, thus evaluating the quality of the software and user experience [10].

The use of clinical cases, even hypothetical ones, allows the tool of theoretical knowledge acquired in classroom [11]. This approach not only allows the practice of the concepts learned, but also offers an opportunity to evaluate the usability of software. By working with simulated scenarios, students can test the effectiveness of tools in conditions that mimic real-world situations, making it easier to identify areas that need improvement and ensuring that the software's interface and functionality are appropriate to users' needs.

Considering these issues, a questionnaire was developed with fictitious clinical cases, allowing veterinary medicine undergraduates to test the usability of the *Dose Fácil* tool in a practical way. The volunteers used the app to solve the proposed cases and, at the end, evaluated the tool based on their personal experiences. For this evaluation, the facial hedonic scale was used, which measures the evaluator's level of satisfaction or acceptance in relation to the tested product.

In the first stage of the evaluation, which consisted of solving questions without using the tool, significant variations were observed in the participants' methodologies. Just under half (44%) presented calculations for one or more questions, 36% demonstrated calculations for all questions, while 18% presented only the final result without demonstrating calculations. This data demonstrates the different approaches and levels of detail among the volunteers, which may reflect different degrees of familiarity with solving mathematical problems without the aid of the tool [12]. However, it is also possible to observe that the lack of complete resolution is due to the number of questions presented.

It was observed that those who solved one or more questions always did so in the order presented, and all questions had the same level of difficulty, which suggests that the resolution capacity was not related to the variation in the complexity of the questions, but possibly to the cognitive load imposed by the total number of questions [12].

The results of the Wilcoxon test showed that, for questions 1-1 and 2-1, the volunteers' answers were identical to those of the tool ($p = 1.000$), questions 2-2 and 3-2 obtained a high similarity with the tool's answers ($p = 0.743$ and $p = 0.927$) and questions 1-2 and 3-1 had notable discrepancies with the tool's answers ($p = 0.006$ and $p = 0.581$). These findings indicate that although volunteers can often achieve correct or similar answers to those in the app, there are still situations where errors occur, possibly due to unfamiliarity with the calculations or human error [13].

The consistency of the results provided by the tool ensures that calculations are performed correctly in all situations, regardless of the user's familiarity with the content. In short, using the app can complement volunteers' knowledge, providing an additional layer of security and accuracy in responses [14].

Analysis of the responses revealed a high acceptance rate of the tool by students. Notably, 78% of participants indicated "I loved it" as the emotion that best represents their impression of the usefulness of the tool in their professional practice. This result highlights the positive reception of the use of technology in the veterinary field, especially among young people [15] [8].

The next steps of this study involve using the tool during a semester of veterinary medicine undergraduate courses, with the aim of evaluating student performance and learning. One of the limiting factors observed in the project is the use of the Kotlin language, which is specific for developing tools on the Android system, especially through Android Studio. This choice restricts the tool's scope to smartphones that use the Android operating system, since it is distributed only via the Google Play Store. To get around this, it would be necessary to migrate the programming language to Flutter, allowing development for iOS systems and thus making the tool available on multiple platforms to reach a larger number of students.

CONCLUSION

In this study, a tool was developed to calculate the drug infusion rate using the syringe and drip infusion methods. The tool had a clear interface and intuitive elements, and its usability was evaluated by volunteers, who demonstrated high acceptance. These results indicate a positive reception by students, suggesting that the tool can be a valuable resource in the teaching of undergraduate veterinary students.

The next step will be to evaluate the effectiveness of the tool in the learning of undergraduate veterinary students throughout the course. In addition, it is necessary to expand the availability of the tool on other platforms to reach a wider audience.

STATEMENTS AND DECLARATIONS

All volunteers signed an informed consent form. This study was approved by the Ethics Committee of the University of Mogi das Cruzes (CAAE: 78751924.5.0000.5497). The authors declare that they have no conflict of interest regarding the publication of this paper. The app was made available as open source on the Zenodo platform in (https://doi.org/10.5281/zenodo.14741996).

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DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

AUTHORS' CONTRIBUTIONS

Mariana da Palma Valério: Manuscript writing (total)
Terigi Augusto Scardovelli: Manuscript writing (partial), App development (partial)
Isabella Titico Moraes: Data collection (total)
Luan de Almeida Moura: App development (partial), Data analysis (partial)
Silvia Cristina Martini: Data analysis (partial)
Silvia Regina Matos da Silva Boschi: Data collection (partial)
Tabajara De Oliveira Gonzalez: Data analysis (partial)
Alessandro Pereira da Silva: Guidance, correction (total)

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