Designing and Developing Interactive Video Experiences to Support M-Learning

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Abstract: In recent years, teachers have started to conduct pedagogical activities to promote different kinds of learning interactions supported by rich media. The deployment of such activities is rapidly increasing, as teachers and students own technological means that allow supporting them along such interactions. These activities can be carried out in traditional classroom settings while using regular computers. Additionally, they can also be conducted from anywhere at any time while using smartphones and tablets. In this paper, we describe a pedagogical activity requiring students to author and later peer- assess learning interactions incorporated to videos in YouTube. We describe EDU.Tube, an environment that enables them to create, share and consume such rich media learning activities across a variety of devices. We then detail a plan for the implementation of an activity that took place in 3 different classes dealing with diverse materials addressing computer science related topics. Finally, we also provide an evaluation presenting students' insights and feedbacks resulting from the experienced activity. We discuss and analyze these outcomes in order to elaborate on them as concerns that could be applied for the further deployment of the EDU.Tube environment.

Keywords: Interactive Video, mobile, EDU.Tube, Mobile Learning

1. Introduction

Nowadays, mobile technologies are used to support numerous types of social interactions practiced for different purposes including among others entertainment and education (Taylor, 2010). These interactions supported by mobile technologies provide alternative ways that can be used for different purposes and in different situations. In an educational context; teachers and students use smartphones in order to actively participate in educational activities enriched by multimedia content that could be experienced from anywhere at any time (Parsons, 2013). For example, students participating in field trips could use mobile technologies in order to participate in a challenging learning activity taking place outdoors.

Mobile applications rely on complex but open technological infrastructures. Current standardizations and specifications among these infrastructures enable a vast utilization of common mobile services supported by a diverse number of end user devices (Godhwani, 2013; Mohammad and Tomberg, 2013). Compatibility and adaptability of mobile devices become crucial aspects while considering the development of mobile learning applications that can be executed by the wide variety of mobile devices owned by teachers and students (Cochrane & Bateman, 2010).

The implementation of learning activities supported by mobile rich media also relies on the ability of designers and programmers to cooperate in order to cope with technical, as well as usability related challenges (Saifudin et al., 2012). One possible way to address those challenges is by adopting programming techniques that incorporate libraries and modules supporting application development for mobile technologies. These modules and libraries may address issues related to design challenges across various types of hardware and software settings. In addition, these types of techniques may enable a wide degree of versatility and agility aiming to provide compatibility with various mobile platforms. Developmental processes aimed for these technological settings must also refer to hardware related conditions like computational abilities and network availabilities. In addition, this kind of developmental efforts should also consider the context in which the mobile applications are being used (Sotsenko et al., 2013). Last but not least, mobile related conditions have to address the display size across devices (Marcotte, 2010; Giemza and Jansen, 2011).

The mentioned above deployment approach could be achieved by the implementation of programming and description languages addressing various types of mobile platforms. Practically, HTML5, CSS3 and JavaScript libraries can support the development of mobile applications. These can later be integrated, compiled and shared as web environments adapted to various type of devices having different operating systems. These developmental efforts are applicable for mobile and educational environments aiming to provide ubiquitous learning experiences enhanced by mobile rich media.

Learning supported by web and mobile technologies is becoming more feasible because students may own more than one device adequately used for a certain purpose (Moran et al., 2010). For example, students may be required to participate in a range of learning activities that can take place across different locations. Such activities may begin outside the classroom and may require students to interact with portable and small-scale devices like smartphones. Furthermore, students may continue with some of their learning interactions in regular classes while practicing a more traditional way of learning (Bollen, 2010).

In this paper, we present a learning activity consisting of different type of interactions supported by various types of web and mobile technologies. This activity has been implemented and tested with 75 students attending courses at bachelor and master level in two different academic institutions. We briefly describe the EDU.Tube environment used to provide technological support for the enactment of this learning scenario. Specifically, we used EDU.Tube to enable authoring, sharing and displaying of digital videos that incorporate educational interactions used along this activity. We then describe how educational interactions authored by students were later offered to their peers as appealing learning opportunities. We also identify various design and development challenges reported by teachers and students providing crucial information to be considered for the further improvement of the tool. Finally, we suggest a set of recommendations that could later be used tto guide an advanced and refined version of EDU.Tube.

2. Motivation

Teachers and developers could join forces while aiming to design and enable learning activities supported by technology that include educational videos available on the web (Lindeberg, 2011). Such developmental challenges should address the composition of various and interrelated pieces of media aiming to provide a meaningful learning experience. In this respect, developers and designers may require to cope with interrelated visual aspects containing information communicated by teacher or students. These aspects include the composition and arrangement of information to be represented by various types of media. Developers should also deal with functionalities related to the user interface addressing the control over the flow of such media.

We aimed to cope with some of the previously described challenges while designing and developing an educational and interactive video environment called EDU.Tube (Kohen-Vacs et al., 2013). This environment is accessible from various types of mobile devices using their existing web browsers. Teachers and students may use EDU.Tube in order to author various types of interactions related to specific moments in occasional video found in YouTube. These videos and their related synchronized interactions could be later offered to students as innovative and appealing pedagogical opportunities.

One of the objectives of this paper is to provide an evaluation of the EDU.Tube technology following its implementation in a pedagogical activity described in a later section. This evaluation was conducted according to a Technology Acceptance Test (TAT) based on the Technology Acceptance Model (TAM) (Davis et al., 1989). TAM sets a theoretical framework that aims to show how users accept technology and also addresses factors that may influence the adoption of innovative technological solutions. This model postulates that the use of an information environment is influenced by the behavioral intention is determined by the person's attitude towards the use of the system. Attitude refers both to the aspects representing the perceived usefulness of a system and the perceived ease of use of such a system. Furthermore, the model claims that there is a direct relation between the ease of use and the usefulness of such system.

We addressed the perceived usefulness and the perceived ease of use as defined in this model in relation to EDU.Tube. We suggest that the incorporation of such a model could be used as a tool to assess educational experiences provided by EDU.Tube, as well as to enable future refinements of these activities potentially providing improved educational experiences. This assessment includes an examination of pedagogical aspects as communicated while been supported by EDU.Tube. Moreover, we specifically examine different aspects of such experience as supported by the different technologies been used. One of the assumptions in our assessment is that web and mobile technologies may directly influence the learning environment's functionalities, as reflected from its user interface. In the next section, we described the pedagogical scenario in which we have tested and validated our ideas.

3. Pedagogical Scenario

The learning activity described in this section was designed for undergraduate and graduate university students learning essential terms in the field of computer science. The activity was technologically supported by the EDU.Tube authoring environment enabling students to convert occasional YouTube videos into interactive educational opportunities. The activity includes a phase in which students are required to author interactions related to YouTube videos. This phase is followed by another one in which these interactions are peer assessed (Kohen-Vacs, et al., 2013). The learning activity consists of three complementary and interrelated phases as described in Figure 1.

The activity commences while students are requested to seek for regular videos available on YouTube that could potentially be related to the subject matters dealt in the courses. These video resources are later incorporated with interactions aiming to foster students' understanding of the learned topics (Gilroy, 2010). Such educational strategy implemented in this activity aims to develop students´ ability to associate and use authentic problems by using video examples related to the subject matter presented in the courses. The actual enactment of this activity required the use of another technological environment called Collaborative e-Learning Structures (CeLS) enabling to author, enact and reuse different types of multiphase and collaborative pedagogical strategies (Ronen, 2010). The integration of the CeLS environment enabled the orchestration of participants into the assignments demanded from students.

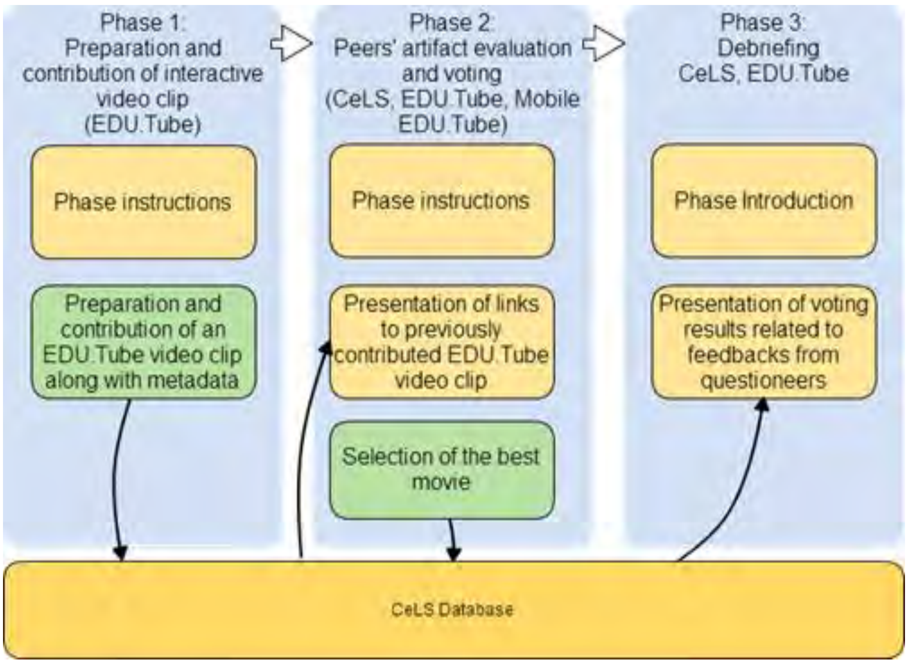

Figure 1. Description of learning Activity's interrelated phases

Below, we describe the goals of each one of the phases, its required educational interactions and the technologies used for their accomplishment:

- Phase 1- *Preparation and contribution of an interactive video clip*: During this phase, students are presented with a specific topic in the field of computer science. Later on, they are requested to search for a short video on YouTube, which could be used as a pedagogical opportunity for exploring and learning the topics under study. The students are requested to use the EDU.Tube authoring environment in which they import the link to a video with a length between three to five minutes. Students are required to enrich this video by three to five interactions along its time line aiming to convert it to an interactive video that could potentially be used as a learning opportunity. In this phase students play the role in which they incorporate interactions to a video with the EDU.Tube authoring environment that should only be used with a stationary environment.
- Phase 2- *Peers' artefact evaluation and voting*: Before the actual initialization of this phase, all the interactive videos and their corresponding metadata are integrated into the CeLS database creating a repository of students' artefacts created in EDU.Tube. This integration aims to provide students with an opportunity to assess the content of the interactive videos contributed by their peers using their own regular, tablet or smartphone computing device independently from their physical and geographical context. These assessments are registered in the CeLS environment and provide teachers and students with the option for further elaboration. During this phase, each student is presented with seven videos created by his/her peers and he/she is asked to vote for the three best videos. In addition, students are asked to textually justify their selections.
- Phase 3 *Debriefing*: During this phase the teacher conducts a debriefing session including the presentation of example videos which were previously contributed by the students for the competition enacted during the second phase. The teacher presents the most selected videos (as a result of the peer assessment) while emphasizing its attributes that potentially can transform it to a learning opportunity that could be reused in the future.

In the following section we provide a description of the EDU.Tube environment used to support the enactment of the described scenario.

4. Environment's Description

As mentioned earlier, the EDU.Tube environment offers support for the authoring of educational interactions to be synchronized and incorporated into YouTube videos. The authoring process of such interactions could be initiated by teachers or students seeking for a YouTube resource that can later be used as an educational opportunity. The link to such video is submitted and played by EDU.Tube. The playback of this video is visually represented by a marker that advances along the timeline of the submitted clip. An author may choose to incorporate an educational interaction at any point along the timeline. This process is done by choosing a desired moment of interaction followed by the selection of the requested type of educational interaction. An author may choose to incorporate various types of interactions like an attention point presenting students with important additional information. In addition he/she may choose different types of questions including open text, single or multiple selections.

Figure 2 illustrate an example of a video incorporated with a single choice type of interaction along a meaningful positive feedback.

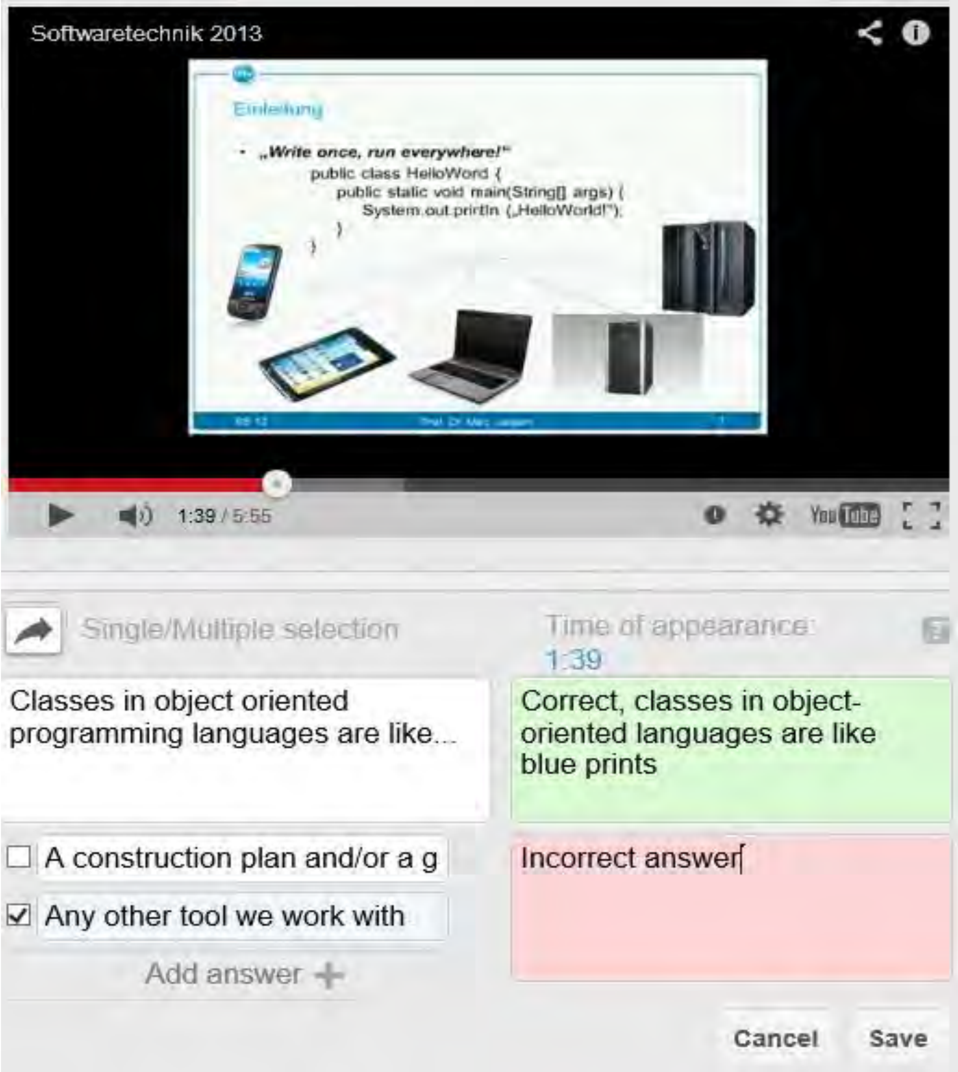

Figure 2. Incorporation of an interaction for a computer science lesson technologically supported by EDU.Tube

Interactive videos can be shared by students and later be used by them on their regular computers, smartphones or tablet devices. These videos can also be shared by students while using different communication channels like regular mail, social networks or the Learning Management Systems (LMS). We mentioned before that the type of device from which a learner consumes an educational service might represent a key factor for providing an optimized pedagogical experience.

Figure 3 illustrates the process in which EDU.Tube detects the type of device from which the student consumes a video and accordingly adapts the content presentation to the used device.

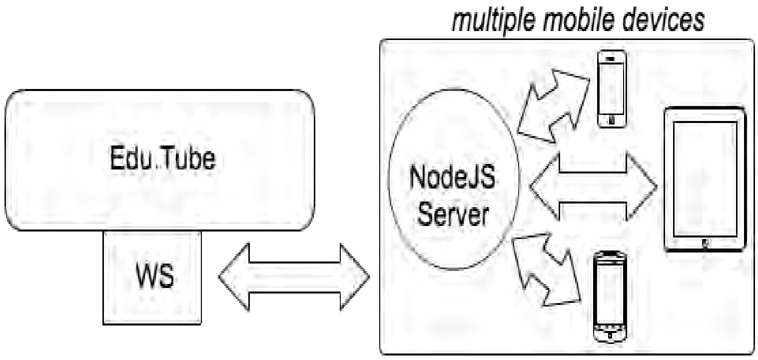

Figure 3. EDU.Tube´s content is adapted and communicated to different type of devices

5. Activity Evaluation

In this section, we provide the results of an evaluation based on a questionnaire presented to students. This evaluation was conducted with 75 students participating in a learning activity following the ideas described in section 3 and supported by EDU.Tube. This activity took place during one semester in 2013 in the context of three courses dealing with introduction to procedural programming, advanced topics in server side programming and software engineering.

First year students of a bachelor degree in instructional technologies attended the introductory course. The second course dealt with server side programming and was attended by second year students of the same program. The third course dealt with software engineering and was attended by first year students of a computer science study program. The number of participants in the introduction course was 27, while 21 participants attended the server side course. The software engineering course also included 27 participants.

Table 1 presents the availability of different technological devices among students, its use for educational purposes while interacting with EDU.Tube. In some cases, students own and use more than one type of device.

Table 1: Technological avaliability and use of EFU.Tube across cources

Category \ Course		Procedural programming	Advanced topics in server side programming	Software engineering
Participants		27	21	27
Use rate of technological devices for studying purposes	Regular	37%	28%	56%
	Laptop	88%	86%	74%
	Mobile	23%	52%	30%
	Tablet	0%	0%	30%
Use rate of EDU.Tube on regular or laptop computers		67%	61%	78%
Use rate of EDU.Tube on smartphones or tablets		33%	33%	19%

As already mentioned, we evaluated the activity with a questionnaire that included a section addressing the type of technology owned by students. In addition the questionnaire also addressed the pattern of use for these technologies, the perceived added value of EDU.Tube, the preferred device to be use with such environment, the reasons for these preferences and finally a request for student's impressions, insights and comments about their overall experience. As previously described, this learning activity included three phases in which students had the opportunity to author educational interactions according to an occasionally found and selected YouTube video. These interactions were later consumed and assessed while using various types of technologies. The first part of the questionnaire addressed the variance of technological devices owned by the students. We checked the availability of stationary, laptops, tablets and smartphones among the students and found that 42 students have stationary computer, while almost all of the students reported to have a laptop computer. In addition, 62 students reported to have a smartphone device while a minority of them (17) reported to have a tablet device. In the majority of the cases the students had both; one major computing device and one small mobile or tablet device. In this respect, we found that 47 students that reported to have a laptop and a smartphone.

The subsequent question addressed the patterns in which students used information technologies while experiencing learning. Almost all the students reported to use their laptop devices while studying. A closer look at the data revealed that in the software engineering course the students used almost all their available technologies while in the introductory course only 22% of the class participants used smartphones. We also checked the use of technology among students attending the advanced server-side programming course and found that 50% of the participants in this course used smartphones.

The next questions addressed EDU.Tube's perceived added values. We addressed a question related to EDU.Tube in general without mentioning specifically its instances (mobile or regular). 70% of the students found that the EDU.Tube activities presented by the teacher after each lecture helped them to some extent to deepen their understanding of the learning materials. A closer look at this data reveals that only a minority of 29% of the students felt that the activity was 'very' or even 'very much' helpful. We then asked the students to specify their preferred instance of EDU.Tube. 69% of the students reported that they would prefer using EDU.Tube on their laptop devices while only 28% of them reported to have no specific preference. Almost none of the students preferred to use the environment exclusively on his smartphone device.

In the next questions, we requested to specifically write down the reasons for which students preferred a specific instance of the technological platform. Most of the commenting students pointed out the lack of convenience for using such an application in a smartphone with a small screen device. The next question in this group referred to the level of user friendliness of the environment. In this respect, we discovered that almost all the students reported that the regular version of the EDU.Tube is user friendly while almost all of them reported that the mobile instance of the environment's interface is difficult to use. We then closely examined the specific reasons for which they indicated their preferences and impressions. Many of the students pointed out that there is a prominent challenge while using small-scale devices for interactions that combine videos along with textual media. Some of the students specifically stated that there is a need to re-arrange these media before experiencing it on a small-scale display.

Some students also commented about the nature of the interaction incorporated to the video. In this respect, they mentioned that for some situations they prefer to continue their video experiences without the disruption typically involved in interactive videos. Furthermore, in some of the cases the students even mentioned that they prefer watching the video fluently while aiming to gain a good idea of the whole content without disruptions. This recommendation included a suggestion for a 1st round of a non-interactive video followed by a second in which the interactions will be presented. Another concern of the students involved the requirement for meaningful feedback and being given credit for the activity. They wondered if the results from their participation were accumulated and they even recommended to re-route students to different learning paths according to a reasoning mechanism based on accumulated history of interactions.

Finally, there were a small minority of students that reported operational issues with mobile phones like problems connecting to the network, lack of compatibility to some mobile operating systems and a very few operational bugs in the environment's mechanism. The final question required students to openly state their comments including aspects of the system that they thought that requires further improvement and other aspects they already found satisfactory. In this section of the questionnaire, students re-stated all points for improvement that they provided previously while they reaffirmed their desire to keep using an improved versions of EDU.Tube. Specifically, they reported that they liked the pedagogical approaches encompassed with interactive videos provided by a relatively user-friendly environment.

6. Conclusions and Future work

In the previous section we have presented and analyzed some of the students' insights followed by their experiences using the EDU.Tube environment. These impressions also described their preferences while considering the use of EDU.Tube from a stationary or mobile device accordingly supported by a proper instance. We also presented their prominent comments and recommendations related to their learning process supported by web and mobile technologies. In this section, we summarize the outcomes as reflected from the TAT questionnaire based from TAM. We also offer our vision for the next version of the mobile instance of EDU.Tube that aims to provide a better user experience supported by improved data arrangement. The results as summarized from the questionnaire indicate that students were willing to accept and recognized the added value of educational and rich media activities combined within their regular learning process. Students identified some of the challenges related their educational experience supported by mobile environment.

One of the main comments addressed by the students, concern interface and technical related aspects of the mobile instance of EDU.Tube. Students pointed out that due to operational and compatibility issues, the environment might not be operational. EDU.Tube, thus, might not be useful across the different devices owned by students. Another operational concern involves the lack of systems' ability to auto restart videos following a user interaction. Such constraint enforces students using the mobile instance of EDU.Tube to commit a manual operation in order to continue interacting with the video clip. This way of operation is originated from a security restriction existing across the smartphones' operating systems. Such challenge could be worked around while presenting students with a meaningful announcement reminding them to reinitiate the playback of the video

One of the most challenging aspects of the environment concerns the requirement for re-arrangement of the user interface aiming to organize and display all relevant media in a convenient composition at the correct instance. In the current mobile version, the appearance of the interactions is detached from the corresponding video while sometimes the details in the video may provide important visual information needed for the student's interaction. Figure 4 illustrates a video reaching the point of interaction (on the left) and then is completely disappearing in order to present the interaction (on the right).

Figure 4. A video and its interaction as displayed in a mobile device

In this case, the implementation of mobile adapted web design could offer a set of approaches aiming to properly represent information in mobile displays.

During the implementation presented in this paper, we used EDU.Tube as a technological tool that provides support for authoring and using interactive videos combined into a multiphase collaborative learning activity. In this implementation we used EDU.Tube's API in order to share information between the EDU.Tube's database and the mobile instance of the environment. This information includes data indicating the location of the resource in YouTube and its synchronized interactions. Such a type of activity may require addressing different aspects related to the orchestration of educational interactions. These aspects may include the place, time, location and technological mean in which these interactions are achieved (Dillenbourg, 2011). In this sense, the contextualized use of technology may require further development of EDU.Tube APIs. These APIs might be required in order to enable teachers to integrate EDU.Tube to additional pedagogical strategies requiring the authoring or use of interactive videos along other related learning tasks.

Feedbacks and insights provided by the students revealed important aspects to be considered in terms of the pedagogical enactment of a rich media used in an educational activity. Those addressed pedagogical, logistical, design and technological interrelated aspects. These aspects point out the requirement for adaptation of educational materials aimed to be consumed on mobile technologies. Specifically, teachers have to consider that students that access educational materials on their mobile devices may experience the learning process anytime and beyond the boundaries of the traditional classroom. In such cases, students could consume an educational activity remotely from their teacher and therefore may not be able to be provided with immediate support both at a pedagogical level, as well as at the operational level. Teachers may require anticipating such type of challenges and coping with them while selecting and incorporating specific mobile activities to their pedagogical strategies. In addition they might consider providing dedicated means of scaffolds and meaningful feedbacks along the educational activity. Another aspect related to the teacher, concerns adaptations required for activities having rich media learning materials. These adaptations need to address the consumption of rich media on diverse type of technological devices. In addition, such adaptations need to address the possible adoption of regular materials to be used on mobile platforms enabling a better exploitation of educational materials consumed ubiquitously (Kukulska-Hulme & Traxler, 2013). Specifically, these adaptations may provide students with a more meaningful learning process while they consume learning materials along a pedagogical process enacted across context. Both educational and technical concerns will be used to guide future deployments of advanced versions of EDU.Tube. We aim at better coordinating techno-pedagogical efforts accordingly practiced by different type of stakeholders.

Despite the mentioned comments, students still showed a positive attitude and enthusiasm for participating in such future activities supported by EDU.Tube´s mobile instance. Students expressed their willingness to try future versions while aiming to exploit additional and more advance features of the environment. Our future efforts will focus on developing a process that allows a better cooperation between the various stakeholders including teachers, designers and developers aiming to improve the deployment of such environment supporting multiphase collaborative learning activities. We will examine the establishment of an agile design and development approach offering a convenient framework that enables each of the stakeholders to concentrate in different aspects of the development process. The actual implementation of such an approach might provide a convenient way to deploy pedagogical strategies supported by different technologies providing an improved used interface. Specifically, we aim towards developing an approach that might enable the representations of educational interactions across different end-user devices properly adapted to a context of use. This approach is also related to the design of learning flows and their corresponded orchestration according to the modeled pedagogical strategy.

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