

Gamified Medical Terminology Learning Through Chatbot-Based Crossword Puzzles: the Termbot

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Research Article

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Abstract

Background: Medical terminology is usually difficult for students to memorize such long and unfamiliar sound words. It really makes challenging for healthcare students. Ordinarily, there're a variety of ways to learn medical terminology such as memorizing root words or making flashcards. However, students often get half the results with double the effort.

Methods: In order to help students learn medical terminology more easily and interestingly, an online chatbot, Termbot, has been produced in this research that aims to provide learners with an interesting method to enhance their medical terminology by using Termbot on the online platform ©LINE at any time. Compared to traditional independent learning with online interactive learning, the Termbot is a great tool for students in memorizing English medical terminology by playing the Termbot online crossword puzzles. In this study, the experimental method is used to check whether Termbot affects students' academic performance in learning medical terminology. Also, the experimental samples are divided into the experimental group and the control group. As the name implies, the experimental group is the group that accepts experimental operations, while the control group does not accept any experimental operations so that the researcher could compare the differences between the two groups to show the results of the experimental operations.

Results: The interaction between students and Termbot via Line, students can use the online crossword puzzles provided by Termbot to help improve their learning of medical terminology. The experimental result in this study has shown that students trained with Termbot have made significant progress in learning such long medical term words. In addition, the result has also shown that the online Termbot has the potential to improve the learning process and learning outcomes.

Conclusions: As students change their learning behaviors, the use of Termbot has improved their learning effectiveness, which clearly proves that it is a very useful learning tool. Without a doubt, Termbot is not only a great help for students' learning medical terminology but can also be used to assist word learning in other fields.

Trial registration: Not applicable.

1. Background

Medical terminology is not about simple English vocabulary, but clinical thinking and application. The learning process of medical terminology always seems to be full of frustrations. Whether he/she is a doctor or a medical student, their feelings are usually the same. Difficult to understand, difficult to remember, large in number, and rote memorization are common experiences encountered by learners. How to overcome these difficulties? A better understanding and familiarity with medical terminology will help medical students to make better preparations before entering the hospital. In daily life, people don't need to know as many professional medical terminology words as doctors, but it is still quite beneficial to learn some of the most basic medical terminologies. Learning these medical terms may save one's life

when necessary, because it may contribute to a person's health. These medical terminologies can give one a clear idea of which outpatient department of the hospital he/she needs to visit? What kind of specialist doctor to look for? It is also an important help to describe one's problems and situations to the doctor more accurately. In this way, doctors will be able to know more clearly how to treat patients. Knowing medical terminology can also help people engaged in related jobs in the future workplace, such as writing medical articles, translating medical articles, engaging in medical insurance, etc.

Now that smartphones are easy to carry around and can easily be used to customize courses for learners. Obviously, mobile learning has become a common phenomenon. Therefore, learners can study anytime and anywhere, and it becomes more and more convenient to acquire knowledge. Furthermore, Miangah & Nezarat stated that the oral function of mobile learning is very important[1]. Gee used digital games to assist learning[2]. It is generally believed that games can provide a fascinating contextual environment through problem-solving, which can be used as introductory knowledge for active and in-depth learning. Another survey conducted by Taylor has shown that students prefer instant messaging as a communication tool[3]. For these reasons, in this study, an online chat robot that can be installed on mobile phones was designed, which contains some crossword puzzles to help students learn medical terminology.

The Crossword puzzles strategy is an active learning strategy designed to ask students to fill in crossword games prepared by the teacher. According to Kazimoglu, digital games involve providing players with the right solutions to take them to the next level. This motivation has promoted the video game industry[4]. In 2016, global game revenue reached 99.6 billion U.S. dollars, an increase of 8.5% over revenue[5]. The game types include educational games, adventure games, action games, and role-playing games. Atkinson (2003) proposed that "using puzzles" enables language teachers to add color to classroom activities and make them lively by providing challenges and entertainment[6].

Kumar et al. pointed out that online crosswords cannot replace traditional crosswords, but it can offer good and interesting teaching opportunities because it can stimulate students' interest and stimulate their interest in learning[7]. Bailey et al. proposed that crossword puzzles can create a challenging and competitive atmosphere, and promote student interaction in a friendly and interesting environment[8]. Gaikwad & Tankhiwale said that crosswords can stimulate thoughts, increase vocabulary, and help develop healthy skepticism[9].

Patel & Dave pointed out that students appreciated the crossword puzzles, and it has carried important learning activities out. The rational use of crossword puzzles can simplify the delivery of content and provide opportunities for discussion and review of basic concepts of university study[10]. Nicol proposed a unique application of self-generated crosswords. Students can create these puzzles and bring a copy of the complete crossword to the classroom so that other students can practice and solve it[11]. Bhaskar stated that activities such as the crossword puzzles can help break the tediousness of pedagogy and stimulate students' active participation and attention in the classroom[12]. Apparently, the crossword

puzzle is one of the great tools for memorizing vocabulary and the self-learning tool to promote active learning and thinking.

A chatbot is a software application designed to interact with users by using text or text-to-speech conversion. The design is done in a way that the users think they are talking with people on site. Most chatbots utilize artificial intelligence (AI) algorithms or natural language processors to generate the desired response. Early chatbots used simple pattern matching and string processing techniques to interact with users based on rules and generated models, thereby creating intelligence. Nowadays, with new technologies, more intelligent systems have emerged using models based on complex knowledge.

Chatbots have been successfully used in many computer applications. Winkler and Söllner stated that chatbots are becoming ubiquitous in many fields such as medicine, the product and service industry, and education[13]. Chatbots can be used to conduct auditory or textual conversations; furthermore, the growing body of evidence revealed that chatbots have the potential to change the way students learn and search for information. Especially in large-scale learning scenarios with more than 100 students per lecturer, chatbots are able to solve the problem of individual student support. Hussain published a survey study discussing the classification of chatbots, the design techniques used in early and modern chatbots, and how the two main categories of chatbots handle conversational context[14]. Heller stated that Freudbot can help us understand the interaction records and task execution rate of psychology students in distance learning and the results showed that the amount of both was very high. Heller indicated that chatbot technology became a teaching tool in distance learning and online education[15]. Matsuura and Ishimura proposed a study that chatbot and dialogue demonstration with a humanoid robot in the lecture class. The study showed that in science lectures, the researchers compared the use of chatbots with humanoid robots and found that the visualization using chatbots can help students to understand the lecture smoothly [16]. Also, Nurhayati et al stated that chatbots play an important role in users' learning. According to these research studies, it's obvious that chatbots have the potential to improve the learning process and learning outcomes[17].

In order to assist students in learning medical terminology easier and even more interesting, this study intends to propose an amusing method to facilitate students learning medical terminology by using JavaScript, jQuery, and HTML to build a chatbot system with crossword puzzles called Termbot that can be used on LINE platform for students' practice in anytime. In Taiwan, Line is used by most people including students. LINE is a freeware app for instant communications on electronic devices such as smartphones, ipads, laptops, and personal computers. It's provided by Line Corporation, a subsidiary of the Korean Internet search engine, Naver Corporation.

The Termbot provides interactive learning opportunity on Line in order to enhance students' learning motivation and memorize English medical terminology by playing the Termbot crossword puzzles. While the learners complete the crossword puzzles, Termbot has already recorded the medical terminology that the learners filled in incorrectly. According to these data, Termbot will classify the learners into several

groups. Therefore, the teacher can conduct different remedial teaching base on different types of students who answer incorrectly.

2. Method

2.1 Study design

In this study, the experimental method is used to check whether Termbot affects students' academic performance in learning medical terminology. Also, the experimental samples are divided into experimental group and control group. As the name implies, the experimental group is the group that accepts experimental operations, while the control group does not accept any experimental operations so that the researchers could compare the differences between the two groups to show the results of the experimental operations.

2.2 Participants

The participants in this study were 58 nursing students who failed the pretest on the medical terminology exam. Among the 58 students, random selected 29 students were assigned to the experimental group, and the remaining students were assigned to the control group. Then, the teacher provided Termbot to the experimental group students so that they could practice medical terminology after class, while the control group students used the independent learning method without Termbot. Four months later, the 58 students took the final examination of the medical terminology again.

2.3 Study instruments

Termbot proposed in this study is an online chatbot based on LINE. LINE is an instant messaging platform, like Messenger, WhatsApp, Telegram..., developed by LINE Co., Ltd. Users can send messages and watch live broadcasts to other users via the Internet without additional costs, and can use functions such as shopping, mobile payment, and news and information through LINE. The Termbot designed in this study can automatically form the crossword puzzles after the teacher enters medical terminologies and clues. Students can access Termbot through their smartphones, ipads, laptops, or personal computers so that they could play crossword puzzles to practice medical terminologies anytime. The Termbot is designed by using JavaScript, jQuery, and HTML on Window-based systems. Figure 1 is a simplified architecture of Termbot.

3. Termbot

Termbot is an online chatbot that can be operated on a Windows-based system. The major languages used for building Termbot are JavaScript, jQuery, and HTML. On the users' side, they only need

3.1. Input screen

Teachers can use the "input" screen interface to enter medical terms and clues. For example, the teacher can enter the term "obstetrics" and then enter the clue "A medical-surgical specialty concerned with childbirth and midwifery" related to this word to remind the students and help them come up with the answer. The input screen is shown in Figure 2.

3.2. Crossword puzzles generator

In recent years, many researchers have proposed crossword puzzle generators applying in different fields. Bonomo et al. proposed a crossword puzzle generator using genetic algorithms with Wisdom of Artificial Crowds[18]. Yampolskiy et al. proposed the wisdom of artificial crowds algorithm for solving NP-hardness problems[19]. Ginsberg et al. presented the search lessons learned from crossword puzzles[20]. Beacham et al. performed an extensive study of different algorithms, models, and heuristics for solving 50 different crossword layouts by using two different dictionaries, "UK" and "words"[21]. Port et al. presented using a genetic algorithm (GA) and the wisdom of artificial crowds to solve solitaire battleship puzzles[22]. Widodo proposed the crossword puzzle generator using a genetic algorithm with multithreaded fitness calculation[23]. Esteche et al. proposed the automatic definition extraction and crossword generation from Spanish news text[24]. Pintér et al. proposed automated word puzzle generation via topic dictionaries[25]. De Kegel & Haahr presented a detailed survey of existing work in Procedural Content Generation (PCG) for puzzles and reviewed 32 methods within eleven categories of puzzles[26]. Making the crossword puzzle's generator is an NP-hardness problem. After understanding these successful methods and ideas, the online crossword puzzle, Termbot, was created in this research to help students memorize medical terminology more easily. In order to create a suitable crossword puzzle of the online chatbot, teachers only need to enter a set of pre-prepared terms and related clues, and the system will automatically form a crossword puzzle, as shown in Figure 3.

3.3. User interface

The user interface is LINE. Students can choose medical terminology for a certain body system or all body systems to practice. For example, when students want to practice the medical terminology of the circulatory system, the online Termbot will generate a crossword puzzle with the related medical terminology and clues inputted by the teacher, as shown in Figure 4.

4. Results

As mentioned earlier, there are 58 students who failed the pretest in medical terminology. Among the 58 students, 29 are in the experimental group and the remaining 29 are in the control group. After class, the students of the experimental group used the Termbot to learn medical terminology at least 2 hours a week, and the control group students used the independent learning method without Termbot. The experimental results show that the students in the experimental group have made great progress, while the students in the control group did not. The statistical analyses are as follows.

4.1. Statistical analysis of pre-experiment

In this study, an independent-sample t test was used to compare the difference in the means between the control group and experimental group. The control group sampled 29 individuals with an average test score of 54.14; the experimental group sampled 29 individuals with an average test score of 53.31, as shown in Table 1. The test statistic t value is 1.1485, and the probability value p value is 0.2557, which does not reach the significance level of $\alpha=0.05$, so the null hypothesis cannot be rejected. The results of the analysis indicate that there is no significant difference between the control group and the experimental group.

Table 1. Independent-sample t-test for experimental group and control group.

Group	Number	Average	Standard deviation	t	p
Control Group	29	54.14	3.25	1.1485	0.2557
Experimental Group	29	53.31	2.12		

4.2. Statistical analysis of post-experiment

Four months later, the 58 students took the posttest on the medical terminology exam again. The test results show that the students in the experimental group have made significant progress. In contrast, students in the control group did not. The control group sampled 29 individuals with an average test score of 61.48; the experimental group sampled 29 individuals with an average test score of 82.69, as shown in Table 2. The test statistic t value is -10.1604, and the probability value p value is 0.0000, reaching the significance level of $\alpha=0.05$. Therefore, the null hypothesis is rejected, and the opposite hypothesis is accepted.

Table 2. Independent-sample t-test for experimental group and control group.

Group	Number	Average	Standard deviation	t	p
Control Group	29	61.48	7.40	-10.1604	0.0000
Experimental Group	29	82.69	8.46		

The results of the analysis indicate that there is a significant difference between the means of the control group and the experimental group. Among them, the experimental group had a significantly larger mean than the control group. The test results showed that the students in the experimental group made significant progress. In contrast, the students in the control group did not.

In addition, a satisfaction survey was conducted at the end of the training. The scale ranges from 1 (not helpful) to 5 (very helpful). According to the results of the satisfaction questionnaire survey, the average scores answered by the experimental group students all exceeded 4.0. Most students find Termbot helpful and their performance in learning medical terminology has also improved. The results are shown in Table 3.

Table 3. The results of the satisfaction survey of experimental group students

Questions	Mean(S.D.)
1 The Termbot prompted me to explore new challenges.	4.6 (0.87)
2 When playing crossword puzzles on Termbot, I learn new words easily.	4.6 (0.93)
3 I think my process of learning medical terminology on Termbot is very interesting.	4.6 (0.88)
4 Termbot can stimulate my thinking ability.	4.7 (0.85)
5 Termbot is easy to use.	4.5 (0.85)
6 The mobile Termbot allows me to learn anytime, anywhere.	4.5 (0.82)
7 I think using Teambot helps me a lot to remember medical terms.	4.8 (0.81)
8 Compared to studying alone, I prefer to use Teambot to learn medical terminology.	4.8 (0.82)
9 I think Termbot will help me get good grades in medical terminology.	4.7 (0.83)
10 The clues provided by Termbot help me answer the questions correctly.	4.8 (0.81)

5. Discussion

The results of the satisfaction survey of experimental group students were considered advantageous, as shown in Table 3. It is obvious from this result, the Termbot is indeed a good self-learning tool, which satisfies the research questions. More importantly, when student learners practice medical terminology through Termbot, it can help them eliminate their anxiety of remembering medical terminology. Because of the convenience of mobile phones, they can practice medical terminology with Termbot at any time. It can be seen that Termbot is a great assisted self-learning tool. As pointed out by Guo (2013), effective learning and practicing out of class is also important[27]. The results of the analysis indicate that there is a significant difference between the means of the control group and the

experimental group. Among them, the experimental group had a significantly larger mean than the control group.

The test results showed that the students in the experimental group made significant progress. In contrast, the students in the control group did not. This result is the same as the Gamified E-learning in medical terminology: the TERMIlator tool proposed by Seidlein et al., [28]. After the students in the control group learned that the students in the experimental group had greatly improved their medical terminology after using Termbot, they also increased their motivation and expected to use Termbot for medical terminology practice.

6. Conclusion And Future Research

In this study, Termbot, the online crossword puzzle chatbot, was created to provide online interactive learning opportunities on the Line platform to enhance students' learning motivation and to more easily remember English medical terminology. Having the fun of crossword puzzles, learning medical terminology becomes more interesting and effective. The interaction between students and Termbot, students can use the online crossword puzzles provided by Termbot to help improve their learning of medical terminology. The experimental results in this study have shown that students trained with Termbot have made significant progress in learning such long medical term words. In addition, the results can also help teachers identify students' weaknesses and give them appropriate assistance. Obviously, Termbot has proven to be a very useful tool to help students improve their learning. There is no doubt that Termbot can not only help students learn medical terminology but can also be used to assist word learning in other fields. This handy application is designed with precision and meets users' need for a boost of brainpower and a refresher at the same time. This Termbot is for professionals, students, and whoever is interested in increasing knowledge or refreshing what you know in this field. This Termbot can be thoroughly enjoyed whether users are on a bus, or in their comfort zone, or even at work. In order to provide learners with stronger language learning assistance, future research will be extended to develop more user interfaces, such as Messenger, Facebook, etc. In addition, future research will combine Termbot with a recommendation system [29, 30] to make it more effective.

Abbreviations

Not applicable.

Declarations

Ethics approval and consent to participate

Not applicable as only anonymized data have been collected for this study.

Consent for publication

Not applicable.

Availability of data and material

Data are available on request

Competing interests

All authors (MHH, CSY) declare that they have no financial or non-financial competing interests. All authors declare that they have no financial relationships that might be perceived as a potential conflict of interest.

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Authors' contributions

MHH conceptualized the paper and contributed essentially to the writing of this manuscript. She developed the questionnaire to evaluate the pilot implementation of the Termbot. She wrote and approved the final manuscript. CSY provided coding and technical support for the online chatbot-based crossword puzzles: the Termbot.

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Chi-Shun Yu is currently a Ph.D. student at National Taipei University of Technology. His interests are in data mining, e-learning, distance learning.

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Figures

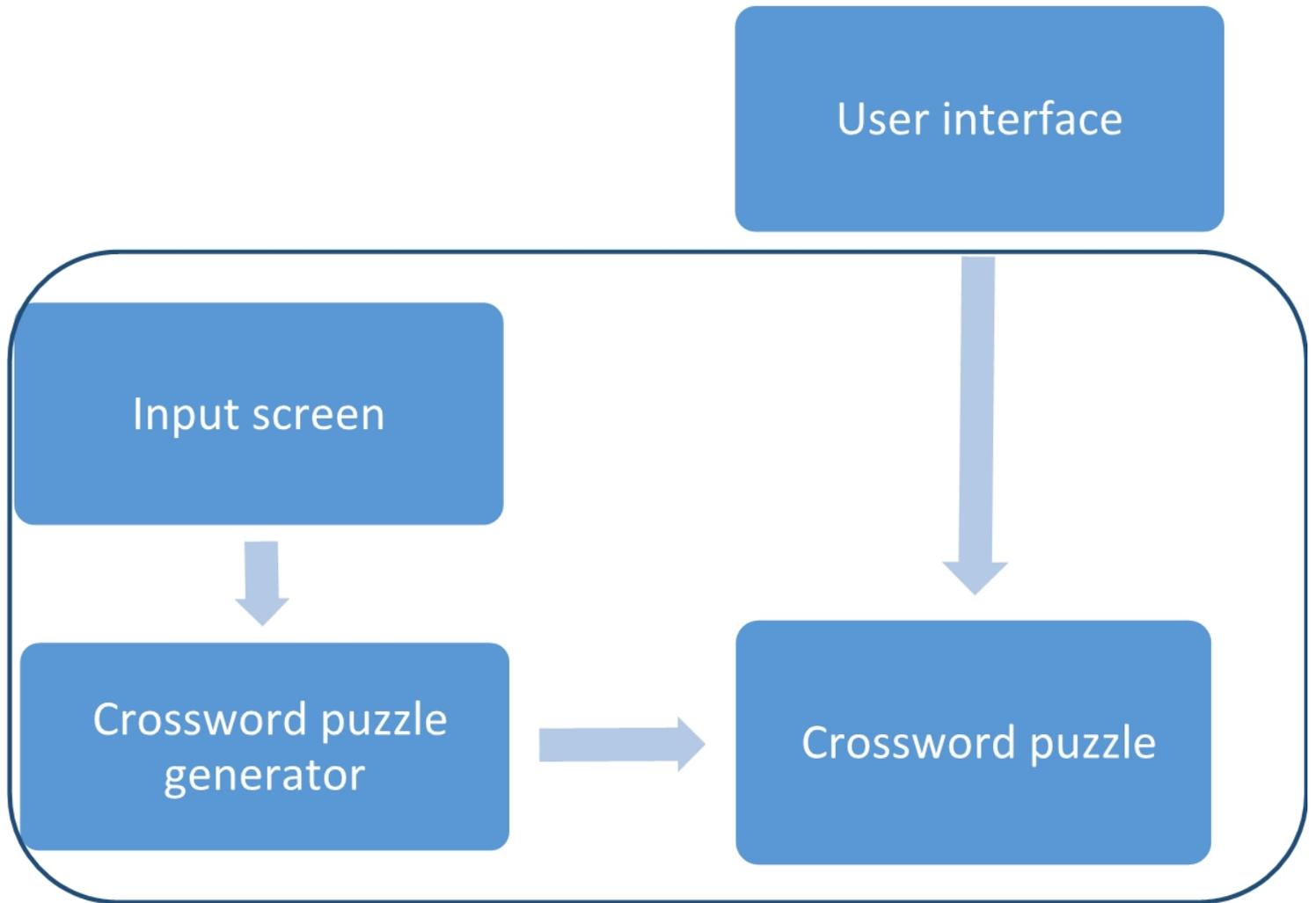


Figure 1

The simplified architecture of Termbot.

Crossword Puzzle Generator

Word 1: Clue 1: Word 2: Clue 2: Word 3: Clue 3:

Word 4: Clue 4: Word 5: Clue 5: Word 6: Clue 6:

Word 7: Clue 7: Word 8: Clue 8: Word 9: Clue 9:

Word 10: Clue 10: Word 11: Clue 11: Word 12: Clue 12:

Word 13: Clue 13: Word 14: Clue 14: Word 15: Clue 15:

Puzzle:

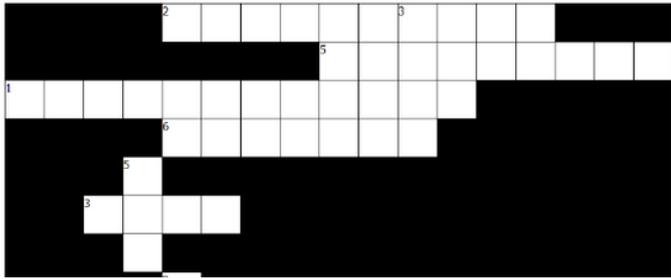
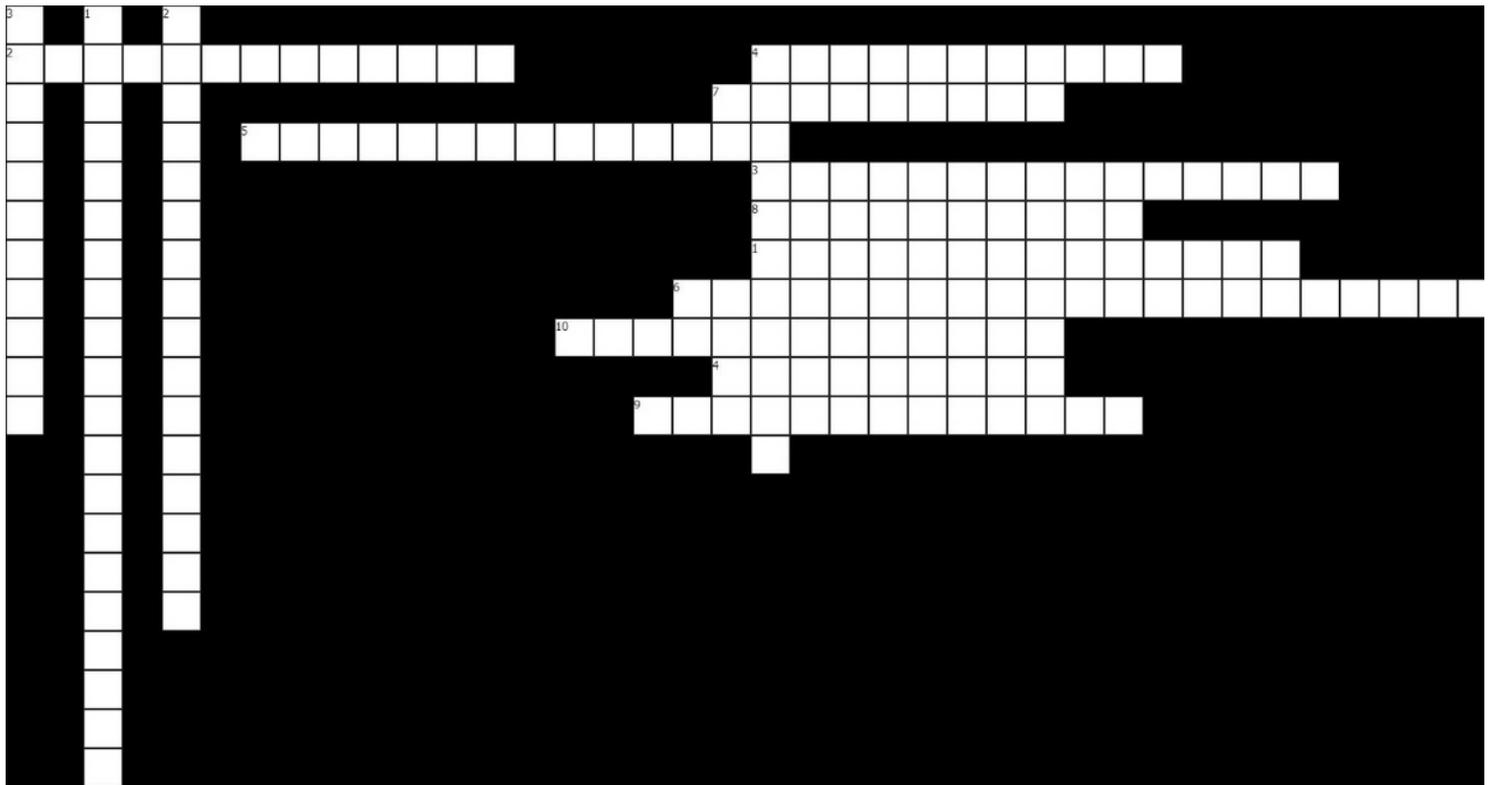


Figure 2

The input screen of Termbot.



Across

Down

- 1 : [An infection caused by the infestation of the larval form of tapeworms of the genus Echinococcus. The liver, lungs, and kidney are the most common areas of infestation.](#)
- 2 : [Analgesic antipyretic derivative of acetanilide. It has weak anti-inflammatory properties and is used as a common analgesic, but may cause liver, blood cell, and kidney damage.](#)
- 3 : [A family in the order Lamiales with several species that are used in TRADITIONAL MEDICINE.](#)
- 4 : [A macrolide antibiotic from Streptomyces narbonensis. The drug has antimicrobial activity against a wide spectrum of pathogens.](#)
- 5 : [Serum globulins with high molecular weight. \(Dorland, 28th ed\)](#)
- 6 : [Surgical fistulization of the LACRIMAL SAC for external drainage of an obstructed nasolacrimal duct.](#)
- 7 : [A free-living soil amoeba pathogenic to humans and animals. It occurs also in water and sewage. The most commonly found species in man is NAEGLERIA FOWLERI which is the pathogen for primary amebic meningoencephalitis in primates.](#)
- 8 : [Any of several generalized skin disorders characterized by dryness, roughness, and scaliness, due to hypertrophy of the stratum corneum epidermis. Most are genetic, but some are acquired, developing in association with other systemic disease or genetic syndrome.](#)
- 9 : [Infection with nematodes of the genus HAEMONCHUS, characterized by digestive abnormalities and anemia similar to that from hookworm infestation.](#)
- 10 : [Excessive or inappropriate LACTATION in females or males, and not necessarily related to PREGNANCY. Galactorrhoea can occur either unilaterally or bilaterally, and be profuse or sparse. Its most common cause is HYPERPROLACTINEMIA.](#)

- 1 : [Simultaneous inflammation of the cornea and conjunctiva.](#)
- 2 : [A family of gram-positive bacteria found regularly in the mouth and intestinal tract of man and other animals, in food and dairy products, and in fermenting vegetable juices. A few species are highly pathogenic.](#)
- 3 : [The presence of viable bacteria circulating in the blood. Fever, chills, tachycardia, and tachypnea are common acute manifestations of bacteremia. The majority of cases are seen in already hospitalized patients, most of whom have underlying diseases or procedures which render their bloodstreams susceptible to invasion.](#)
- 4 : [Surgical incision on the FASCIA. It is used to decompress compartment pressure \(e.g. in COMPARTMENT SYNDROMES; circumferential burns and extremity injuries\) or to release contractures \(e.g. in DUPUYTREN'S CONTRACTURE\)..](#)

Figure 3

The crossword puzzle

