



# Design an Intelligent System to automatically Tutor the Method for Solving Problems

Hien D. Nguyen<sup>1,3\*</sup>, Dung A. Tran<sup>2,3</sup>, Huan P. Do<sup>4</sup>, Vuong T. Pham<sup>5</sup>

<sup>1</sup>Faculty of Computer Science, University of Information Technology,  
Quarter 6, Linh Trung Ward, Thu Duc District, Ho Chi Minh City, 70000, VIETNAM

<sup>2</sup>Faculty of Software Engineering, University of Information Technology,  
Quarter 6, Linh Trung Ward, Thu Duc District, Ho Chi Minh City, 70000, VIETNAM

<sup>3</sup>Vietnam National University – Ho Chi Minh city (VNU-HCM),  
Quarter 6, Linh Trung Ward, Thu Duc District, Ho Chi Minh City, 70000, VIETNAM

<sup>4</sup>Tien Giang Department of Information and Communication,  
02 Le Van Duyet street, My Tho city, Tien Giang province, 84000, VIETNAM

<sup>5</sup>Faculty of Information Technology, Sai Gon University,  
273 An Duong Vuong street, District 5, Ho Chi Minh City, 70000, VIETNAM

\*Corresponding Author

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**Abstract:** Nowadays, intelligent systems have been applied in many real-world domains. The Intelligent chatbot is an intelligent system, it can interact with the human to tutor how to work some activities. In this work, we design an architecture to build an intelligent chatbot, which can tutor to solve problems, and construct scripts for automatically tutoring. The knowledge base of the intelligent tutoring chatbot is designed by using the requirements of an Intelligent Problem Solver. It is the combination between the knowledge model of relations and operators, and the structures of hint questions and sample problems, which are practical cases. Based on the knowledge base and tutoring scripts, a tutoring engine is designed. The tutoring chatbot plays as an instructor for solving real-world problems. It simulates the working of the instructor to tutor the user for solving problems. By utilizing the knowledge base and reasoning, the architecture of the intelligent chatbot are emerging to apply in the real-world. It is used to build an intelligent chatbot to support the learning of high-school mathematics and a consultant system in public administration. The experimental results show the effectiveness of the proposed method in comparison with the existing systems.

**Keywords:** Intelligent tutoring system, chatbot, intelligent problem solver, knowledge engineering

## 1. Introduction

Nowadays, the intelligent system is an emerging trend for the technological application [1]. The chatbot is a piece of software which can communicate to the user through audio or text [2]. An intelligent chatbot using artificial intelligent technologies helps users to complete specific tasks by detecting user purpose from text or voice conversations. Moreover, the chatbot can be used to tutor the user how to solve problems. In that case, with inputted problems from the user, it will be an instructor to guide or give some tips for solving them. Beside the requirement of a user interface

supporting interaction with an intelligent chatbot [3], the foundation of a tutoring chatbot for problem solving includes a knowledge base representing the knowledge domain and an inference engine tutoring how to solve a problem [4].

The tutoring chatbot is an Intelligent Problem Solver (IPS). There are many methods for building IPS systems, such as ontology, frames, scripts, logic [5, 6, 7], and deductive methods: forward chaining, backward chaining, reasoning with heuristic rules [8, 9]. However, those methods have not yet been applied to tutor the method for solving problems in practice, such as: the system supports to learn how to solve exercises in mathematics, and another system instructs the work in public administration.

In this paper, an intelligent chatbot for guiding how to solve problems is presented. The knowledge base of chatbot consists of a knowledge model representing the knowledge domain, a set of hint questions, and a set of sample problems. The knowledge model is represented by the model about combining relations and operators, called Rela-Ops model [10]. Hint questions are tips for instructing the solving method [11]. Sample problems are problems related to the current problem [9]. Using sample problems, the chatbot can find the solution quickly. Based on the knowledge base, the scripts for tutoring have been constructed. From that, the general algorithms for tutoring engine are also designed. Those algorithms make the communication between the chatbot and the user to search a solution of a problem. The knowledge base combining those algorithms make an intelligent tutoring chatbot.

The architecture of intelligent chatbot is utilized to build an intelligent system for supporting the learning of high-school mathematics and a consultant system in public administration. The kind of exercises about surveying a function/map is important in high-school exams. It usually appears in Vietnamese high-school tests. The intelligent tutoring chatbot is designed as a lecturer to instruct the learner studying the method for solving problems in this kind. Beside that, in the service of public administration, the license of printing is a necessary document of the enterprise of information and communication. The intelligent chatbot helps the resident to know how to complete the procedure online for getting the license of printing. It can solve problems to consult the suitable document of this work. This bot has been tested at Department of Information and Communication of Tien Giang province, Vietnam.

The next section presents related work for building the intelligent chatbot for solving problems. Section 3 designs an intelligent tutoring chatbot to solve problems. This chatbot includes a knowledge base representing the knowledge domain and a tutoring engine for instructing the method of problem solving. Section 4 and section 5 present the application of the architecture of intelligent tutoring chatbot in building an intelligent supporting system in the learning of high-school mathematics and a consultant system in public administration, respectively. The conclusion of this paper and some future works are presented in the last section.

## 2. Related work

There are many studies about designing of chatbots in many domains, such as supporting the learning, services consulting, communication in social. However, those bots have some limitations.

In [12], the authors present a framework of a chatbot to detect information from the cameras. The information between user and Human Detection Server of this bot is transformed by using Facebook Messenger Platform. Beside detecting human in real-time, it can use transfer learning with more case taken from surveillance camera to update dataset for retraining. Nonetheless, it does not have a knowledge base to solve problems automatically.

The study in [13] designs and implements a supporting chatbot for the airport. This research presents the engineering process and the details of the working prototype of an airport chatbot. Nevertheless, this bot cannot reason to recognize the problems which need to be solved.

Xiaocle is an empathetic social chatbot with an emotional connection [14]. It is integrated both intelligent quotient (IQ) and emotional quotient (EQ) in the designing of that system. The architecture of the system includes core chat, skills, dialogue manager, and an empathetic computing module. This bot can recognize feelings and states of human, and react to user needs dynamically. However, this bot is general, so it cannot solve some characteristic problems in a major knowledge domain.

The IPSs are also emerging applications for teaching and learning in STEM education [15]. Those systems are equipped the knowledge base to support high-school students self-studying and training [16], especially in learning of mathematics. The students can enhance their problem-solving skill for final high-school exams through the refresher training [5]. In every Vietnamese high-school exam for 12<sup>th</sup>-grade students at mathematics, which are semester exams and the graduation exam, the problems about surveying a function always appear [17]. The current programs only draw a graph of a function, they do not have steps to instruct how to do it, and problems related to determine the value of a parameter cannot be solved.

Mathway [18] and Math Solver [19] are applications for solving many kinds of mathematics. They can show their solutions of problems. However, they only support to draw a graph of a function, they cannot consider neither the function's properties nor determining the parameter to meet some given conditions.

The educational application requires higher requirements for the problem solving. Beside the proofs which are generated automatically by the system are the same as those in the usual textbooks, the system also helps the learner to

analyze how to get those proofs. This intelligent software has better be interactive. It can communicate to the learner to instruct or give some tips for the solving method. The intelligent chatbot in [11] is potential to apply in practice, it meets the requirements of learning in high-schools.

The consultancy in services of public administration is the necessary for supporting the residents. Some of consulting systems have been studied, such as the system for Estimating Costs of an Information Technology Hardware Project [20], consultancy for sexual and reproductive health [21], and healthcare [22], The improvement of the architecture of the chatbot in [11] can apply in building the consulting system for public administration.

### 3. Design the Intelligent tutoring chatbot

When the user has a question or a problem, the intelligent chatbot will instruct the method for solving problem. It will give some questions to orient a solution of the current problem. Through the answer of user, it will give the next suitable question. The working of this bot simulates the working of an instructor to the user.

#### 3.1 The architecture of the intelligent tutoring chatbot

The architecture of the intelligent tutoring chatbot is established based on the combining the architecture of an IPS [10] and the chatbot architecture [4] as Fig. 1. This architecture includes a knowledge base representing the knowledge domain and an inference engine tutoring how to solve a problem.

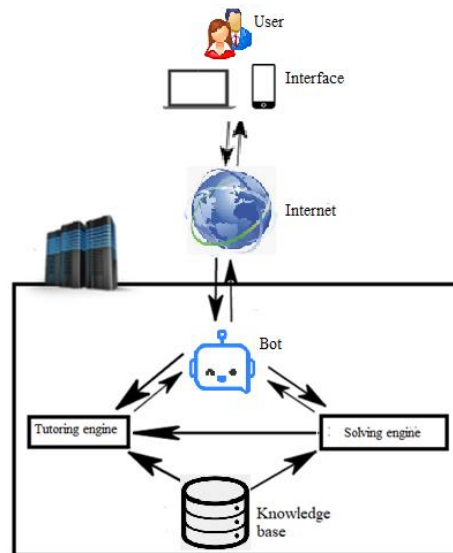


Fig. 1 - The architecture of the intelligent system for tutoring

In Fig.1: When receiving an inputted problem from the user, the bot passes it to the tutoring engine. Using knowledge base, the tutoring engine selects a script tutoring how to solve the current problem. From the result of tutoring engine, the system can communicate to the user for orienting to the solution. Moreover, the system also uses solving engine to find the solution of that problem by using the knowledge base. The operation of the solving component was studied in [10, 23]. The next section presents the designing of the tutoring engine.

#### 3.2 Construct the script for tutoring

Firstly, problems of the knowledge domain have been classified. For each classified kind, the system has a script tutoring the solving method. Based on those scripts, the system converses to the user. It gives some hint questions or some tips to lead to a step-by-step solution. After the tutoring process, the system can show all steps of the current problem's solution. Some scenarios of the general script for instructing the solving method are as follows:

**Scenario 1:** Collect problems in the knowledge domain and classify kinds of them.

**Scenario 2:** Though the practical cases and the comments of experts when solving collected problems, design some hint questions which were used to remind the knowledge. Those questions orient the deductive way at each step of the solution.

**Scenario 3:** Repeat the list of related knowledge at each step.

**Scenario 4:** After the previous scenario, if the user still cannot understand or do at that step, the system will show an example of a similarly step.

**Scenario 5:** Guide the user to solve the problem completely.

### 3.3 Knowledge base of the intelligent tutoring chatbot

The knowledge base of an intelligent bot includes three components shown in Fig.2:

$$\mathcal{K} = (KB, SP, Q)$$

In which, KB is the knowledge base of the knowledge domain. The knowledge base of the intelligent tutoring chatbot is organized by Rela-Ops model, which is a knowledge model representing the combination between relations and operators [10]. SP is a set of sample problems. Sample problems are problems related to the corresponding method [9]. Q is a set of hint questions. Each question includes the content of question and answers for tutoring the solving method.

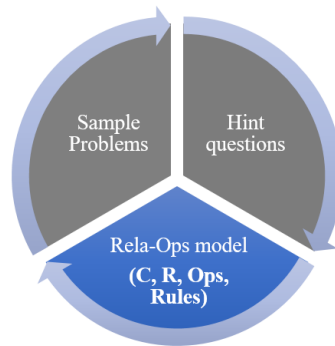


Fig. 2 - The knowledge base of an intelligent chatbot for tutoring.

#### 3.3.1 KB - Knowledge base of the knowledge domain

The knowledge base of the knowledge domain is organized by Rela-Ops model, which is the knowledge model combination relations and operators. Rela-Ops model consists of four components [10, 30]:

$$(C, R, Ops, Rules)$$

- **C** is a set of concepts. Each concept is a tube (*Attrs, Facts, EqObj, RulObj*), which *Attrs* is a set of attributes, *Facts* is a set of facts, *EqObj* is a set of equations, and *RulObj* is a set of deductive rules of the concept. Beside the structure, each concept is a class of objects which have behaviors to solve problems by themselves.
- **R** is a set of relations between concepts in **C**. It contains hierarchical relations and other binary relations.
- **Ops** is a set of operators between concepts in **C**. It contains unary and binary operators.
- **Rules** is a set of inference rules. There are three kinds of rules: deductive rules, equivalent rules, and equation rules.

Rela-Ops model is an ontology which was constructed based on object-oriented approach. The structures of the model's components have been presented in [10, 30].

#### 3.3.2 SP – Set of Sample problems

A sample problem is a problem related to a method for solving the current problem. The criteria of a sample problem are: it has the high frequency to use in the knowledge domain, and the number of objects in it is small. The structure of the sample problem is a tube:

$$(H_P, D_P)$$

where, **H<sub>P</sub>** is the hypothesis of sample problem, and **D<sub>P</sub>** is the list of rules can be applied on **H<sub>P</sub>**. Using the sample problem, the system can find the method for solving the current problem more quickly. The algorithms for solving problems using Sample problems have been studied in [11, 24].

#### 3.3.3 Q – Set of hint questions

Each hint question is a communication step of the chatbot with the user. It is used to instruct the method for solving problem. The structure of a hint question includes the content of questions and their answers for tutoring the solving method.

$$(Content, Ans, Hint)$$

where, **Content** is the content of the question. **Ans** is the exactly answer of the question. **Hint** is the set of sub-questions to get the exactly answer. The Content and Hint-set are built based on the collection from the expert and the practice of knowledge domain. Some examples of hint questions are presented in Table 2.

### 3.4 Design algorithms for tutoring

The tutoring script is the foundation of algorithms for instructing the problem-solving method. In the general tutoring script, the building of hint questions in scenario 2 is very crucial. It collects tutoring steps of an instructor in practice. It shows the communication of the chatbot and the user. The tutoring script is used to build the tutoring engine of a bot. In this section, the questions-answering (QA) algorithm of the user and the bot is presented. Based on that QA algorithm, the algorithm for tutoring how to solve problem is designed.

#### 3.4.1 Question-Answering algorithm of the user and bot

The system has a set of hint questions collected from the knowledge domain. Those questions also can be given from experts. The QA process simulates the tutoring in the practice as follows:

At each step for searching the solution of the inputted problem:

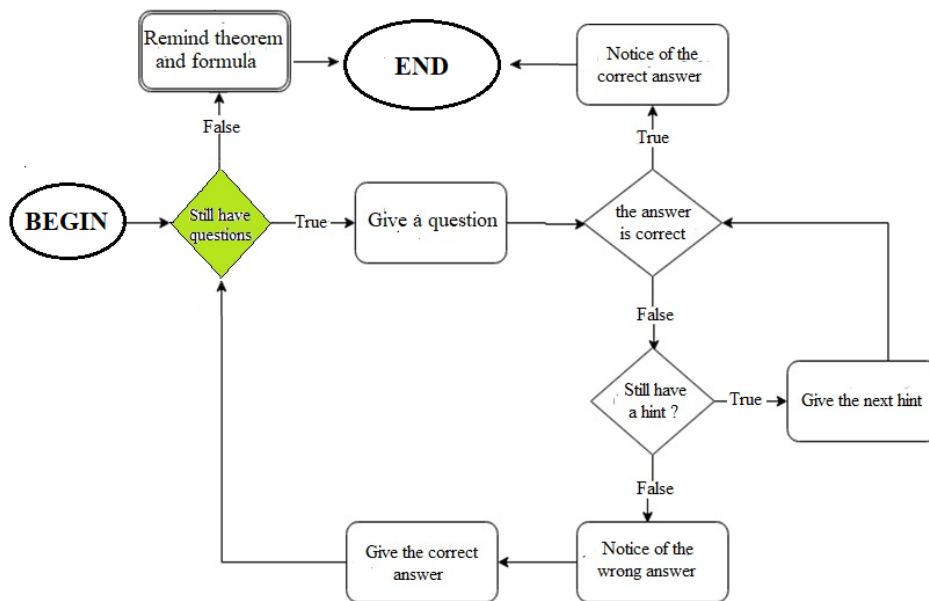
**Step 1:** The chatbot gives a hint question and the user answers it.

**Step 2:** Check the user's answering:

If the answer is wrong, the bot continues to give some other hint to lead the user getting the correct answer. If all of hints are used, the system will present the solution of the question.

**Step 3:** If the system still has hint questions, the system will go back to Step 1.

If there are not any hint questions, the system will go to the next step of the solution.



**Fig. 3 - Question-answering algorithm of the user and chatbot.**

#### 3.4.2 Tutoring algorithm for solving problem

After QA process, the user understands the method for solving problem and the system tutor it step-by-step.

At each step of the solution:

**Step 1:** The system shows some outcomes of this step. The user does them and inputs their results.

**Step 2:** Checking of results.

2.1 If (the inputted result is right) Goto Step 3.

2.2 If (the inputted result is wrong or the user cannot do it)

If (the system still has hint questions)

Goto Step 1.

Else

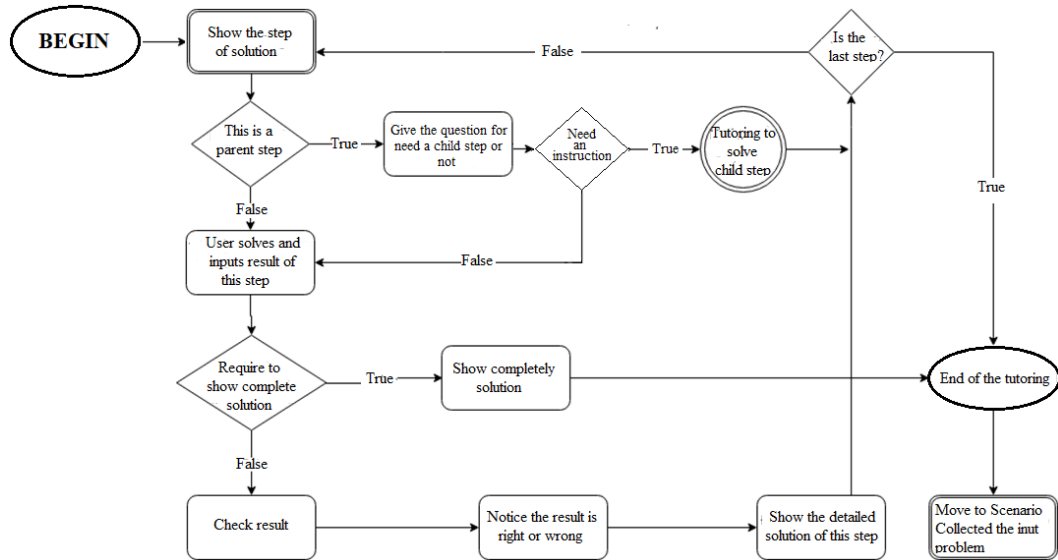
The system presents the correct result of this step.

**Step 3:** If (this step is the last)

Show all solution steps of the problem.

Else

Move to the next deductive step.



**Fig. 4 - Tutoring algorithm for solving problem.**

#### 4. Intelligent Consulting System in Public Administration

The chatbot has been applied in many social services in Vietnam, especially in public services. For example, chatbot 1022 supports the information of public services in Danang city, Vietnam [25]. In the service of public administration, the license of printing is the necessary document of an enterprise of information and communication [26]. For getting this license, the company must understand the procedure of the printing license permitting completely. However, because related to the information and communication, this procedure is very complex, it has many documents which belong to the kind of enterprise and the purpose of the enterprise [26, 27 28].

In this section, an intelligent chatbot that consults the suitable document for online submitting to complete the procedure of of the printing license permitting. The chatbot helps people to know how to complete the online procedure. Beside the ability for automatically consulting the procedure, this chatbot can answer or solve some commonly questions of the users when they submit document. This work makes people more convenient in dealing with the documents of public administration. The consulting chatbot has been tested at Department of Information and Communication of Tien Giang province, Vietnam.

##### 4.1 Knowledge base of the consulting system

Knowledge base of the consulting chatbot for tutoring how to get a printing license is organized as the model (KB, SP, Q). The knowledge domain KB is organized by the Rela-Ops model. It is collected from the law documents [26, 27, 28], the practice and the consultants of public administration.

The kinds of problems about permitting a printing license are classified as Table 1:

**Table 1 – The classification of consulting problems about permitting a printing license.**

Kind	Name	Content
1	Consulting an online procedure.	Present the detailed steps for the online procedure.
2	Consulting about where people can online submit the procedure.	The problem determines the answer about where does provide online procedures. Example: Department of Information and Communication provides the online procedure of printing license.
3	Consulting about how to make a particular online procedure.	The problem determines the steps to make an online procedure.
4	Consulting about how to pay the fee of online procedure.	The problem determines the answer of fee of an online procedure.

5	Consulting about how to receive the result of a particular online procedure.	The problem determines the answer about receiving the result of an online procedure.
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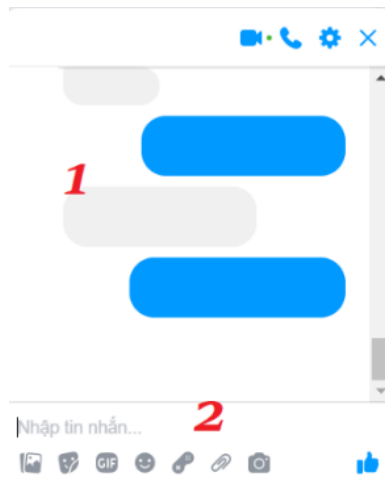
The set of hint questions  $Q$  is retrieved from the questions of people when they want to get a printing license. It is also collected from the consultant at the office of Publishing and Printing, Tien Giang Department of Information and Communication. Some hint questions about the fee of an online procedure and how to receive the result are shown in Table 2:

**Table 2 - Hint questions for consulting of permitting a printing license**

Kind	Solving method	Hint question (H: hint, Q: Question, A: Answer)
Consulting about where people can online submit the procedure.	<ul style="list-style-type: none"> <li>• S1: Determine the fields to be online submitted the procedure.</li> <li>• S2: Determine the provider of the filling document.</li> <li>• S3: Determine the necessary documents of the procedure for online submitting.</li> </ul>	Q: Which field do you want to submit? A: Photocopy H: Printing and publishing?
		Q: Do you want to get license for printing? A: Yes. Q: Is local or nation license? A: Local, please H: The Department of Information and Communications is the provider.
Consulting about how to make a particular online procedure.	<ul style="list-style-type: none"> <li>• S1: Search the procedure to be submitted.</li> <li>• S2: Check the related documents.</li> <li>• S3: Determine documents that need to be notarized.</li> <li>• S4: Fill in the information.</li> <li>• S5: Determine the method to pay the fee.</li> <li>• S6: Determine the method for receiving the result.</li> <li>• S7: Compute the date for receiving the result.</li> </ul>	Q: How many cases of this procedure? A: Three (3)
		Q: How many related documents of printing license? A: Three H: What is the related documents?

## 4.2 Results of testing

Facebook Messenger [29] is a messaging application and platform developed by Facebook Inc. The user-interface of the consulting chatbot for tutoring how to get a printing license is designed via the platform of Facebook Messenger.



**Fig. 5 - The user-interface on Facebook Messenger of the consulting chatbot.**

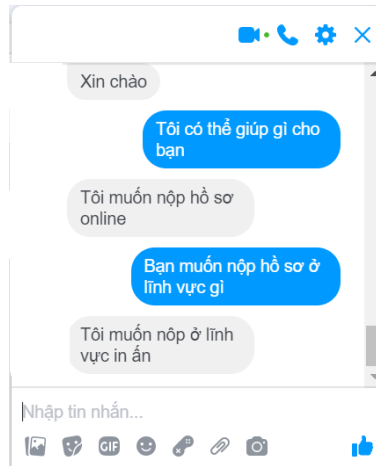
In Fig.5, there are two main components in the user-interface of the consulting chatbot:

- (1): Display the QA process between the user and the bot.
- (2): The typing frame of the user. It also supports the link of documents.

Example 4.1: Consulting the necessary documents for online submitting of the printing license procedure (Fig. 6).

At the first, the user inputs the problem that need to be consulted. After that, the chatbot tutors how to do the procedure for printing license. It will give some necessary documents and the methods to get them. It also can answer to the user automatically for the frequently asked questions. Based on the question of the user, it will give the tips to do it for supporting the submitting of the print procedure.

If the user does not know or cannot do at any step, the bot will give an ordinary method for the similarly step. He/She can work following the sample solution. At the end, the bot will conclude all tutoring steps for online submitting this procedure.



**Fig. 6 - A consulting process of the bot.**

The consulting chatbot has been tested at Tien Giang Department of information and communication, Vietnam. The issues for testing are collected in practice. They are real cases in the consultation process about the procedures of permitting of printing license at Tien Giang province. There are two kinds of printing licenses in Vietnam:

- The photocopy licenses: those licenses permit residents or enterprises can work in printing and photocopy.
- The publishing licenses: those licenses permit enterprises can work in publishing of magazines or books.

Results of testing the consulting for tutoring those online procedures are as Table 3:

**Table 3 - Result of tutoring on printing license.**

Group	Test cases	Successful cases	Proportion
The online procedures about photocopy licenses	20	16	80%
The online procedures about publishing licenses	23	19	82%

The consulting bot can instruct some commonly online procedures of printing license at Tien Giang Department of Information and Communication, Vietnam. Its instructions are suitable to people. Nevertheless, the consult in some cases is still machinery. The instructions are not flexible with actual situations. Besides, some procedures cannot work because those are very difficult which require the depth-knowledge of the consultant.

Chatbot 1022 is a call-center for supporting the information of public services in Danang city, Vietnam [25]. Table 4 compares our system and Chatbot 1022 about the ability to automatically tutor the public services.

**Table 4 - Comparison between chatbots for the public services.**

Function	Chatbot 1020	Our system
User-Interface	The user-interface of these systems is design based on the platform of Facebook Messenger, so people interact with them easily.	
Tutor the public services	<ul style="list-style-type: none"> <li>- It can support the user in many public srevices.</li> <li>- It only give the information of each public service.</li> <li>- It does not a knowledge base, the information of this system is hard. Thus, it cannot solve the problem or understand requirements of a user.</li> </ul>	<ul style="list-style-type: none"> <li>- It only support to tutor the online procedures in printing license.</li> <li>- It has an adequate knowledge base about this knowledge domain.</li> <li>- It can solve the problems of a user as well as give some hints to answer the questions of people.</li> </ul>



## 5. Intelligent Tutoring Chatbot for Solving Problems in Mathematics

With 12th-grade students in high-schools, the system supporting the learning of mathematics is very essential to improve their problem-solving skill [31]. The students can train and self-study their ability about solving problems. This supporting system can play as an advisor to guide some skills for solving a mathematical problem [32]. The problem about surveying a function is a crucial kind in Vietnamese high-school mathematical exams. This kind has two types of exercises:

- (1) Considering properties of a function or a map;
- (2) Determining the parameter's value such that some properties of a given function are satisfied.

At the first type, the student has to examine some characteristics of a function, such as considering the monotonic ranges, asymptotic convergence, determining the convexo-concave, drawing the graph of the function. Those characteristics help the learner understanding more the function, and the examining them is also solution steps of the problem about considering function's properties. The second type, which is determining the parameter's value, is a hard problem for high-school students. This kind must to be solved in every high-school exams [17].

The tutoring chatbot for solving those kinds of mathematical exercises is designed at two aspects: instructing the method for solving or giving some tips, finding the step-by-step solution which is deduced as human reasoning. This system plays as a tutor assistant for learners studying the knowledge of surveying a function.

### 5.1 Knowledge base of the system

The knowledge base of this tutoring chatbot is represented by the combination of Rela-Ops model and scripts of the knowledge domain. This intellectual is accumulated from exercises in [33] and Vietnamese high-school exams [17]. The collected exercises are distinguished as follows:

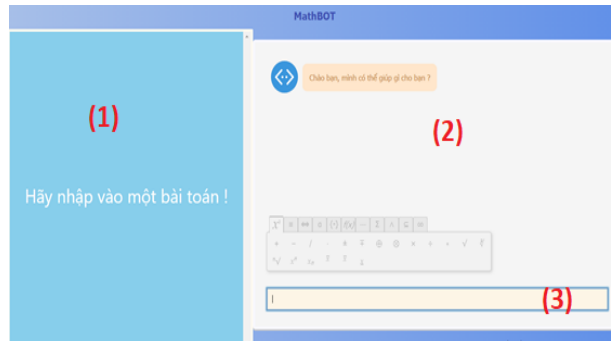
- Kind 1: Survey and consider properties of a certain function/map
- Kind 2: Determine a tangent of a function at a point.
- Kind 3: Determine the parameter's value such that a function is monotonic on a certain range.
- Kind 4: Determine the parameter's value such that some conditions about extremes of a function.
- Kind 5: Consider the number of roots of an equation based on a parameter.

The hint questions of this bot are accumulated from high-school lecturers in mathematics. They are also extracted from the joining mathematical classes in practice. Based on the kinds of exercises in this knowledge domain, those hint questions are classified to apply in the real-word suitably. Table 5 presents some hint questions for exercises about surveying a function.

**Table 5 – Hint questions for problems about surveying a function**

Kind	Solving method	Hint question (H: hint, Q: Question, A: Answer)
Surveying a certain function $f(x)$	<ul style="list-style-type: none"> <li>• Step 1: Determine the domain of <math>f(x)</math>.</li> <li>• Step 2: Compute the derivative and its roots.</li> <li>• Step 3: Determine the limitations of <math>f(x)</math> at infinity.</li> <li>• Step 4: Draw the monotonic table of <math>f(x)</math> and get the results of its extreme points.</li> <li>• Step 5: Draw the graph of <math>f(x)</math></li> </ul>	Q: How many steps for surveying and drawing a function? A: Four (4). H: Five or six ?
		Q: What do you do for the first work? A: Compute the domain of function.
		Q: What is the kind of table for surveying? A: The monotonic table H: The table shows information about increase and decrease ranges.
Determining the parameter's value such that the graph of the cubic function $f(x)$ has only one share point with the horizontal axis.	<ul style="list-style-type: none"> <li>• Step 1: Compute the derivative <math>f'(x)</math> of the given cubic function <math>f(x)</math>.</li> <li>• Step 2: Case 1: if the function does not have any extreme points <math>\Rightarrow</math> The equation <math>f'(x) = 0</math> has the multiple root or does not have any roots.</li> <li>• Step 3: Case 2: if the function has two extreme points <math>\Rightarrow</math> those points are located on two sides of the horizon axis.</li> <li>• Step 4: Conclude the results.</li> </ul>	Q: How many cases of this problem? A: Two (2)  Q: If the function has extreme points, what is the relations between those points? A: Locate on two sides of the horizon axis. H: What is the axis ?

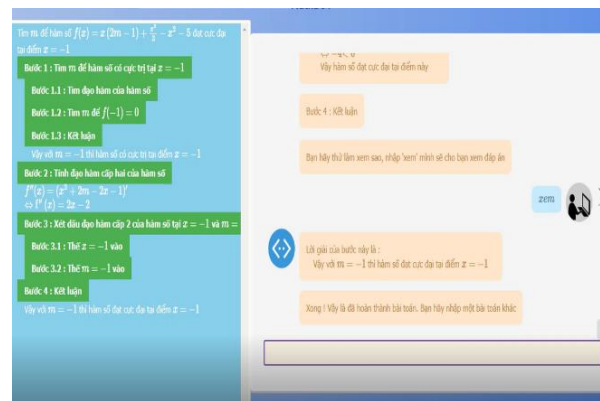
### 5.2 Results of testing



**Fig. 7 - User-interface of the chatbot**

- (1): The solving process of the user.
- (2): The QA process between the user and the bot.
- (3): The typing frame of the user. It supports to type mathematical symbols and formulas.

Fig. 7 shows the user-interface of the chatbot for instructing to solve mathematical problems about surveying a function/map. Firstly, the function and its requirements are inputted by the user. Secondly, the chatbot guides to solve this problem step-by-step. It tutors by giving some hint questions related to the current solution step. If the user answers correctly, the bot will give the next question. If not, it will continue to give some tips for the current step. After finishing the hint, the bot can remind some definitions, formulas, or theorems to solve the current problem. Finally, the bot can show all steps of the solution. Fig. 8 shows some instructing steps for solving an exercise.

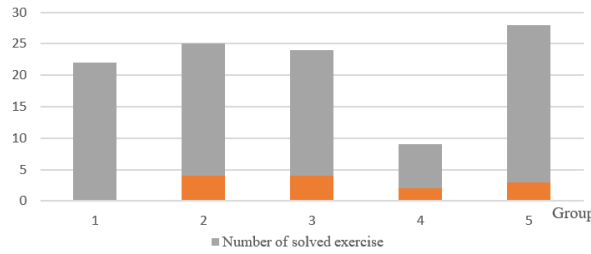


**Fig. 8 - The tutoring process of the chatbot**

The tested exercises are collected from [17, 33]. The tutoring bot has three main functions: (1) A problem can be inputted naturally by using mathematical symbols; (2) The instructions are clearly, step-by-step and similarly to the working of an advisor; (3) The user-interface is friendly and simple to use. The testing results for this tutoring system are as Table 6 and Fig. 9:

**Table 6 - Result of tutoring for solving exercises**

Kind	Number of exercises	Number of solved exercise	Proportion
1	20	20	100%
2	25	21	84%
3	24	20	83%
4	9	7	78%
5	28	25	89%



**Fig. 9 - Results of testing**

This chatbot can do some kinds of mathematical problems at high-school about surveying a function. Its tutoring is suitable the intellectual level of students, and the tutoring method is similarly the advisor. However, there still has some cases are not naturally, they are still machinery. Those guiding follow a determined process and they are not flexible with actual situations. Besides, some problems require the combination of knowledge (such as geometry, vector algebra) for solving, then they are very hard problems; thus, the system cannot solve them.

Mathway is a mathematical website for solving exercises [18]. It can work as a chatbot to communicate with the user. Table 7 compares Mathway and our system for solving problems about surveying a function/map.

**Table 7 - Comparison for solving problems about surveying a function**

Function	Mathway	Our system
Solving the problems	<ul style="list-style-type: none"> <li>- It only can draw a map.</li> <li>- It cannot consider properties of a function, such as the convex-concave, monotonic ranges.</li> <li>- It cannot solve the problems about computing the parameter's value to satisfy some properties of a given function.</li> </ul>	<ul style="list-style-type: none"> <li>- Beside showing the graph of a function, it can analyze some basic properties. That analyzing is also solution steps to solve problems about surveying a function.</li> <li>- It can solve the commonly problems related to parameter to satisfy some properties of a given function.</li> </ul>
Tutoring the solving method	The communication between the chatbot and user is basic. It does not lead to the tutoring of the solving method.	<ul style="list-style-type: none"> <li>- It has a script to tutor the method for solving a problem.</li> <li>- The question-answering of the system tends to find a solution of the problem.</li> </ul>

## 6. Conclusions and Future work

In this paper, the architecture of an intelligent bot to tutor the problem solving is presented. The bot includes a knowledge base representing the knowledge domain and a tutoring engine for solving problems. The knowledge base consists of a knowledge model, a set of hint questions and a set of sample problems. This knowledge base can automatically solve problems in knowledge domain. The tutoring engine is constructed based on the tutoring scripts. Through that, algorithms for questions-answering and tutoring are designed. They make the chatbot as an advisor tutoring the method for finding the solution of a problem.

The architecture of the intelligent tutoring chatbot is utilized to design an intelligent system to support the learning of high-school mathematics and a consulting system in public administration:

An intelligent tutoring chatbot can work automatically to lead the learner how to solve high-school mathematical problems about surveying a function. It is an instructor giving the explanation of each step in the proof. This system can interact to the learner as the communication between the teacher and the student. Its instructions help the students catching the solving method and they can enhance their problem-solving skill.

A consulting system for tutoring the online procedures of permitting a printing license helps the people to know how to complete the online procedures. It can solve problems to consult the suitable document of this work. This chatbot is designed via the platform of Facebook Messenger, so people can use it easily. It plays a consultant to tutor the necessary document for online submitting the procedures of printing license. This bot also has been tested at Tien Giang Department of Information and Communication, Vietnam.

In the future work, the intelligent tutoring chatbot has been developed. Some tutoring techniques will be improved to solve more hard problems with complex requirements. This system will be set up as an intelligent mobile application. Besides, the natural language processing will be studied for the natural communication of the chatbot.

Besides, the collaboration and integration of knowledge can apply to different fields [31]. The emerged knowledge model will be studied to integrate many knowledge domains. That integrating model will enhance the ability to solve problems which requires the depth-knowledge in many fields.

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