CHATBOTS IN EDUCATION

A passing trend or a valuable pedagogical tool?

Department of Informatics and Media
Uppsala University
Abstract

Digitalizing education and reinventing the learning experience is one of the big challenges in this age of information. In the field of E-learning, the application of a chatbot as part of the education has shown interesting potential, both as a teaching and administrative tool. Chatbots have been 'trending' for a few years and quite a few papers examining it in the educational sector have been published, albeit very little interest seems to have been given to the summation of this knowledge. In an attempt to fill the knowledge gap this thesis performed a literature study to examine the documented features and possible uses for chatbots in an educational context. Since quite a few chatbot technologies have been developed at this time and exhibit varied functions, this study was limited to only examine bots based on the XML derived language AIML.

The results imply that chatbots in education have quite a few uses and even more possible features. An AIML-based chatbot can be both simple and complex to implement, all depending on the effort put into implementation. The tool is diverse and may be used for many different purposes and aims, the only limitation being the creators creativity and imagination.

Keywords: Chatbot, Artificial Intelligence Markup Language (AIML), Artificial intelligence (AI), Education, Learning, E-learning
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Chapter 1

Introduction

Chatbots are trending and they can now be found in almost every industry from e-commerce to travel. The increased use of late may be due to improved language processing or the more accessible development tools for non-developers. It may also be that many chatbots are made available through mainstream messaging applications, thus not forcing the user to download yet another application and allowing them to keep using an application they are already comfortable with. (Jennifer Lachs, 2017). But what is a chatbot?

1.1 Defining the chatbot

A chatbot is a computer program that is designed to simulate a conversation with its users, often over the Internet. Furthermore the analogy that a chatbot often treats a conversation like a game of tennis can be used to describe the conversation flow of a chatbot, i.e. get message, reply, get message, reply, and so on (The Oxford Dictionary, 2018). Deryugina (2010) provides almost the same definition, but adds the word 'intelligent' before communication, specifying the need for intelligent replies rather than just random ones. The chatbot technology has been referred to by many names, the more established ones include: Chatbot (can be spelled chat bot, chat-bot as well), Chatterbot, Conversational Agent, Conversational System and Pedagogical Agent (or Intelligent Pedagogical Agent, IPA). The last is exclusively used in educational settings or educational papers. (Deryugina, 2010; Doering, Veletsianos, and Yerasimou, 2008; Heller and Procter, 2009). Chatbots are build in many ways, but a popular and quite simple way is through the use of AIML, which is presented in the next section.

1.2 AIML - The brains of the chatbot

Artificial Intelligence Markup Language or AIML was built to work as the brain of the chatbot

```
<category>
<pattern>DO YOU KNOW WHO * IS</pattern>
<template><srai>WHO IS <star/></srai></template>
</category>
```

Figure 1.1: Simple AIML object

Artificial Intelligence Markup Language or AIML was built to work as the brain of the chatbot
by Dr. Wallace and an open source community (the Alice foundation) (Pandorabots, 2018b; Kerly, Hall, and Bull, 2007). It is a derivative of XML that AIML enables the botmaster (the person who manages the chatbot) to add knowledge to the chatbot, with the AIML files as the chatbots’ knowledge base or brain. These files consist of AIML objects (see figure 1.1), which are made up of sets called topics and categories. A category is the basic unit of knowledge in AIML, and each category consist of an input question, an output answer, and an optional context. The question is the pattern and the answer the template. The language used in the AIML pattern or template is simple, consisting of words, spaces and wildcard symbols like _ or *. The words can be letters or numbers, but no other characters. There are two primary types of optional contexts that can contribute more advanced functionality to the chatbot, <that> and <topic>. The <that> tag is inside the category and its pattern always match what was last said by the chatbot, something that is important when chaining conversations. The <topic> tag is found outside the category, and can be used to group categories together. (Pandorabots, 2018a)

AIML use recursion in order to connect patterns that have synonymous meaning to each other, this way the botmaster can streamline the production of categories. The tag <srai> is used to achieve recursion and it has many uses, some of these are 1) Symbolic reduction: Reducing more complex terms to their simpler equivalents, 2) Divide and Conquer: Split an input into subparts, then combine the answers again, 3) Synonyms: Map synonyms of a phrase to the same reply, 4) Spelling or grammar corrections, 5) Detecting keywords anywhere in the input, and 6) Conditionals: Branching patterns. An example AIML implementing technique 1 is shown in figure 1.2. (Pandorabots, 2018a)

```
<category>
<pattern>DO YOU KNOW WHO * IS</pattern>
<template><srai>WHO IS <star/></srai></template>
</category>
```

Figure 1.2: Using srai for symbolic reduction in AIML object

### 1.3 Common uses of chatbots

Initially chatbots were developed to be entertaining and to mimic human conversation. This is still a popular reason when developing chatbots, but since the popularity with the technology has gone up, so has the different uses. The chatbot technology has then been used for many things, like for retrieving information, answering questions, helping make fact based decision, as a shopping assistant, as a museum guide, language partner, or in education, among other things. (Shawar and Atwell, 2007)

As mentioned, a chatbot can be used as an information retrieval tool, in order to answer a users questions on a specific topic. This kind of chatbot has a wide range of applications, from interactive FAQ to helping a customer make decisions. An example of a bot like this is the YPA, a chatbot used to provide users with information from the British Telecom’s Yellow pages. The user might ask for a plumber with an emergency service, and the chatbot will search its knowledge base and retrieve an adress, or if none was found, ask for additional details. (Shawar and Atwell, 2007). Of course this type of chatbot has applications in education as well, for example a chatbot
named ALEX, who can help students wanting to find basic legal information. (Deryugina, 2010)

The chatbot can be used as a tool to learn and practice a language. There are many perks of having a chatbot as a conversational partner when learning language, for example a it could allow a student to practice their language skills anytime, it would not mind repeating the same material several times, it can incorporate both text, speech which might help a student with both their reading, writing and listening skills. However, the chatbot as a language tool also has a few disadvantages. The responses of a chatbot is often predictable, redundant or retain no memory of previous responses. Most chatbots are also bad at detecting spelling or grammatical mistakes. But the chatbot could still be useful for non-beginner language learners, and besides being used as a teacher or learning partner with rich knowledge, it may be a friend who listens to the woes of the user. (Shawar and Atwell, 2007)

When it comes to chatbots in education, Shawar and Atwell (2007) states that it is important to remember that the teacher is the backbone of the teaching process and the learning technology may act as an amplifier but not a replacement. One example is that when a chatbot is used to answer student questions, the teacher can use generated log files of the conversations to see what the students are having issues with and what their weaknesses are. Thus, the teacher can use a chatbot to look for problems as the students use it to solve them. (Shawar and Atwell, 2007). Unfortunately not many chatbots can be found that are actually in continuous use in education, a reason for this may be that their capabilities are still quite undocumented.

1.4 Aim of the study

Continuing with the problem introduced in the previous section that chatbots are still not commonly implemented in education, the aim of this thesis is set in context. In order to further the development of educational chatbots it is important to find out what has been done, and to summarize this knowledge in a concise and relevant manner. No such summarizing study was found, thus, the aim of this study was to produce that summary to find out what pedagogical uses and capabilities a chatbot has in an educational context by reviewing the literature in the field, this means looking at what the chatbot can do and be used for in an educational context. In this circumstance it is also relevant to look at if the chatbot can be useful on its own or if additional technology is needed, such as any system the chatbot needs to be encompassed in or that enhance its capabilities, e.g. e-learning system or text-to-speech technology. Hence, the work in this study can be used as a stepping stone for coming researchers who might more efficiently uncover further potential of the technology. This aim was developed with the focus on what might be needed for teachers and researchers when continuing to develop the chatbot technology. Of course there may be more that one thing that is important, for example which type of chatbot to use, how to adapt it properly to a course, what kind of architecture the chatbot system might need, how to achieve the greatest pedagogical value and so on. But the question of what role a chatbot could take and what can it actually do in the context of education seemed more acutely relevant, since its answer is a good starting point to answering other questions.

1.5 Research question

In order to fulfill the aim, two specific questions were developed. In this thesis the questions are narrowed even more by limiting it them to only AIML-based chatbots. This decision was taken on
the base of the simple use of AIML and the open source nature of the system, making it a good base for continued development. The question posed in the aim was divided into two parts for clarity and they are thus:

- What roles can AIML-based chatbots take in an educational context?
- What features can AIML-based chatbots have in an educational context?

By answering these questions the knowledge gap regarding what has been done with chatbots in education, and what capabilities the technology has shown will be filled.

1.6 Limitations

The limitations to this study are mainly concerned with the databases searched and the papers chosen, these were Elsevier (Science Direct), ProQuest (ABI/INFORM), IEEE (Xplore) and ACM (Digital Lib). The motivation of the choice for databases 3. Within these databases only papers published in Journals or conferences were chosen. Considering the content of the papers, only the ones concerning an educational use of an AIML based chatbot have been reviewed, to stay in line with what the research question seeks to answer. This study was performed as a qualitative literature review, which means a limitation to the result is always the researchers bias, specifically when analyzing the results.

1.7 Ethics

Apart from correctly citing the reviewed works no ethical considerations was taken, considering all the reviewed works was published and thus are already ethically scrutinized by the authors and their peers.

1.8 Outline

Chapter 2 - Background

The background chapter addresses some important grounding knowledge that is needed for the scope of this thesis. The first part addresses the definition of a chatbot, some relevant history, examples of famous chatbots and their structure and some common uses of chatbots today. The second part briefly explains e-learning systems and their relevance to education.

Chapter 3 - Methodology

An important piece in the thesis puzzle is the methodology, it is the frame the thesis was built on. The work was conducted as a qualitative integrative literature review, with a thematic analysis focused on finding themes in the different papers and summarizing the gathered knowledge into a concise conclusion. These choices are motivated and the process explained in the methodology chapter.
Chapter 4 - Results
The chapter presents the results of the literature review. Initially the papers that were analyses are introduced. Then the found themes and sub-themes are described and validated with quotes form the data, both in the order they were initially designed in within the methodology chapter and in relation to each reviewed paper.

Chapter 5 - Analysis
The results are analyzed in this chapter in the same order they were presented in the results chapter. Any interesting details of the data are examined and analyzed.

Chapter 6 - Discussion
The results and analysis are discussed and elaborated on.

Chapter 7 - Conclusion
A conclusion is made from the results, the analysis and the discussion and the thesis ends with suggested further research.
Chapter 2

Background

The background contains two parts. The first part addresses the origins of the chatbot, presenting some relevant history with examples of famous chatbots. The second part briefly explains e-learning systems and their relevance to education.

2.1 Origins of the AIML-based Chatbot

2.1.1 Thinking machines and weak AI

In 1950 Turing asked himself the groundbreaking question “Can machines think?” He then defined the now famous Imitation game (or Turing test), the game where the computer is supposed to convince a human interrogator that the computer is in fact also human (Turing, 1950). Turing questions his own reasoning and after defining both his meaning of a machine, and of the concept of thinking, he goes on to revise the initial question to instead read: “Are there imaginable digital computers which would do well in the imitation game?” The imitation game is thus used as the scale on which the machines ability to think would be measured.

No machine or digital computer has yet been able to beat Turing’s imitation game, and even the best contestants seem to still be far off. As a way of furthering the development of intelligent machines Hugh Loebner came up with a limited version of the Turing test in 1990, called the Loebner Prize Competition. This is considered the first formal instantiation of a Turing test and it is carried out annually. In the contest 4 judges take turn interacting with two dialogue partners in a chat system. The interaction is limited to a total of 25 minutes and at the end the judge is asked to declare which partner is the machine. If a program were to fool half the judges that it is human a Silver Medal and $25,000 would be awarded as a prize. If the judges managed to identify the machine, they were asked to score its “thinking” capabilities between 0 and 100 and cash prizes are awarded the top 4 AI’s. The Grand Prize of $100,000 and the Gold Medal will be awarded the program who can provide answers that are indistinguishable from a human, which according to Turing’s definition would then be proof of a thinking machine. (Loebner.net, 2017; Loebner, H., 1994; Floridi, Taddeo, and Turilli, 2009)

Turing’s ideas had a huge impact on the technological development in the field we today call Artificial intelligence, or AI for short. AI is a branch of computer technology dedicated to making digital computers of computer-controlled robots do tasks that are generally identified as requiring intelligence (or thinking) like that of a human brain (Copeland, B.J, 2018). But like all things revolutionary his ideas also received a lot of criticism.
One of Turing’s bigger critics was Searle (1980) who, based on two propositions and three consequences of these propositions, argues that “only a machine could think, and only very special kinds of machines, namely brains and machines with internal causal power equivalent to those of brains.” With this argument in mind Searle (1980) wanted to differentiate between what he identified as two types of AI, strong AI and weak AI. Strong AI the definition of an actual thinking machine, i.e. a system that possesses these causal brain powers that Searle argued for. Weak AI, on the other hand, is a system lacking the causal brain powers, thus not an actual thinking machine but rather a machine making a plausible imitation of human intellectual behavior. (Searle, 1980; Deryugina, 2010)

According to the previously given definition of a chatbot, and after presenting the concept of weak AI from Searle (1980) a conclusion can be drawn. The chatbot technology fall under the category of Weak AI (Deryugina, 2010). A chatbot is not an actual thinking machine, but rather a machine feigning intelligence after imitating human conversation patterns. Non the less, it is still considered AI and it has a lot of valuable and popular uses. Two such popular chatbots from history are presented in the next section, the ELIZA and ALICE chatbots.

2.1.2 ELIZA and ALICE: The foundation of pattern matching chatbots

One of the first and most famous chatbots was ELIZA developed by Weizenbaum (1966). He published an explanation of ELIZA and explains it as a computer program which enables a natural language conversation between human and computer. ELIZA is programmed to imitate a Rogerian psychotherapist and works by identifying keywords and then mapping them to an associated rule which transforms the input sentence and then outputs a response, this is called pattern matching. If no keyword was found a content-free remark or an earlier rule transformation is retrieved and printed (Weizenbaum, 1966). Since this was the first program of its kind it made a great impression on specialists from the AI-field but also on non-technical people (Deryugina, 2010). One of the claimed reasons for Eliza’s success was the fact that she was developed to try and replicate the conversation between a therapist and a patient, the success stemming from the fact that the job of the therapist consists mainly of asking questions and listening to the answer. This might be the case, but it only means that it is important to be aware of the limitations of the technology and use it in a way that enhances its capabilities instead.(Weizenbaum, 1966).

2.2 A brief explanation of educational systems

E-learning

E-learning is simply learning making use of digital resources in order to get/give access to an educational curriculum outside the classroom or to support students learning (Travis, 2008). E-learning can be performed through many means, but a few common systems used for e-learning will be explained in the following paragraphs.

2.2.1 E-learning systems

LMS

LMS is an abbreviation for Learning Management System which is a type of software often used to launch and track online learning activities. Most commonly the teacher will upload resources and thus make them accessible to learners remotely. A LMS is, in its core, a repository to store and track information, most often related to learning of some sort (Pappas, 2018). Its aim is to
offer management functionality to its users (Mikic, Burguillo, Llamas, Rodríguez, and Rodríguez, 2009) who usually fall into one of two categories, 1) Online learners who use the LMS to join online training courses, and 2) an e-learning team who uses the system to distribute information and training content. Having a LMS is very beneficial to educational institutions, the five main benefits being: 1) It can organize and safely store big data. 2) It can monitor learner progress and performance. 3) It improves resource allocation. 4) It can personalize the online learning experience. 5) It improves accessibility. (Pappas, 2018)

**LCMS**

LCMS is an abbreviation for Learning Content Management System. It is used to create and manage the contents of an educational program, typically a course. A great LCMS provides its user with the tools to easily create content, add different types of learning material, store contents in a repository, reuse and export contents (even to different systems, and, manage and maintain tasks over the content. It is often confused with the LMS but it provides another dept in its tools. The two are however often combined to give users the LMS’s management abilities as well as the content creation abilities of the LCMS. (Mikic et al., 2009)
Chapter 3

Methodology

In this chapter the chosen methodological approach is presented and motivated along with the different steps that are necessary to perform during the approach.

3.1 Research approach

Since the aim of the thesis was to find the capabilities of an AIML-based chatbot in an educational context the approach to the entire research was a qualitative one. A qualitative approach is preferable when examining everything from peoples lives, life experiences, behaviors, emotions and feelings to organizational functions, social movements, cultural phenomena and interactions between nations (Strauss and Corbin, 1998). The thesis examines the current literature on the subject, trying to identify the capabilities, pros and cons of the chatbot implementation in an educational context. This might be considered examining cultural phenomena, as the chatbots are designed and implemented within certain cultures. This fact was the basis of the choice of a qualitative approach and it was in turn reflected on the chosen data gathering and analysis methods.

3.2 Research strategy

The same reason that dictated the use of a qualitative approach also dictated that the strategy used was an exploratory one. The research questions reflect this choice as well, being more or less open ended, without claiming a hypothesis or leaning towards any predetermined probable conclusion. Since the aim was to look at what the current literature is saying about the capabilities of chatbots the natural step was to perform a literature review. The literature review was not focused on setting the context for the thesis or justifying the study as is, two goals Levy and Ellis (2006) lists for literature review, instead it examined specifically what has been written about using chatbots in education.

The type of literature review that was performed was an integrative review. This type of review looks at the representative literature of the topic to review and synthesize it in a concise way. The goal of an integrative review is generally to be generate new frameworks of perspectives on the topics, This fit well with the aim of this study as it aimed to bring forth the perspectives of the literature and review them. The literature set in an integrative review should include studies related to the research question, in this case, literature about AIML-based chatbots in educational settings. University of Southern California (2018) writes that: “A well-done integrative review meets the same standards as primary research in regard to clarity, rigor, and replication. This is
the most common form of review in the social sciences.”

3.2.1 Structure of the literature review

The literature review was executed in three steps, the first was a number of ‘wild searches’ using the Google search engine and the second slightly more structured focused on academic databases and the third and last a very structured search using databases containing both educational research and IT-research.

The initial ‘wild search’ had the aim of providing the researcher with the basic knowledge about chatbots and some current trends regarding them, and subsequently to provide relevant search terms to be used in the following steps, mainly in regards to what terms were commonly used to denote a chatbot. The second search followed up on this wild theme but added slightly more structure, using the found terms to figure out which where relevant to this research and what research had actually been done. It resulted both in literature to build the theoretic background with, by describing chatbots, and it confirmed the found terms as relevant (see table 3.1). This search also highlighted that the area of research is quite young, i.e. a lot of articles may not have been published in journals yet, but only at conferences. A decision to include both papers published in journals and at conferences was therefore taken, to be able to analyze as much relevant data as possible. These two initial searches resulted in the search strategy used to make the third search as good as possible.

Main search strategy

After having identified key terms for the research area the next step in the search process was to identify databases containing key journals/conferences. The work of Levy and Ellis (2006) was utilized to find databases that cover as many of the 50 top-ranking journals in the field of informatics, leading to the choice of Elsevier (Science Direct), ProQuest (ABI/INFORM), IEEE (Xplore) and ACM (Digital Lib) thus covering approximately 80% of the list in Levy and Ellis (2006).

The identified search terms are listed in table 3.1. The terms in the table were combined into one complex search string using logical operators AND and OR to delimit (see table 3.2). This was used to run searches on the chosen databases. Other limitations applied to the search was that the papers should be peer-reviewed (if this option was available on the chosen database) and published after 1995 in either a journal or as a conference proceedings. The final sum from all 4 databases was 72 papers. The year 1995 was used since this is the year Dr. Wallace first published ALICE and was thus the year AIML was invented. All of the found papers where exported into EndNote reference system which could then be used to store and organize the papers. The next step was to start reviewing the articles and removing those not deemed relevant for the scope of the research defined in the introductory chapter. This was carried out by first reading only the titles of articles and removing those clearly irrelevant right away. Secondly the abstracts was reviewed and, if needed, the extended content of the papers as well. Then the same process was repeated again, removing those considered off scope. Eventually this resulted in 14 remaining papers.

Two criteria were used to determine if a paper was in the scope and they were both a direct result of the research question. They were 1) The chatbot should be AIML based - If the paper didn’t report what technology the bot was based on or it reported a different technology, it was removed. 2) The chatbot should have been used or evaluated in an educational context.
### Table 3.1: Literature-search terms

<table>
<thead>
<tr>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
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<tbody>
<tr>
<td>Chatbot*</td>
<td>Education</td>
<td>AIML</td>
</tr>
<tr>
<td>Chat-bot</td>
<td>Pedagogy</td>
<td>Alice</td>
</tr>
<tr>
<td>Conversational agent</td>
<td>-</td>
<td>Artificial intelligence markup language</td>
</tr>
<tr>
<td>Conversational system</td>
<td>-</td>
<td>Pandorabots</td>
</tr>
<tr>
<td>Pedagogical agent</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chatterbot*</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 3.2: Literature-search string

```
((Chatbot* OR "Conversational agent" OR "Conversational system" OR "Pedagogical agent" OR Chatterbot* OR Chat-bot*)
AND (Education OR Pedagogy) AND (AIML OR ALICE OR "Artificial intelligence markup language" OR Pandorabots))
```

### 3.3 Coding and Analysis of the Literature

When coding and analyzing the found papers thematic analysis was used as a way to organize and describe the data in a detailed way (Braun and Clarke, 2006). Thematic analysis, its purpose and how it is done is explained briefly below, along with how it was applied in this particular research case. After that the actual process of the coding analysis is described and the found themes presented.

#### 3.3.1 Defining thematic analysis in relation to the research

The purpose of thematic analysis is to identify, analyze and report themes within the data. Thematic analysis is not the only method that strives to find themes in qualitative data, however according to Braun and Clarke (2006) there are three main benefits to thematic analysis in comparison to other methods. 1) Researchers using thematic analysis does not have to take on the theoretical undertaking of grounded theory, something that is appropriate for the current research, since grounded theory is not the goal. 2) It can offer a more accessible form of analysis, in particular to a beginner researcher. 3) Thematic analysis is versatile enough to allow the researcher to both reflect reality and to look beneath the surface of reality. In relation to point three’s dual nature Braun and Clarke (2006) states that it is important to make the position of a thematic analysis clear and transparent. The next few paragraphs tries to do just that by considering the decisions Braun and Clarke (2006) find important and then motivating the made choices in relation to the research goal.
The focus is on the details

Braun and Clarke (2006) lists two ways of conducting the analysis, 1) producing a rich narrative of the data set, or 2) making a detailed account of one particular aspect. The first way can lend the reader a sense of what the most important themes in the data set are and this demands that the identified themes must be an holistic reflection of the whole data set. This in turn, inevitably leads to a loss of detail and depth. The second way however may provide this precise and nuanced rendering of one specific theme or group of themes, which of course is done at the cost of the broader narrative. (Braun and Clarke, 2006)

Since the research question at hand was quite narrow, looking specifically to find out what has been done with chatbots in education the choice here was quite straightforward. Like the headline hints this research has gone for the details specific to the research question and thus the themes and their creation followed the same path. In reality this means that, at every introduction of a code, the question: Does this relate to the chatbot that the paper describes? If the answer was no, the detail wasn’t coded at all, or else, it was coded with its relation to the chatbot in mind.

Identifying themes in the data

There are two main ways of finding the themes in the data, the inductive (bottom up) way or the deductive (top down) way. The purpose of inductive analysis is to code the data without trying to make it fit in any pre-determined frame of codes, deductive analysis on the other hand is solely driven by the pre-determined interest of the research. This translates to coding either for a specific research question to begin with (deductive approach) or that the coding process is a part of the evolution of a specific research question (inductive approach). (Braun and Clarke, 2006).

In regard to the exploratory nature of this research the way of finding themes would always contain a certain amount of exploration. It was also analyzed with the specific research question in mind, but the specific formulation of the question was largely influenced by the coding process. Because of this duality in the nature of the study, a sort of mix between the deductive and the inductive analysis was performed. The deductive approach was the main part, used to find initial themes which were independent of the actual data, in order to make sure all codes of initial interest were identified. This resulted in overarching theme groups which incorporated several more detailed themes illustrating different aspects of the analysis that were important. The inductive approach came in to play when the coding of the themes started and new sub-themes and codes emerged with this exploration. Since the focus was still on the details of the chatbot, all new themes could be comfortably sorted in to one of the identified overarching theme groups and thus keep the initial top down structure.

The level of the themes

This decision centered on the question of which level the themes should be identified at, this could be either at the semantic level or at a latent level. If the themes are at a semantic level they are found at the surface level of the data (explicit). The analytic process of semantic themes often include going from a description, with the data organized to display the themes in a semantic context and to then summarize the themes interpretively in an attempt to give them broader meaning. In contrast, if the themes are at a latent level they go beyond the explicit meaning of the data and strive to find the underlying ideas or assumptions that shape the semantic data content. The interpretation is performed already at the identification of the the themes and the
subsequent analysis is not just a description but in fact already theorized. (Braun and Clarke, 2006).

Since this research was all about looking at other researchers work in a straightforward manner and then to retell and summarize what was found, the themes are exclusively on the semantic level, thus the process of analysis started with a description displaying the found themes in their semantic context and then interprets them to give a broader meaning.

What is a theme?

If something in the data can be considered important relative to the research question it can be considered a theme. A theme often show some level of patterned meaning within the data set. According to Braun and Clarke (2006) there are not hard-and-fast rules to how encompassing or grounded a theme needs to be in the data set to be considered valid. Thus the decision of what a valid theme comprises depends a lot on the earlier analysis decisions.

Leaning on the previously explained decisions of the analysis, the definition of a theme in this research is that a theme is somehow related to the precise research question and aim, so as to stay in the details of the data. A theme that is related to the research interest can therefore be sorted into one of the theme groups. Further, a theme is semantic, no underlying meaning is interpreted at this stage. And lastly due to the exploratory nature, a theme doesn’t have to be grounded in the entire set to be of interest, rather any singularity is an interesting find, as long as it can still be related to the overarching groups.

3.3.2 Performing the coding and analysis

With the above analysis decisions in mind, the actual coding began. This work iterated over the 6 phases of thematic analysis listed by Braun and Clarke (2006), which were used in a recursive fashion to achieve a thorough and reliable result. The steps are: 1) Getting to know the data, 2) Setting up initial codes, 3) Looking for themes, 4) Reviewing the themes, 5) Establish and name themes, and 6) Generate the report. How these steps were performed is outlined below, however, due to the fact that the analysis was performed top-down, the steps were not done in the order Braun and Clarke (2006) listed, and will thus be presented in the order they were used below. Step 6 was omitted since that was the actual production of the report. The final theme groups and sub-themes with accompanied descriptions can be found in table 3.3.

Looking for themes

As mentioned, due to the top down, deductive, nature of the analysis, the order of the steps was shuffled to better fit the needed process. The analysis thus started with drawing out three overarching themes that were important for the research aim and question. These were developed before the initial read through (phase 1), to avoid getting sidetracked by details in the data and were thus developed with the background information and the research question as the main focus. The three themes where comprised of the details about the publications themselves, details about the educational context described, and details about the ICT specifications, in this case, the chatbot and its environment. The themes are described more closely in step 3 but relevant here since they dictated what codes were selected, due to the top-down nature of the analysis.
The encompassing themes are both wide and narrow, in the way that they kept the codes inside the scope of the research, but at the same time allow for exploration with discovered codes. The themes where then used as the theoretical frame from which to locate interesting codes. Since this research used published literature as its data it was important to code the details of the papers, such as the authors, where and when the paper was published, the location of the authors and the keywords used. The purpose of this was to be able to identify any patterns in this meta-data in relation to itself or the content patterns. As for the educational details the focus was now to look at the actual data, searching for the details about the educational context in which the chatbot was developed or tested. Lastly the details about the ICT, maybe the most critical group since this is where the actual answers to the research question could be found. This theme included all the technical details surrounding the chatbot, like the purpose of the bot, what features were implemented, if it was integrated into a larger LMS or used as a stand-alone application and so on.

Some initial sub-themes were also generated within the scope of the three overarching themes. The publication theme included 5 sub-themes, the education theme 7 sub-themes and the ICT theme 4 sub-themes. These were later revised slightly to accommodate for the new knowledge gained about the data during the next step and also when the actual coding started it naturally revised the themes as well to better fit both the data and the theory. The revised themes are shown in table 3.3

### Table 3.3: Final Themes

<table>
<thead>
<tr>
<th>Theme Group</th>
<th>Sub-Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication details</td>
<td>Author(s)</td>
<td>Who did the research?</td>
</tr>
<tr>
<td></td>
<td>Institution</td>
<td>Origins of the authors</td>
</tr>
<tr>
<td></td>
<td>Time published</td>
<td>When was it published?</td>
</tr>
<tr>
<td></td>
<td>Journal/Conference</td>
<td>Where was it published?</td>
</tr>
<tr>
<td></td>
<td>Keywords in Paper</td>
<td>The authors’ chosen keywords</td>
</tr>
<tr>
<td>Educational Context</td>
<td>Level of education</td>
<td>University, High School, etc.</td>
</tr>
<tr>
<td></td>
<td>Student demographics</td>
<td>Age, gender, nationality, etc.</td>
</tr>
<tr>
<td></td>
<td>Subjects &amp; Courses</td>
<td>Course specific or general etc.</td>
</tr>
<tr>
<td></td>
<td>Type of education</td>
<td>Course given on distance, campus or blended?</td>
</tr>
<tr>
<td>ICT Specifications</td>
<td>Role of chatbot</td>
<td>What will the bot be used for?</td>
</tr>
<tr>
<td></td>
<td>Bot Features</td>
<td>What can the bot do?</td>
</tr>
<tr>
<td></td>
<td>Encompassing system</td>
<td>Is it stand-alone or in a larger system?</td>
</tr>
<tr>
<td></td>
<td>Bot Augmenting Tech</td>
<td>Addition of technology to enhance bot</td>
</tr>
<tr>
<td></td>
<td>Platform</td>
<td>Implemented in Web or some OS?</td>
</tr>
</tbody>
</table>

The purpose of this phase was, like the title entails, to get to know the data. This was done through careful reading of all the data, several times, and noting interesting details and initial patterns. Sometimes this phase includes transcribing the data, but this was not necessary in this research since the papers were already in a good format. In this research all of the papers where initially read straight through without a lot of thoughts or notes, to get a first idea of the content and to be able to create an initial set of codes (phase 1 and 2 were very mixed).
The second read notes were taken on the data and an even better feel for the content was procured.

**Setting up initial codes**

When developing initial codes the analysis decisions was kept in mind, primarily the definition of what a code is and on what level of meaning if should be. The code should always represent a feature of the data that is interesting to the researcher (Braun and Clarke, 2006). In this research the focus was to make a deep-dive in the details of the data, but to stay in the semantic meaning, the codes should also be contained in the scope of one of three the overarching themes.

Once this step of coding was reached, it consisted of the initial themes or sub-themes which had been coded in the data. For example, the authors of a paper was located and coded as Author. This straightforward way of coding was done for all initial sub-themes, with the intent of later working through these themes to search for patterns of more detailed codes. For several of the themes a deeper specification of code was deemed unnecessary due to the fact that no specific pattern could be found, thus the coding could be kept at the general level of the theme for the most part. One example of this is the Subjects or courses theme, which were supposed to find what subjects the chatbots had been tried in. This theme yielded such a varied result it was necessary to keep it at the general level, as to not lose the variety, the same was true for all other themes in the groups of Publication details and Educational context.

In the theme group of ICT specifications however, a more detailed view of some the themes was identified and coded. For example, Role of bot, was deemed a way too diverse group and thus needed more detail. This detail was initially just codes, to be refined into new sub-themes in the following steps. The data was the key part in all these decisions, if a theme contained obvious importance and support after the initial coding, it was reviewed again and given more detail with generated codes.

**Reviewing the themes**

This step started with the initial themes and the generated codes and sought to refine those even more. During this process the generated codes were streamlined into the themes, and in a few cases, they helped identify themes missing from the initial core and were thus added instead. This step mainly involved refining the codes generated as details of the themes, for example, the codes of the theme Role of Bot were reviewed and could eventually be divided into 7 sub-themes. The same process was repeated with the other themes of the ICT group as well. Braun and Clarke (2006) writes that the step involves looking for patterns in the coded data extracts and to also make sure that the themes fit the data, or else, revise or extract the ill-fitting codes into another theme. The step is done when the thematic map of the data is satisfactory, and when the researcher have a good idea about what the themes are and how they fit together. (Braun and Clarke, 2006)

**Establish and name themes**

At this point in the analysis it was time to define and finalize the themes and then to analyze the data within them. This was done by first trying to find the ‘essence’ of each theme by itself and the themes overall. In this stage a lot more sub-themes were defined (like the ones in figure 4.3, which according to Braun and Clarke (2006) can be used in order to give a better structure to large
and complex themes. A theme still needs to be concise and clear, and (Braun and Clarke, 2006, p. 92) describes it with the following quote: “It is important that by the end of this phase you can clearly define what your themes are and what they are not. One test for this is to see whether you can describe the scope and content of each theme in a couple of sentences.” This description is presented in a very short version in the theme table at the start of the section (table 3.3) and a longer description of each theme and its containing data will be presented in the results chapter.

The original idea with the initial themes were to be able to establish sub-themes within all of them, but for the themes in the groups Publication details and Educational context the data was so dispersed no particular patterns could be identified, thus no further coding was possible or even necessary. The themes on those groups was thus kept as presented in the initial theme table (3.3). In the group of ICT implementation details however, 5 out of the 6 themes were divided into sub-themes. Not all sub-themes have equal grounding in the data, but every theme illustrate a point of information in the data that was interesting to the research question. The example of the ‘Role of bot’ theme has already been illustrated as having 5 sub-themes which all describe a role the chatbot has played in the research, see table 3.4 as well. Additionally, sub-themes were identified in the other themes: ‘Bot Features’ have 18 sub-themes (table 3.5); ‘Encompassing system’ have 4 sub-themes (table 3.6); ‘Bot augmenting Tech’ have 3 sub-themes (table 3.7); and ‘Platform’ have 5 sub-themes (table 3.8). The Access to bot theme did not include any sub-themes. The themes with their sub-themes are presented in the respective tables referenced.

<p>| Role of Bot |
| What will the bot be used for? |</p>
<table>
<thead>
<tr>
<th>Sub-Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutor</td>
<td>Provide individual didactic support</td>
</tr>
<tr>
<td>Student evaluation</td>
<td>Evaluate student progress or performance</td>
</tr>
<tr>
<td>Questions &amp; Answers</td>
<td>Answer students topic specific questions</td>
</tr>
<tr>
<td>Teacher communication</td>
<td>Medium for student to communicate with teacher</td>
</tr>
<tr>
<td>Natural conversation</td>
<td>Chatbot is a conversational partner</td>
</tr>
</tbody>
</table>

Table 3.4: Role of Bot sub-themes

3.4 Limitations of the method

The method used when conducting this work was an integrative literature review, followed by a thematic analysis. The main points of delimitation is the choice of databases and search strategy, and the theme choices made within the analysis.

When gathering the data for the literature review 4 databases were selected based on their coverage of popular journals and conferences in the field of informatics. Combined with a quite limited search strategy only 14 papers were gathered for review, a set that is quite small. The reason for these severe delimitations were the time limitations set on the thesis work, as finding and reading papers as well as performing the analysis were very time consuming tasks, even with the small set. The advantage of having this small dataset is that the papers could be more thoroughly analyzed, most likely leading to better results.
### Bot Features

What can the bot do?

<table>
<thead>
<tr>
<th>Sub-Theme</th>
<th>Description (The chatbot can … )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate learning task</td>
<td>demonstrate a task</td>
</tr>
<tr>
<td>Animated gestures supporting knowledge base</td>
<td>use animated gestures</td>
</tr>
<tr>
<td>Allow input as speech</td>
<td>accept input in speech format</td>
</tr>
<tr>
<td>Control e-learning platform’s activity</td>
<td>monitor activity on platform</td>
</tr>
<tr>
<td>Provide means of contact with teacher</td>
<td>contact teacher for learner</td>
</tr>
<tr>
<td>Point of interaction for learner</td>
<td>act as a point of interaction</td>
</tr>
<tr>
<td>Provide output as speech</td>
<td>provide spoken output</td>
</tr>
<tr>
<td>Help students 24/7</td>
<td>provide its services anytime of day and year</td>
</tr>
<tr>
<td>Provide content from other knowledge sources</td>
<td>use other knowledge sources for its answers</td>
</tr>
<tr>
<td>Support feedback to students</td>
<td>provide feedback to students or teachers</td>
</tr>
<tr>
<td>Give recommendations about learning material</td>
<td>give recommendations about learning material</td>
</tr>
<tr>
<td>Hold topic specific conversation</td>
<td>conduct a topic specific conversation</td>
</tr>
<tr>
<td>Hold general conversation</td>
<td>conduct a general conversation</td>
</tr>
<tr>
<td>Teacher can edit bot content</td>
<td>be edited by the teacher</td>
</tr>
<tr>
<td>Ask the student questions</td>
<td>ask the student questions</td>
</tr>
<tr>
<td>Conversational strategies</td>
<td>use conversational strategies</td>
</tr>
<tr>
<td>Answer student questions</td>
<td>answer the students questions</td>
</tr>
</tbody>
</table>

Table 3.5: Bot Features sub-themes

By choosing initial themes to work with rather than keeping the analysis process completely inductive the results were limited. This was a known fact taken into account while making the decision, as the research question, even though open, is quite specific and targeted. However it is an important fact to remember, as a researcher looking at the exact same papers but in a fully inductive way will most likely discover other details in them.
### Encompassing system

Is it stand-alone or in a larger system?

<table>
<thead>
<tr>
<th>Sub-Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library system</td>
<td>Chatbot is included in a library system</td>
</tr>
<tr>
<td>Virtual environment</td>
<td>Chatbot is used in a virtual environment</td>
</tr>
<tr>
<td>E-learning system</td>
<td>Chatbot is included in an E-learning system</td>
</tr>
<tr>
<td>Stand-alone</td>
<td>Chatbot is not encompassed in any system</td>
</tr>
</tbody>
</table>

Table 3.6: Encompassing system sub-themes

---

### Bot Augmenting Tech

Addition of technology to enhance bot

<table>
<thead>
<tr>
<th>Sub-Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguistic tools</td>
<td>Tools to enhance the chatbots language capabilities</td>
</tr>
<tr>
<td>Animation</td>
<td>Chatbot was embodied and animated</td>
</tr>
<tr>
<td>Text-To-Speech</td>
<td>Speech as input or output was implemented</td>
</tr>
</tbody>
</table>

Table 3.7: Bot Augmenting Tech sub-themes

---

### Platform

Implemented in Web or some OS?

<table>
<thead>
<tr>
<th>Sub-Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web</td>
<td>Chatbot was published on a Web platform</td>
</tr>
<tr>
<td>Mobile OS</td>
<td>Chatbot was published on some mobile platform</td>
</tr>
<tr>
<td>Not-specified</td>
<td>The paper did not specify a platform</td>
</tr>
</tbody>
</table>

Table 3.8: Platform sub-themes
Chapter 4

Results

This chapter presents the results of the literature review. Initially the papers reviewed are described.

4.1 The papers

As mentioned in chapter 3, 14 papers were found in the search. These 14 papers were published in different journals or conference proceedings and apart from 3 papers they were written by different authors. The authors originated from different parts of the world and also from different universities. The papers are presented in the table below, their authors, the paper title (sometimes shortened slightly) and a short summary of the paper. The full references can be found in the reference list.

<table>
<thead>
<tr>
<th>Id</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Author(s) Orlando and Giovanni (2008)</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
</tr>
<tr>
<td>2</td>
<td>Author(s) Doering, Veletsianos, and Yerasimou (2008)</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
</tr>
<tr>
<td>Id</td>
<td>Author(s)</td>
</tr>
<tr>
<td>----</td>
<td>-----------</td>
</tr>
<tr>
<td>3</td>
<td>Mikic, Burguillo, Rodríguez, Rodríguez, and Llamas (2008)</td>
</tr>
<tr>
<td>4</td>
<td>Heller and Procter (2009)</td>
</tr>
<tr>
<td>5</td>
<td>Mikic, Burguillo, Llamas, Rodríguez, and Rodríguez (2009)</td>
</tr>
<tr>
<td>6</td>
<td>Ibáñez, Rueda, Galán, Maroto, Morillo, and Kloos (2011)</td>
</tr>
<tr>
<td>7</td>
<td>Rossi and Carletti (2011)</td>
</tr>
<tr>
<td>Id</td>
<td>Author(s)</td>
</tr>
<tr>
<td>----</td>
<td>----------------------</td>
</tr>
<tr>
<td>8</td>
<td>Allison (2012)</td>
</tr>
<tr>
<td>9</td>
<td>Masmuzidin and Wan (2012)</td>
</tr>
<tr>
<td>10</td>
<td>Soliman and Guetl (2013)</td>
</tr>
<tr>
<td>11</td>
<td>Gang, Bo, Chen, Yi, and Zi (2014)</td>
</tr>
</tbody>
</table>
Table 4.1: (continued)

<table>
<thead>
<tr>
<th>Id</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td><strong>Author(s)</strong> Kumar, Chandar, Prasad, and Sumangali (2016)</td>
</tr>
<tr>
<td></td>
<td><strong>Title</strong> Android Based Educational Chatbot for Visually Impaired People</td>
</tr>
<tr>
<td></td>
<td><strong>Summary</strong> The purpose of the paper is to present an Android application containing an educational Chatbot designed for visually impaired people. The application can be launched with Google Voice Search and is used by asking questions in spoken natural language, the application will then convert it to text and run the query against the AIML database or, if no pre-saved answer was found, against the Wikipedia API. The answer is then returned to the application as both text and voice.</td>
</tr>
<tr>
<td>13</td>
<td><strong>Author(s)</strong> Fonte, Nistal, Rial, and Rodríguez (2016)</td>
</tr>
<tr>
<td></td>
<td><strong>Title</strong> NLAST: A natural language assistant for students</td>
</tr>
<tr>
<td></td>
<td><strong>Summary</strong> The researchers present a system consisting of two parts, an android application and a server platform. The android application implements a chatbot which interacts with both the student and the server. The objective for the system was to enable the student to carry out several actions related to their studies like: consult exams questions, receive recommendations about learning materials, ask questions about a course, and check their assessed exams. The purpose of the chatbot is thus to provide a friendly interface which can be interacted with using natural language.</td>
</tr>
<tr>
<td>14</td>
<td><strong>Author(s)</strong> Ranoliya, Raghuvanshi, and Singh (2017)</td>
</tr>
<tr>
<td></td>
<td><strong>Title</strong> Chatbot for University Related FAQs</td>
</tr>
<tr>
<td></td>
<td><strong>Summary</strong> The paper presents a chatbot design implemented to be able to answer FAQs regarding university related questions in an efficient and accurate way. The implemented chatbot is based on AIML and the researchers have the goal to further improve the capabilities by eventually also using Latent Semantic Analysis. The bot works well to provide 24/7 service to students or others interested in the university.</td>
</tr>
</tbody>
</table>

### 4.2 Publication Details

This theme group contains the themes regarding the meta-details of the data, in this case the details regarding the publications. The themes are Author(s), Institution, Time published, Keywords in paper and Journal/Conference (see table 3.3). These were analyzed in order to find patterns (or the absence of patterns) in the data and thus be able to draw conclusions regarding who has an interest in the chosen field, or where and when this interest manifested itself.

#### 4.2.1 Author(s)

In most of the dataset the authors differed between the papers, the only deviation was three papers, paper 3, 5, and 13. Paper 3 and 5 shared the same four authors, and in paper 13 three of these four authors appeared again, along with a new author. Other than that, no author appear more than once in the set and the names of the authors can be seen in table 4.1.
4.2.2 Institution

As with the authors, no institution stands out as having a greater representation in the dataset. This fact implies that no institution has tried to specialize their work towards chatbots in education. The sole exception of this was the three papers mentioned in the 'Author(s)’ section, in which the institution was the same in all three papers as well (papers 3, 5, and 13). The authors of these papers were all from the Telematics Engineering Department, at the University of Vigo.

4.2.3 Time Published

The papers have been published during a span of 9 years, from 2008 to 2017, with 3 papers published in 2008, 2 each in 2009, 2011, 2012, and 2016, and 1 each in 2013, 2014, and 2017. Ergo the papers were published quite evenly from 2008 until 2017. The search strategy restricted the time of publication to after 1995, but no article was found in the span between 1995 and 2008.

4.2.4 Keywords in paper

![Keywords in the papers](image)

This theme encompassed the keywords the authors had tagged their papers with, most papers defined these just below the abstract in order to make their paper more searchable. There were 50 keywords identified in the whole set (see fig 4.1), the majority used only once (43 words). The most used keyword is AIML at 5 times, closely followed by Chatbot at 3 times. Five keywords were used 2 times each; ALICE, Artificial Intelligence Markup Language, Chatterbots, Intelligent Tutoring System and Patterns Matching. However a few of the words used as keywords in the same or in different papers are synonymous, making the simple count more unrepresentative. For
example AIML and Artificial Intelligence Markup Language are counted as different keywords but as they are synonymous could be counted as only one keyword. The issue at hand was that the abbreviation and the full phrase were both used as keywords for the same paper, a choice the authors made which was therefore respected in the thesis, thus keeping the words separate. This phenomena is showed in figure 4.2 where the full phrase has been written first and then the abbreviation is included as a parenthesis. If these duplications were to be disregarded however, the list of tags would be shortened.

Keywords— Artificial Intelligence Markup Language (AIML); Chinese Intelligent Chat Robot; Pattern matching; Corpus; Chinese word segmentation.

Keywords— Artificial Intelligence Markup Language (AIML), Latent Semantic Analysis (LSA), Pattern Matching, chatbot, Human Computer Interaction (HCI)

Figure 4.2: Abbreviated Keywords paper 11 and 14

4.2.5 Journal/conference

No Journal or conference was represented more than once i.e. no publication stands out as having a greater representation in the dataset. The majority of the papers, 8 out of 14, were published as conference proceedings.

4.3 Educational Context

This theme group examined what educational context the chatbots in the papers were developed to target by looking at the predetermined themes. The themes were 'Level of education', 'Student demographics', 'Subjects & Courses' and 'Type of education' (see table 3.3). They were analysed in order to see if any educational context were more clearly represented in the set or to find if any context stood out.

4.3.1 Level of education

This theme encompassed what level of education the bot was developed for or tried in, and was relevant in order to see if anything differed in the approaches of the researchers or in the implementation of the chatbot depending on the targeted level. Not all papers clearly state that they are directing their efforts towards a specific level, although in the non explicit ones it was implied that the chatbot was developed toward university or at least, simply adults. 6 papers explicitly stated their level, 5 out of these declared that their target level was university students in graduate or post-graduate courses. The 6th paper, which was the only clear deviant in this theme was targeting children, or Malaysian Children to be exact. This was paper 9 and the chatbots purpose was to teach the Malaysian children about morals through the virtual telling of Malaysian folktales.
4.3.2 Student demographics

As with the level of education, not all papers contained information about who the chatbot system was designed for or tested by, and not all researchers even described the testing of their chatbot, if any testing was done at all. 6 papers did however mention their participants, papers 2, 4, 6, 7, 9, and 14. Again all except paper 9 had tested their chatbots on students or adults, in line with the findings in the theme Level of education. Apart from this pattern no other similarities in the demographics were found, the tested students ranged from 18 to around 200 in the different papers. Two papers (2 and 4) reported the gender of their participants, and in both cases the overwhelming majority was women.

4.3.3 Subjects & Courses

This theme had only 6 findings. Two papers directed their chatbots toward courses in education or educational technology (2 and 7). One paper developed their bot to target Psychology students (4) and one for courses in Computer Architecture (13), and again, the chatbot in paper 9 was build with the subject of folktales and morals in mind. A slightly different subject was that of the chatbot in paper 10, which was build to incorporate “remote and online labs and simulations”. No specific course or subject is mentioned however, which means the implementation might be intended to be flexible as to subject, as long as experiments or simulations are a part of the corpus.

4.3.4 Type of education

This theme was included among the initial theme since it was thought to embrace an important aspect of the chatbots profitability, namely that it is beneficial for online courses. But unfortunately only two references to this theme could be found in the literature. Paper 2 described the type of their education in terms of how often the students would meet: “students met seven times throughout the semester for an average of three hours”. The type of education seems to be in part campus based, but online/distance based as well. In paper 7 the course stated as online based and would serve up to 2000 students.

4.4 ICT implementation details

Due to the more complex nature of this theme-group the presentation of the results within was first explained in relation to each theme, and after that according to the respective Chatbot described in the papers. This is done in order to be able to both look at each individual theme on its own, but to also be able to see more clearly how the themes fit together within the chatbots. Thus the section starts with the codes, explaining them, validating their foundation in the dataset and showing an overview of each theme and its sub-themes. Next the individual paper will be discussed along with the present themes and sub-themes of that paper, thus a more detailed description of that papers chatbot might be given as well as a view of how the themes and sub-themes relate to one another. Whats important here is not any hidden meaning or inference made from the findings, but the findings themselves, i.e. the presence of the themes and sub-themes.
4.4.1 The themes in the ICT implementation details group

The themes found in the ICT group are 'Role of Chatbot', 'Bot Features', Encompassing system', 'Bot Augmenting Tech', 'Platform', and 'Access to bot' (see table 3.3). The findings of these themes will be presented and validated below. These themes were decided before the coding, as initial themes, and were coded in the papers. The results of each theme were then reviewed on order to locate the sub-themes which are presented in this section and in the tables 3.4, 3.5, 3.6, 3.7, 3.8.

Role of chatbot

This theme encompass the roles of the different chatbots. A chatbot might have one or more roles and the role of a chatbot might hint to what the chatbot does, but these facts are not the main focus of the theme. The focus is instead on what purpose the chatbot was given and thus which role it was supposed to play in the system at large. 5 sub-themes were extracted and their relationships evaluated through their appearances together. The sub-themes were: 'Teacher communication', 'Natural conversation', 'Student Evaluation', 'Questions & Answers', and 'Tutor'.

As mentioned, the relationships between the themes were evaluated, as this seemed like both an interesting and important factor. As figure 4.3 shows, the relationships are rather complex, with several sub-themes being related both to the main theme and the sub-theme 'Tutor'.

Sub-theme: Tutor

The chatbot is used as a Tutor. Defining what a tutor is turned out to be a rather difficult task, as there are many kinds of tutors and the definitions and tasks of a tutor may vary both depending on the level of education and the geographical location. The word tutor can be used both as a noun and a verb, one describing the person and the other the act. A tutor is typically a paid teacher or instructor who works privately with one student or a small group. This might be to provide extra help outside school hours with a subject the learner finds difficult or to instruct and guide someone in some branch of learning, in summary, to give additional, special, or remedial instruction to someone. The tutor can be a teacher without institutional connection.
who assists students when preparing for examinations, or a teacher in some university who has a lower rank than that of an instructor. With this definition it’s clear that a tutor can be many things. (Cambridge dictionary, 2018; Oxford dictionaries, 2018; Collins English Dictionary, 2018; Merriam-Webster, 2018; The free dictionary, 2018)

In 9 of the 14 paper the chatbots desired role was determined to be that of a tutor (papers 1, 2, 3, 5, 7, 9, 10, 11, 13) however, it was never the sole role. In the papers where a 'Tutor' role could be determined, it was usually in relation to other roles, e.g. in paper 3 the researchers state that their chatbot “… gives students a virtual tutor capable of solving their doubts as real ones”, as well as that it “… gives students a virtual evaluator capable of evaluating and monitoring their progress…”. The first quote explicitly stating the role of ‘Tutor’ while the second quote describes a role of ‘Student Evaluator’. On one occasion however this was not true, in paper 5 the researchers describe their chatbot as “… able to maintain a general conversation with students, showing them contents of courses, and asking them questions about the learning material” which is targeting the very core of what a tutor is but cannot comfortably include any other sub-theme. That means a chatbot in the role of a tutor can be only that, but most often it includes other roles as well, widening the functions of the chatbot in the process.

The relationships discovered in the data showed that 5 of the sub-themes could themselves be sub-themes of ‘Tutor’, since the definition of a tutor is very broad. These 3 sub-themes were ‘Teacher communication’, ‘Student Evaluation’, and ‘Questions & Answers’. Of course a tutor might also be able to hold a natural conversation but in the data it was not found that this was ever the role of a chatbot, thus a distinction was made regarding the context of the themes. These relationships will become more clear in the section where each paper’s chatbot and its themes are presented, but a brief example will be given here as proof of the claim.

Furthermore, in paper 10 the researchers describe their chatbot as follows:

“…the avatar learner can ask the pedagogical agent questions on the scope of an experiment, gets information about the experiment, listens to and sees a demonstration to running an experiment visually. The IPA has the ability to monitor learner actions versus expected ones to run the experiment and upon errors, the IPA provides feedback, corrects errors, and updates learner assessment data.”

This quote show that the chatbot has the roles of ‘Questions & Answers’ and ‘Student Evaluation’. While it doesn’t explicitly use the term tutor the definition of what a tutor is encompass the same values they describe here, thus it can be inferred to be a role as well.

Sub-Theme: Student evaluation

The role of the bot is to evaluate the students progress or performance, in order to help the student improve or for the teacher to keep an eye on the development in the group. Two papers present bots developed to perform student evaluation, paper 3, from which relevant quotes have already been presented, and paper 10. Both chatbots have been given other roles as well, 3 is, as mentioned given the role Tutor, whereas 10 has been given both the role of 'Tutor' and of 'Questions & Answers', made clear with the quote below.

“With this implementation, the avatar learner can ask the pedagogical agent questions on the scope of an experiment, gets information about the experiment, listens to and sees a demonstration to running an experiment visually. The IPA has the ability to monitor learner actions versus expected ones to run the experiment and upon errors, the IPA provides feedback, corrects errors, and updates learner assessment data.”
Sub-theme: Questions & Answers
The theme included chatbots whose purpose was to answer student questions, often topic specific questions. 9 papers were determined to have this role, paper 1, 2, 4, 7, 8, 10, 11, 12, and 14. In paper 8 the authors write that their chatbot is “giving immediate answers to questions about library services and resources. […] It is also designed to guide researchers to appropriate resources and help them solve problems in a similar way as the more conventional FAQ.”.

Sub-theme: Teacher communication
A chatbot can be used as a medium to communicate with a teacher. In the dataset one paper (paper 1) used their chatbot as a communicator between student and teacher, giving the chatbot a role of 'Teacher communication'. They state that “… in case of necessity it [the chatbot] activates the PABX to send a direct short message (SMS) to the teaching team, containing the problem’s object asked from the user to the agent.”. The chatbot first try to answer the students question on its own, searching its knowledge base. If it does not find a suitable answer a teacher is contacted either through email or phone (using text-to-speech technology) in order to give the student an answer efficiently.

Sub-theme: Natural conversation
A chatbot used simply for a conversation, utilizing its ability to converse in natural language. Paper 6 presented chatbots for language learning which students may interact with as an NPC in a virtual world. The chatbots “… perform interactive dialogues with students. These behaviors contribute to the acquisition of listening and writing skills…”, the sole role is thus to keep a ‘Natural Conversation’. Other chatbots has the ability to have natural conversations as well, but it is not their role, rather just a feature.

Bot Features
A chatbots features is all the things it can do. For the most part it is connected to the role of the chatbot, but a chatbot might have features outside the main role. For example, almost all chatbots can keep a natural conversation, but not all chatbot has this as a role. However, accepting input or giving output in natural language is not regarded a feature in this list, as it is something every chatbot in the set is able to do. The 17 features found in the dataset are:

- Demonstrate learning task
- Animated gestures supporting knowledge base
- Allow input as speech
- Control e-learning platform’s activity
- Provide means of contact with teacher
- Point of interaction for learner
- Provide output as speech
- Help students 24/7
- Provide content from other knowledge sources
- Support feedback to students
- Give recommendations about learning material
- Hold topic specific conversation
- Hold general conversation
- Teacher can edit bot content
- Ask the student questions
- Conversational strategies
- Answer student questions

Sub-Theme: Demonstrate learning task
The chatbot can demonstrate a task for the learner, for the learner to better grasp the contents of the task. In paper 10, the chatbot has been used as an NPC avatar in a virtual world and can demonstrate the experiments within if the learner asks for it: “the avatar learner can ask
the pedagogical agent questions on the scope of an experiment, […] listens to and sees a demonstration to running an experiment visually.”

**Sub-Theme: Animated gestures supporting knowledge base**
The chatbot uses animated gestures to enhance their message. This feature is only possible with animated embodied agents, like that in paper 10. “Attention and gesture supporting knowledge base to emotional state of the learner. For example, ‘Can I help you? It is not a difficult experiment (linked to gesture)’.”. The purpose of animated gestures seems to be to provide emotional support as well as didactic and to enforce the chatbots message even more. ”

**Sub-Theme: Allow input as speech**
The chatbot can accept input in speech format. In order to allow blind learners the opportunity to learn easily on their own, the researchers of paper 12 needed their chatbot to be able to accept voice input. “It has the capability to get the input as speech format from the user. So [the] user [has] no need to type the keyboard [to] provide the input.”

**Sub-Theme: Control e-learning platform’s activity**
The chatbot can control and monitor the activity on the platform and in need alert the responsible teacher. In paper 1 this is done through the integration of a control daemon and a system to contact a teacher. “control bases on the interaction of TutorBot which picks up eventual signals from the learners, TutorBot when receives the signals sparks off […] alarm to a competent staff for platform contents.”. The motivation of this feature in the paper is that “it’s necessary [to have] a continuous monitoring activity of e-learning platforms, to spare the disadvantages that could jeopardized the right course of on-line didactical activities”.

**Sub-Theme: Provide means of contact with teacher**
The chatbot can provide the learner with a means to contact the teacher, effectively providing “prescreening” of the learners questions. This feature was found in the chatbot in paper 1: “in case of necessity it [the chatbot] activates the PABX to send a direct short message (SMS) to the teaching team, containing the problem’s object asked from the user to the agent.”

**Sub-Theme: Point of interaction for learner**
The chatbot can act as the point of interaction between the learner and the learning environment. In this dataset this is explicitly stated in paper 6 and 10, where in both cases the chatbot acts as a NPC which the learner interacts with. In paper 10 the chatbot is made to “Act as a central point of interaction between the learner and the environment providing verbal and non-verbal support to the learner.” and in paper 6 “chatbots perform interactive dialogues with students.”.

**Sub-Theme: Provide output as speech**
The chatbot can provide its output in a spoken format. In this dataset the output is always given as text, but three papers (6, 10 and 12) also provided their chatbots with a voice output. The three papers describe it differently, but aims at the same thing, improving the learning experience. “chatbots perform interactive dialogues with students. These behaviors contribute to the acquisition of listening and writing skills” (Paper 6). “When the IPA [chatbot] receives the question, ‘is it an easy experiment’, the answer with ‘yes’ in either voice or text ” (Paper 10). “Output of this application will be given as text and speech format.” (Paper 12). Paper 12 also has the additional goal of benefiting blind learners, making speech output a necessity.

**Sub-Theme: Help students 24/7**
A chatbot can provide its services anytime of the day and year, and will never have on off day.
4 papers specifically state this fact (papers 3, 8, 10, and 11), but unless the platform the bot is set on has a time limited access, the same should be true for all chatbots in the dataset. Paper 8 describe this feature in their chatbot Pixel: “Pixel will work 24 / 7 with less than 1 percent downtime, and will provide consistent answers. It searches across varied sources and brings together information in a similar way a librarian would work with a user.”.

Sub-Theme: Provide content from other knowledge sources
The chatbots own knowledge base might not always be enough to provide adequate service to the users, in that case it can use other knowledge sources to gather data in order to answer a query. Such a source might be an online encyclopedia (e.g. Wikipedia), a search engine (e.g. Google), or some licensed database (e.g. a library database). This feature is present in 4 papers’ chatbots, 1, 2, 8, and 12. Paper 8 use both licensed databases and Google in their chatbot implementation: “The libraries provides access to licensed databases [. . .]. The chatbot Pixel incorporates all of these resources into the context sensitive responses “she” generates”, and “It is [. . .] a tool for undergraduates and researchers looking for quick information and tips on searching databases and conducting research. As such, Pixel sends factual questions (what is the population of the US) to Google.”. Paper 12 on the other hand use Wikipedia: “The proposed android Chatbot application could provide any kind of information which included in Wikipedia and it can also provide user defined information”.

Sub-Theme: Support feedback to students
The chatbot supports providing feedback to students or teachers. This feature is present in paper 3, 9, 10. The feedback might be related to the student progress, giving the teacher an easy way to make sure no one falls behind in a large group and to allow the teacher utilize his/hers resources accordingly. Paper 3 claims this: “obtain direct feedback about student difficulties [. . .], teachers can concentrate on those concepts that require more expertise and real human interaction.”. The feedback might also be given directly to the learner, as is the case in paper 9 and 10: “[The chatbot] can interact with children [. . .] by giving immediate feedback” (9). “The IPA has the ability to monitor learner actions versus expected ones [. . .] and upon errors, the IPA provides feedback, corrects errors, and updates learner assessment data.” (10).

Sub-Theme: Give recommendations to students about learning material
The chatbot can give a student recommendations about learning content on for example the e-learning platform the bot implemented in. It can also be used to simply present the student with content of a specific course. The feature is present in 3 papers: 1, 5, and 13. Paper 5 says that the chatbot is “showing them [the students] contents of courses” and paper 13 that “When the student is viewing an exam question, he/she can asks the chatterbot for a recommendation about educational contents related to the concepts of the question.”.

Sub-Theme: Hold topic specific conversation
The chatbot is capable of conducting a topic specific conversation. The chatbot can hold a conversation on a specific subject contained in its knowledge base, letting the learner ask questions or in some cases asking the learner questions. This feature was found in 7 papers, which means that it is very well grounded in the dataset. The papers are 2, 3, 4, 5, 10, 13, and 14. Paper 4 for example describe their chatbot as: “programmed to chat in the first person about Freudian theory, concepts and biographical events”, whereas paper 14 built a “chatbot for [the] educational sector, where user [. . .] can ask query regarding college admission, about college information and other things related to academics”.

Sub-Theme: Hold general conversation
The chatbot is capable of conducting a general conversation. This could mean that the chatbot can talk about general topics such as the weather or their preferences. This feature may give the learner more motivation to interact with the chatbot and make it feel more human. 5 papers explicitly stated this feature in their chatbot, papers 3, 5, 6, 9, and 10. Paper 3 explains that the student can hold a conversation with the chatbot and that “This conversation can be a general conversation (thanks to a set of predefined AIML files that contain general information)” . Paper 9 also provides the motivation of this feature: “[The chatbot] was designed to raise a child’s interest since it could engage with them in a continuous conversation. The presences of PA could motivate children to stay longer […] since […] the chatbot] maintained children’s level of confidence and encouraged their learning”.

Sub-Theme: Teacher can edit bot content
The chatbots implementation allows the teacher or administrator to edit the content of the bot. This might be the general information, course specific content, or the learning resources the chatbot can access. Paper 3 and 5 implement this feature, note that these papers are written by almost the same authors. Paper 3 claims that “it is possible to customize the bot giving it a name, hobbies, home town, birthday, etc. and a background image for the conversation window” and that “[The chatbot] has an interface where teachers can select the resources from a structure of modules . . .”.

Sub-Theme: Ask the student questions
The chatbot has the capability to ask the student questions on the learning content. 3 papers in the dataset show this feature, paper 3, 5, and 13, again note that these papers are written by almost the same authors. In all papers it is possible for the learner to ask the chatbot for questions, these might be exam questions, questions associated with a predefined test or personalized, or, what they call ‘free questions’. Paper 13 says that “If the student asks for exam questions related to specific concepts […] the chatterbot will […] search into a repository of exam questions […] chose ones related to the concepts specified by the student.”. Furthermore, in paper 5 the researchers write:

“while a student is talking to the bot, he/she can request several activities related to tests: [1] Ask for a test: The bot chooses one over all the tests the administrator had created. [2] Ask for a personalized test: The student must choose the number of questions the test will include and the bot will create the test that fits this requisite. [3] Ask for questions that do not belong to a test (free questions): The bot starts to ask questions and keeps on it until the student wants to stop.”

Sub-Theme: Conversational strategies
A chatbot can exhibit conversational strategies, such as the ability to ‘chain’ a conversation or to return to a topic after a branching. The purpose of a conversational strategy is to keep the learner focused on the important material and to provide believability to the chatbot. Strategies such as these were found in 6 papers, papers 4, 5, 6, 7, 8, and 10. In paper 4 the researchers write that the chatbot “has the capacity to return to a story after branching to a new location and also retains the parts of a story that have been told to prevent repetition.” and paper 8 claims that “The metadata supports the ability to “chain” a conversation. This is accomplished when Pixel asks a follow-up question in response to the initial input. Based on the user’s answer, additional information is provided. Using this Q&A approach surprisingly complex conversations can be held between the bot and the chatter.”

Sub-Theme: Answer student questions
The chatbot has the capability of answering the students questions. This may be the most basic of
an AIML-based chatbots features, and is one it is very well suited for due to the implementation. Thus almost all papers’ chatbots exhibit this skill in one way or another. The remaining 3 papers’ chatbots (2, 5, 7) might contain the feature as well, but it cannot be inferred from the paper without making several assumptions. Paper 3 for example state that their chatbot “is able to answer students’ questions about different subjects using natural language.” and paper 14 describe their chatbot as an “interactive chatbot for University related Frequently Asked Questions (FAQs)”.

**Encompassing system**

The theme compass the system (if any) the chatbot has been implemented into. This system might be used to limit the users of the chatbot to a specific course, to provide additional technology to enhance the overall experience or it might be the opposite, that the chatbot is added to the system to enhance its qualities. The 4 sub-themes of the theme are: ‘Library system’, ‘Virtual environment’, ‘E-learning system’, and ‘Stand-alone’. The last is, of course, not technically a system but rather the lack of one, but it is as important to the theme as the others.

**Sub-Theme: Library system**
The chatbot is incorporated in a library system, in this dataset it only applies to the chatbot in paper 8, Pixel. Due to this integration the chatbot is easy to reach for the intended users (students and researchers) and the chatbot has access to the library’s databases. The write that the chatbot works by “giving immediate answers to questions about library services and resources”. They also claim that “Pixel flattens the website so users do not need to interpret the website and navigate through pages to find the specific information they are seeking. It is also designed to guide researchers to appropriate resources and help them solve problems in a similar way as the more conventional FAQ”.

**Sub-Theme: Virtual environment**
The chatbot is implemented in a virtual environment. In the dataset the chatbots are used as virtual characters, or NPC’s, the learner can interact with. Three papers have used their chatbot in this manner, paper 6, 9, and 10. In paper 6 this virtual world is a “3D multi-user virtual world that imitates cultural sights of Madrid in which a community of learners experience auditory and visual immersion.”. In paper 9 the virtual environment is: “Hikayat Land[: . . .] a virtual folktales land containing a series of Malaysian children’s literature, the folktales of Hikayat Sang Kancil.”. Lastly in paper 10 the researchers virtual world is “implementing learning scenarios with intelligent pedagogical agent in Open Wonderland virtual world.”.

**Sub-Theme: E-learning system**
The chatbot works as a part of an e-learning system, it may be as the main interaction point or as just one tool in the system. 5 papers fall into this sub-theme, papers 1, 3, 5, 7, and 13. In paper 1, the chatbot “takes directly the role of front end on the elearning platform”. In paper 5 the chatbot is the intelligent part of a bigger system “INES is a functional prototype of an online learning platform, which combines three essential capabilities related to e-learning activities. These capabilities are those concerning to a LMS (Learning Management System), a LCMS (Learning Content Management System), and an ITS (Intelligent Tutoring System)”.

**Sub-Theme: Stand-alone**
A stand-alone chatbot is not incorporated in any larger system, other than the platform on which it is installed. 5 papers (2, 4, 11, 12, 14) were found to belong in this sub-theme. Paper 12 states this simply with the sentence “This application can run in every android devices with Internet
connection”. Paper 11 explains that they “built the function of WEB and mobile usage”. With paper 2, 4, and 14 however, no encompassed system or lack thereof was explicitly stated, they were therefore assumed to be stand-alone components, something that is of course important to note for the reader.

**Bot Augmenting Tech**

This theme encompass the technology that has been added to the bot to enhance it or to compensate for some weakness it has. There were three sub-themes found in this theme: ‘Linguistic tools’, ‘Animation’, and ‘Text-to-speech’.

**Sub-Theme: Linguistic tools**
The language capabilities of an AIML-based chatbot are limited to what has been programmed into the knowledge base, thus a linguistic tool might be used to compensate this limitation. In the dataset 4 papers have used some linguistic tool in their chatbot, papers 3, 5, 11, and 14. Papers 3 and 5 both implemented a linguistic analyzer in order to “obtain a recommendation of key words/concepts related to the [newly added] course content.” (3). Paper 11 used a word segmentation tool to aid their chinese reading chatbots understanding of the complex language, it “is based on the research of a large semantic dictionary by Peking University, with the functions of word segmentation and part-of-speech tagging.”. Paper 14 states that they intend to implement latent semantic analysis (LSA) as an upgrade for their chatbot on order to “discover likenesses between words as vector representation. So that the unanswered queries by AIML will be viewed as a reply by LSA.”

**Sub-Theme: Animation**
The chatbot has been embodied and animated, the goal being to create a more engaging experience for the learner. Two papers explicitly state animating their chatbot, that is paper 4 and 10. Paper 4 created a Haptek animated image of Sigmund Freud for their Freudbot and then “When the Haptek Player software is installed on the user’s computer, output from the AIML server is fed through the Haptek client’s text-to-speech engine to produce speech output with synchronized lip movement.”. Paper 10 used the built in functions in the Open Wonderland: “The multi-modal communication module integrates gesture generation, text chat (through Natural Language question making), and Text-To-Speech generation.”.

**Sub-Theme: Text-to-speech**
The chatbot can give output/input as speech instead of text. This augmentation is relevant for the animated chatbots, to actually achieve the full experience. It may also be relevant to reinforce the text message or to provide a service to users who are blind or have reduced eyesight. 5 papers have used this augmentation in their chatbot, papers 1, 4, 6, 10, and 12, i.e. both the animated chatbots have it (see sub-theme: animation). Paper 1 use it in order to ‘translate’ the students’ question for their phone transmission to the teacher: “The phone call’s content, as we said, is a vocal synthesis (text to speech) of conversation between the ChatBot and the learner.”. Paper 12, who specifically targets blind learners as their user group, write: “output will be given as speech by the TTS”.

**Platform**

Every chatbot has been implemented on some platform, the choice of platform is closely connected to what encompassing system was used, for example most e-learning systems are located on the
‘Web platform’. The sub-themes are thus, ‘Web’, ‘Mobile OS’, and ‘Not-specified’.

**Sub-Theme: Web**

A chatbot implemented on a web platform has the advantage of platform independence in a sense, since basically all devices today can reach the web. The papers who took advantage of this fact are papers 1, 3, 5, 6, 7, 8, 10 and 11. Out of these, 6 papers had been encompassed in an e-learning system, paper 3 for example simply write that “The students are able to connect to the e-learning platform through the Internet”. The chatbot in paper 8 was published in a web-based library system, ‘web pages on the libraries’ website’. Papers 6 and 10 was published in a virtual world which provide the web-access: “Data common to all clients are stored in a WebDav-based content repository hosted by the Open Wonderland Server. With this content repository, the client can access these data via the HTTP protocol.”

**Sub-Theme: Mobile OS**

The chatbot was build for a mobile platform, this could Android, iPhone or Windows phone. 3 papers built their chatbot for a mobile platform, 12, 13, and 14, coincidentally these three papers were published most recently. Paper 12 and 13 both implemented their chatbot on an Andoroid system, “This application can run in every android devices with Internet connection” (12) and “The Android application is basically a chatterbot, which provides a clean interface using text or voice/audio to communicate with the user in natural language” (13). Paper 14 does not mention a specific system, but show some application snapshots.

**Sub-Theme: Not-specified**

Some researchers did not specify the platform on which they implemented their chatbot. This was paper 2, 4, and 9.

### 4.4.2 The papers and their chatbots

In this section the chatbots in the papers will be described in regards to which themes and sub-themes of the ICT theme group they adhere to. Each section will start with the summary of the paper from table 4.1.

**Paper 1: Orlando and Giovanni (2008)**

**Summary**

The paper describes an integrated system with the purpose of monitoring and supporting an e-learning systems activities and discovering the students issues. The system alerts the teacher with a phone call if a learner poses a question that cannot be answered, the question has then been vocalized using text-to-speech technology. An AIML-based chatbot works as the front-end of the application and is the instance the learner interacts with. For the present subthemes, see table 4.2.

**Paper 2: Doering et al. (2008)**

**Summary**

The study investigated the effect of conversational agents on communication and interaction when used to assist participants in developing an online portfolio. Data gathered during four weeks revealed that participants talked to the agents on a range of subjects, not only related to the domain of e-portfolio. The participants didn’t find the agents very helpful in completing class
activities, but used them as social companions. The researchers conclude that further research is needed on three points: 1) Learner-developed conversational agents, 2) Improve the agents’ “intelligence” regarding the domain knowledge, and 3) Agents that better meet users’ humanistic and utilitarian expectations. For the present subthemes, see table 4.3.

### Paper 3: Mikic et al. (2008)

**Summary**
The authors have developed two AIML-based bots with the purpose of helping students during the learning process and supporting teaching activities on an e-learning platform like Claroline or Moodle. One bot has the role of a tutor (T-bot) and communicates with the learner in natural language to give them adequate and domain specific answers and guiding students to the right course material. The other bot had the role of an evaluator (Q-bot) and can track and supervise the student through personalized questionnaires. Both bots have been developed as easily integrated modules for Claroline or Moodle. For the present subthemes, see table 4.4.

### Paper 4: Heller and Procter (2009)

**Summary**
The authors perform an experiment to explore how an historical figure application of a pedagogical agent affected student engagement and motivation. 88 participants were randomly assigned to one of three groups; a no image agent, a static image agent and an animated image agent. The
results contradicted the expectations and previous research on animated pedagogical agents in that the no image agent received higher ratings for half the measures. For the present subthemes, see table 4.5.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Tutor</td>
</tr>
<tr>
<td></td>
<td>Student Evaluation</td>
</tr>
<tr>
<td></td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Help students 24/7</td>
</tr>
<tr>
<td></td>
<td>Support feedback to students</td>
</tr>
<tr>
<td></td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td></td>
<td>Hold general conversation</td>
</tr>
<tr>
<td></td>
<td>Teacher edit bot content</td>
</tr>
<tr>
<td></td>
<td>Ask student questions</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Linguistic tool</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>E-learning system</td>
</tr>
<tr>
<td>Platform</td>
<td>Web</td>
</tr>
</tbody>
</table>

Table 4.4: Paper 3: Chatbot sub-themes

**Paper 5: Mikic et al. (2009)**

**Summary**

INES (INtelligent Educational System) is an e-learning platform which comprises a set of different technologies. One of these technologies is a chatbot which communicates with the students in natural language and act as the “brain” of the system. The paper focuses on the description of this chatbot called CHARLIE (CHAtteR Learning Interface Entity). CHARLIE can communicate with students in natural language and answer general or domain specific questions. The student can also request questionnaires or free questions from the bot to test their knowledge. For the present subthemes, see table 4.6.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td></td>
<td>Conversational strategies</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Animation</td>
</tr>
<tr>
<td></td>
<td>Text-To-Speech</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>Stand-alone</td>
</tr>
<tr>
<td>Platform</td>
<td>Not-specified</td>
</tr>
</tbody>
</table>

Table 4.5: Paper 4: Chatbot sub-themes

**Paper 6: Ibáñez et al. (2011)**

**Summary**

The paper describes a 3D multi-user virtual world for language learning. It was developed to test
if it would create an engaging learning experience and thus foster communication skills with minimal teacher involvement. The open-source development toolkit Open Wonderland was used as a base and then extended to provide natural language conversation with Non-Player Character chatbots, textual tagging of virtual objects, automatic reading of texts in learning sequences and the arrangement of learning activities meant to promote collaboration. The authors preliminary evaluation of the experience shows great promise. For the present subthemes, see table 4.7.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Tutor</td>
</tr>
<tr>
<td></td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Give recommendations about learning material</td>
</tr>
<tr>
<td></td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td></td>
<td>Hold general conversation</td>
</tr>
<tr>
<td></td>
<td>Teacher can edit bot content</td>
</tr>
<tr>
<td></td>
<td>Ask student questions</td>
</tr>
<tr>
<td></td>
<td>Conversational strategies</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Linguistic tool</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>E-learning system</td>
</tr>
<tr>
<td>Platform</td>
<td>Web</td>
</tr>
</tbody>
</table>

Table 4.6: Paper 5: Chatbot sub-themes

**Paper 7: Rossi and Carletti (2011)**

**Summary**
The researchers describe an open source Learning management system containing a chatbot. The system is aimed at supporting online teachers work by implementing a knowledge base specific to pedagogical aspects and not a specific subject. The chatbot developed was based on the ALICE chatbot and should retrieve information already coded in the courses or originated in student activity logs and then answer the students most common questions in order to relieve teachers from the task giving them time to answer more difficult questions better. For the present subthemes, see table 4.8.

**Paper 8: Allison (2012)**

**Summary**
The paper describes a chatbot pilot “Pixel” developed to answer questions about the library and
its resources at the University of Nebraska-Lincoln. The chatbot could answer questions from a variety of users from around the world and, surprisingly for the author, attracted a lot of social chatter. The majority of questions where of a factual nature which the Pixel could handle and the database was proved easily revised as library resources or personnel changed. The chatbot provided a consistent service 24/7 and also a playful interface which engaged users, relieving them from complicated navigation systems and endless scrolling through search results. At the same time it could refer the more complicated questions to the librarians. For the present subthemes, see table 4.9.

\[
\begin{array}{|l|l|}
\hline
\text{Theme} & \text{Sub-Theme found in chatbot} \\
\hline
\text{Role of bot} & \text{Tutor} \\
& \text{Questions & Answers} \\
\hline
\text{Bot Features} & \text{Conversational strategies} \\
& \text{Answer student questions} \\
\hline
\text{Bot Augmenting Tech} & \text{None} \\
\hline
\text{Encompassing System} & \text{E-learning system} \\
\hline
\text{Platform} & \text{Web} \\
\hline
\end{array}
\]

Table 4.8: Paper 7: Chatbot sub-themes

\[
\begin{array}{|l|l|}
\hline
\text{Theme} & \text{Sub-Theme found in chatbot} \\
\hline
\text{Role of bot} & \text{Help students 24/7} \\
& \text{Provide content from other knowledge sources} \\
& \text{Conversational strategies} \\
& \text{Answer student questions} \\
\hline
\text{Bot Features} & \text{Text-To-Speech} \\
\hline
\text{Bot Augmenting Tech} & \text{Library system} \\
\hline
\text{Platform} & \text{Web} \\
\hline
\end{array}
\]

Table 4.9: Paper 8: Chatbot sub-themes

\textbf{Paper 9: Masmuzidin and Wan (2012)}

\textbf{Summary}
Pedagogical agents have been praised as a tool to enhance learning and teaching, only the authors identified a limited application with children as participants. The research then investigate if a pedagogical agent can enhance children’s learning as well. They developed an agent set in a virtual learning world called Hikayat Land, with the purpose of teaching children Malaysian folktales and moral values. The agent has the role of a traditional storyteller and the children can interact with him using natural language. For the present subthemes, see table 4.10.

\textbf{Paper 10: Soliman and Guetl (2013)}

\textbf{Summary}
Virtual worlds are providing an interesting medium for engineering education since it can provide visual collaboration and authentic and active learning experiences. However, they lack the important educational support provided by a teacher. The authors solution is to include pedagogical agents
in the virtual worlds and thus adding the lacking learning support. The paper presents a prototype implementation of an IPA which can interact with a learner in natural language and support their understanding of the virtual experiments. Both the IPA and the learning scenarios are implemented in the open source platform Open Wonderland. For the present subthemes, see table 4.11.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Tutor</td>
</tr>
<tr>
<td></td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td></td>
<td>Teacher Communication</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Support feedback to students</td>
</tr>
<tr>
<td></td>
<td>Hold general conversations</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>None</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>Virtual environment</td>
</tr>
<tr>
<td>Platform</td>
<td>Not-specified</td>
</tr>
</tbody>
</table>

Table 4.10: Paper 9: Chatbot sub-themes

**Paper 11: Gang et al. (2014)**

**Summary**
The paper shows different aspects of an implemented Chinese Intelligent Chatbot, like the internal structure, the foundation, the final effect and most importantly the problems met during construction and how they were solved. A Chinese chatbot encounters unique problems due to the lack of a perfect corpus and the Chinese word segmentation system. The paper presents a way to handle these problems through the inclusion of a word segmentation system in the bot as well as a means to handle synonymous sentences. For the present subthemes, see table 4.12.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Tutor</td>
</tr>
<tr>
<td></td>
<td>Student evaluation</td>
</tr>
<tr>
<td></td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Demonstrate learning task</td>
</tr>
<tr>
<td></td>
<td>Gestures supporting knowledge base</td>
</tr>
<tr>
<td></td>
<td>Point of interaction for learner</td>
</tr>
<tr>
<td></td>
<td>Provide output as speech</td>
</tr>
<tr>
<td></td>
<td>Help students 24/7</td>
</tr>
<tr>
<td></td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td></td>
<td>Support feedback to students</td>
</tr>
<tr>
<td></td>
<td>Conversational strategies</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Animation</td>
</tr>
<tr>
<td></td>
<td>Text-To-Speech</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>Virtual environment</td>
</tr>
<tr>
<td>Platform</td>
<td>Web</td>
</tr>
</tbody>
</table>

Table 4.11: Paper 10: Chatbot sub-themes
**Paper 12: Kumar et al. (2016)**

**Summary**
The purpose of the paper is to present an Android application containing an educational Chatbot designed for visually impaired people. The application can be launched with Google Voice Search and is used by asking questions in spoken natural language, the application will then convert it to text and run the query against the AIML database or, if no pre-saved answer was found, against the Wikipedia API. The answer is then returned to the application as both text and voice. For the present subthemes, see table 4.13.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Help students 24/7</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Linguistic tool</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>Stand-alone</td>
</tr>
<tr>
<td>Platform</td>
<td>Web</td>
</tr>
</tbody>
</table>

Table 4.13: Paper 12: Chatbot sub-themes

**Paper 13: Fonte et al. (2016)**

**Summary**
The researchers present a system consisting of two parts, an android application and a server platform. The android application implements a chatbot which interacts with both the student and the server. The objective for the system was to enable the student to carry out several actions related to their studies like: consult exams questions, receive recommendations about learning materials, ask questions about a course, and check their assessed exams. The purpose of the chatbot is thus to provide a friendly interface which can be interacted with using natural language. For the present subthemes, see table 4.14.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Allow input as speech</td>
</tr>
<tr>
<td></td>
<td>Provide output as speech</td>
</tr>
<tr>
<td></td>
<td>Provide content from other knowledge sources</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Text-To-Speech</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>Stand-alone</td>
</tr>
<tr>
<td>Platform</td>
<td>Mobile</td>
</tr>
</tbody>
</table>

Table 4.14: Paper 12: Chatbot sub-themes

**Paper 14: Ranoliya et al. (2017)**

**Summary**
The paper presents a chatbot design implemented to be able to answer FAQs regarding university related questions in an efficient and accurate way. The implemented chatbot is based on AIML and the researchers have the goal to further improve the capabilities by eventually also using
Latent Semantic Analysis. The bot works well to provide 24/7 service to students or others interested in the university. For the present subthemes, see table 4.15.

Table 4.14: Paper 13: Chatbot sub-themes

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Tutor</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Provide content from other knowledge sources</td>
</tr>
<tr>
<td></td>
<td>Give recommendations about learning material</td>
</tr>
<tr>
<td></td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td></td>
<td>Ask student questions</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>None</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>E-learning system</td>
</tr>
<tr>
<td>Platform</td>
<td>Mobile</td>
</tr>
</tbody>
</table>

Table 4.15: Paper 14: Chatbot sub-themes

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-Theme found in chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of bot</td>
<td>Questions &amp; Answers</td>
</tr>
<tr>
<td>Bot Features</td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td></td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Bot Augmenting Tech</td>
<td>Linguistic tool</td>
</tr>
<tr>
<td>Encompassing System</td>
<td>Stand-alone</td>
</tr>
<tr>
<td>Platform</td>
<td>Mobile</td>
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Chapter 5
Analysis

The chapter contains the analysis of the results acquired in the literature review. The structure of the chapter will follow that of the results presentation, in order to provide a clear and concise report. The chapter starts with the analysis of the results from the publication theme group, move on to the analysis of the educational context theme group, and finish with the analysis of the themes and sub-themes in the ICT implementation details theme group.

5.1 Publication details

The finding in the publication theme group is analyzed. The most interesting findings in this group include the diversity of the authors, institutions, publication dates, keywords, and publication venues used within the dataset. This diversity imply that the subjects is of interest for a large group of researchers, within diverse fields of studies.

5.1.1 Author(s)

11 of the 14 papers had different authors, something that indicates a dispersed interest for the subject, rather than a limited circle of researchers. A benefit of this might be that the research in the area is broader and more diverse, although a disadvantage might be that no depth of knowledge in specific factors are procured. 3 papers had authors common authors, and in these papers a similarity and progression of ideas was clearly visible, i.e. here we can see the advantage of the knowledge deepening.

5.1.2 Institution

This themes’ results really tell the same tale as that of the authors, no single institution stands out as having a greater representation. Naturally the same three papers which shared authors also share an institution and the analysis remained the same, a similarity and progression of ideas was clearly visible.

5.1.3 Time published

The publications spanned 9 years, from 2008 until 2017. The surprising fact here was that no found papers had been published between 1995 and 2007. 1995 is the time the ALICE-bot was first
published, so that there was be a slight time gap before others caught on to the technology might be expected but 12 years seem excessive. This might be due to some error in the search strategy or the fact that educational uses might take longer to be developed within a new technology.

5.1.4 Keywords in paper

Within this theme it is interesting to note that the amount of unique keywords in the dataset, 50 unique keywords in only 14 papers. This implied a breadth of the field and use of chatbots even in this very limited scope of context (education and AIML-based bots in 4 databases). This analysis is supported by the earlier analysis that a diverse set of authors produce a broader set of research.

5.1.5 Journal/conference

The finding that the papers were published all in different journals/conference proceedings might imply a lack of a clear venue for these kinds of cross-subject projects, the mix of education and IT/HCI/Informatics, in the academic world. Or it might just imply that the same cross-subject platform contains to many suitable venues, leading the work to be spread out over several different conferences and journals. 8 out of 14 papers were published for conferences, this fact might indicate that the research was young when published and then abandoned for more fruitful endeavors. It might also mean that when the paper was published in a journal, other keywords were used and thus the paper was not collected in the search.

5.2 Educational context

The findings of the educational context theme group are presented in this section. On the whole, the four themes in this group yielded a lot fewer results than was expected. Few researchers had gotten to the stage of testing their chatbot and thus less information on the setting of the chatbot was reviled. This is the most likely reason to the unexpected lack of results. However, some were found and these will be presented below.

5.2.1 Level of education

There might be a very simple reason for this clear pattern of target level, namely that since the technology is still young, and it demands expertise in both the desired corpus and the implementation details, researchers might find it both safest and easiest to start development “close to home” by trying it on their own students initially. Education on all levels is a critical endeavor, not easily changed or experimented with. When testing new software on non-critical courses or aspects of courses this risk is lessened. In the same way, the burden of finding corpus expertise is lessened by implementing the chatbot into a context the researchers themselves are already familiar with.

5.2.2 Student demographics

The majority of the targeted group were adults, and where information was given (paper 2 and 4) another majority were women. How this might have affected the development or evaluation of the chatbot was impossible to tell since the researchers themselves did not reflect more closely
on it. None of these findings seemed to have particular relevance to the development, testing or evaluation of the chatbots.

5.2.3 Subject & Courses

There was 6 findings in this theme, i.e. less than half of the researchers had specified which subject or course their chatbot was developed for. This might mean that the goal of the chatbot was not to serve a single subject or course, instead developing a tool that might be easily adapted. It might also mean that the research and development is very new to the researchers, i.e they have not been applied in any specific course contexts get. The last implication is supported by the conclusion from the Journal/Conference theme; that the research is young.

5.2.4 Type of Education

This theme did not yield as many results as expected and because of this it will be impossible to draw any relevant conclusions from it. The expected result was that a lot of the chatbots would be implemented in online courses with many students, as this is the area where a chatbot might shine the most. The two papers which mentioned the type of education supported this expectation, by both claiming to be used in courses with full or part time distance online.

5.3 ICT implementation details

In this section the results from the two subsections in the ICT implementation details section (4.4), 4.4.1 and 4.4.2, are looked at collectively and referred to across the sub-themes. The most important findings in this group was located within the themes of ‘Role of chatbot’ and ‘Bot features’, since the sub-themes of these themes explain what a chatbot can be used for and what a chatbot can do. Secondly the sub-themes of 'Encompassing system' and 'Bot augmenting tech' are important to see if the chatbot technology can stand on its own of if it requires additional technology to be of value.

5.3.1 Role of Chatbot

The theme was divided into 5 sub-themes to encompass the different roles that were found. The found roles were ‘Student evaluation’, ‘Questions & Answers’, ‘Teacher communication’, ‘Natural conversation’ and ‘Tutor’. The roles encompass different aspects of a teachers responsibilities and thus show that the researchers have thought of the chatbot as an extension of the teacher role, rather than something separate. The roles are generous in their definition, and might encompass varied features and other attributes.

The most common role of the chatbots in the dataset were ‘Tutor’, a likely reason for this might be that a tutor is viewed as someone who helps a teacher. It may also be the fact that a tutor is difficult to define and the views on what a tutor-role include are varied. However none of the 9 chatbots found to be tutors were given only this role, the tutor role came in relation to other roles leading to the figure presented in the results chapter (see fig. 4.3). This implies that a tutor might include these other roles or tasks, but, e.g. a ‘Student Evaluation’ chatbot does not have to be a tutor, it can simply give students feedback.
5.3.2 Bot Features

There were 17 features found in the 14 chatbots, most appearing more than once. The fact that the dataset showed such a breadth in the chatbots capabilities is not surprising, taking the conclusion from the publication details theme group into consideration, especially the wide range of keywords used. The fact that so many features were found point to a conclusion that chatbots are extremely flexible and extensible, lending themselves able to perform many different tasks. The four most used features were 'Answer student questions', 'Conversational strategies', 'Hold topic specific conversation' and 'Hold general conversation'. The of the most used features are related to holding a conversation, something chatbots are documented to be good at. That these four are in the top is in line with the findings in the 'Role of bot' theme, where 'Tutor' and 'Questions & Answers' were the most popular, both roles which often include questions or conversations with students.

5.3.3 Encompassing System

Most chatbots had been implemented in some encompassing system, the three present in the data being 'Library system', 'Virtual environment', and 'E-learning system', but 5 chatbots were 'Stand-alone' applications. This shows that the chatbot can be implemented into other systems, as well as work on its own. The most used encompassing system was the E-learning system, with 5 chatbots as well. This may be because it is easy to keep all tools in one place, as well as giving the chatbot easy access to the learning material and the students easy access to the chatbot. An interesting finding in this group were the chatbots used as NPC in virtual worlds, the chatbot working as the brain of the NPC and thus being able to communicate with the users avatar using natural language. The chatbot used in the context of a library system was one of a kind, but when looking at the general functionality of the system, it is simply a website containing access to several databases, of which the chatbot was made a part. Thus the generalization could be made that a chatbot might be implemented into a database heavy system and work well as its front-end interaction point.

5.3.4 Bot Augmenting Tech

Three sub-themes were found in the scope of this theme, the researchers had improved the chatbots’ capabilities by adding 'Linguistic tool', 'Animation', and 'Text-to-speech'. Not all chatbots had used augmenting technology, which implied that the chatbot may be equally valuable with or without it, the depending factor seems to be the general aim and goal of the chatbot implementation. For example, the chatbot aimed at helping blind students would not be valuable without the text-to-speech function.

5.3.5 Platform

The platform of the chatbot seems to have little relevance, other than it being connected to the Internet in some way. The platforms used were either the 'Web' or some 'Mobile OS', or it was not specified in the papers. The conclusion from this theme is thus that Internet connection is a crucial function for any chatbot, since otherwise it will not be easy to reach for the students who need to use it.
Chapter 6

Discussion

The results were interesting and despite the small dataset they showed a lot of diversity. The publication details themes showed the most diversity, implying that the subject of chatbots in education is of interest to a wide array of authors, institutions, and journals/conferences. It also showed a broad interest and usability in the application of the chatbot technology, with the high amount of unique keywords discovered in the papers. This finding was also backed by the high amount of chatbot features discovered, really showing the diversity of the tool. The fact that the findings here were so diverse also shows a lack of focused expertise from any single researcher, institution or publication, no one seems has chosen the application of the chatbot technology in education as their main field of interest. This of course excludes the three papers actually written by almost the same authors, where then the opposite could be said, they chose to have this focus and a clear development of knowledge and ideas can be seen through the three papers.

The educational context themes yielded less coherent findings, with fewer results than the other theme-groups. The most important finding in this group was that most researchers had targeted students or adults rather than children or teens, the reasons for this may be many, for example students are a simple target since most researchers have access to a lot of them already. Another reason might be that despite the chatbots natural language proficiency, it is quite bad at interpreting incorrect spelling or grammar, something that is most likely more common among children, making them a more difficult target group during this time of implementation. Another interesting point of finding in this theme group was that only a few of the chatbots in the papers had been tested in actual education as of the publication of the paper, this might mean that the papers located in the search only depicted the development, and that other keywords or search criteria are necessary to find the testing of the chatbots. It might also mean that the researchers never got that far, but instead abandoned the research for other ventures.

The most important findings were located in the third theme group, ICT implementation details, the theme group created to encompass all the details of the chatbot itself. Within this group different possible roles of the chatbots were discovered and the capabilities of the chatbots in the form of their features. Supporting factors of the chatbot were found as well, in encompassing systems, chatbot augmenting technology and platforms. The findings imply that an AIML-based chatbot may be used for many different purposes and aims, include many different features, work well on it own or together with additional technology and be implemented on various platforms.

The roles a chatbot could take that were found in the data included: 'Tutor', 'Student evaluator', 'Questions & Answers', 'Teacher Communication', and 'Natural conversation'. The most common of these were Tutor, closely followed by Questions & Answers. Both these roles are big in their definitions, and may thus encompass a lot of different things, something that might be seen in the
large number of features these bots include. That tutor is a common role may be quite natural since a tutor is practically an extension of the teacher, ultimately performing some of the same tasks as a teacher might perform. The tutor role was always in combination with other roles, indicating that the role involves multiple responsibilities, again, just as a teacher. The other roles may be less frequently represented, but they were represented separate from the role of 'Tutor' too, implying that for example the 'Student evaluation' is a valuable role for a chatbot even without the added responsibilities of a tutor. The chatbots role can thus be adapted to suit a range of needs, something that is also clearly shown in the large range of features present in the results.

The results reveled 17 features a chatbot might have, the most common being 'Answer student questions', 'Conversational strategies', 'Hold topic specific conversation' and 'Hold general conversation'. This indicates that a chatbots' main proficiency is still holding natural language conversations or answering questions in natural language, the core skills of a chatbot and how it all started with ELIZA and ALICE. It can be concluded that it is important to remember this main skill when implementing a chatbot, as this is where both its greatest strength, simple natural conversation, and weakness, understanding incorrect grammar or unusual patterns, seems to lie.

By keeping the focus on this main skill the chatbot can show its greatest applications, and the weakness must be remembered in order to mitigate it as much as possible. If natural language communication is not the key feature or requirement, another type of technology might be better suited for that particular development.

Some of the reported roles or features would not have been possible without the use of the augmenting technology like linguistic tools, text-to-speech or animation, or without implementing the chatbot into a larger system, like an e-learning platform, a virtual environment or a database collecting system such as that of a library. The results and analysis show that the AIML-based chatbot is valuable without these additions, but also that the chatbot may perform even better when they are added. When making these decisions it will be important to look at the role the chatbot should take, what features it needs to include and then start thinking about if the AIML chatbot can manage this on its own or if it requires additional technology. For example if a requirement is for the chatbot to output speech obviously text-to-speech would have to be included. Another example might be if the chatbots' purpose is language learning, some semantic tool to help the chatbot better handle spelling and grammar mistakes would most likely be necessary in order to create the best pedagogical value.

A quite surprising but very interesting find was the fact that the chatbot could be used as an NPC (non-player character) in a virtual world. The chatbot was used as the decision making entity or brain of the NPC’s that the users avatars could interact with, creating an interactive learning experience for the user. This kind of use of the chatbot may lead to even more applications of it for learning, for example it could be used as a guide in an historical virtual world to who the listeners can ask questions, or as a companion that gives clues in a puzzle game that promotes logical thinking.
Chapter 7

Conclusion

The thesis ends with the conclusion which looks at the research questions and the aim, and summarizes the found answers and the key points of the discussion. Future research is also presented and discussed.

The aim of the thesis was to further the development of educational chatbots by reviewing what had been done and summarize this knowledge. This would be done by finding out what capabilities the chatbot might have in an educational context and if it could stand on its own or if it required additional technology to add pedagogical value in education. This aim was boiled down to the open-ended questions: What roles can AIML-based chatbots take in an educational context? and What features can AIML-based chatbots have in an educational context?. These questions have been answered thoroughly in this thesis but the answer might be summarized as: The features and uses of AIML-based chatbots are many, and they seem only to be limited by what we humans might imagine it doing. It is a flexible and diverse tool, simultaneously simple and complex, limited only by the inventiveness of its creator. It can work well on its own and provide educational value, but may reach even better results when combined with other technology.

A more specific answer might be that a chatbot can be used as a tutor, a student evaluator, for questions and answers, to communicate with a teacher or simply for natural conversation. The applications of these roles seem endless, and the 17 features (see table 7.1) found in this work is most likely only a subset of the things chatbots can really do. The chatbots capabilities can be expanded by including it in other systems such as e-learning systems, virtual environment or library system (or other database heavy systems) or by adding augmenting technology like text-to-speech technology, linguistic tools or animation.

<table>
<thead>
<tr>
<th>Demonstrate learning task</th>
<th>Support feedback to students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animated gestures supporting knowledge base</td>
<td>Give recommendations about learning material</td>
</tr>
<tr>
<td>Allow input as speech</td>
<td>Hold topic specific conversation</td>
</tr>
<tr>
<td>Control e-learning platform’s activity</td>
<td>Hold general conversation</td>
</tr>
<tr>
<td>Provide means of contact with teacher</td>
<td>Teacher can edit bot content</td>
</tr>
<tr>
<td>Point of interaction for learner</td>
<td>Ask the student questions</td>
</tr>
<tr>
<td>Provide output as speech</td>
<td>Conversational strategies</td>
</tr>
<tr>
<td>Help students 24/7</td>
<td>Answer student questions</td>
</tr>
<tr>
<td>Provide content from other knowledge sources</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.1: Chatbot features
7.1 Future research

As technology in education is ever changing, the chatbot may well have a chance to make a real impact in the field. This work might be a stepping stone for the researchers looking to make that possibility into reality. From this point there is a lot of possible future research to suggest. For example, to look more into the actual pedagogical benefits of the different chatbot implementations, this would be both important and interesting, as only a few of the works reviewed in this work actually go on to perform that step. Another possible research idea might be to implement a chatbot system that is easy to adapt to the current subject or course, so that the teacher managing the chatbot could do so without the requirement of development skills. It would also be interesting to investigate if a chatbot might bring something completely new to the table of pedagogics, rather than just being a substitute for a teacher or an interactive FAQ, one examples of this might be a study buddy, like an assistant keeping track of tasks, submissions and results, in a more personal way than a common calendar.

A separate line of future research might be to look more at what the chatbot could bring to the virtual world and if this could become a valuable pedagogical tool. The chatbot as an NPC is an interesting concept that could well be used not only in the field of education, but maybe even more in the field of entertainment. This idea again shows how diverse the uses of the chatbot technology can be.
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