Facilitating Teachers’ Reuse of Mobile Assisted Language Learning Resources Using Educational Metadata

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Abstract—Mobile assisted language learning (MALL) and open access repositories for language learning resources are both topics that have attracted the interest of researchers and practitioners in technology enhanced learning (TeL). Yet, there is limited experimental evidence about possible factors that can influence and potentially enhance reuse of MALL resources stored in open access repositories. In this paper the Mobile2Learn Framework is proposed, which aims at supporting sharing and reuse of MALL resources within the context of MALL courses development. Moreover, a quantitative analysis of the reuse of MALL resources developed with the proposed Mobile2Learn Framework is conducted. The results of this analysis provided with evidence that completeness of metadata fields related with educational objectives based on Common European Framework of Reference for Languages (CEFR) can strongly influence reuse taking place among Mobile2Learn Framework users.

Index Terms—Learning objects, mobile and personal devices, E-learning standards

1 INTRODUCTION

Language learning has been a primary field of application of mobile learning, which is defined as the process of learning and teaching that occurs with the use of mobile devices providing flexible on-demand access (without time and device constraints) to learning resources, experts, peers and learning services from any place [1], [2]. This has led to the development of a new approach for technology-enhanced language learning (TELL) which is commonly referred to as mobile assisted language learning (MALL). MALL is typically defined as “an approach to language learning that is assisted or enhanced through the use of a handheld mobile device” [3]. As a result, a number of MALL systems have been proposed such as CAMLES [4], TAMALLE+[5], JAPELAS2 [6] and PALLAS [7], aiming to investigate the potential advantages of using mobile devices in language learning.

On the other hand, the emerging open educational resources (OERs) initiatives have enabled teachers to organize, classify and store digital educational resources and their associated metadata in web-based repositories towards facilitating their sharing and reuse by other teachers [8], [9]. These initiatives have also influenced the field of TELL and some web-based open access repositories have been recently developed towards supporting open access, sharing and reuse of digital language learning resources. However, these repositories do not include digital language learning resources that can be delivered to mobile devices for supporting MALL. Additionally, these repositories do not put emphasis on the reuse of digital language learning resources and there is limited evidence about the factors that could influence and possibly enhance reuse of educational resources in the field of Language Learning, as well as in the field of MALL. As a result, it is worthy to investigate technology-supported solutions that can support open access and reuse of MALL resources.

Within this context, in this paper we present the Mobile2Learn Framework, which aims at providing the technological means to facilitate open access and reuse of MALL resources from the perspective of MALL courses design and development. Moreover, a quantitative analysis of the reuse of MALL resources developed with the proposed Mobile2Learn Framework is conducted. In particular, from the results of this analysis it was identified that completeness of MALL resources metadata records can strongly influence reuse taking place among Mobile2Learn Framework users (namely, foreign language teachers), whereas completeness of metadata fields related with educational objectives based on Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR) can strongly influence reuse taking place among Mobile2Learn Framework users with different countries of origin.

The paper is organized as follows: Following this introduction, in Section 2 we discuss existing efforts in the OERs area for supporting open access and reuse of MALL resources and we identify the limitations of current practices. Section 3 describes our proposal, namely, the Mobile2Learn framework for facilitating open access and reuse to MALL resources within the context of MALL courses design and development and we present the tools of the proposed framework with emphasis on the educational metadata aspects of the framework. In Section 4, we conduct a quantitative analysis of the reuse of MALL resources within MALL courses developed with the proposed Mobile2Learn
Framework Tools and we discuss the results of our study. Finally, we present our concluding suggestions and our ideas for future work in this field.

2 Open Access and Reuse of Mobile Assisted Language Learning Resources

Over the past years a number of web-based open access repositories with digital language learning resources have been developed such as:

- **The FLORE Repository** (http://flore.uvic.ca/), which was developed by the “French Learning Object Repository for Education” project and provides open access to digital resources for teaching French as second language [10].
- **The Tutela Repository** (Tutela, http://tutela.ca/), which has been funded by Citizenship and Immigration Canada and provides open access to digital resources for teaching Canadian English and French as second language.
- **The Languages Open Resources Online Repository** (LORO, http://loro.open.ac.uk/), which was developed by Department of Languages at the UK Open University and provides open access to digital resources for teaching a variety of languages.
- **The Language Box** (http://languagebox.ac.uk), which was developed by the Faroes project and provides open access to digital resources for a wide variety of languages at various levels [11].
- **The SPEAKAPPS Repository** (http://oer.speakapps.org/), which was developed by the EU-funded SPEAKAPPS Project and provides open access to digital resources for a wide variety of languages at various levels [12].

These repositories are mainly used by foreign language teachers for: (a) searching and reusing digital language learning resources for their teaching activities and (b) sharing their digital language learning resources with other foreign language teachers. An important factor, in order to facilitate foreign language teachers in the process of searching, retrieving and reusing digital language learning resources, is the existence of educational metadata for these resources. The dominant metadata standard for characterizing educational resources with metadata is the IEEE Learning Object Metadata (IEEE LOM) Standard [13]. FLORE Repository and Tutela Repository adopt the IEEE LOM standard for characterizing their language learning resources, whereas LORO Repository adopts Dublin Core Metadata Element Set [14] and Language Box Repository and SPEAKAPPS Repository adopt their own metadata model. However, the majority of the examined repositories do not put emphasis on specific metadata for describing the language learning characteristics of their language learning resources. More specifically, language learning resources stored in most of these repositories cannot be searched and retrieved based on the particular language learning objectives they address. Moreover, although all examined repositories support open access to language learning resources, these resources have not been designed by following the W3C Mobile Web Best Practices [15]. As a result these resources will not have an optimum performance when delivered to mobile devices in terms of page layout and content, navigation and links, as well as user input.

On the other hand, the issue of whether language learning resources are reused and how, seems to be an important one for the existing language learning repositories. More specifically, recent studies by Beaven [16], by Pulker and Calvi [17], as well as by Comas-Quinn et al. [18] have investigated, focusing on the LORO Repository, the type of changes made to language learning resources when reused and the reasons for these changes. Nevertheless, these studies do not provide metrics for measuring reuse of language learning resources stored in LORO Repository or in others existing language learning repositories, in general. Consequently, there is no experimental evidence about the possible factors that can influence and possibly enhance reuse of educational resources in the field of Language Learning, as well as in the field of MALL.

Next, we address these issues by introducing the Mobile2Learn Framework, which aims to support open access and reuse to MALL resources within the context of MALL courses design and development. Finally, it is worth mentioning that there is an increasing interest in current MALL research that focuses on MALL systems that aim to engage learners in the process of sharing and reusing their own resources and there are several studies that investigate these issues as reported in [19], [20], [21], [22]. Nevertheless, Mobile2Learn Framework focuses only on sharing and reuse of MALL resources that are generated by foreign language teachers. Thus, aspects related to the sharing and reuse of learner-generated MALL resources are beyond the scope of the proposed Mobile2Learn Framework.

3 The Mobile2Learn Framework

3.1 Mobile2Learn User Roles

The Mobile2Learn Framework targets foreign language teachers. However, within the Mobile2Learn Framework there are three main user roles that foreign language teachers could undertake, namely:

- **MALL Content Suppliers**, that is, the role responsible for designing and developing MALL resources in the form of “Learning Objects (LOs)” [23]. For the purpose of our work, a Learning Object is defined as “any type of digital resource that can be reused to support learning” [24]. The MALL Content Suppliers need to be able to (a) convert their existing digital language learning resources and/or create new digital language learning resources that meet mobile delivery requirements and (b) characterize these resources with metadata that are meaningful in relation to the MALL characteristics of the resources. Thus, the Mobile2Learn Framework provides them with a set of guidelines (based on the W3C Mobile Web Best Practices 1.0) and the technological means (namely, a metadata authoring toolkit, described in Section 3.2.2) for developing MALL resources and tagging them with appropriate educational metadata.
based on an appropriate designed LOM application profile (described in Section 3.2.2).

- **MALL Courses Suppliers**, that is, the role responsible for designing MALL courses based on a pre-defined sequence of learning activities (in our work, referred to as course template) which represents the adopted language teaching practice as a workflow. Therefore, in our work a MALL course is defined as: a sequence of learning activities populated with MALL resources [25] conducted entirely via a mobile device, targeting specific educational objectives and with duration of 8 to 16 teaching hours in total. Moreover, a MALL course template is defined as: a sequence of generic learning activities representing a specific MALL teaching practice [26], which potentially can be populated with different MALL resources for developing different MALL courses. Thus, the Mobile2Learn Framework provides the MALL Courses Suppliers with a methodology and the technological means (namely, a course authoring toolkit described in Section 3.2.3) for defining their MALL teaching practices and for representing them in a common machine understandable format following the IMS Learning Design (LD) specification [27]. Furthermore, the Mobile2Learn Framework provides them with a set of indicative examples of MALL course templates representing specific MALL teaching practices, which they can use and modify. Finally, it offers them access to a web-based repository of MALL Resources (in the form of LOs characterized with appropriate educational metadata) to facilitate them in the design and the development of their MALL courses.

- **MALL Services Providers**, that is, the role responsible for designing MALL programs as a synthesis of MALL courses and delivering them to their students. The Mobile2Learn Framework provides them with (a) access to a repository of MALL courses (represented in the form of IMS Learning Designs) which they can use to search and retrieve MALL courses and (b) the technological means (namely, a course delivery tool) for delivering MALL courses to their students via mobile devices.

Fig. 1 presents the identified user roles, their interconnections, as well as, their needs and the tools that the Mobile2Learn Framework offers them to support these needs.

### 3.2 Mobile2Learn Tools

The Mobile2Learn Framework provides the user roles identified in Section 3.1 with a set of key tools that are described next in detail.

#### 3.2.1 Mobile2Learn MALL Courses Authoring Toolkit for Designing MALL Course Templates and MALL Courses

This is a software tool that enables the MALL Courses Suppliers (a) to express their MALL teaching practices, in the form of MALL course templates, using a common machine understandable way, and (b) to design and develop MALL courses using a reference set of pre-defined MALL course templates. As a result, a set of MALL course templates, which represent different MALL teaching practices, can be designed to facilitate the development of MALL courses that adopt these practices. Fig. 2 presents a snapshot of the Mobile2Learn MALL Courses Authoring Toolkit, which provides MALL Courses Suppliers with a graphical interface for creating MALL courses conformant with the IMS LD Specification and packaging them along with their related MALL resources.

#### 3.2.2 Mobile2Learn Metadata Authoring Toolkit

This is a software tool that allows the MALL Content Suppliers and the MALL Courses Suppliers to author educational metadata for their MALL resources and courses, as well as, to organize and offer MALL resources and courses through the Mobile2Learn Web Repository. Educational metadata describe the different characteristics and attributes of a MALL resource or course, e.g., title, description, keywords, target user group or subject domain. They are made up of data items that are associated with a MALL resource or course, which are called metadata elements. Each MALL resource or course is...
associated with a metadata record composed by metadata elements with specific values. The more complete a metadata record is, better informed decisions can be taken by MALL Courses Suppliers and MALL Services Providers, when searching to (re)use MALL resources and MALL courses correspondingly.

The Mobile2Learn Metadata Authoring Toolkit offers an authoring wizard for describing MALL resources and courses with educational metadata conformant with IEEE LOM standard. However, it is beyond the scope of IEEE LOM to directly support the description of characteristics related with MALL. As a result, in order to handle the specific characteristics of the MALL resources and courses, extensions have been implemented to the value space of the IEEE LOM Classification Category (Nr. 9) through a LOM Application Profile, proposed in Zervas and Sampson [28]. More specifically, two controlled vocabularies have been introduced for the sub-element “Taxon Path.Taxon.Entry (Nr. 9.2.2.2)” based on the different values that the sub-element “Purpose (Nr. 9.1)” takes, as described below:

- When the value is “educational objective” then the purpose of the Classification Element (Nr. 9) is to define the educational objectives that a learning object is targeting. As a result, in the sub-element Taxon Path.Source we can use the “CEFR Levels” value to state that the educational objectives are derived from those defined in Common European Framework of Reference for Languages: Learning, Teaching, Assessment which is a framework used to describe achievements of learners in foreign languages across Europe [29]. CEFR provides six reference levels, which are becoming widely accepted as the European standard for grading an individual’s language proficiency, adopted also from the Europass Language Portfolio [30]. These six levels are [29]: (a) Basic User: A1 and A2, (b) Independent User: B1 and B2 (c) Proficient User: C1 and C2. As a result, the sub-element “Taxon Path.Taxon.Entry” can take these values. Fig. 3 presents the process of characterizing a MALL resource or course based on the CEFR educational objectives addressed.

- When the value is “accessibility restrictions” then the purpose of the Classification Element (Nr. 9) is to define the accessibility restrictions, which need to be followed so that the learning object can be properly delivered through a specific mobile device. As a result, in the sub-element Taxon Path.Source we can use the “Screen Resolution” value to state the accessibility requirements for the screen resolution of the mobile device to be used for the proper delivery of the learning object and in the sub-element “Taxon Path.Taxon.Entry” we can use the values of different mobile devices screen resolutions. Fig. 4 presents the process of characterizing a MALL resource or course according to the screen resolution of the mobile device that it is going to be delivered in.

3.2.3 Mobile2Learn Web Repository

This is a web-based platform enabling the MALL Content Suppliers and the MALL Courses Suppliers to share their MALL resources and courses. Moreover, the Mobile2Learn Web Repository (http://www.mobile2learn.eu/) provides the MALL Services Providers with the possibility to search and retrieve MALL courses that can be integrated to their educational offers.

The functionalities of the Mobile2Learn Web Repository can be summarized as follows:

- **Submit and Store.** MALL Content Suppliers and MALL Courses Suppliers are able to submit and store MALL resources and courses to the Mobile2Learn Web Repository along with their related educational metadata, which has been previously developed by using the Mobile2Learn Metadata Authoring Toolkit.

- **Search and Retrieve.** All user roles of the Mobile2Learn Web Repository are able to search and retrieve MALL resources and courses by using searching criteria, which match with the educational metadata of these resources and courses (see Fig. 5). More specifically, the search form includes searching elements according to the CEFR levels and the screen resolution of the mobile device (as described in Section 3.2.2), as well as other searching elements, which are mapped to metadata elements provided by the IEEE LOM standard.
Rate/Comment. All user roles of the Mobile2Learn Web Repository are able to provide their ratings and comments for the MALL resources and courses stored in the Mobile2Learn Web Repository. These ratings and comments are typically related with the impressions of the users who have used a specific MALL resource/course.

3.2.4 Mobile2Learn MALL Courses Delivery Tool
This is a software tool suitable for mobile devices with Windows mobile or Android operating systems that facilitates MALL Services Providers to deliver to their students MALL courses that have been retrieved from the Mobile2Learn Web Repository. Figs. 6 and 7 present snapshots of the Mobile2Learn MALL Courses Delivery Tool, a platform for delivering MALL courses, which are conformant with the IMS LD Specification [31]. Furthermore, the Mobile2Learn MALL Courses Delivery Tool enables enrolment of multiple roles/actors (individual learners, groups of learners and teachers), as well as rendering of HTML-based content and flash files.

3.3 Mobile2Learn Aspects of Sharing and Reuse
As we can notice from the description of the Mobile2Learn Framework, the MALL resources and courses produced by the tools of the framework follow the current Learning Technology and Web Mobile Content Specifications and Standards, namely the IEEE LOM Standard, the IMS LD Specification and the W3C Mobile Web Best Practices 1.0. This fact facilitates the development of an underlying infrastructure for sharing MALL resources though the Mobile2Learn Repository and potentially reusing them in different MALL courses that are developed with the Mobile2Learn MALL Courses Authoring Toolkit and delivered with the Mobile2Learn MALL Courses Delivery Tool.

However, in order to evaluate whether the proposed Mobile2Learn Framework can contribute towards the reuse of MALL resources within different MALL courses, we conduct a quantitative analysis of MALL resources reuse. This analysis can provide with evidence about the factors that could influence and possibly enhance MALL resources reuse within different MALL courses developed with Mobile2Learn Framework Tools.

4 QUANTITATIVE ANALYSIS OF MALL RESOURCES REUSE
In this section, we present a quantitative analysis of the reuse of MALL resources within the Mobile2Learn Framework. First, related work is introduced regarding similar studies focused on LOs reuse. Then, the research questions and the adopted research method are described. Finally, the results are outlined.

4.1 Related Work
Within the TeL literature, there are existing works that have studied the issue of measuring LOs reuse for different data sets [32]. Koper [33] has defined three levels of LOs reuse, as follows:

- First level reuse. The creator of the LO reuses it to construct another LO of higher granularity.
- **Second level reuse.** A member of a community reuses a LO created by someone else within the same community.
- **Third level reuse.** A member of a community reuses a LO created by someone who is not a member of this community.

Ochoa [34] has conducted a quantitative analysis of LOs reuse in ARIADNE Repository (http://ariadne.cs.kuleuven.be/finder/ariadne/). Within this study, the reuse was considered to take place at second level, as defined by Koper [33]. The total reuse percentage was calculated around 22 percent across learning objects of different granularity. This percentage was calculated as the number of LOs that have been reused by any user within LOs of higher granularity compared to the total number of LOs in the repository. Additionally, within this study it was analyzed whether LOs popularity (regarding how many times a LO has been accessed) can influence the LOs reuse. The analysis was based on calculating the Kendall’s tau correlation coefficient between the rank of the LO in the reuse and its popularity scale. The results of the study revealed that there was no correlation between the popularity of a LO and the number of times that it has been reused.

Other similar studies have been conducted by Petrides et al. [35] and Duncan [36], who have also studied LOs reuse in Connexions Repository (http://cnx.org/). Within both studies, the reuse was considered taking place at second level, as defined by Koper [33]. A similar approach to Ochoa [34] was adopted and a reuse percentage was calculated around 20.50 percent across learning objects of different granularity. Furthermore, Duncan [36] analyzed whether the age of the LOs and the number of keywords available in the metadata of the LOs can influence the LOs reuse. The analysis was based on the Pearson’s correlation coefficient between the rank of the LO in the reuse and its age, as well as the number of keywords assigned to it. The results of the study showed that there was no significant correlation between LOs reuse and their age, as well as their number of keywords.

Finally, Vuorikari and Koper [32] conducted a similar study and examined LOs reuse in Learning Resource Exchange (LRE) Repository (http://trefschools.eun.org/) and LeMill (http://lemill.net/) Repository. The reuse was considered as taking place at the second and third levels, as defined by Koper [33]. More specifically, they reported (a) a second level reuse rate of approximately 19 and 22 percent for LRE Repository and LeMill Repository respectively and (b) third level reuse rate of approximately 12 and 7 percent for LRE Repository and LeMill Repository respectively. The third level reuse was calculated across communities with users of different spoken languages or different countries of origin. Nevertheless, no evidence was provided within this study about possible factors that could influence the second and/or third levels of LOs reuse.

As a result, it appears, from the aforementioned studies related with LOs reuse in existing repositories, that second level reuse percentage varies from 19 to 22 percent, whereas third level reuse percentage varies from 7 to 12 percent. Nevertheless, there is limited evidence about the factors that can influence LOs reuse and achieve reuse percentages higher than previously reported ones. Thus, the main purpose of our study is to measure the reuse of MALL resources within different MALL courses developed with Mobile2Learn Framework Tools and identify empirical evidence about the factors that influence the reuse within Mobile2Learn Framework.

### 4.2 Research Questions

The primary research question that we aim to answer with this study is: "What are the main factors that influence MALL resources reuse within different MALL courses developed with Mobile2Learn Framework Tools?" More precise sub-questions related to the primary research question, that could be answered include the following:

1. **What is the percentage of MALL resources reuse at first, second and third level within different MALL courses produced by the Mobile2Learn Framework?** We should mention here that we consider:
   - Second level reuse as taking place among all Mobile2Learn Framework, users (namely, foreign language teachers). This is a key hypothesis in similar studies from the literature [32], [34], [35], [36], [37].
   - Third level reuse as taking place among Mobile2Learn Framework users with different countries of origin. The reason for investigating reuse among users of different country of origin is that cross-country reuse of MALL resources has been a key recent hypothesis in similar studies in the field of technology-enhanced learning [32] and we considered that it will be worthy to investigate this also in the field of MALL.

2. **Is there a relation between MALL resources reuse at first, second and third level and the level of completeness of MALL resources metadata records?**

3. **Is there a relation between MALL resources reuse at first, second and third level and the number of metadata values related with CEFR educational objectives added for the Classification metadata element?**

The answers to these questions could facilitate us to compare MALL resources reuse with similar studies (as discussed in Section 4.1) and identify differences or similarities. Moreover, the study of metadata records completeness versus MALL resources reuse could provide us with evidence whether the information added via metadata to MALL resources can influence their reuse. Additionally, the study of the number of CEFR educational objectives added for the Classification metadata element versus MALL resources reuse could provide us evidence about the validity of our approach for enhancing MALL resources metadata with language learning educational objectives related with CEFR levels (as presented in Section 3.2.2) towards increasing MALL resources reuse. Finally, we should clarify at this point that only educational metadata records were analyzed, whereas ratings and comments added by the users of the Mobile2Learn Repository were not considered in this study.
4.3 Research Method

4.3.1 Participants

The participants who used the Mobile2Learn Framework tools were English language teachers and they were selected based on their previous experience in using ICT tools for foreign language teaching. The participants’ average teaching experience with ICT tools was 4.7 years, so they can be characterized as experienced teachers. The participants were engaged in specially designed five-day workshops, which were held in four Vocational Education and Training Organizations (VET) located in four European countries, namely Greece, Czech Republic, Netherlands and Spain.

The procedure that was followed was the following:

- **During the workshops.** The participants were trained in the process of using the Mobile2Learn Framework tools. Next, they assumed the role of MALL content suppliers and developed MALL resources, which were characterized with educational metadata (by following the LOM application profile presented in Section 3.2.2) and uploaded to the Mobile2Learn Repository. The participants chose to create these MALL resources in flash format. The MALL resources were also tailored to meet the specific screen resolution value of the mobile devices handed to them for testing purposes. During this phase, the participants were supervised by the workshops’ tutors, who also provided with face to face assistance to the participants for using the Mobile2Learn Framework Tools.

- **After the workshops.** The participants were allowed a three-month period to undertake the role of MALL Courses suppliers and develop MALL courses by using or re-using the MALL resources that were developed during the workshops and were available in the Mobile2Learn Repository. During this process, the participants were also able to develop new MALL resources when existing MALL resources were not suitable to be used in the context of the MALL courses that they were developing. It should be noted that during this phase the participants were not supervised and they were asked to develop MALL courses on their own. However, they were able to request online technical support by the workshop tutors in case of difficulties with Mobile2Learn Framework Tools.

4.3.2 Data Set

Table 1 presents the snapshot of the Mobile2Learn Repository which was used for performing our study.

As we can notice from Table 1, the total sample of MALL content suppliers and MALL courses suppliers consists of N = 112 participants. The countries of origin of the participants were Greece (N = 33), Netherlands (N = 27), Spain (N = 26) and Czech Republic (N = 26).

The total number of MALL resources developed was 719 and the total number of MALL courses developed was 132. It is worth mentioning that 582 (80.94 percent) MALL resources were developed during the workshops, whereas 137 (19.06 percent) MALL resources were developed after the workshops period. Regarding the MALL courses, all of them were developed during the three-month period after the workshops. Finally, each participant developed an average of six MALL Resources (SD = 0.96) and 1 MALL Course (SD = 0.49). The fact that the calculated standard deviation is rather low means that the number of MALL resources and MALL courses developed by each participant was almost evenly distributed.

4.3.3 Methodology

In order to address the primary research question, as well as the additional sub-questions (presented in Section 4.2), we adopt a similar methodology for a quantitative analysis of LOs reuse proposed by Ochoa [34] and we adopt the three levels of reuse proposed by Koper [33]. More specifically, our methodology includes the following steps:

1. **Amount of reuse.** (a) Quantitatively analyze MALL resources reuse within different MALL courses by following the metrics for measuring LOs reuse at first, second and third level, as proposed by Koper [33] and adapted in the context of our study (see Table 2) and (b) compare reuse percentages with similar studies from the literature and identify differences or similarities (addressing sub-question 1).
2. **Reuse versus Metadata Completeness.** (a) Calculate the completeness of MALL resources metadata records by using the following formula:

\[
Q_{\text{Comp}} = \frac{\sum_{i=1}^{N} P(i)}{N},
\]

where \(P(i)\) is 1 if the \(i\)th metadata field has a no-null value or 0 otherwise. \(N\) is the number of metadata fields defined in the Mobile2Learn LOM application profile used for describing the MALL resources and (b) calculate Kendall’s tau correlation coefficient between MALL resources reuse (at first, second and third level) and completeness of MALL resources metadata records (addressing sub-question 2).

3. **Reuse versus number of CEFR educational objectives addressed.** Calculate Kendall’s tau correlation coefficient between MALL resources reuse (at first, second and third level) and the number of different metadata values related with CEFR educational objectives added for the Classification metadata element (addressing sub-question 3).

### 4.4 Results

#### 4.4.1 Amount of Reuse

In order to measure the reuse at first, second and third level, we applied the reuse metrics presented in Table 2 to the data set of the Mobile2Learn Repository presented in Table 1. The results of the reuse metrics at each level is presented in Table 3.

As we can notice from Table 3, Mobile2Learn Framework noticeably facilitates reuse at first, second and third level. More specifically, reuse at first level is 19.88 percent but although the amount of reuse at first level is promising there were not any previous studies, so as to compare with. Additionally, at second level, Mobile2Learn Framework goes beyond (35.04 percent) the general trend of 22 percent reuse, which has been reported from similar studies. We can also notice that second level reuse is higher than first level reuse. This means that MALL resources creators acted mainly as MALL content suppliers and they were not also involved in the process of developing MALL courses. Finally, Mobile2Learn Framework outperformed also at third level reuse (13.49 percent), where the reported reuse from similar studies was 7 to 12 percent. These results provided us with evidence that Mobile2Learn Framework could (a) support reuse for the creators of the MALL resources and (b) improve reuse among users of the Mobile2Learn Framework, as well as across country boundaries (that is, among users with different countries of origin).

#### 4.4.2 Reuse versus Metadata Completeness

Table 4 presents the calculated Kendall’s tau correlation coefficient between number of times of MALL resources reuse and the completeness of their metadata records, so as to identify if a statistically significant correlation between these two variables existed. We should also mention at this point that the average number of completeness of MALL resources metadata records was 0.7387 (SD = 0.1102).

As we can notice from Table 4, there was no correlation between the number of times of reuse at first level and the metadata completeness. This means that the completeness of metadata records does not affect reuse when this is taking place at first level (that is by the creator). This was expected since the MALL resource creator does not need to be informed about the metadata of a MALL resource that he/she has created, so as to decide whether to reuse a MALL resource or not. On the other hand, there was a significant, positive correlation (\(\tau = 0.898, p < 0.05\)) between the number of times of reuse at second level and the metadata completeness. As a result, we can identify that metadata completeness is an important factor that influence reuse within the Mobile2Learn Framework, when reuse is taking place among all users of the Mobile2Learn Framework (second level reuse). This provides with evidence that the LOM application profile used for characterizing the MALL resources of the Mobile2Learn repository (as presented in Section 3.2.2) includes meaningful metadata elements, which can enhance MALL resources reuse when they have been completed by the MALL resources’ creators. Finally, there was also a positive correlation (\(\tau = 0.467, p < 0.05\)) between the number of times of reuse and the metadata completeness for third level reuse but this correlation was weaker than the calculated correlation for second level reuse. This means that reuse across country boundaries (third level) is less strongly linked with completeness of the MALL resources metadata records. This could be explained by the fact that reuse taking place across country boundaries could be linked with the completeness of only specific metadata elements of MALL resources metadata records related with the facilitation of cross-country reuse. This is further investigated and discussed in the next section.

#### 4.4.3 Reuse versus Number of CEFR Educational Objectives Addressed

Table 5 presents the calculated Kendall’s tau correlation coefficient between the number of times of MALL resources reuse and the number of different metadata values related with CEFR educational objectives added for the Classification metadata element.

<table>
<thead>
<tr>
<th>Level</th>
<th>Kendall’s tau ((\tau)) coefficient</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Level Reuse</td>
<td>0.016</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>2nd Level Reuse</td>
<td>0.898</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>3rd Level Reuse</td>
<td>0.467</td>
<td>&lt;0.05</td>
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### Table 3

<table>
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<th>Level of Reuse</th>
<th>MALL Resources Reused</th>
<th>% of Reuse</th>
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<tbody>
<tr>
<td>First Level Reuse</td>
<td>143</td>
<td>19.88%</td>
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<tr>
<td>Second Level Reuse</td>
<td>252</td>
<td>35.04%</td>
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<tr>
<td>Third Level Reuse</td>
<td>97</td>
<td>13.49%</td>
</tr>
</tbody>
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### Table 4

<table>
<thead>
<tr>
<th>Level</th>
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<tr>
<td>3rd Level Reuse</td>
<td>0.467</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

### Table 5

<table>
<thead>
<tr>
<th>Objectives Addressed</th>
<th>1st Level</th>
<th>2nd Level</th>
<th>3rd Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Level</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As we can notice from Table 5, there was no correlation between the number of times of reuse at first level and the number of CEFR educational objectives addressed for each MALL resource. This means that number of educational objectives addressed for each MALL resource does not affect its reuse when this is taking place at first level (that is by the creator). This was expected, since the MALL resource creator is able to reuse a MALL resource created by him/her without being informed about the educational objectives that this MALL resource is targeting. On the other hand, there was a positive correlation ($r = 0.768$, $p < 0.01$) between the number of times of reuse at second level and the number of CEFR educational objectives addressed. As a result, we can identify that the number of CEFR educational objectives addressed for each MALL resource is a notable factor that influence reuse within the Mobile2Learn Framework, when reuse is taking place all users of the Mobile2Learn Framework (second level reuse). Finally, there was also a significant positive correlation ($r = 0.945$, $p < 0.05$) between the number of times of reuse and the number of CEFR educational objectives addressed for third level reuse. This means that reuse across country boundaries (third level) is noticeably linked with the number of CEFR educational objectives addressed for each MALL resource. The positive correlation at second and third level reuse with the number of educational objectives addressed by the MALL resources can be explained by the fact that the educational objectives are expressed by the CEFR levels (as presented in Section 3.2.2). CEFR levels are widely accepted across Europe for describing achievements of learners of foreign languages and they are important information to be exploited when reuse is taking place at second and third level. This also provides us with evidence that our proposal for enhancing MALL resources metadata with language learning educational objectives related with CEFR levels (as presented in Section 3.2.2) was a valid approach for enhancing MALL resources reuse.

### 5 Conclusions and Future Work

In this paper, we presented the Mobile2Learn Framework, which adopts the current Learning Technology specifications and Web Mobile Content Specifications, aiming to support open access and reuse to MALL resources within the context of MALL courses design and development. In this framework, we identified the main user roles and we presented the key tools which empower them in the process of the design and development of MALL resources and courses. Within the proposed Mobile2Learn Framework, we conducted a quantitative analysis of MALL resources reuse, so as to measure the reuse percentage of MALL resources within different MALL courses developed by Mobile2Learn Framework, as well as to identify empirical evidence about the factors that influence the reuse within this framework.

The results of this analysis provided us with indications that:

- The proposed Mobile2Learn Framework can significantly (a) facilitate reuse taking place by the creators of the MALL resources (first level) and (b) enhance reuse among all users of the Mobile2Learn Framework (second level), as well as across users of the Mobile2Learn Framework with different countries of origin (third level). The proposed Mobile2Learn Framework resulted in better second and third level reuse results compared with similar studies from the literature.

- Completeness of metadata records, as well as the number of educational objectives addressed for each MALL resource does not appear to influence the first level reuse. This was expected and can be explained by the fact that MALL resource creator is able to reuse a MALL resource created by him/her without being informed about the MALL resource metadata or educational objectives that the MALL resource is targeting. On the other hand, second level reuse is influenced mainly by the completeness of metadata records and less strongly by the number of educational objectives addressed for each MALL resource, which are derived from the CEFR levels (as described in Section 3.2.2). This could be explained by the fact that users, who performed second level reuse, need to be informed about all metadata elements of a MALL resource before reusing it. Additionally, third level reuse is influenced significantly by the number of CEFR educational objectives addressed for each MALL resource and less strongly by the completeness of MALL resources metadata records. This could be explained by the fact that users, who performed third level reuse, need to be informed about suitable metadata elements (that could facilitate cross-country reuse) before reusing a MALL resource. Finally, this provided us with evidence that our proposal for enhancing MALL resources metadata with language learning educational objectives related with CEFR levels was a valid approach for enhancing MALL resources reuse.

On the other hand, there was also a significant positive correlation ($r = 0.945$, $p < 0.05$) between the number of times of reuse and the number of CEFR educational objectives addressed for third level reuse. This means that reuse across country boundaries (third level) is noticeably linked with the number of CEFR educational objectives addressed for each MALL resource. The positive correlation at second and third level reuse with the number of educational objectives addressed by the MALL resources can be explained by the fact that the educational objectives are expressed by the CEFR levels (as presented in Section 3.2.2). CEFR levels are widely accepted across Europe for describing achievements of learners of foreign languages and they are important information to be exploited when reuse is taking place at second and third level. This also provides us with evidence that our proposal for enhancing MALL resources metadata with language learning educational objectives related with CEFR levels (as presented in Section 3.2.2) was a valid approach for enhancing MALL resources reuse. The aforementioned indications could also facilitate developers of MALL repositories during the process of developing new repositories or enhancing existing MALL repositories towards achieving higher reuse results of MALL resources. More specifically, developers of MALL repositories should consider:

- Empowering their end-users with appropriate and user-friendly metadata authoring tools, so as to motivate them to provide complete metadata descriptions that will eventually facilitate and enhance second level reuse.

- Enhancing the metadata model that is used to describe MALL resources with language learning educational objectives related to existing commonly accepted frameworks such as CEFR. This can eventually facilitate and enhance third level reuse.
Finally, it should be also noted that there could be other factors that may have affected reuse of MALL resources except from the metadata that were used for characterizing them. For example, the profile of the participants, who were ICT experienced English language teachers, could have affected the reuse results. Moreover, our experimental design, with the first phase including specially designed five-day training workshops, could have motivated the participants to further reuse MALL resources. These factors could be further exploited in future experiments with the proposed framework. Additionally, future work regarding the proposed Mobile2Learn Framework includes its extension to consider, also, the learner user role and identify aspects that are related with sharing and reuse of learner-generated MALL resources. This will enable us to design and execute experiments with language learners, so as to identify metadata elements that are required and/or useful in promoting open access and reuse of learner-generated MALL resources.

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