Computer assisted language learning: an outline and discussion of current issues

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***Abstract*—This paper gives a brief overview of current issues and recent developments in the field of computer assisted language learning (CALL) and intelligent computer assisted language learning (ICALL). We outline and discuss how computers are employed in language learning and teaching, the typology of CALL, research within CALL, and the importance of learner modelling and feedback within ICALL. We conclude by offering examples of ICALL systems currently used and researched.**

Keywords—computer assisted language learning (CALL); intelligent computer assisted language learning (ICALL); language teaching; SLA.

I. INTRODUCTION

Living in the era of rapidly developing technology, in which new products and advances are presented on almost daily basis, we find technology uses in numerous domains of human existence. Using information and communication technology (ICT) in general and computers in particular, for educational purposes, has received a wider attention in the past couple of decades. To be more exact, this trend has been particularly noticeable since the appearance of personal computers and, more recently, the Internet, which opened novelty ways of communicating and offered new, easier paths to disseminating knowledge.

A body of research has focused on how to successfully apply computers (all emerging technologies for that matter) in the educational context [1, 2, 3], and it has been shown that they can be a viable support for meaningful educational experiences [4].

Technology has also entered the field of language learning and teaching to constitute what we refer to as computer assisted language learning (CALL). However, using technology in the context of language classroom is somewhat different than is the case with other disciplines [5]: we have to take into account that language learning is one of the most complex human undertakings involving not only knowledge-based, but also skill-based approach [6, 7]. The addition of technology into the language learning "equation" significantly complicates the matter, which calls for special attention to using sound theoretical and pedagogical approaches in order to maximise the effects of CALL [1, 7, 8, 9, 10, 11]. Shifts in focus of second language acquisition (SLA) theories, as well as in pedagogical principles of foreign language teaching have been reflected throughout the historical development of CALL, the roots of which can be traced back as far as the 1950s and 1960s [6, 7, 12, 13]. Also, as technology progressed and evolved, there has been a constant struggle among language teachers regarding effective implementation of these technologies into the learning and teaching process. Today, there seems to exist a strong tendency towards socio-cultural and socio-cognitive approaches to language learning [14, 15, 16], and a general positive attitude towards using computers in the language learning process [1, 7, 17, 18, 19].

This paper aims to give an outline of current issues in the field of CALL and, more specifically, intelligent CALL (ICALL), discuss in brief technological, theoretical and pedagogical implications surrounding the use of computers in language learning, and try to suggest possible guidelines for future work and research. The rest of the paper is structured as follows: first, we define CALL and discuss past and current issues and problems within the field; second, we turn to ICALL and explain how artificial intelligence and related disciplines have come to help language learning and teaching community; last, we conclude the paper and give a brief indication of our future work.

II. COMPUTER ASSISTED LANGUAGE LEARNING

The use of ICT in education is not restricted to computers only. As can be seen from a relatively recent survey reported in [3], the usage of other technologies, such as audio-cassette and CD players, seems to be more frequent than use of computers: desktop computers came close second in the same survey, while portable computer devices were reported to be among those more seldom used. The last two fall within the scope of CALL and, thus, under the scope of this paper; the first, however, does not.

Computer assisted language learning is an interdisciplinary field that draws significantly on other disciplines, such as computer science, general linguistics, second language acquisition, language education, language assessment, computational linguistics, and psycholinguistics,

among others[1]. As a discipline in its own right, CALL can be defined as representing the search for ways in which computers may be applied in language learning and teaching [20]. It is necessary, however, to note here that using computers in such an environment does not only constitute usage of computers for language instruction, but for administrative and testing purposes as well. These include uses such as taking attendance, managing grades and evaluation process, classroom management, synchronous and asynchronous communication with students regarding a variety of issues related to the course, proficiency testing, etc [1]. For the purposes of this paper we will only consider using computers with the goal of language instruction.

Also, in this paper we will refer to CALL as the *process* in which users improve their target language by making use of computers [Beatty in 21]. This is a very broad definition in that it may encompass a variety of perspectives upon which a learner may improve within the course of instruction, such as [21]: (i) learning efficacy, (ii) learning effectiveness, (iii) access to materials, (iv) convenience regardless of time and place, (v) motivation, and (vi) institutional efficiency resulting in less teacher time or less expensive resources.

A. *CALL components*

According to [5], there are three components to CALL: pedagogy, theory and technology. These can be seen as three pillars supporting the foundations of CALL and guiding all the activity within the field. Despite some ambiguities that exist in defining the first two components [6], we will consider *theory* to be the knowledge about the way languages are learned (in this case, SLA), and *pedagogy* the practical application of theoretical knowledge in teaching situations. The notion of *technology* important for this work has already been defined in the previous subsection and said to include only computers. Fig. 1 offers a graphic view of the three components of CALL, and how they are related.

Garrett [5] posits that all three faucets of the CALL triad are involved in an intricate interplay in which none of them should exhibit dominance over the other two. This view was not the prevalent one during the entire history of CALL, especially in its early stages: the initial fascination with technology, caused by its range of possibilities, was the driving force of pedagogy. Since then, the approach of introducing technology for the sake of technology has been widely criticized and ultimately abandoned as it proved to be non-beneficial for the learners with regards to learning efficiency and ultimate attainment [10, 22]. A view that is more up-to-date, and still supported by a large majority of researchers in the field, suggests that the way we use technology should be grounded in pedagogy [7, 9, 16]. Even though Garrett [5] is right in asserting that we do not know everything about instructed SLA, we maintain that sound pedagogy, supported by what we know from SLA theory, is currently the best option when deciding how to employ technology to support/enhance language learning. In addition, we have to be aware that technology has its limits as well, so we have to make sure that what was planned on theoretical and pedagogical basis is achievable using technology [16, 23, 24, 25].

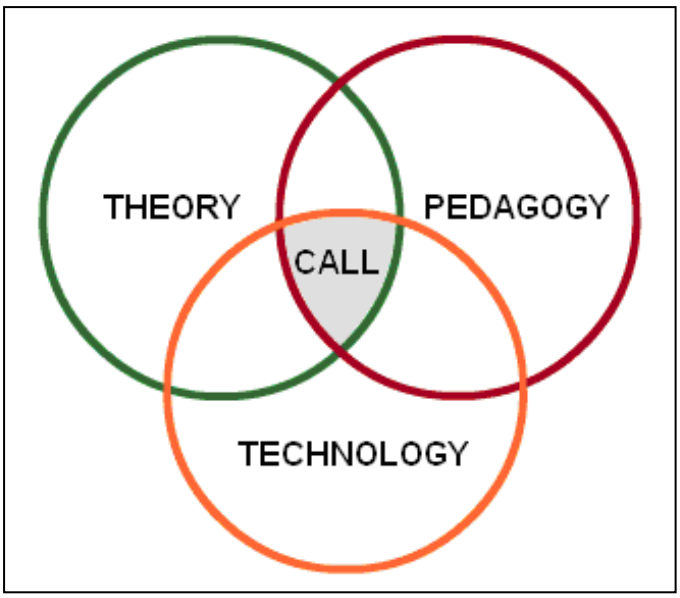

Fig. 1. The three components of CALL

The three components of CALL are complex in their nature and may change over time as research yields new findings [5]. Subsequently, the interrelationship between any two is also subject to change (as has been witnessed before throughout the history of CALL).

B. *Typology of CALL*

Over the years there have been various theoretical attempts to pinpoint the typology of CALL in order to capture its diverse interrelationships. This quest resulted in numerous accounts [e.g. 9, 12, 22]. In this review we will focus only on two accounts that received significant attention, namely, the mainstream one provided by Warschauer [12], and Bax's proposition [22] which represents the critique of Warschauer's work.

Warschauer [12, 26] suggests that there are three identifiable historical phases, each addressing a particular theory of language learning and characterised by its own attitude towards technology. The three phases are known as behaviouristic CALL[2], communicative CALL, and integrative CALL. The following accounts of phases are all from [12] and [26].

[1] SLA, language education, language assessment, computational linguistics and psycholinguistics fall under the umbrella term *applied linguistics*. A detailed distinction is made here to illustrate the variety of disciplines CALL relies on.

[2] In one of Warschauer's later revisions of his typology, this phase was termed *structural* CALL (e.g. [26]).

The use of computers in the first phase was governed by the behaviourist theories of learning, and, accordingly, computers were viewed simply as vehicles for delivery of instructional materials. Learning activities were mainly of drill-and-practice type. The main conceptual principle was that the computer is a tutor which allows students to progress through learning materials at their own pace, making the approach to learning more "individualized".

With the rejection of behaviouristic tendencies in language teaching circles, the advent of microcomputers opened new possibilities previously unimaginable with mainframe computers. This marked the beginning of communicative phase, which allowed exposure to more authentic communication. The focus on form was shifted to the focus on practical usage, and originality replaced prefabricated utterances. In addition to the computer as tutor model, two more models emerged: computer as stimulus (stimulus for learner production) and computer as tool (empowers users with appropriate tools).

However, there appeared the need to further integrate language skills in order to create a more authentic and meaningful language learning environment. The need was satisfied by task- or project-based approach which was made possible by multimedia (hypermedia) systems and the Internet. This socio-cognitive approach to language learning is where Warschauer argues we currently are.

Bax strongly criticised Warschauer in his approach and disputed inconsistencies in labelling phases, unclear criteria for proclaiming the termination of communicative phase, and even the concept of phases itself, arguing that the term is overly bounding when we take into consideration that there is a possibility of traits of all three phases co-existing simultaneously today [22]. Subsequently, the last point was taken into account by Warschauer himself, who admitted that there should not necessarily exist a "rigid sequence" of phases, nor that they are explicitly separated [26]. Thus, Bax proposed an alternative analysis based on the concept of approaches. This resulted in 3 approaches, namely, restricted CALL, open CALL and integrated CALL.

Bax sees restricted CALL as a more appropriate term as it best describes the underlying theory or learning, actual software and activity types, as well as the teacher's role and the form of feedback in such an approach to CALL: they are all restricted. Accordingly, the open CALL approach represents openness in these same domains. Integrated CALL, on the other hand, signifies something we should be working towards, something that has not been reached yet. Integrated CALL will become reality only when the process of normalisation[3] is finished.

C. CALL research

Research in CALL also reflects the field's interdisciplinary nature, as the researchers often draw on the theories and methods from other related disciplines [27]. The main research question that has been widely addressed seems to be the one of effectiveness: even though there is a general consensus that using computers with language learners is beneficial, the question is to what extent [9, 19, 28, 29]?

CALL researchers have been mostly focusing on small-scale, short term studies which are not enough to draw general conclusions [19, 27, 28]. In particular, studies have focused mostly on reading, writing, and vocabulary learning, while other skills appear to have received less attention [19, 28]. However, it has been stressed that such studies have their merit, as well as practical implications [1, 8].

In order to overcome the issue of findings that cannot be generalized, Felix [19] advocates meta-studies that take into account a large body of empirical research and try to come up with general conclusions regarding a single common issue. Meta-studies approach eliminates the factor of subjectivity which is often present in small-scale empirical research, and provides "statistically sound review" of previous work [19].

Additionally, early research ventures in CALL were predominantly quantitative in nature [21]. This has changed recently in that qualitative and mixed-method approaches are becoming more common. Whereas the former emphasise the importance of the goal of language learning, measured by the level of attainment, the latter emphasise the learning process itself. We can attribute this to the already discussed paradigm shift towards socio-cognitive view of language learning in which the learning process, placed in a communicative, integrated, social context, is marked as crucial.

D. Tutor-tool distinction

Traditionally, there have been two modalities of computer use within the language classroom: computer as a tutor and computer as a tool.

In the computer as a tutor paradigm, computer is seen as temporarily taking the human role, namely that of a teacher, and is usually a standalone program. This view follows the tradition of intelligent tutoring systems (ITS). Thus, computer needs to evaluate the learner and is responsible for the entire learning process [30]. Tutoring software often involves elements of artificial intelligence (AI) in order to achieve better results in tracking learner progress, giving appropriate feedback and suggesting next content to be learned, all with the goal of better imitating the work of a real teacher. The significance and impact of AI in CALL will be discussed later in this paper.

On the other hand, computer can be seen as a teaching tool that increases the efficiency and/or effectiveness of language learning [30]. This paradigm is closely associated with the socio-cultural view of language learning that is, for most part, focused on computer mediated communication (CMC) and Web 2.0 tools. The usage of both synchronous and asynchronous CMC has received much attention in CALL research as well as practice, and is possibly the most researched area of CALL [21]. In short, it includes the use of e-mail, discussion forums, video/audio/textual chats, and participation in virtual environments, with the goal of

[3] "…normalisation refers to the stage when technology becomes invisible, embedded in everyday practice…" [22]

constructing language knowledge through well defined and structured tasks [5, 8, 21]. There are numerous reports regarding the successful use of Web authoring tools such as blogs [e.g. 31, 32, 33], wikis [e.g. 11, 15, 34, 35], and podcasts [31, 36] in support of acquiring language knowledge and skills. For example, wikis are most often used for collaborative writing tasks and their organisation, and seem to be a valuable tool in promoting language fluency [31]; blogs are considered to contribute most to reflective writing, critical thinking and developing persuasion and argumentation skills [32, 33, 37]; podcasts open possibilities for salient input and samples of real, authentic speech [36]. The accounts of using social networks in the language classroom have also been reported, e.g. in [4].

The tutor-tool distinction has often been regarded as a dichotomy, but some researchers in the field warn that this distinction is not applicable to all CALL software and that the boundaries between them may not be clear cut [30, 38]. Thus, they propose we talk about the degree to which certain software is either a tutor or a tool [30].

Even though the computer as a tool has been the dominant paradigm for some time now [30], the advances in AI and computational linguistics have led to an increase in the possibilities of tutorial CALL, and, possibly, the interest for developing such software. The reminder of the paper will be devoted to intelligent CALL (ICALL), with special emphasis on ITSs and system adaptivity.

III. Intelligent Computer Assisted Language Learning

CALL systems have often been criticised for their rigidness, lack of interactivity, and lack of intelligence [23, 39]. This has been mainly due to the inability of technology to answer the needs of language teachers and learners, but, with rapid developments in AI and other areas of computer science, this is no longer an issue[4].

Intelligent computer assisted language learning is a discipline closely related to CALL, interested in the use of methods and techniques from AI for language learning [40]. These methods and techniques include, but are not limited to, natural language processing (NLP), user modelling, expert systems and ITSs [24, 25, 40, 41].

According to Mozgovoy [23], most common uses of AI within ICALL are for grammar and vocabulary checking, generation of textual feedback and automatic speech recognition. These features allow an educational system to become intelligent, which Brusilovsky [42] sees as an important goal for any (Web-based or standalone) courseware. Thus, the aims of introducing AI technologies to CALL may be defined as:

- the need for an individual approach to teaching and learning languages, because one size does not fit all [42, 43, 44, 45, 46, 47]; and
- enabling language teaching and learning even when the teacher is distant or nonexistent, by simulating their work and responsibilities [30, 38].

Brusilovsky [42] asserts that historically, adaptive and intelligent educational systems inherit from either ITSs or adaptive hypermedia systems (AHSs). He goes on to identify three basic ITS technologies as curriculum sequencing, intelligent analysis of student's solutions, and interactive problem solving. Curriculum sequencing is concerned with providing the learner with the most appropriate learning path, i.e. the sequence of learning tasks to achieve the learning goal. Intelligent analysis of student's solutions aims to decide whether a learner response is correct or not, and evaluate the gap between current knowledge and target knowledge. Finally, interactive problem solving helps the learner at each step of the problem solving process.

A. *The importance of a learner model*

In order to recognise individual learners' needs successfully and take appropriate pedagogical action, software needs to be able to track what students do with it while learning a language, i.e., how they behave during usage [16, 38, 43, 46, 48]. Regardless of whether there is a degree of control over the learning process, or learners are left to manage their own learning, ICALL systems need to "communicate" with the learner by offering them appropriate feedback, suggesting new learning paths, adapting learning content or taking remedial action, something a real teacher would do as well [24, 25, 43]. Bertin [16] referred to the process of monitoring learner work as the virtual presence of a teacher who is responsible for reaching learning goals.

In most cases, monitoring entails the creation of the, so called, learner or student model, which gathers all the necessary data from the learner, be it the learning path, correctness of answers to questions, time taken to offer a solution, or success in solving a task [16, 43, 46, 48, 49, 50]. The concept of learner model is taken from ITS domain, and together with the domain knowledge model and tutor model, makes an integral part of every ITS [40, 42].

In the same vein, learner models can contain other relevant information about the learner, such as their previous level of knowledge, learning style preference, cognitive style, strategic competence, goals, or interests, to name just a few [45, 46, 48, 50]. After taking into consideration all the information obtained from learner interaction with the system and what is already contained in the model, the model is updated accordingly [43, 46, 48, 50].

However, we should be aware that monitoring is not an end in itself [16, 51]. In addition to carefully deciding what and when to monitor [50, 51, 52], the tracking process is further complicated by the issue of appropriate interpretation of gathered data and correctness of inferences made from that data [48, 51, 52, 53]. Erroneous assumptions about the learner's input, his knowledge and skills, may lead to wrong action by the system, consequently leading to inefficient learning process and poor language attainment [49].

[4] At least to a degree. Of course, there are still a lot of limitations concerning technology, as computers are far from replacing the teacher.

Research has found that making the learner model available to both learners and teachers, can be beneficial in rising awareness of problem areas and, possibly, empowering students to take responsibility for their language learning [43, 46]. Vandewaetere [46], quoting Bull and colleagues, suggests that such open learner models can be represented in different ways, namely, by skill meters and graphs, various animations or even haptic feedback[5].

In tutoring, monitoring is often coupled with scaffolding: the provision of appropriate assistance that helps learners achieve learning goals [16, 25]. Bertin [16] refers to it as a retroactive process in which a message is sent to either the learner or the teacher regarding the adaptation of a task to the competence observed in completing a task.

B. The importance of feedback

Besides monitoring and scaffolding, teachers are often engaged in giving feedback to learners concerning their progress, success on a particular task, language areas they need to work on, etc. Similarly, tutoring systems should also be able to adequately respond to learner activity.

Feedback may consist in a straightforward declaration of error(s) (e.g. *The answer you provided is not correct.*), request for additional clarification (e.g. *What do you mean by...*) or restating something in a correct manner [38].

From the point of view of technology, Shaalan [41] suggests there are three possible approaches in giving appropriate feedback: pattern matching-based approach, statistical-based approach and rule-based approach.

Pattern matching-based approach is very time consuming and requires a lot of effort from the task creator as she needs to enter a variety of correct and wrong answers into the system with corresponding feedback. The main drawback is obvious in that task creators need to anticipate a wide range of possible solutions, which, in turn, requires a lot or knowledge and experience.

Statistical-based approach is less time consuming and allows task creator to enter only one correct answer. Subsequently, statistical methods are used to acquire knowledge about the learner input, as parameters are automatically estimated from a labelled corpus.

Rule-based approach analyses in detail the learner's answer using morphological and syntactic knowledge, usually presented in the form of rules. It relies on hand-constructed rules rather than on statistics and automated training, which represents the main difference from the statistical-based approach.

A good example of an ICALL system offering tailored feedback is Heift's E-Tutor [43, 52]. This system employs NLP to parse and analyse the linguistic input, with the goal of giving individualised, error-specific, corrective feedback. Firstly, it highlights the error in the learner's input. Secondly, it offers a meta-linguistic explanation related to the error. Lastly, depending on the type of error, the learner is issued a link to the online dictionary, or is given a more detailed grammatical explanation. The feedback generator of another ICALL system, namely Arabic ICALL, operates in a similar way. Using NLP, it parses students' answers and compares them to the correct ones provided by the system. Subsequently, appropriate feedback message is delivered to the learner [41].

C. Examples of successful ICALL systems

There have been numerous reports on the development of ICALL systems over the years; however, it seems that most of the systems have remained in the prototype phase or have been developed purely for research purposes. Literature review has revealed three systems in particular that are confirmedly used in the language classroom, integrated into the foreign language learning curriculum [49], and continuously updated and improved: the E-Tutor for learning German as a second language [43, 52], TAGARELA system for learning Portuguese at the university level [48, 49], and Robo-Sensei for Japanese [Nagata in 24 and 49].

E-Tutor system is a comprehensive Web-based learning environment for university level learners of German. It employs AI and NLP techniques in order to achieve individualised learning experience. The system is mainly focused on vocabulary and grammar improvement, for which it offers several types of exercises, namely, translation, dictation, sentence formation and providing the missing word. Evaluation of these activities is supported by NLP and feedback is generated based on learner performance. In addition, each section has activities for listening and reading comprehension, culture and writing. Writing assessment, however, is not automated, and is done by the teacher [43, 52]. The learner model employed in this system has been described above.

TAGARELA is an ICALL system for learning university level Portuguese, intended to complement the existing pedagogical materials. It serves the purpose of an electronic workbook, and offers feedback on spelling, morphology, syntax and semantics to each individual learner. There are six activity types in total: reading and listening comprehension, picture description, rephrasing, fill-in-the-blanks and vocabulary exercises. Creators of the system point out four main tasks the system can perform: detect errors in the student input, diagnose knowledge level and skills of the learner, adapt the system accordingly and generate feedback [48, 49].

Robo-Sensei is used for teaching and learning Japanese through 24 lessons, and focuses mainly on translation tasks. It receives input from the learner, performs itemization and morphological analysis, and parses the sentence syntactically. However, the sequence of activities is the same for all learners, as is the feedback. Thus, the system does not adapt to student level of proficiency or knowledge about particular language items [Nagata in 24 and 49].

Additional examples of ICALL systems mostly address vocabulary learning. Thus, Ma [29, 51] reports on WUFUN, a system for Chinese university students learning English, based on a regularly updated learner model. The

[5] Also known as *tactile* feedback.

system is special as it features both aural and visual input, which contributes to saliency, and, possibly, better attainment.

Esit [54] describes an ICALL system called Your Verbal Zone (YVZ), which is used to support Turkish students' English vocabulary learning. YVZ contains a morphological analyzer which is able to find the root of a morphologically complex word and return its base form together with affixes. It, of course, uses NLP in order to achieve that. In order to further support students, the system contains a built-in, bilingual dictionary, a number of examples related to word use and details of function and meaning of particular affixes.

Mozgovoy [23] argues the case for WordBricks, an intelligent system supporting the process of writing grammatically correct sentences. The system features a grammar checker and allows students to produce free utterances. This also permits learners to experiment with language and test their own hypotheses on language structures. Feedback generation system is also implemented.

Lastly, we mention Wang and colleagues [55] who have gone a step further in speech-processing technologies for language learning with their system Engkoo. This system introduces the concept of life-like talking heads which serve as a vehicle for delivery of text-to-speech synthesised audio. In addition, their system offers a phonetic similarity search option, which allows browsing an online dictionary for words based on their phonetic similarity (e.g. search based on words such as *fiziks* or *randevu*). This may prove be extremely beneficial in conscious vocabulary learning.

The examples of software given above clearly reveal that ICALL constitutes a broad field of both research and practice. Programs differ in their focus on skill, level of complexity, degree and manner of employing AI and NLP, way of generating feedback, even learner modelling. Also, they are usually restricted to a single problem area instead of addressing a variety of issues. Regardless of these differences, we should evaluate a program not by what it is capable of doing, but by *how well* it does what it is intended to do.

IV. CONCLUSION

In this work, we have addressed some of the past and current issues that have received significant attention from researchers within the field of CALL. We have shown that even though technology or, better yet, computers, are widely accepted within the language classroom, and using computers is potentially beneficial for learners, they cannot be seen as solving all the problems of language teaching on their own. Technology in itself does not teach languages. Instead, it depends on how it is implemented into the classroom dynamics and the overall language curriculum. This requires significant effort, knowledge, experience and a decent amount of research undertaken by the teacher for each particular group of learners. However, even this may not be enough to fit all learners' needs, so a more individualized approach may be required.

Individualising language learning experience is certainly facilitated by the maturation of technologies from computer science, AI, and NLP. They offer new possibilities for developing better and more efficient software that will be available even at a distance and without the presence of a teacher. We, however, maintain that at present, software cannot fully replace the language teacher, but can do so only to a degree.

We will conclude this paper with a list of "requirements" for ICALL, which can serve us as guidelines for future development of successful ICALL systems [Oxford in 24]:

- communicative competence must be the cornerstone of ICALL;
- ICALL must provide appropriate language assistance tailored to meet student needs;
- ICALL must offer rich, authentic language input;
- the ICALL student model must be based in part on a variety of learning styles;
- ICALL material is most easily learned through associations, which are facilitated by interesting and relevant themes and meaningful language tasks;
- ICALL tasks must involve interactions of many kinds, and these interactions need not be just student-tutor interactions;
- ICALL must provide useful, appropriate error correction suited to the student's changing needs;
- ICALL must involve all relevant language skills and must use each skill to support all other skills;
- ICALL must teach students to become increasingly self-directed and self-confident language learners through explicit training in the use of learning strategies.

We believe that by addressing above issues, there is a possibility of developing a comprehensive ICALL system that will be successfully employed in both teaching and learning situations.

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