Chapter 2
An Architectural Model to Design Graphical User Interfaces of Mobile Applications for Learning Problems in Basic Mathematics

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Abstract Nowadays, a large amount of digital content and mobile educative application can be identified for the construction of online courses at elementary school; but some design issues need to be solved in order to have an effective use of this kind of educative resource to support learning problems. This work purposes an architectural model to design graphical user interfaces (GUI) of mobile applications in particular basic mathematic. The proposal considers the use of learning paths; web services and also a multidisciplinary group of stakeholders are taken into account such as teachers and content providers. The purposed model is applied here throughout a case study teams. The methodology will be illustrated as long with the some examples of the solutions that we have produced using it.

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2.1 Introduction

Education is considered the engine that drives the economies of a world actually so competing. Thus, a country with high education rates among its population has higher expectations in economic, political, and social development. However, some of the problems that we have to impart the knowledge in our country are based on the exact sciences, especially in mathematics, this affects both people who do not have a learning disability and it is accentuated in those who have some learning problems.

A learning problem consists of problems not associated with severe motor or cognitive disability such as acalculia, dyscalculia, dyspraxia, dyslexia, or any language disorder [1, 2]; however, it takes care of all those factors such as the difficulties of calculation, difficulties in the solution of problems or related personal aspects, some of these problems, sustained attention deficit, deficit in the use of working memory, deficit in the coherent representation in the working memory of the problem components, and so on [3].

According to UNESCO [4], information and communication technologies (ICT) can contribute to universal access to education, equality in education, quality teaching and learning and professional development of teachers, as well as the more efficient management and administration of the education system; it is for this reason that it applies a broad and inclusive strategy regarding the promotion of ICT in education. The access, integration, and quality are among the main problems that ICT can board [5].

Nowadays, a great amount of educational resources are enable in the network, which are being used as a new way to obtain knowledge, so it is necessary to sort, classify, and manage these resources [6] with the support of a experts group in educational and pedagogical topics called the multidisciplinary group in favor of children with mild learning problems in basic mathematics [7]. This multidisciplinary group will help to distribute the educational resources through services, using knowledge maps and learning paths to model the knowledge of each one of the communities, all these contained within a service-oriented architecture. This architecture offers services to the communities of children with learning problems through open educational resources according to the both needs general and specific; these resources are cataloged according to the specialists in levels of mathematical abilities and these specialists give the guidelines for different levels of learning.

In recent years, E-learning is more widely accepted as a new form of learning which grows at an accelerated rate [8]; this generates a great abundance of educational products that help to generate knowledge among students, who use these tools, but there is no order of use, so that knowledge can be generated but not necessarily in the most optimal forms, or at least, not close to the most optimal. So, it is necessary to organize and produce applications according to the needs of children with learning problems in mathematical competence that can be managed by a service-oriented architecture, such architecture contains among its characteristics the administration of services through learning paths, which are the best way to manage the a large number of technological tools that exist today [6], giving an organization and management of resources supported by the experts knowledge in pedagogy for children with learning problems.

The present work considers that the learning paths will be make up by services, each service as such, can be integrated by a "composition of services," i.e., the packaging of all those educational resources necessary to mitigate a specific mathematical problem, the services will take the educational resources from repositories that will store all those learning objects and deliver them to the individuals of the communities according to the specifications of the multidisciplinary team, waiting for feedback from the communities and the multidisciplinary team to improve learning paths and develop applications more specific to the learning communities' needs and the individuals that comprise them.

The present work has a structure that begins with an introduction in section one that is related to the subjects that competes to basic education, services architectures, and e-learning as a new method of teaching educational competences. In the next section, the problem mentions the lack of service-oriented architectural models that help to mitigate the learning problems in mathematics of basic education children. The third section shows the proposed contribution through the description of an architectural model. The next section shows a case study with two children of basic education who belong to two different learning communities (USAER and CAM). In the fifth section, the related works show a comparative table of works identified in the literature and from that comparison it shows the advantages that our work proposes in the resolution of the raised problem. In the last section, the conclusions are presented and some future work is proposed.

2.2 Problem Outline

Today, there are a lot of children who have learning difficulties in areas such as literacy and math [9], these problems make learning difficult from the early stages of people. The present work focuses on the learning problems that correspond to the basic mathematics with children who are between the ages of 6 and 12, those ages make up the early ages of knowledge in the area of mathematics, this problem is detected more easily when the child presents some difficulty in acquiring basic mathematical knowledge. These types of problems delay or limit a student's progress in their education and basic training, the children are denoted by not achieving the expected average results in a student of their age [10, 11], these problems can be classified according to the Piaget's pedagogical approach in two great branches as are the logical and infralogical operations [12] in order to be able to attend to them in a more specific way.

As mentioned at the beginning of the introduction one of the main problems is about the use of technologies as a tool to acquire certain skills in basic mathematics and how to mitigate the problems that can present children in basic mathematics [5].

Another type of problem is reflected in the way in which the large number of mobile applications and educational resources are used for the acquisition of mathematical competence, in particular the way in which these technological tools are administered, which contributes to reducing the problems of children with learning difficulties, according to [6] results can be obtained with the simple use of the applications due to the own technological and the human–computer interaction offered by the mobile devices, but it is sought to obtain the necessary resources according to the children profiles through the correct use of mobile applications [13].

Another problem is based on the lack of service-oriented architectures that organize educational resources for children with learning problems. There are some architectures in the literature that model the knowledge and help manage educational resources but do not use multidisciplinary groups that help model the necessary and specific knowledge for each of the learning communities [14], besides this they are not oriented to the mathematics imparted during the elementary education and less they use pedagogical profiles to guide the construction of their maps of knowledge and maps of learning, last they are not oriented toward children with learning problems, so it is necessary to make the proposal present in later sections.

The following is a list of problems found in the delivery of basic mathematics for children with learning problems at the elementary education level [15–17]:

1. The main problem in basic education is found in the failure rates in reading, writing, and mathematical skills.
2. Problems of availability and access to the necessary contents to work in inclusive education at elementary level.
3. Lack of support for continuous teacher training.
4. The lack of diffusion means to apply the educational models.
5. Integrate new pedagogical approaches appropriate for the inclusive teaching of basic mathematics
6. Changing the attitude of technologists to collaborate and meet the teachers' requirements who use ICT in the processes of inclusive teaching of basic mathematics.
7. Lack of architectural models that allow the distribution of educational resources and services for basic mathematics.

2.3 An Architectural Model

The present work advocates the use of educational resources under mobile technology as a support in the learning of basic mathematics, here it is proposed to organize educational resources, and then to make these resources available to the end user through online learning services. Availability and access to services are designed according to learning paths, so that services offer learning objects according to the specific mathematical ability of learning community users. It is important to say that a set of repositories are used to store the learning resources that are developed a priori, other repositories are for storing evaluations and user profiles of communities. The aforementioned set of components is integrated within a service-oriented architecture. Thus, the proposed architectural model is composed by a series of service production layers, namely, the layer of **content providers, collaborative work, repositories, service composition, and use of learning objects** and within the service consumption layer are **the behavioral modeling sections of learning, levels of mathematical skills, user interfaces, and learning communities**. The set of previous layers are presented in the following architecture model of the following figure.

The previous architecture is described in more detail in the following subsections.

A. *Learning Communities*

A population of individuals can be considered to be composed of learning communities that are grouped according to the similarity of their characteristics, among them can be by educational subsystems such as public and private education, regular education, and education for outstanding or lagged children. Each community is considered learning because its purpose is to meet the learning needs of its participants, so it requires learning services. The proposed architectural model advocates that the production of services and their use be made concrete. For them, it is necessary to take into account both producers and consumers to attend the education of children with learning problems, thus identifying a set of services of education to address the creation of more homogeneous learning communities. Thus, from forming learning communities as homogeneous as possible it is possible to obtain more enriched requirements that allow to specify the mathematical skills to be acquired, as well as the necessary infrastructure, characteristics, and types of learning contents, and later, to create the most suitable digital literacy services according to the requirements. In this way, it is possible to create models of use of differentiated learning objects capable of adjusting more to the real needs of each children community with learning problems, this means to be able to specify models of integral solutions of ad hoc mathematical services to the learning community.

B. *User Interfaces*

Graphical user interfaces (GUI) provide spaces of interaction through which learning communities access mathematical services (mobile applications) to develop digital competencies at different levels. Implicitly, each GUI is determined by a set of self-learning activities and when a user within a learning community progresses in level, it can adapt the GUI in such a way, that it can streamline its process learning.

C. *Levels of Mathematical Skills*

The levels of mathematical abilities refer to the degrees of understanding of the knowledge about the nature and daily situations of the real life. In the case of a child presenting learning problems, the adults in the corresponding community should understand the possibilities offered by ICT's as tools to support creativity and innovation. In this sense, if a child has certain learning needs in mathematics, it is necessary that first acquire a series of digital competences at the levels of basic competences, initial, basic, and intermediate through formal, nonformal, and informal educational processes. In such a way that when the individual makes continuous use in his daily activities of the ICT's, and thus, can enter more easily to a process teaching mathematical abilities, achieving to mitigate little by little the necessary problems until the child can be consider as regular in his or her basic math skills.

D. *Modeling of Learning Behavior*

The learning behavior modeling layer is composed of conceptual models to represent the different strategies that can be offered for children to be facilitated learning. The models here are described under the specification of the user's task, knowledge maps, and learning paths.

User task analysis is a general technique used to describe and evaluate the activities required by a user to achieve a goal in an interactive environment. The task of the user is represented by a service task model to be developed. The task model describes the interaction between the entities (services, learning communities, content providers) that are integrated in the architecture, in terms of tasks that are carried out by the learning communities. The task of the user as a whole is broken down into sub-tasks that are structured in task hierarchies. Thus, through the analysis of the user's tasks, it is possible to define the requirements for the user interfaces.

The user task allows the user to provide an argument necessary to reach a service. Some of the interactive tasks that users can perform are: launch the request for a service; Cancel the invocation of a service, evaluate the services, make feedback, recommend services, etc.

The knowledge maps for this work are representations of the mathematical abilities necessary for children with learning problems, generally represented, those abilities indicate their predecessor and precursor skills, which are the basis of the following knowledge, this proposal is shaken by specialists in special education and can be perfected according to the learning community's profile. According to [6], it defines the learning paths as a product of a course of study, which includes the steps for a student to obtain through this path the knowledge of a course, at each step the student assimilates certain contents corresponding to the course, which must be appropriate according to a specific pedagogy.

After modeling the knowledge maps, we continue with the construction of learning paths that according to [8] define the learning paths as a product of study course, comprising the steps for a student to obtain through these routes the knowledge of a specific course, in each step the student assimilates certain contents corresponding to the course, which must be adequate according to a specific pedagogy. Learning paths in education have emerged as an important advantage in planning, organizing, and controlling learning processes. The adaptability of learning paths includes changes to the user interfaces that are used to control the learning process. A learning path defines the steps that should guide a student in effectively building their knowledge and skills. The learning path adds a logical approach to model the task for a user interface, necessary to provide a cognitive function for the adaptation of the context, in this case, context is represented by each learning community.

In this sense, a learning path can be used as the link between a digital competence and one or more services that are appropriate to guarantee the development or acquisition of the competition. Another way in which learning paths can be seen within the ecosystem, are enriched logical behavior models that allow controlling the flow and consumption of services in the processes of digital competences appropriation.

E. *Use of Mathematical Learning Objects*

A service is defined as an economic activity offered by a supplier to a consumer, using time to bring value to customers or their objects.

In this sense, based on this definition, a Mathematical Learning Service can be defined as a learning activity offered to users within a learning community that over time increases the Mathematical competencies of users. Services are autonomous entities independent of the platform that allow access to one or more capabilities, which are accessible by provided interfaces. The design of a new service must meet the requirements of the learning community specified by the established digital competencies.

Also, Mathematical Learning Services have levels of granularity and composition. Granularity is determined based on the range of functions that services need to develop a Mathematical competence, or how services need to be organized into compositions. In this sense, a given Mathematical Learning Service will be assigned a defined functional context called "Learning Community" and will contain one or more functional capacities that are probably involving it in one or more service compositions.

F. *Composition of Services*

The service composition refers to the situation in which an individual's service request is not satisfied by a single preexisting service, but can be satisfied by the appropriate combination of some preexisting services available. The composition of services has been used by companies to support complex but stable processes. In this sense, the processes of Mathematical acquisition competences within each learning community are complex, and at the same time, it is necessary to differentiate the needs between each community, which is why it is necessary to create mechanisms of services composition capable of supporting multiple service needs. Thus, the composition of services is applied to support the personalization of services to each learning community.

Generally, a single service provides limited functions, so they require mechanisms of composition of services to create services that meet the requirements and demands of users. The service composition therefore has the function of creating different workflows that can be configured to support the use of multi-user learning objects.

A potential benefit of the service composition approach is that it allows new services to be created quickly, such as a combination of existing basic services, rather than being developed from the start.

G. *Repositories*

The repositories are used by institutions as a place for organizing, accessing, preserving, and disseminating learning resources in a specific subject, in this case basic mathematical applications for children with learning problems, or digital files of different topologies. In this sense, within the ecosystem, it is necessary to have repositories where producers can publish, classify, disseminate, and improve their services. The repositories must support the reuse, integration, and interoperability of services. Repositories must be open access for all service producers. A service producer can also evaluate other services created by other producers, with the aim of improving them if necessary, so that they can adapt them to other learning communities. As shown in Fig. 2.1, service repositories are classified into three types of services:

Disability Profiles: Within the repositories it is necessary to have the control of the requirements according to the learning communities' needs, that is why an essential part is the administration of the learning objects according to the problem presented and a part of the repositories provides services of identification of the learning communities' needs.

Educational Resources: These services are all those actions and tasks that an individual performs as part of the process of acquiring mathematical competences that help him/her to strengthen the knowledge where they have learning difficulties.

Evaluation Services: They are services that serve as instruments to measure the level of acquisition of mathematical competences, where an expert has detected problems of learning in the basic mathematical competence.

H. *Collaborative Work*

The collaborative work is carried out with the participation of a multidisciplinary group that includes psychologists, social workers, regular education teachers, teachers of inclusive education, technologists, and parents, collaborating each one from their respective fields of work for the benefit of the creation of mobile applications [18, 19] and educational content, which conform the learning objects according to the needs of each of the learning communities and this multidisciplinary group is who not only consume services of mathematical learning objects, but also produce services and feedback to be able to iterate and to develop mobile applications and educational contents more and more precise to the learning communities.

I. *Content Providers*

As mentioned in previous sections, it requires the collaboration and interaction of a number of actors and the sum of their resources (technological, infrastructure, human, economic, etc.) destined to form ecosystems of Mathematical Learning

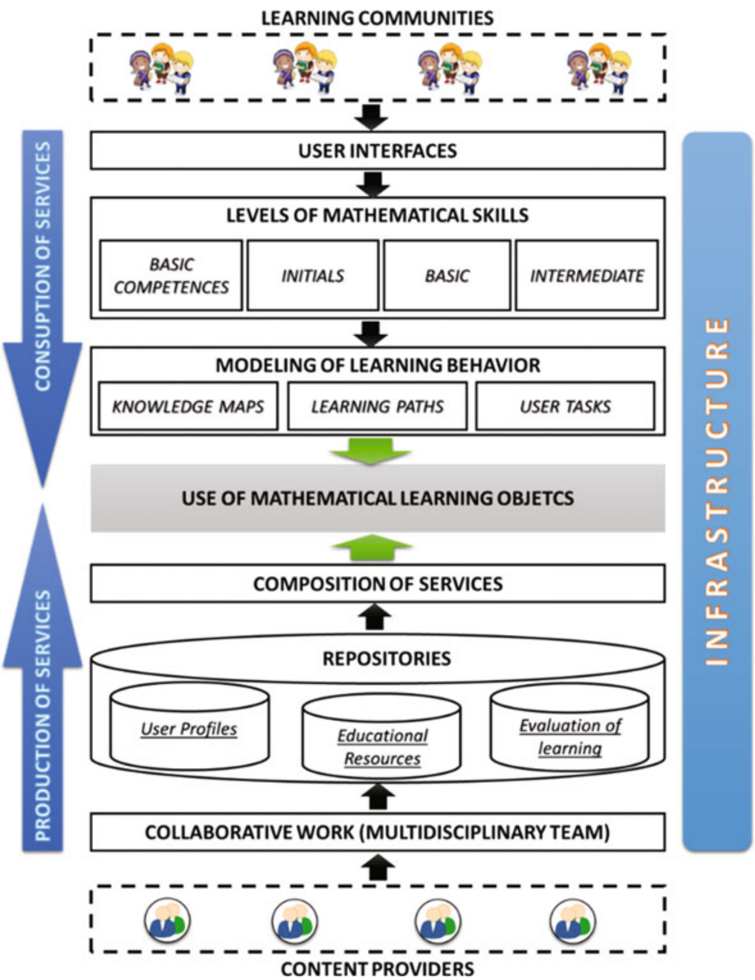

Fig. 2.1 Architectural model for designing graphical user interfaces of mobile applications to assist children with learning problems in basic math

Services self-sustainable and self-organized to mitigate the communities' problems composed of children with learning problems in basic mathematics.

As can be seen in Fig. 2.2, four types of actors have been identified: (a) governments, whether at the municipal, state or federal level; (b) Universities, whether public or private; (c) small and medium-sized enterprises (private sector); And (d) Social organizations, directly responsible for the managing and implementing mathematical services projects for children with learning problems. From the ecosystem approach, these actors are organized to form communities that produce services such as educational content in mobile applications, text presentations, videos, audios, etc.

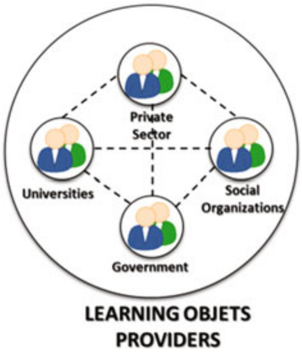

Fig. 2.2 Content providers to build mobile applications for children with learning disabilities in basic math

2.4 Case Study

The application and effectiveness of the proposed architectural model is presented in this section through a case study in educational institutions of the education magisterium in Mexico, for it, were observed two children with learning problems in basic mathematics each child coming from two different learning communities of educational institutions in the state of Aguascalientes, Mexico. The first child belongs to a multiple special education care center (CAM) and the second child has been cared in a regular education institution (USAER). The architectural model Fig. 2.1 has been instantiated for each of the children of the study case, each instance shows in itself the components that correspond to each layer of the model, as shown in Fig. 2.3.

The detailed description of each of the instances of the architectural model for student 1 and student 2 is shown below.

A. *Learning Communities*

The learning communities involved in this case study were two, USAER (Support Services to Regular Education) and CAM (Multiple Care Center), the CAM children are children with different abilities with characteristics belonging to those of Down Syndrome, Autism, Asperger, etc. And children belonging to the USAER system are those with ADHD problems, intellectual disabilities with children with characteristics mentioned above which implies having the services distributed in different physical places and for which it is necessary to provide support for teachers as much support as of regular education and parents can access these contents through technological services (Fig. 2.4).

B. *User Interfaces*

For this case study, the specifications of each of the learning communities were taken into account is to say, in a certain way each of the learning communities requires certain specifications in common in the design of learning objects of which certain specifications were made for each student from these general specifications; all these specifications have a greater inference in the part of the design of the user

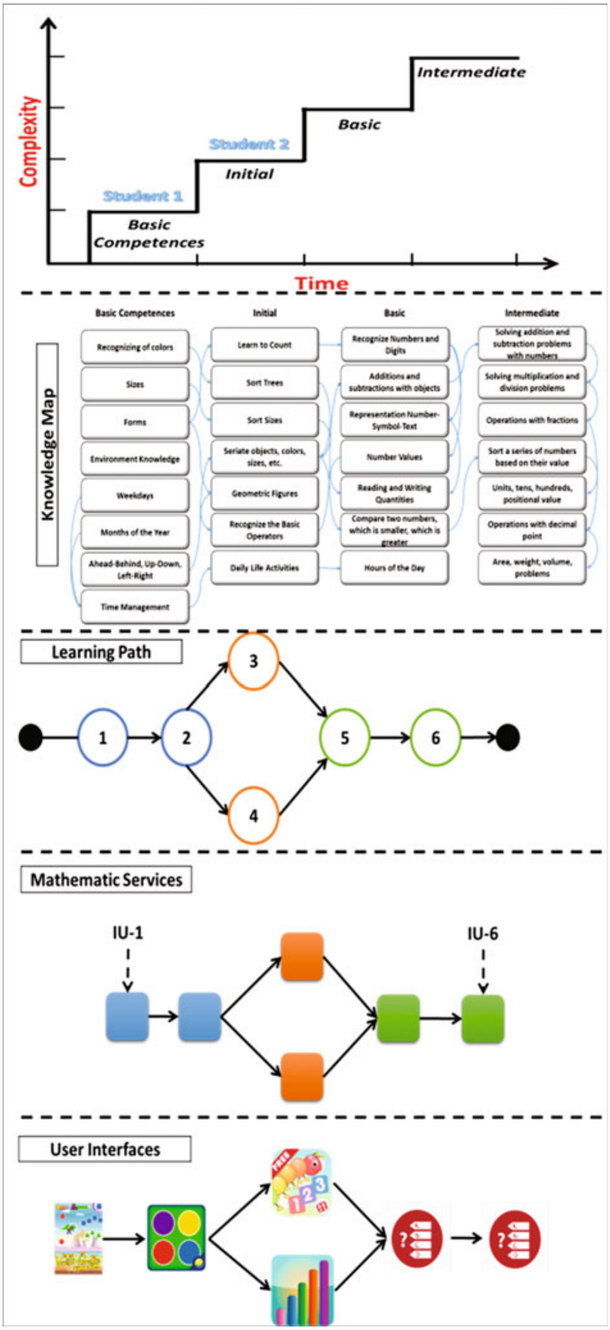

Fig. 2.3 Instances of the architectural model for mobiles application for student 1 from CAM and student 2 from USAER

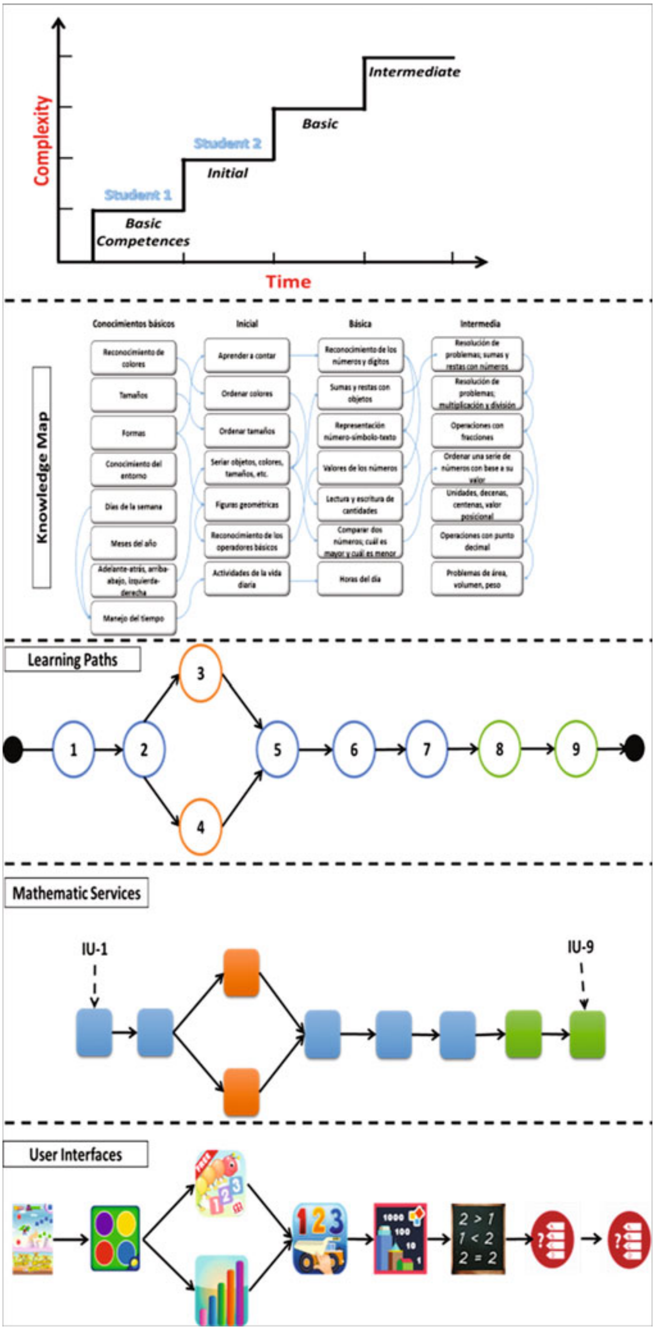

Fig. 2.3 (continued)

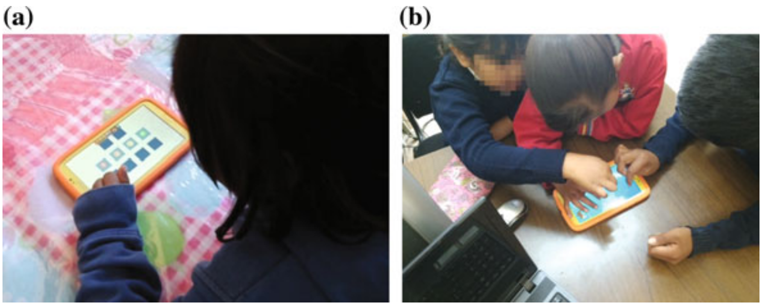

Fig. 2.4 **a** Use of mobile application named "*Series*" by student 1 from CAM. **b** Use of mobile application named "*Learning to count*" by student 2 from USAER

Fig. 2.5 User interfaces of mobile applications used for this case study, on the left side those used by student 1, on the right side those used by student 2

interface, because it is the part that interacts with the child and which makes it mostly the desired goal can be achieved in each of the learning communities and each child in particular.

For student 1, large and color-rich designs were required, also the movement of objects was not so rapid in comparison with other learning communities. For student 2, a design was required that was more oriented to the child's rapid interaction with the application, that its contents were in constant interaction with the child so that this one did not lose the interest in the application (Fig. 2.5).

C. *Levels of Mathematical Skills*

As a first step was to detect the problems that each child had in mathematical competences, so that student 1 was detected with problems in basic skills knowledge, i.e., problems with color representation, sizes, counting, etc., student 2 was detected with learning problems at the initial level, i.e., problems with the representation of numbers, positional value (units, tens, hundreds) and with the numbers comparison (which is greater between two numbers and which is smaller) (Fig. 2.6).

D. *Modeling of Learning Behavior*

For the modeling of mathematical knowledge is specified here through knowledge maps, in this case through the contribution of Piaget's logical and infralogical operations [12], the mathematical competences required by four necessary levels such as Basic Competencies, Initial, Basic, and Intermediate, whereby the following knowledge map is proposed with two traces, the solid line trace corresponds to student 1 and the trace with broken line corresponds to student 2, as shown below.

Within the learning behavior modeling section, different tasks can be perform to indicate how to consume resources in a specific way and thus to try to optimize resources in favor of children with problems and teachers who help these children, it is for that reason that some learning paths were modeled according to the one detected by the specialists in inclusive education.

The learning paths for student 1 and student 2 according to the recommendations given to us by specialists are as follows (Fig. 2.8).

For student 1 in the learning path located on the left side of Fig. 2.7, knowledge of colors, ordering, and seriation of objects through colors, sizes, counting, etc. is incorporated. But at same time they can perform parallel counting of objects to strengthen the numerical part. Once the learning objects were consumed, user's usability and user's experience were conducted to obtain the feedback through

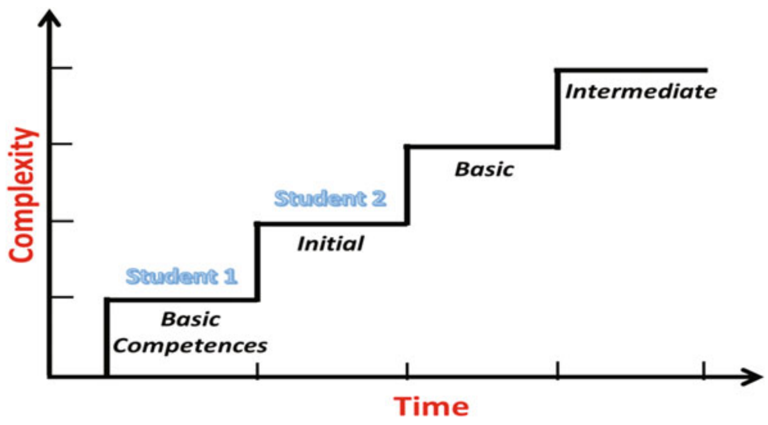

Fig. 2.6 Levels of learning problems in basic math

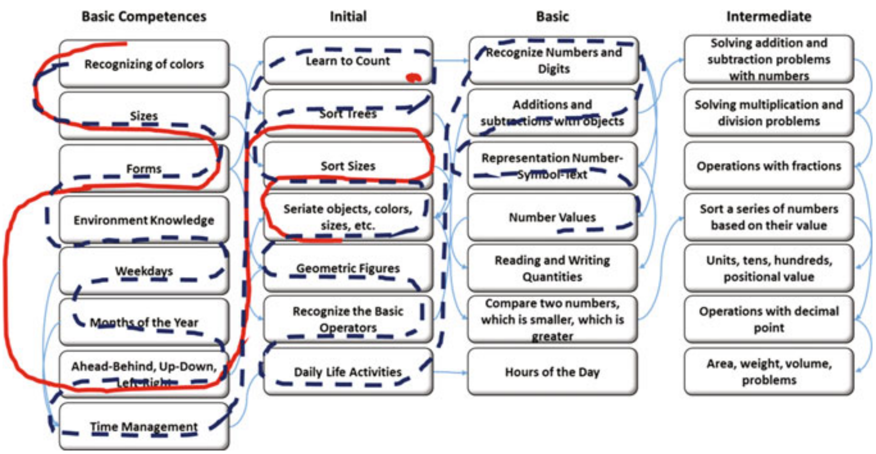

Fig. 2.7 Map of basic mathematics skills for student 1 (CAM), shown in solid line trace and student 2 (USAER), which is shown in a broken line

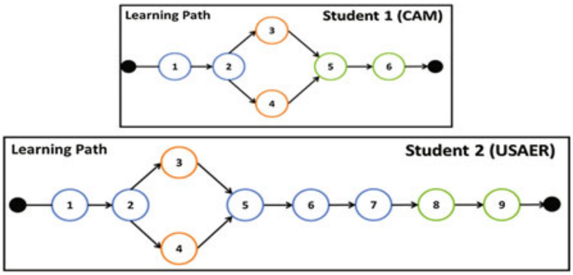

Fig. 2.8 Mathematical skills according to the learning paths for both student 1 and student 2, respectively

questionnaires, that questionnaires are needed to develop more specific mobile applications in the following iterations.

For student 2, the learning path is shown in the right part of Fig. 2.7, which shows the services that can be granted to mitigate the problem detected in the mentioned student, which are more oriented toward the sizing of numbers, the recognition of units, tens and hundreds in addition to the comparison of numbers, that is to say, to recognize which of two numbers is greater or smaller between them and their respective ordering.

E. *Learning Objects*

This stage of architecture is really the implementation of educational applications and resources. The two learning communities mentioned above used the composition of services that comprise the learning objects according to the students' profiles, during this exercise the support teachers, regular education teachers or parents, as appropriate, they downloaded the learning objects and the composition of services to use the applications, each community separately, through the questionnaires was obtained feedback which helps to improve both learning paths, the composition of services and learning objects, improving the specific techniques of delivery for each of the above-mentioned learning communities.

F. *Services Composition*

The composition of services is a variant of educational resources use, where learning objects (services of our architecture) are composed of two or more objects of learning, i.e., in our case study we used more than two mobile applications and educational resources to mitigate a single basic mathematical problem presented by children. In other words, the composition of services helped mitigate the problem of a mathematical ability, attacking it from various points through the variety of mobile applications for a single skill.

G. *Repositories*

Once the learning objects were identified and the specific profiles of the 2 children were taken with the help of the multidisciplinary group, the learning objects that contained the mobile applications for mathematics and the educational contents were classified, these learning objects were labeled to help to mitigate a problem of specific mathematical skills and that the services in turn can identify and use according to the rates obtained by the multidisciplinary group.

This was done through the use of learning paths designed by the specialists in inclusive education that make up the multidisciplinary group.

After each child consumed each of the learning objects recommended by the specialists, usability and user experience tests were made, where the conclusions were positive but there were still recommendations for modification by the multidisciplinary group to improve the objects of learning.

H. *Collaborative Work*

The collaborative work for the mobile applications development and educational resources, includes the technologists mentioned in section A, who are students and researchers of the Autonomous University of Aguascalientes, as well as all those who develop mobile applications in different parts of the planet and upload them to Google's store [20]. On the part of USAER and CAM, which are subsystems of the Aguascalientes Institute of Education, social workers, psychologists, teachers of inclusive education, as well as teachers of regular education and parents of the two learning communities (USAER, CAM).

These collaborators during the sessions of use of the applications and learning objects observed the interaction of the children with the mobile applications and how they consumed, in the case of the Student of the CAM, they were recommended that the applications and the educational resources had content with less complexity of use, more practical and larger and that preferably the mobile device was the largest possible dimensions.

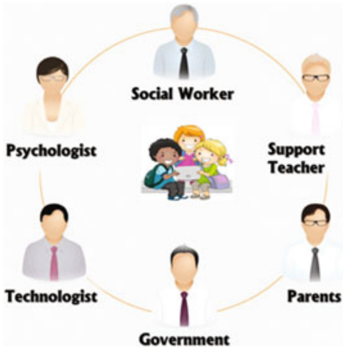

Fig. 2.9 Multidisciplinary group that supports in the construction and improvement of teaching techniques and the development of learning objects

For the USAER child, several recommendations were made by the multidisciplinary team, as the application had sounds and colors that attract more attention, because the child has difficulties to retain attention in what is being taught (Fig. 2.9).

I. *Content Providers*

According to the specialist, they were oriented toward the use of applications developed until now by development groups of the Autonomous University of Aguascalientes and the resources found in the official website of google (Play Store) [20], so it can be said that the providers active are the public institutions and social organizations, among which are all those people who develop individually for social use.

2.5 Related Work

In the literature on E-learning and computer science, there is a great variety of works related to the subject, in this section we analyze a series of works, in their characteristics and positions compared to the present work.

According to Table 2.2, the first work analyzed is [6], this paper talks about the importance of learning paths to model knowledge and guide it through a large cumulus of educational resources that exist in the network (Internet), which are known as an essential part of E-Learning [6], also it shows the advantages of using learning paths through a study carried out in Taiwan City with children of elementary education who show better results when they used learning paths than when randomized educational content. However, this first work lacks a service-oriented architectural model in order to be able to distribute learning objects. Note that it leaves aside the handling of interfaces necessary for the student to have a better interaction with the learning objects in specific with the applications, also it gives a general approach to all the competences and does not define a signature as can be the mathematics, does not even establish maps of knowledge and finally does not guide children with some problematic of learning in basic mathematics through multidisciplinary groups.

The second work [8] proposes as part of the modeling of knowledge learning maps that is the construction of knowledge guided by the construction of a typography formed by the skills necessary to develop guiding them through knowledge precursors and predecessors, which indicate the importance of knowledge guided, then in a more specific way employs learning paths as a finer granularity of knowledge for the acquisition of a specific competence. However, in a similar way as the first work, it does not have a service-oriented architecture, does not handle user interfaces, nor does it use a multidisciplinary support team that helps to develop specific mobile applications for children with learning problems, not has a focus on basic education, nor does it contain a specific competence such as mathematics.

The third work [14] proposes a service-oriented architecture for literacy learning communities; these architectures are capable of creating literacy services that can respond more quickly and adapt more quickly to the needs of learning communities. Also providing a complex solution for the analysis, design, maintenance, and integration of services-based applications. The services paradigm allows the design of an interoperable, flexible, and dynamic environment, where services are housed in highly distributed heterogeneous repositories. The third work, proposes services, user interfaces is oriented to the design of systems for digital literacy without considering in order specifying learning environments in the area of inclusive basic mathematics. It is important to say that it does not consider a multidisciplinary team as support for the development of educational applications in mobile, nor the learning paths and knowledge maps are considered.

Finally the fourth work [21] proposes learning paths with the intention of ordering the great amount of educational resources that exist in the network, but oriented to generate user profiles by grouping users with similar characteristics considering learning preferences, interests, and navigation behaviors, from these characteristics are generated common profiles and thus generate the best learning paths, which are perfectible.

This work, although it works with user profiles, does not have the assessment of experts in education, also it not being based on a service-oriented architecture, nor does it use or mention user interfaces according to the needs of the users, lastly it does not use an orientation toward basic or elementary education mathematics.

According to the works shown in Table 2.1, the works in their main proposals do not tend to an integrative approach, leaving aside the required attention to the needs of the user with learning problems. Given the user-centered approach is not taken into account then the requirements of some students who may have problems are not considered, this is why the present work integrates a multidisciplinary group that provides the most specific technological knowledge essential for the type of users mentioned, besides managing ad hoc user interfaces for each of the learning communities, these being perfectible in each moment because the characteristics of

Table 2.1 Staff involved in the treatment of children with learning disabilities in basic mathematics in each of the communities

CAM	USAER
Regular education teacher	Regular education teacher
Teacher of inclusive education	Support teacher
Psychologist	Psychologist
Social and communication workers	Social worker
Physical or occupational therapists	Parents
Educational assistants	
Teaching staff	
Workshop instructors	
Parents	

Table 2.2 Related work

	Work 1 [6]	Work 2 [8]	Work 3 [14]	Work 4 [21]	Proposal
Service-oriented architecture			x		x
Graphical user interface management			x		x
Multidisciplinary team			x		x
Elementary education level	x				x
Online educational resources			x	x	x
User-centered approach				x	x
E-learning	x	x	x	x	x
Learning paths	x	x	x	x	x
Conceptual maps		x	x		x

the same ones vary according to the members that comprise them, all this is intended perform through a service-oriented architecture where the finest granularity are reusable learning objects for each of the users of learning communities (Table 2.2).

2.6 Conclusions and Future Work

In conclusion, the present work presents a service-oriented architectural model in order to assist people with math problems. Through the use of the proposal of the service-oriented architectural model, two learning communities (USAER and CAM) were provided learning objects through the employment specifications suggested by a multidisciplinary group through knowledge maps and paths of learning, which helped us to organize and manage the learning objects in a specific way and that are stored in repositories and distributed through services, these services were distributed to the two students noting an advance in the development of basic mathematical skills specific for each of the children in the learning communities, also that the feedback provided by children through the use of learning objects as the multidisciplinary group.

Through this work it was also possible to verify the importance of technology as an educational tool, as long as it is conducted by a multidisciplinary group that helps to guide through learning maps and learning paths the objects of learning and thus through the use of in the previous architecture, the importance of making technological developments (learning objects) more in line with the needs of the learning communities (CAM and USAER) could be verified. This work also stand out the importance of feedback from multidisciplinary groups which facilitates that little by little they are developed developing more specific learning objects for the learning communities that are intended to attend.

As future work, a digital ecosystem could be defined in order to help children with mild learning problems in basic math, taking into account learning communities and content providers. Another initiative is for developing educational resources in basic mathematics through the use of software product lines and agile methods.

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