Video-Based Learning: A Critical Analysis of The Research Published in 2003-2013 and Future Visions

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***Abstract*— Video-Based Learning (VBL) has a long history in the educational design research. In the past decade, the interest in VBL has increased as a result of new forms of online education, such as flipped classrooms, and most prominently MOOCs. VBL has unique features that make it an effective Technology-Enhanced Learning (TEL) approach. This study critically analyzed the current research of VBL published in 2003-2013 to build a deep understanding on what are the educational benefits and effectiveness that VBL has on teaching and learning. 67 peer reviewed papers were selected in this review and categorized into four main dimensions, namely, effectiveness, teaching methods, design, and reflection. In the light of the discussion of current research in terms of these categories, we present the future vision and research opportunities of VBL that support self-organized and network learning.**

Keywords-Video-Based Learning; VBL; MOOC; Blended Learning; Video Design.

I. INTRODUCTION

Video-based learning (VBL) has a long tradition as a learning method in educational classes. First experiments started during the Second World War. Soldiers were then trained with a combination of audio and film strips [12]. As a result, the static film strips helped to increase their skills while saving a lot of time as well. By the late 1960s, educational television was used as an extra tool in classrooms. Also teachers were confronted with videos of their own lessons to reflect on their teaching methods and improve their performance [63]. In the 1980s, VHS videotapes meant a quantum leap as it became much easier to use video in classrooms. But, still, learners were rather passive and could only watch the video. This changed with the rise of digital video CDs in the mid-1990s. Teachers could now add multimedia control and assessment tools by using the video on a computer. Thus, learners became much more active than before. By the 2000s, classrooms got connected to the internet and interactive digital video as well as video conferences became possible. Since then, new technologies such as smartphones and tablets in combination with social media such as YouTube have contributed to increasing social interaction and have made it easier as ever to integrate video applications in education [15][39]. In recent years, VBL publications have increased in order to discuss how VBL can facilitate learning and enhance learner's outcome as well as teacher's performance. Thus, there was a need to collect existing research, document the benefits of video in improving learning, and explore the design and teaching methods in VBL environments. In this study, we critically analyze the research on VBL to answer the following research questions:

1. What are the educational benefits that VBL has on teaching and learning?
2. How VBL technologies enhance students' learning outcome?
3. How educators and researchers design VBL environments?
4. How is VBL used to improve teacher's and learner's reflection?

In order to answer these questions, this paper will discuss different angles of VBL. The remainder of this paper is structured as follows: Section II is a review of the related work. Section III describes the research methodology and how we collected the research data. In Section V, we review and discuss the current research based on several dimensions. Finally, Section VI gives a summary of the main findings of this paper and highlights new research opportunities for future work.

II. RELATED WORK

This section summarizes the previous work most closely related to our study.

Tripp and Rich [77] reviewed 63 studies in order to understand the ability of teachers to reflect on their teaching through video recording. The result of this study was that teachers prefer to use video recording for reflection in collaboration with colleagues than reflecting individually. Also, teachers report that the use of a guiding framework (e.g., rubric, checklist, teaching principles) helps to focus on their reflection by focusing their attention on certain tasks.

Borgo et al., [57] conducted a study to provide an overview of the major advances in automated video analysis and investigate some techniques in the field of graphic design and visualization.

Greenberg and Zanetis [1] reported the positive impact of video broadcast and streaming in education. As a result of their study, the authors encourage teachers and educators to use interactive video training materials in classes especially with children.

Although these studies asserted that the video is a powerful tool in Technology-Enhanced Learning (TEL) and that videos enable teachers to reflect on their teaching, they do not take into account the teaching methodologies, design

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approaches, and the impact of teachers' reflections on their students' learning outcomes. As compared to the above studies, our study adds a wide range of peer-reviewed studies that have been conducted between 2003 and 2013 and provides a quantitative as well as qualitative analysis of the VBL literature. Moreover, we apply a cognitive mapping approach to categorize the VBL publication into several dimensions. The study further provides critical discussion according to each dimension and suggests new opportunities for future work.

III. METHODOLOGY

The research methodology was carried out in two main phases including identification of eligible studies followed by a cognitive mapping approach to categorize the VBL literature into several dimensions.

A. *Identification of Eligible Studies*

The significant research method of identifying papers from Internet resources was applied to collect data in this study [2]. This method was carried out in three rounds. Firstly, we conducted a search in 7 major refereed academic databases. These include Education Resources Information Center (ERIC), JSTOR, ALT Open Access Repository, Google Scholar, PsychInfo, ACM publication, IEEEXplorer, and Wiley Online Library.

Secondly, we searched 21 academic journals in the field of educational technology and TEL indexed by Journal Citation Reports (JCR) including Australasian Journal of Educational Technology, British Journal of Educational Technology, Canadian journal of learning and technology, CITE Journal, The Electronic Journal of e-Learning (EJEL), European Journal of Open, Distance and E-Learning (EURODL), Interactions Journal, The International Journal of Instructional Technology and Distance Learning, International Review of Research in Open and Distance Learning (IRRODL), Journal of Asynchronous Learning Networks, Journal of computer assisted learning (JCAL), Journal of Computing in Higher Education, Journal of distance education, Journal of Interactive Media in Education, Journal of Interactive Online Learning, Journal of Learning Design, Journal of Online Learning and Teaching (JOLT), Journal of Technology, Learning, and Assessment , Learning, Media and Technology, and Turkish Online Journal of Distance Education (TOJDE), using the keywords (and their plurals) "Video-based learning", "VBL", "teaching with interactive video", and "Video Instruction". As a result, 98 peer-reviewed papers were found.

Thirdly, a set of selection criteria were identified as follows:

1. Studies must focus on VBL in educational development. Studies on video coding and semantic retrieval of video were excluded.
2. Experimental or empirical case studies on how learners learn with and from videos were included. Studies of video recording strategies were excluded.
3. Studies that focus on ability of teachers to reflect on their teaching via video recording were included.
4. Studies evaluating the VBL activities and effectiveness in education were included. Studies that focused on video-games and video conferencing tools were excluded.

This resulted in a final set of 67 peer-reviewed studies, which met the selection criteria above. Figure 1 shows the number of VBL publications between 2003 and 2013, which were found to be relevant for this study.

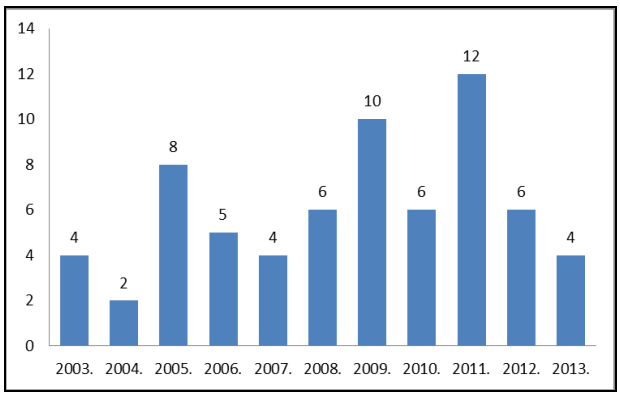

Figure 1. VBL studies by publication year.

B. *Cognitive Mapping Approach*

Cognitive mapping approach is a method enabling the researchers to clarify and categorize the research literature conceptions into several dimensions regarding to the research questions. These dimensions are recorded in graphic flowchart to show the hierarchy of VBL terms [72]. We applied the cognitive mapping approach as a classification technique for dividing the VBL literature into four dimensions relevant to the research questions, namely effectiveness, teaching methods, reflection, and design (see Figure 2).

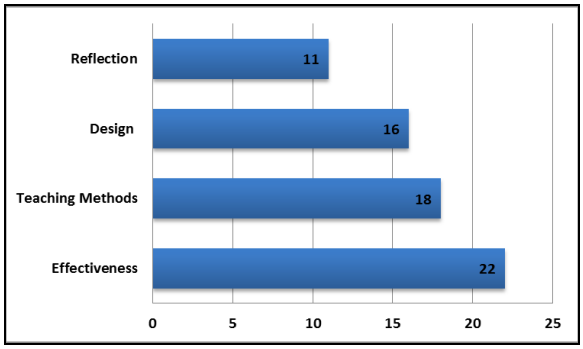

Figure 2. VBL classification map.

In order to capture the information gained from the literature analysis, we created a VBL field diagram (see Figure 3), which has been partitioned into four categories and ten sub-categories.

IV. DISCUSSION

In this section, we critically discuss in details the VBL literature based on the cognitive map dimensions that have been identified in Section III. For the critical discussion part,

we apply the meta-analysis method, which aims to contrast and combine results from several studies into a single scientific work [2].

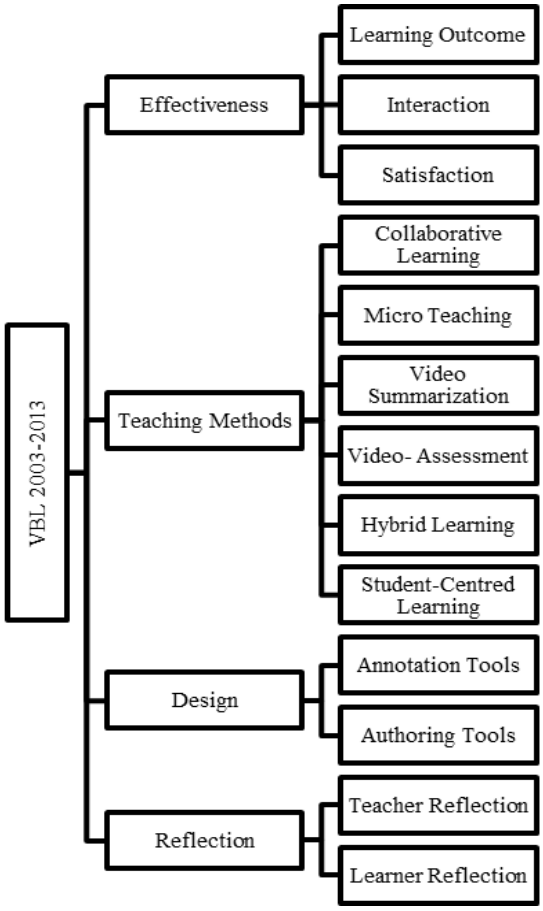

Figure 3. VBL cognitive map.

A. *Effectiveness*

Effectiveness of VBL has received a great deal of attention from academic scientists. 33% of the studies reviewed in this paper examined the effectiveness of VBL. Most of the reviewed case studies asserted the effectiveness of VBL as a powerful medium used in education. We analyzed each study for the following characteristics: research goal, subject, target group, sample size, and summary of results. In the following sections, we discuss the effectiveness of VBL in terms of learning outcome, interaction, and learners' satisfaction.

1) Learning Outcome: A learning outcome (or achievement) can be described as knowledge, skills, and abilities that learners have to achieve as a result of the learning process [47]. Many scholars believe that VBL has the potential to promote the learning outcome. VBL can, for instance, present knowledge in an attractive and consistent manner [19][51]. Further, Kay and Edward [60] and Balslev et al. [74] compared VBL supported by a cognitive approach with text-based learning. The results showed statistically significant differences in improving learners' skills. Moreover, the authors reported that learners liked the followed cognitive approach in which knowledge was generated through step by step learning in video lectures.

In addition, Lin and Tseng [8] and Hsu et al. [13] conducted two studies to investigate the effect of different VBL designs to improve English language skills of K-12 students. The findings indicated that the groups which used VBL outperformed the other groups. Other studies reported the invaluable impact of using VBL in improving teachers' performance. The results asserted that using videos as educational tools improved teaching methods and increased the learning outcome [4][50][63][71].

On the other hand, some studies indicated that there were no statistically significant differences between teaching with video and other methods, and that both are equivalent [23][42][61]. Moreover, Chuang and Rosenbusch [28] pointed out that using only video technology without pedagogy approach doesn't make sense. The authors stressed that video technology should go side by side with pedagogy and provided a constructivist framework to engage learners to learn with videos.

In sum, the reviewed studies indicated that there were conflicting results of using VBL in educational environments as some found it valuable while others reported no significant results. There was, however, an agreement among researchers that VBL in conjunction with appropriate pedagogical methods has the potential to improve the learning outcome.

2) Interaction: Improved interaction and communication among participants is another effectiveness aspect in VBL. DeLoache and Korac [40] reviewed some case studies of using videos with infants. The authors pointed out that video stories indeed improved communication between children. Hakkarainen and Vapalahti [52] investigated learning with video in the forum-theatre. This study showed that VBL can enhance interaction among learners and improve the ability to solve every day social problems.

On the contrary, Muhirwa [37] investigated VBL in TEL environments in Africa pointed out that VBL has a less important role in increasing the interaction among learners due to internet disconnectivity, limited student access to computers, and lack of trained instructors in Africa.

3) Satisfaction: The level of learning satisfaction is important in evaluating the effectiveness of VBL environments. Zhang et al. [19] examined the level of satisfaction through interactive VBL in a study involving 138 students. As a result, students who used a TEL environment that provides interactive instructional video reported higher levels of satisfaction than those in the control group without video.

Moreover, it has been shown that interactive videos have an impact on the emotional side of the learners' behaviour (e.g., real-life interaction, incorporate the different sound and musical effects that can fit the emotional contents of the learning subject) and that videos can improve the attention

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to the subject of the lecture in addition to the positive impact on the learners' motivation level [3][54][68].

B. Teaching Methods

Educationists and scholars use a broad range of teaching methodologies in VBL environments. In this literature review, collaborative learning is a key aspect underlying most of the studies. Other methods involved micro teaching, video summarization, video assessment, hybrid learning, and student-centered learning.

1) Collaborative Learning: In video-based collaborative learning, which focuses on developing, discussing, exploring alternatives rather than directions, learners are able to share responsibilities for their learning [16][19][36]. Most of the reviewed studies validate the efficacy of collaborative VBL, where learners can develop their problem-solving abilities via collaboration with others [1]. These studies reported various educational benefits for learners working cooperatively in teams such as shared goals, ideas, resources, activities, and supporting each other [17][18][29][38]. For instance, Pea and Lindgren [62] investigated which collaboration design patterns are used by learners when they have access to a Web-based video collaboration platform. Five collaboration patterns were identified, namely collective interpretation, distributed design, performance feedback, distributed data coding, and video-based prompting. These patterns support teacher-centred learning by providing knowledge and allowing learners to discuss and find solutions.

2) Micro Teaching: The micro teaching method was used in some studies as a teaching practice with a smaller class size and time (e.g., four to nine learners in a class that is held for five to ten minutes). Educators are able to give learners some quick and easy feedback on their learning performance through video podcasts [21]. Finlay et al. [34] reported that learners' responses on micro teaching with video podcasts are very positive. The authors, however, noted that the video of 10 minutes length was too long for many learners and found that the shorter video podcasts (4-5 minutes) have the advantage of giving greater flexibility in micro teaching lessons. Other studies showed that micro teaching provides a friendly and supportive learning environment [43][76].

3) Video Summarization: Video summarization technique extracts important information and provides short but informative summary of the lecture content [11][78]. Chang et al. [79] designed a keyword-based video summarization learning platform (KVSUM) which provides a keyword cloud as a textual surrogate to support learners to organize information of videos and enhance them to follow the videos and reducing the learning time.

4) Video Assessment: A video assessment is short video that simulates real life activities and provides possible responses to the several daily problems. Learners are asked to select which of the responses they would take in these circumstances. Afterwards, teachers discuss each response and evaluate learner's responses [22][56].

5) Hybrid Learning: Hybrid Learning has become one important TEL model, by integrating online learning and traditional face-to-face classroom together [25][59]. Pang [81] conducted a study by following a hybrid learning approach that uses video-based learning materials in a Physical Education course. In this course, the trainer can review the learner's actions video, pick out the wrong actions, and provide feedback. Then, students can reflect, find out mistakes. The experiment shows that 80.9% out of learners think that the video review indeed improved their physical skills.

In other studies, Shih [58] and Kırkgöz [80] investigated a hybrid learning approach supported by video lectures for an English speaking course. The study showed that the learners made noticeable improvement in their oral communication skills, and that they were satisfied with the blended learning model.

6) Student-Centred Learning: Most of the reviewed VBL studies followed a teacher-centred approach. Only 15% of studies have focused on student-centred learning [35][67]. These studies don't depend on teachers as content providers. They aimed at providing the space for students to be active participants in their learning environment, interact to build and construct knowledge, and get mutual support to make decisions using reflection and critical judgement.

C. Design

Several researchers in TEL have explored how to design effective VBL environments. Annotation and authoring tools are the most used design tools in the reviewed VBL literature.

1) Annotation Tools: Annotation means adding note, comment, explanation, and presentational mark-up attached to a document, image, or video [53]. In VBL, annotation refers to the additional notes added to the video without modifying the resource itself, which help in searching, highlighting, analysis, retrieval, and providing feedback [41]. Moreover, video annotation provides an easy way for indexing, discussion, reflection, and conclusion of content [49][66].

Colasante [45] examined the integration of a video annotation tool (MAT) into the learning and assessment activities of a third year class "Physical Education" course at RMIT University. This tool allowed learners to select and annotate parts of a video. These annotations are then used by students and teachers to discuss, receive feedback, reflect, and evaluate their learning and teaching practice. The results showed that MAT was effective for receiving feedback form teachers and peers. But, some issues regarding the quality of the collaborative input from peers were noted.

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2) Authoring Tools: A number of studies have developed a wide range of authoring tools for VBL content. The primary function of these authoring tool is to increase the interactivity with the VBL environment, thus engaging learners in the learning processe [73]. The following tools were used in various VBL environments:

- Synchronize lecture note: The aim of this tool is to synchronize a video stream with the presentation slide by means of video clip timing [73].
- Content summarization tool: This tool is able to extract summary information from lecture videos and provide it to the learners automatically [33] [55].
- Digital Video Library: This tool uses indexing to enable content-based search for a particular information of a video lecture [48].
- Discussion forum: A space integrated in the VBL environment where learners can discuss and share common interests or goals on a learning topic [30][32].

D. Reflection

There is an interest in using VBL to support teachers' and students' reflection on their teaching and learning activities [69][77].

1) Teacher Reflection: Video recording of the classroom lessons enables teachers to reflect on their teaching [20]. Teachers can record their own teaching, watch what they did in the classroom, think about it, and reflect on the performance using both individual and collaborative reflection [5][9].

Studies examined both individual and collaborative reflection. 85% of the studies on reflection in VBL noted that teachers prefer to reflect on their teaching performance with colleagues [9][20][46]. Similarly, Calandra et al. [5] and Calandra et al. [6] stressed that the teacher's reflective process should be collaborative where groups of teachers provide comments or feedback to each other. Several reflection methods were used, e.g., daily reflection, weekly reflection, and end of semester reflection [64][65].

Only 15% of studies examined self-reflection where teachers reflected individually on their teaching. Teachers used video-taped lesson analysis and wrote comments for self-reflection [14]. Likewise, Gainsburg, [35] implemented video annotation tools to scaffold, structure, and transform teacher reflection.

2) Learner Reflection: Recording classroom activities is also important for learners to reflect on their own learning experience, evaluate their performance, and get a clearer overview of their learning progress. Video recordings further help learners in revision prior to exams [31][69].

V. FUTURE VISIONS

In this section, we will present the future visions carried out from the critical analysis of the VBL literature. In the last few years, the expansion of new open VBL models, such as Massive Open Online Courses (MOOCs) and flipped classrooms has changed the TEL landscape by providing more opportunities for informal learners than ever before, regardless of their educational level, culture, location, age, income, and admission requirements.

A. MOOCs

MOOCs are leading the new revolution of TEL, by providing new opportunities to a massive number of learners to attend online courses from anywhere all over the world [75]. Different forms of MOOCs have been introduced in the MOOC literature. Siemens [27] characterize MOOCs into cMOOCs-based on a theory of connectivism, and xMOOCs by virtue of behaviorism and cognitivist theories with some social constructivism aspects as more institutional model, e.g., Coursera, edX and Udacity. cMOOCs enable learners to build their own networks via blogs, wikis, Google groups, Twitter, Facebook, and other social networking tools outside the learning platform without any restrictions from the teacher [26]. In xMOOCs, by contrast, learning objectives are pre-defined by teachers who impart their knowledge through short video lectures, often followed by simple e-assessment tasks (e.g. quiz, eTest) [70]. Recently, new forms of MOOCs have emerged. These include smOOCs as open online courses with a relatively small number of participants and blended MOOCs (bMOOCs) as hybrid MOOCs including in-class and online video-based learning activities [27].

In general, MOOCs require key stakeholders to address a number of challenges, including questions about hybrid education, the role of the university/teacher, plagiarism, certification, completion rates, and innovation beyond traditional learning models. These challenges will need to be addressed as the understanding of the technical and pedagogical issues surrounding MOOCs evolves.

B. Flipped Classroom

In the flipped classroom model, learners watch video lectures as homework. The class is then an active learning session where the teacher use case studies, labs, games, simulations, or experiments to discuss the concepts presented in the video lecture [10]. The flipped classroom is also an instance of VBL model that enables to save time in the classroom by discussing only difficulties, problems, and practical aspects of the learning course [7].

VI. CONCLUSION

VBL is a rich and powerful model used in TEL to improve learning outcomes as well as learner satisfaction. In this paper, we analysed the research on VBL published in 2003-2013. 67 peer reviewed papers were selected in this review. A cognitive mapping approach was used to map the conducted research on VBL into four main dimensions namely, effectiveness, teaching methods, design, and reflection.

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The following is a summary of the main findings in our study as well as aspects of VBL that need further research, according to each dimension.

A. Effectivness

The analysis of the VBL research showed mixed results in terms of learning outcomes in VBL environments. There is, however, a tendency that users of VBL environments rate interaction and learner satisfaction significantly higher than in traditional classroom environments. Despite these possible advantages, several aspects concerning effectiveness in VBL need further investigation: (1) what are the positive and negative attitudes towards using video lectures? (2) How can VBL motivate learners? (3) How can a MOOC as VBL environment personalize the learning experience for learners? This would enable learners to select the educational resources and the learning style that meet their characteristics best, thus increasing the effectiveness of the learning experience.

B. Teaching Methods

Educators use a broad range of teaching methodologies in VBL environments. These include collaborative learning, micro teaching, video summarization, video assessment, hybrid learning, and student-centered learning. Most of VBL implementations so far still follow a top-down, controlled, teacher-centered, and centralized learning model. Only, 15% of the reviewed research papers describe attempts to implement bottom-up, student-cantered approaches. Additional research is needed to investigate the benefits of new ways of VBL based on new learning concepts such as personal learning environments [1] and network learning [9].

C. Design

Several tools were used in VBL to increase interactivity, collaboration, and learners' satisfaction with the VBL environment. Annotation tools are utilized in searching, highlighting, analysis, retrieval, and providing feedback. To increase interactivity a number of authoring tools were used. These include lecture note synchronization and content summarization tools as well as video libraries and forums. Future research needs to find out how to design more open models of VBL such as MOOCs and flipped classroom.

D. Reflection

VBL facilitates teachers' as well as learners' reflection. Our study showed that teachers prefer to reflect on their teaching performance with colleagues rather than individually. And, learners think that videos have the potential to be used as a reflection tool. Future research is needed to investigate how learning analytics can help to better understand and improve reflection and awareness in VBL environments, such as MOOCs.

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