crowdsourcing and education - bridging the edtech GAP

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***“[experto crede!](https://www.etymonline.com/word/experto%20crede" \l "etymonline_v_38620" \o "Origin and meaning of experto crede)*[”](https://www.etymonline.com/word/experto%20crede" \l "etymonline_v_38620" \o "Origin and meaning of experto crede)*- "take it from one who knows" (Virgil, Aeneid, XI.283)***

***“crede!” - "believe!" (in Latin)***

**Abstract**

As a result of COVID-19 - in the area of EdTech we have witnessed for the two years an unprecedented field test involving hundreds of millions of students. Alas, the world-wide consensus about the results is ranging from “COVID-19 remote ed was not a success although tech was there” to “it was a complete disaster - why the governments poured billions into developing the tech?”. In this paper we describe the gap between ed and tech, analyze its causes, propose new models to deal with it, and describe our real-life successful application bridging the gap. CREDE (**Cr**owdsourced **Ed**utainment **E**nvironment) system for creation and approval of educational content, its design principles and requirements are presented in this paper. It was already used to create applications. One described here is a successful platform for learning Hebrew (kindergarten or grade A beginning of reading level) - an Autonomous System that uses Gamification and Crowdsourcing elements for beginning of reading. The field tests helped to refine the CREDE model. Using quantitative research methods, we analyzed actions of 37 grown-up users of the system over period of three months. The finding about the collected data set and the willingness of the crowd to contribute are presented. The results show that crowd is willing to perform crowdsource activities, however data evaluation (crowd-rating) is preferred to data creation. One of the conclusions is that it is possible to use crowdsourcing in education and to develop a crowdsourced autonomous educational software. The next step is to move to universal world-wide architecture of CREDE – an effort already going on as pan-European research with representatives of every European country funded by the EU since 2016.

**Keywords:** *gamification, crowdsourcing, game-based learning, design of educational environment, language learning*

# Introduction

Since the beginning of technological leap there was an effort to use it to drastically improve learning and teaching and to move away from frontal synchronous classroom traditional model to more flexible, more individualized learning. Real life applications of technology in education are available at least from the fifties (1954 Skinner’s teaching machine is one prominent example). Since the inception of EdTech (Educational Technologies) there were two competing fundamental approaches to the direction the research and development should have taken. One puts emphasis on developing better technology. The other – on adapting the pedagogy to the new reality. Unfortunately, while the pedagogical theoretical research was going on, in practice the technological approach won in the industry.

Game-Based Learning (GBL), gamification, Games With A Purpose (GWAP) and their usage in education viewed in a new light due to the outbreak of coronavirus pandemic (COVID-19) and its impact on delivery modes of education, from instructional delivery to alternative delivery modes. The term edutainment defined in the 1980’s as “the use of entertainment devices or activities to teach school-based and education subjects or concepts” (Gerber, 2014; Huotari, & Hamari, 2017) now represents a market industry called edutainment (Hildmann, & Hildmann, 2011; Majuri, Koivisto, & Hamari, 2018). The goal of edutainment is to make learning enjoyable and fun (Resnick, 2004; Prensky, 2003; Aksakal, 2015). The gamification of education noted to have a positive impact on active learning (Raitskaya, & Tikhonova, 2019; Oe et al., 2020; Parra-González et al., 2020). According to Data Bridge Market Research global edutainment market is expected to grow with the healthy CAGR of 15.8% in the forecast period of 2019-2026 (<https://www.databridgemarketresearch.com/reports/global-edutainment-market>). Global [E-Learning Market](https://www.accurizemarketresearch.com/report/e-learning-market) Report, published by Accurize Market Research, forecast that the global market is expected to reach $398.3 billion by 2026, growing at a CAGR of 9.6% from 2019 to 2026 (https://www.accurizemarketresearch.com/report/e-learning-market).

The field of GBL is broad and it can describe a wide range of learning objectives, learning environments and teaching techniques. GBL and educational games are part of EdTech. There are three types of educational technology: synchronous and asynchronous, linear learning and collaborative learning. All those types are used in GBL. Educational games can be used at any time, at any place, at the classroom and/or at home, using various devices from computers to smartphones. If implemented correctly GBL enhances learning and increases student’s engagement and motivation. In general computer-based games are played online or offline, synchronously or asynchronously, some are single-player and others are dual or multi-player games, some are free and others are paid, some are collaborative and others are competitive, some are standalone and others are platform based. In the field of beginning of reading, learning alphabet, spelling letters and words, identifying phonemes in words and learning how to read a lot of free games can be found online. The player only needs to download a game or to connect to the Internet site and start playing.

Automated content generation for education and educational games has been one of the research problems for years since manual authoring is often time consuming and costly. Creation of educational games and e-learning environments is time-consuming and often requires consulting and hiring entire team of field specific experts. Creation of valid and appropriate content for small or under-resourced languages, like Hebrew, is even more challenging, not always applicable and requires applying new techniques and approaches. One of the approaches can be usage of crowdsourcing. User-generated content creation is a great way to use the crowd for creation and/or evaluation of educational resources for under-resourced languages.

The term crowdsourcing initiated from the integration between two words of “crowds” and “outsourcing”. Crowdsourcing is a new technique of gathering data or performing large scale tasks by outsourcing it to a wider public. Crowdsourcing is often based on the framework of collective intelligence (Lévy, 1997) and can be defined as a tool to gather collective intelligence for certain tasks. When applied in the right circumstances and to the right crowd, crowdsourcing can deliver considerable benefits to firms in terms of inputs into innovation (Morschheuser, et al., 2017). The scale of using crowdsourcing for language learning is not researched enough. But the consensus is that it is used much less than it should have been. This is a real crisis where there is tragic dissonance between the dire need and the great abundance of offline (and sometimes even online) resources, on the one hand, and the extremely limited use of the resources.

The role of crowdsourcing and its potential in language education is investigated in enetCollect (European Network for the Combination of Language Learning and Crowdsourcing Techniques) COST action. The action addresses the major European challenge of fostering language skills of all citizens regardless of their diversified social, educational, and linguistic backgrounds. Its focus is to enhance the production of learning material by crowdsourcing in order to cope with both the possible increase for learning foreign/second language due to migration, business and tourism, and the demand for more accessible materials in many languages that are of interests to various learners. This article presents a crowdsourced autonomous gamified educational software system, called CREDE (Crowdsourced Edutainment Environment), for learning how to read in Hebrew. The system is based on CREDE Paradigm, explained later. The first CREDE system was designed as a part of enetCollect COST action (Zviel Girshin & Raskin, 2019) to show that it is possible to build a GBL autonomous educational system for learning how to read in which content is created by the crowd. CREDE uses crowdsourcing approach for collecting and rating language learning educational materials.

We argue that COVID-19 educational trial on an unprecedented scale proved the immense limitations of educational technologies that were available (Dhawan, 2020; Selwyn, et al., 2020; Teräs, et al., 2020; Doyumgaç, Tanhan, & Kiymaz, 2021). It proves the edTech gap, especially of lack of educational materials, deficiencies in resourcing and methods customized to the individual student to make him motivated and successful. There is the need for a more pedagogy-based new model. We present here one important aspect of this model – individualized crowdsourcing. Although it sounds like an oxymoron, we report here both the model and its successful application.

The paper structure is as follows. We start with literature review. Then we present CREDE paradigm. After that CREDE system and its requirements, such as crowdsourcing, gamification and autonomy are explained. We describe the experiment and finding about CREDE usage by the crowd. At the last section of the paper, we conclude our findings and provide some recommendation for creators of crowdsourced educational software.

# Literature review

In our literature review we will start with what experts think about computer–based and game-based learning in early childhood. We move to discussion about gamified computer-aided environments for beginning of reading and CALL (Computer Assisted Language Learning). After that we emphasize some issued related to creation of educational games and e-learning environments for small or under-resourced languages. Then we move to combining of crowdsourcing and language learning.

## Computer–based and game-based learning in early childhood

For several decades, experts have debated whether computers can support early literacy learning (Plowman & Stephen, 2003; Lankshear & Knobel, 2003; McCarrick & Li, 2007; Nolan, & McBride, 2014; Montgomery, 2015). The debate over the potential benefits and hazards associated with computer use by young children may still be an issue, however majority of stakeholders agreed to use ICT (Information and Communications Technology) tools and educational software to contribute to and promote early childhood education. Educational games have been found to be effective teaching aid in a wide range of domains. Educational games have been successfully used to teach students several of school subjects, such as mathematics, reading, and biology (Murphy, et al., 2002; Fokides, 2018; Russo, Bragg, & Russo, 2021). A lot of educators claim that there is nothing as important in early childhood learning as the learning of literacy, language and having adequate reading skills (Baker & Scher, 2002; Wigfield, et al., 2007; Lonigan & Shanahan, 2009; Shute ,2009; Plowman, Stephen, & McPake, 2010; Garrity, et al., 2010; Grant et al., 2012; Kankaanranta, et al., 2017; McTigue, & Uppstad, 2019; Teale, Whittingham, & Hoffman, 2020). Adding computer-based instruction, connected toys, and educational games to accelerate the acquisition of reading skills is widely studied (Charlton, Williams, & McLaughli; 2005; Stephen, & Plowman, 2014; Luo, Lee, & Molina, 2017; Schmitt, et al., 2018; Amorim, et al., 2020). As for young children, games have found to support the development of skills such as phonological awareness, memory enhancement strategies, motor skills, and coordination (Peirce, 2013). Several studies indicated that educational systems and websites with a leveled series of literacy-themed games could promote early literacy, even when played at home (Mioduser, Tur‐Kaspa, & Leitner, 2000; Garrity, et al., 2010; Grant et al., 2012; Luo, Lee, & Molina, 2017; Schmitt, et al., 2018). Connected toys, ICT devices and systems can contribute to blurring the boundaries between formal and informal learning (Montgomery, 2015). Harris (1956) found that "Many kinds of drill can be disguised as games, becoming play rather than distasteful work”.

## Computer Assisted Language Learning

CALL has been used in language classrooms since 1960’s. In the context of CALL, the purpose of gamification is to apply a specific pedagogical strategy to engage and empower learners’ motivational skills toward learning another language (L2) (Flores, 2015; Dehghanzadeh, et al., 2019). While keeping the learners entertained, this strategy may motivate them towards further solving tasks and thus enhance learning. This is especially important in blended learning, in which the learner combines the opportunity of face-to-face learning with a tutor with the opportunities of the online environment on an individual basis (Hew and Cheung, 2014). During the individual part of learning, it is important to keep the learner motivated. This can be done, for instance, by enriching educational applications or online learning platforms for features of gamification (Arce, & Valdivia, 2020; Zou, Huang, & Xie, 2021). The effectiveness of these features, however, depends on the context in which they are implemented as well as on the users using it (Hamari, et al., 2014; Sun, & Hsieh, 2018). However, it is widely known that attention has been given mostly to English, while GBL and CALL in language classroom of languages other than English still play a very incipient role.

## Games and e-learning environments for small languages

Creation of e-learning environments with content-controlled materials is time-consuming and often requires consulting and hiring entire team of field specific and education experts. The number of apps available in the local language may differ and might be related to country’s prosperity or language’s dispersion (Sari, Takacs, & Bus, 2019). Adding an oral foreign language explanation or a translation to local language of existing games requires additional resources and team members. One of the studies of the best-selling apps for the age group (0-8) in four economically diverse European countries: Hungary, Turkey, Greece and the Netherlands revealed that on average, only 27% of the apps included oral language in the local language and showed significant differences between countries. This finding illustrate that the quality of educational materials differs, at the expense of children growing up in less wealthy circumstances (Putnam, 2016; Sari, Takacs, & Bus, 2019). Therefore content generation and/or automatic content generation for educational games or learning environments became one of the emerging research items that many try to solve (Tseng, et al., 2011 ; Hooshyar, Yousefi, & Lim, 2018). An additional solution for content generation for poor resourced countries or languages can be usage of crowdsourcing.

## Crowdsourcing and language learning

Crowdsourcing (CS (is a new technique of gathering data or performing large scale tasks which is often based on the framework of collective intelligence (Lévy, 1997). Related concepts to crowdsourcing are co-creation, open innovation and user innovation (Prahalad & Ramaswamy, 2000; Chesbrough, 2003; Von Hippel, 2003). Although the benefits of crowdsourcing have been thoroughly established (Von Ahn, & Dabbish, 2008; Buecheler, et al., 2010; Aitamurto, Leiponen, & Tee, 2011; Lew 2013; Benjamin, 2015; Morschheuser, et al., 2017) the implementation lags behind. When applied in the right circumstances and to the right crowd, crowdsourcing can deliver considerable outcomes. However, success requires careful analysis of goals, problem-solving environment, required expertise, complementary activities and capabilities, and the competitive environment (Aitamurto, Leiponen, & Tee, 2011; Pe-Than, Goh, & Lee, 2015; Morschheuser, et al., 2017).

Combining CS and language learning is not a new thing. It is possible to merge CS and language learning in order to mass-produce language resources for any language for which a crowd of language learners can be involved (Lyding, et al., 2018; Bédi, et al., 2019; Nicolas, 2020; Arhar Holdt, et al., 2021). Exists several language learning portals based on CS which gather huge multilingual audiences. Although it is not the place for a detailed presentation of any of them, some data provide insights into the scale of the crowd they reached in 2017-2018 (Gorovaia, Forascu, 2019). Busuu which started in 2008 reached the audience of 70,000,000. Mango languages, launched in 2007, addressed 300,000 users. Duolingo reached 300,000,000 users starting in 2011. The Duolingo, has built one of the world’s most popular language learning apps while only hiring a handful of translators. Each day, it serves up millions of sentences, almost all of them created by its 300 or so volunteers. Babbel, opened in 2007, gathered 20,000,000 users. Rosetta Stone - the oldest in the set, founded in 1992, addressed 75,720,00 users. LiveMocha started in 2007, it attracted 12,000,000 in its final year 2016. All of the mentioned above portals are examples of educational business entities. It means that educational businesses are able to attract users as the content may facilitate and improve teaching and the idea of crowdsourcing may be used to help to create resources for additional educational areas or new languages.

# CREDE Paradigm

## Crowdsourcing paradigm shift

Traditional simplistic CS was proved to have its limitations, among which can be mentioned the lack of participants and the quality of the crowdsourced work. CS in the field of education, called Crowdsourcing for Education (CfE), has its benefits, develops innovation education with large-scale learning resources, state-of-the-practice activities, more accurate and diverse feedbacks (Jiang, Benatallah, & Schlagwein, 2018; Alenezi, & Faisal, 2020), however its design and implementations are not good enough. Among the reasons we can mention CS not being motivating enough to the content providers (teachers or parents, students), also known as producers, and not fun enough, individualized enough for the learners (users or students), also known as consumers.

More sophisticated CS with models of all involved is needed. For example, when building the content providers producers model (crowd-creation) we see basic dichotomy into creators and critics (crowd-rating). This can be defined like a p+ to p- scale, where p+ means only creation of new resources and p- means rating or evaluation of the resources. The task of CS should optimally be adapted to the p-scale mark. Also, there are other roles the producers can undertake in CS, such as monitoring and managing.

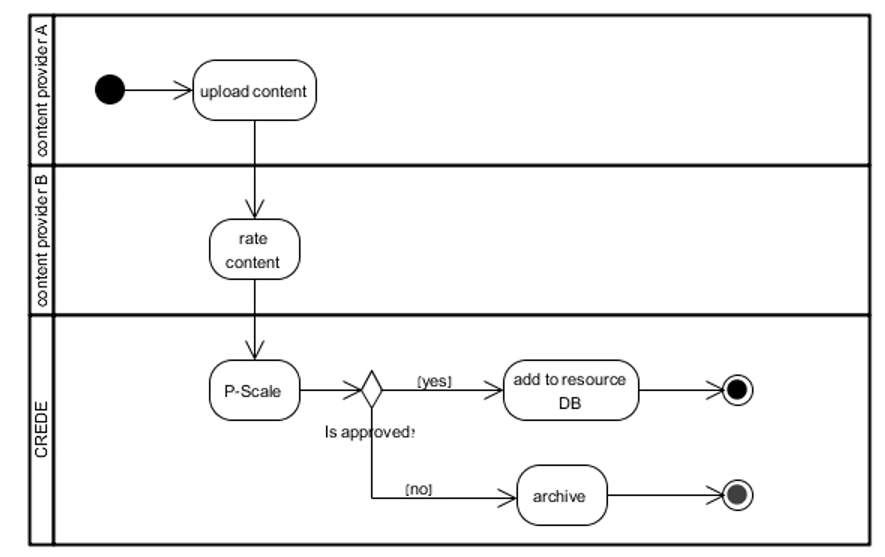
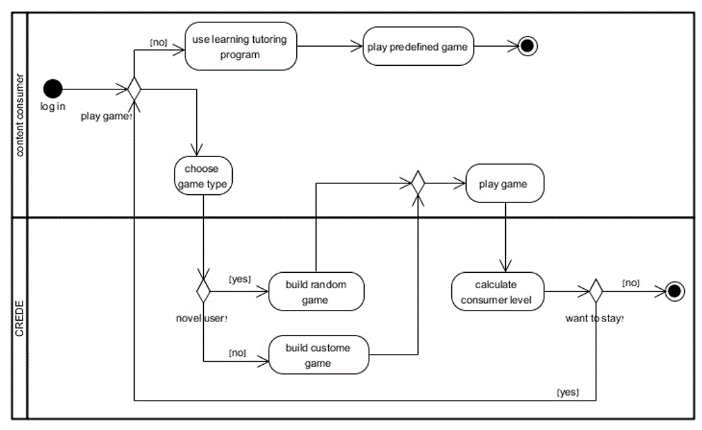


Figure X. Diagram explaining content provider and content consumer actions.

## CREDE Paradigm features

Among different features that can be important for educational ICT system for CREDE the following features are the most important ones:

* edutainment, gamification and individualization for motivation,
* infrastructure to allow cooperation of all stakeholders for inclusivity,
* fully autonomous operation mode,
* crowdsourcing and knowledgebase for variety,
* monitoring and feedback mechanisms.

The proposed solution can be design and implementation of CS that diverts from the traditional CS model by being: proximity centered, individualized, managed, evolving process with all-directional interactions and feedback vs one-time say-and-leave approaches. For each learner the system will hold updated personal data, which includes learner’s progress and achievements, and will try to find the best personalized learning path. The system will identify common patterns of learning behaviour versus those which are anomalous, i.e. those learners experiencing either exceptionally good or poor progress. It will propose which tasks are more difficult for a learner to complete, suggesting which skills and knowledge they should enhance to achieve a more effective learning outcome, which gamification elements should be added for this user to keep him engaged with the system. The system will use learning analytics to influence participant’s motivation, improve learner behaviour, to keep the learner active. The system will use additional crowdsourcer’s analytics to keep crowd-creators engaged and willing to contribute. On the other hand, the macroscopic granulation may suggest which tasks are more likely to be completed with ease or with more difficulty by specific groups of learners or group of content creators.

Interested involved close immediately knowledgeable “crowdsourcers” can be a solution for many problems, like willingness to contribute and quality of the resources. Crowdsourcers can be classified by concentrical circles around the student defined by proximity to him. The more intimate the circle and crowdsourcer’s knowledge and contact, the more important is his effort and it should be given greater weight. Not only the quality becomes better, but the proximity and personal interest give great motivation and feedback to the crowdsourcer.

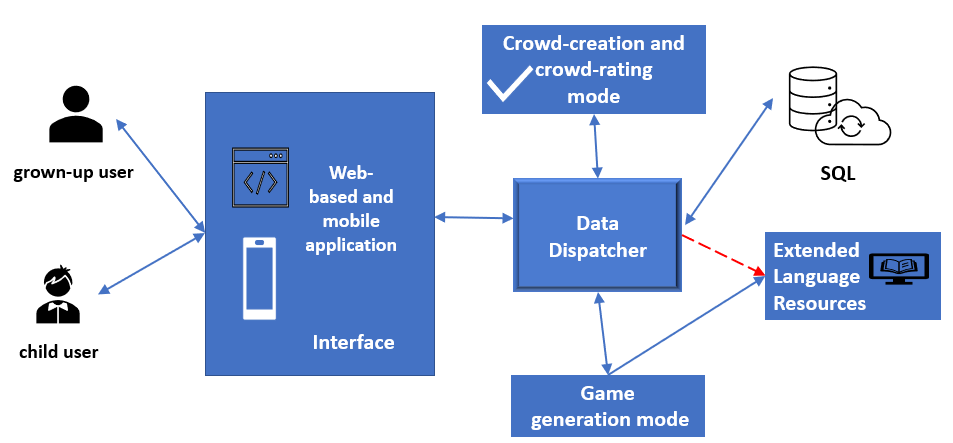
The four major roles of all actors (including importantly the learner) are:

* creation,
* rating or evaluation,
* monitoring,
* managing.

# CREDE system and its requirements

A special system to prove the feasibility of CREDE paradigm was created and tested. Creation of valid and appropriate content is not always applicable to small or under-resourced languages, like Hebrew. Therefore, new approaches, techniques and methodologies should be designed and tested for these small languages. One of which can be the usage of the approaches is usage crowdsourcing for content creation and approval.

The designed CREDE system architecture has several core modules. A detailed description of system requirements and implementation are written below. An overview of the proposed CREDE architecture, presenting the core modules of the system, the data interchange and user interaction is shown in Figure 1.



*Figure 1. An overview of the proposed architecture, presenting the core modules of the system, the data interchange and user interaction. The red dashed-line arrow represents the update of the Extended Language Resources storage with crowd-contributed data items.*

## Basic system description

This educational software for learning Hebrew (kindergarten or grade A beginning of reading level) was built as an Autonomous System that uses Gamification and Crowdsourcing elements and implements CREDE paradigm. Educational aspects of the system and game designs were implemented according to Israeli Ministry of Education kindergarten and school program for reading, a program called “Infrastructure for reading and writing” (Tashtit likrat kriya ve ktuva). As young children begin to learn to read, they first develop concepts of knowledge of print conventions (e.g., a correct reading direction, that text in Hebrew is read from right to left), alphabetic knowledge of the names and printing of letters of the alphabet, and graphophonemic awareness or an understanding of language sounds (Grant, et al., 2012). Children's ability to provide the sound associated with each letter allows them to move on to more complex skills of phonics (the ability to map letters and sounds) and spelling (Foulin, 2005). Therefore, a process of learning to read can divided into several parts: from a basic understanding of the alphabet sounds and letters to a more complicated level of reading, from reading a single letter to reading and later spelling small words. From the linguistics point of view CREDE has the following elements:

* graphophonemic awareness,
* alphabetic understanding,
* phonics (letter-sound correspondence) and
* phonological recording (use of one or both of spelling-sound rules and word-specific associations).

The main system requirements for CREDE are crowdsourcing, gamification and autonomy. The theories and implementation methods for those principles are defined in the following sub-sections.

The CREDE system uses crowdsourcing for content-controlled resource gathering. The main goal of the system is to help preschool children to acquire basics reading skills using game-based learning environment. The interface of the system is done according to KISS (Keep It Simple) principles and a responsive design approach, which allows users to use it ATAWAD (anytime, anywhere, any device).

The system has three types of users:

* an unknown user (a guest anonymous learner),
* an identified user (a registered learner) and
* a crowd grown up user (a registered parent/teacher).

The software has three major modes:

* training or tutoring (Figure 2),
* playing and testing (Figure 3),
* reports and crowd contribution.

A picture containing diagram

Description automatically generated

Figure 2. The beginning page of the training mode of CREDE.

In a training or tutoring mode, also called a presentation mode, each letter, its sound, and syllable are presented and explained using multimedia. Hebrew alphabet consists of 22 letters. For each letter a content is presented according to increasing level of difficulty from a single letter to a word consisting of 4-7 letters. 4 letters word considered to be a difficult word since according to Hebrew orthography only consonants are written and vowels are written as a niqqud (In Hebrew orthography, niqqud or nikud is a system of diacritical signs used to represent vowels or distinguish between alternative pronunciations of letters of the Hebrew alphabet). Therefore, in majority of cases 4 letters word is a 4 consonants word. The tutoring section for each letter ends with some kind of letter recognition’s game.

For identified users (a registered learner) the game content is built and adapted according to collected and tracked data about the learning progress of individual users. Information about learner’s errors and mistakes, the time spent on solving tasks, learner’s progress, engagement and usage of the program is stored at the system. The content is adapted to a learner’s academic level, provides personalized learning paths and a variety of reading strategies. For each successful game points are given to the user. For each game data about user’s actions is added to the database (number of games played, number of correct incorrect answers, incorrect letter or word, average time for play and more). A specially designed graphical leader board is added to keep the learner active and to encourage users to play more games, which basically means to learn and train more letters and words.

In playing and testing mode a learner (a child) can play any game that he/she chooses. All games are customized for this learner using information about learner’s errors and mistakes, successes and achievements, the time spent on solving previous tasks and learner’s progress. CREDE system uses learning analytics and suggests a great variety of games and activities available to a child. It analyses which tasks are more difficult for a learner to complete, suggesting which skills and knowledge they should enhance to achieve a more effective learning outcome, which gamification elements should be added for this user to keep him engaged with the system. The system encourages children to learn and experiment through play. Constant and very exact feedback allows putting in front of the child the optimal next stage activity allowing the games to evolve naturally into learning and forming very sophisticated environment that keeps the learner active.

An unknown user (a guest anonymous learner) can access and use a training mode freely with all the learning part and the end games for this part. In case of anonymous learner, the system does not remember user’s behavior, choices, successes and mistakes. This unknown user gets only a partial default functionality of the playing and testing mode.

Graphical user interface

Description automatically generated with medium confidence

Figure 3. The playground page from which different games for playing and testing can be chosen.

In a third grown-up mode, after registration and a child-parent matching phase, a grown-up becomes a registered grown-up user (parent/teacher). For each registered grown-up user different kind of reports are generated related to child/children’s progress, activities and system usage. Each grown-up user also receives a request to perform some crowdsource related activities. Contribution to CREDE system consist of data gathering (crowd-creation) and data evaluation (crowd-rating).

## Crowdsourcing activities

One of the features of CREDE paradigm is using crowdsourcing. In the categorization of crowdsourcing approaches, “implicit crowdsourcing” means that the purpose of the task is secondary or even partially hidden to the participants, as opposed to “explicit crowdsourcing” where the task is the primary purpose of participation (Lyding et al. 2018).

Crowdsourcing in education defined as "a type of an (online) activity in which an educator or an educational organization proposes to a group of individuals via a flexible open call to directly help learning or teaching” (Jiang, Benatallah, & Schlagwein, 2018). Crowdsourcing activities may

1. benefit education by content,
2. provide practical experience for the participants,
3. contribute to the exchange of complementary knowledge and
4. augment abundant feedback (evaluations) for learners.

In CREDE creation of educational content is done by the crowd. This process is called crowd-creation. It is an explicit crowdsourcing approach in which a new content, that includes a new word, its picture, its pronunciation, its sound, some metadata (like initial and final letter of the word) and its Hebrew orthography (niqqud), is uploaded to the system by a specific user. Later this new content is approved by a random group of other users. This process is called crowd-rating. Only verified (in our case 100% approved) content is added to CREDE extended language resources database of items and is used in future training and game-based testing.

An informed consent form (term of usage) is used to provide all the users with the information they need to know to make a decision about participating in crowdsourcing activities. A cookie that allows user to agree or disclaim the website, is added according to General Data Protection Regulation (GDPR) for CREDE system website. All the users receive warnings about

* uploading only free pictures, which means not a copyrighted material (but the system does not check it)
* usage of uploaded audio and photo files in other projects or games.

## Game Based Learning and Gamification

Game-based learning and gamification are each buzzwords or more correctly buzz-phrases in the fields of learning and education. GBL is training that uses game elements to teach specific skills or achieve specific learning outcomes. The basic idea of GBL is to take some content and objectives and to make it fun. Gamification is the application or integration of game-design elements and game principles in non-game contexts. Gamification is not GBL, nor does it require students to play games.

The gamification of learning is an educational approach to motivate students to learn by using games and game elements in learning environments. The goal is to maximize enjoyment and engagement through capturing the interest of learners and inspiring them to continue learning (Kim, Song, Lockee, and Burton, 2018). CREDE system uses a combination of GBL and gamification. Majority of learning is done via playing games in a so called playing and testing mode of the system and all of content creation and evaluation is done via gamified interface.

A playground page (Figure 3) provides a training and testing interface through which child users choose which game to play. The game is an “invisible” test for a specific letter or letters of Hebrew alphabet. Each child, playing as identified user, receives a specially tailored set of letters and words. All the successes and mistakes are gathered and added to the database for future games and for the reports. All letters and words with which a user struggled in the past together with previous mistakes and knowledge about learner’s progress are taken into account during creation of data items for the next game.

In a grown-up mode, a parent user that contributes to the system gets points, budges, and encouragement phrases. For crowd-creating (collaborative creation) points are given for each item submitted to the system, and later additional points are added after item’s approval. Different types of budges are given to the user according to contribution done by the user. During crowd-rating stage (content evaluation) different encouragement phrases are given to users about agreement with other’s judgements or comparison with other content contributors. For example, “90% of the parents think like you” or “3 more parents found this content to be inappropriate”.

## Autonomous System

One of the requirements for the designed software was its autonomy. The basic idea of autonomous system is that it continues to grow and evolve without original creators. It also means that the software does not require management and/or maintenance. The initial system is designed by developers, but later the system grows and evolves using knowledge and resources supplied and approved by the crowd or other source, without any interaction with the original developers.

In CREDE a new content is created and uploaded by crowd (parent/teacher users). A new data item includes a new word, its picture, its pronunciation, its sound, some metadata (like initial and final letter of the word) and its Hebrew orthography (niqqud). Later this new data item is rated by a random group of other users. Only verified content enters CREDE extended language resources database of data items and used in future training and game-based testing. The same word but different picture or sound files are allowed. Therefore, for some word X sometimes an image A is used and sometimes a different image B (or any other image) is used. Sometimes some image Y can be associated with several words. But this multiple content option was not given to the crowd creator. In this case a crowd-creator will have to upload each word and its data for image I separately.

CREDE software does not require persistent management or maintenance. It is not a heavily used computer system. An expected time-limit for usage of the designed CREDE system is only several months (which is a logical time during which a child learns Hebrew alphabet). Therefore, certain types of predefined thresholds are defined and set of actions which should be done after this threshold is reached. For example, if the system reaches some capacity threshold value the oldest and/or unactive items will be removed or archived, some functions of the system become unavailable for a specific user.

# Experiment and Results

## The experiment

The designed educational software was tested for a short period of time (January till March 2020) in three kindergartens. An official approval to conduct research was received from the Scientific Officer in Israel Ministry of Education. The approval allowed the researchers to perform various assessments and evaluations, to gather data, and to conduct interviews and activities related to CREDE. The short period of time was due to COVID-19 lockdown of kindergartens.

During our experiments parents of 110 kindergarten children were contacted by emails, messages, posters and a flyer. In all media formats a brief explanation about CREDE system and the experiment were given to the parents and an additional link for more detailed explanation was provided. Kindergarten teachers helped the research team to distribute those materials and helped with creation of user’s account for some of the children.

During the experiment one of the researchers entered a system weekly as a parent and provided 10 incorrect or inappropriate data items.

## Results

The researchers made a detailed analysis of the collected data set to evaluate the success of the proposed approach. The researchers monitored the child's involvement (number of games played, number of correct/incorrect answers, content of correct/incorrect answers, the time spent on solving tasks, average time for play, game choices), system usage (average time for play, daily, weekly entrances to the system) and parents' willingness to contribute and approve new content. In this article only findings related to crowdsource activities are presented and examined below. The quantitative analysis of participants’ data is done by analyzing user’s log files.

At the end of March 2020

* 67 child users were created (some with the help of kindergarten teachers) and
* only 37 parent/teacher users were created.

Some of grown-up users were related to the same child and 9 were related to more than one child. The following data about parent’s system usage was found:

* 4 parents entered the system only once,
* 13 parents entered the system once in a week,
* 8 entered every 2-3 days,
* the rest (12 parents) did not have any entering pattern (some entered daily and later did not enter at all, some entered every 2 weeks, some entered several times a day).

Altogether 91 new items were uploaded to the system by only 17 parents. Number of submitted items by user and number of approved items can be found in Table 1. 23% of the users submitted 52% of the uploaded content. 88 out of 91 items were approved by at least 3 parents and were added to CREDE extended language resources database.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Number of users per uploaded items | Total number of uploaded items | Total number of approved items |
|  | 2 uploaded 1 | 2 | 1 |
| 4 uploaded 2 | 8 | 8 |
| 3 uploaded 4 | 12 | 12 |
| 3 uploaded 5 | 15 | 15 |
| 1 uploaded 7 | 7 | 7 |
| 2 uploaded 10 | 20 | 18 |
| 1 uploaded 12 | 12 | 12 |
| 1 uploaded 15 | 15 | 15 |
| Summary | 17 uploaded 91 | 91 | 88 |

Table 1. Statistics about number of submitted and approved items.

All 10 malicious items uploaded by the research team member were disapproved by users (nevertheless 3 malicious items got several approvals).

30 out 34 parents, who entered the system more than once, agreed to do some crowd-rating. Only 6 data items had some rating disagreements (3 of the malicious items provided be the research team and 3 provided by the parents). Statistics about items willingness to rate content is difficult to provide since sometimes a parent entered a system and there were no items to rate (there were no new items, submitted by other users, waiting for rating in a temporary item’s table).

# Discussion and conclusions

As a result of COVID-19 - in the area of EdTech we have witnessed an unprecedented field test involving hundreds of millions of educators and students world-wide using EdTech, information and communication technologies, remote ed and distance learning. One of the barriers educators faced were adoption of these technologies, inability to use technical knowledge and skills. But in many countries in addition to technical difficulties there was also lack or shortage of good and free educational resources.

In edutainment and e-learning world exist a lot of games, GBL environments and platforms. Nevertheless, majority of those are for English speaking audience. Creation of educational content-controlled resources and games is time-consuming and often requires help from entire team of experts. This creation of valid and appropriate educational content for small or under-resourced languages, requires to be creative and apply novel techniques and approaches. The authors believe that this lack of educational content-controlled resources can be bridged with the help of the crowd. In this paper we described a new CREDE paradigm, it’s implementation to a specially designed system for beginning of reading and analyze the willingness of the crowd to contribute. We showed that the model and its successful application. Individualized crowdsourcing of involved crowdsourcers (parents) not only the improves the quality of the gathered resources, but the proximity and personal interest gives great motivation and feedback to the crowdsourcer.

Our experiment shows that parents are willing to perform crowdsource activities and create valid and appropriate content. However, they prefer data evaluation activities to data creation activities. Majority of users (30 of 34) agreed to do some crowd-rating but only half of the users (17 of 34) provided some new data items. Though, 52% of the uploaded content was provided by only 23% of the users, which is actually a good result according to the crowdsourcing literature (for example, 95% of Khan Academy crowd translators withdraw from the translation activities in a period shorter than three years or Duolingo's contributor’s retention rate was only 13% in 2012).

In light of the theories and activities mentioned above we can conclude that crowdsourcing in education and language learning, if used correctly, can bring a great benefit and enrich educational content, stimulate creating new data and new knowledge (metadata) and encourage creation of new valid content. User-generated content creation is a great way to use the crowd for creation of educational and language learning resources for under-resourced or small languages. Our experiment shows that parents (a so-called motivated crowd) are willing to contribute as crowd-creators and/or crowd-raters. Individualized crowdsourcing of involved crowdsourcers assures good quality of the gathered resources. We believe that crowdsourcing in education has a great potential and will be widely used.

Currently the designed system is a supplement environment for learning how to read. However, it can be added as a learning tool to different platforms. Different research showed that games can accelerate learning, especially when they are scheduled with course syllabus and combined with teacher-instruction. Adding games to a carefully planned program can improve child’s learning, reinforce child’ ability to master a specific skill or topic, and can serve as a valid supplement to course syllabus. That is why in future versions of the CREDE a “syllabus support” agent should be added to create an optimal path for learning via playing.

# Conclusions and Further Research

The next stage is to develop a learning mechanism that adapts the pedagogy to other, more distant, students, and thus each individual’s effort can serve all students wherever they are. Thus a truly universal network of extremely vital educational knowledgebases will be created and dramatically improve EdTech results and education success even for the most disadvantaged and under-resourced.

In the last years the authors are involved in such multinational (pan-European) effort involving many dozens of researchers from every European country, that already proved highly successful. enetCollect is a COST funded by EU Commission project operating since 2016 that already proved the feasibility of the concept many times over.

This study has several limitations. From the security point of view a group of malicious users can create a coalition and approve incorrect content. Similarly, some user can create several grown-ups accounts and rate its own data items. The findings should be interpreted with caution due to limited number of participants and limited research methods. The study only employed a quantitative method to explore theoretical and practical research concepts. Adding qualitative method could provide a greater understanding of crowd actions in a particular research setting.

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