Studying the positive influence of the use of video in teaching & learning environments, focusing on registration of the directions where it improves the PBL effectiveness: A systematic literature review

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Abstract. Previous studies report the involvement of the use of video in the frameworks of problem-based learning (PBL), case-based learning, and project-based learning. This systematic literature review, through two research questions, explores the positive influence of the use of video in those instructional methods, and, while focusing on PBL, identifies and registers the directions where the use of video improves the PBL effectiveness. The findings of this research could prove beneficial to education policy-makers; the frameworks may be more effectively placed to ensure they are used to provide the greatest advantage and benefit. The theoretical model, created and utilized for the needs of this research, resulted as a productive artifact: The positive results of its utilization were reflected mainly in relation with the ordered and grouped 16 identified directions where the use of video improves the effectiveness of PBL, according to the six core characteristics of PBL.

Keywords: problem-based learning (PBL), case-based learning, project-based learning, use of video, effectiveness of PBL

Introduction

Although there have been massive changes in video technology over the last 25 years that have resulted in dramatic reductions in the costs of both creating and distributing video recordings, the unique educational characteristics have been largely unaffected. Video is a much richer medium than either text or audio; in addition to its ability to offer text and sound, video can also offer dynamic or moving visual images. Thus, while it can offer all the affordances of audio, and some of text, it also has unique pedagogical characteristics of its own (Bates, 2015).

Effectiveness of PBL instructional method: research results and current trends

Problem-based learning (PBL) has been utilized for over 40 years in a variety of different disciplines. Although extensively researched, there is heated debate about the effectiveness of PBL. Several meta-analyses have been conducted that provide a synthesis of the effects of PBL in comparison to traditional forms of instruction (Strobel & Barneveld, 2009).

Related to the effectiveness of PBL, Mayer and Alexander, (2011) in a section entitled "Research on the Effects of PBL" emphasized: "Interestingly, an often-heard criticism of PBL is that it requires fairly large initial investments, financial and otherwise" (p. 373). In addition, Loyens et al. (2011) stated that "the introduction of new educational methods goes hand in hand with research scrutinizing the effectiveness of the method as a whole or elements of that new method". These studies target the development of 'the ideal PBL

format', but are less concerned with the effectiveness of PBL as a whole" (pp. 25-26). Furthermore, they highlighted the fact that, "the great majority of studies on PBL have been conducted in higher education. The effects of PBL could be different for younger learners" (Loyens et al., 2011, p. 38).

According to Kirschner et al. (2006), "also important for medical educators has been the constant finding in research summaries that PBL is not more effective but is more costly than traditional instruction" (p. 83). Kirschner et al. (2006) gave special emphasis to the issue of the superiority of guided instruction:

> "*Although unguided or minimally guided instructional approaches are very popular and intuitively appealing, the point is made that these approaches ignore both the structures that constitute human cognitive architecture and evidence from empirical studies over the past half-century that consistently indicate that minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process. The advantage of guidance begins to recede only when learners have sufficiently high prior knowledge to provide "internal" guidance*". (p. 1)

Their analysis concerned several issues related to constructivism instructional methods: discovery, problem-based, experiential, and inquiry-based teaching.

Again, per Sweller et al. (2007), in "A Reply to Commentaries" they declared,

> "*Unlike many researchers who favor PBL or indeed, take constructivist teaching positions, Schmidt et al. (2007) are aware of the critical importance of taking human cognitive architecture into account when devising instructional procedures. More importantly in the present context, we share their concern that instructional procedures need to be tested using randomized, controlled experiments. Nevertheless, we do not believe the studies they cite provide a test of the PBL hypothesis that addresses its effectiveness over minimally guided instruction. The closest available studies are concerned with the worked-example effect and the results of those studies are unambiguous: PBL is ineffective compared with instruction that provides direct, explicit information*". (p. 117)

Hattie (2008) presents an evidence-based critical analysis of the PBL instructional method in general and an overview focusing on its effectiveness. A summary of the analyzed issues is shown below.

- Hattie (2008) indirectly suggests as basic characteristics of making up and representing the PBL instructional method, the "six core characteristics of PBL" outlined by Gijbels et al. (2005, p. 29).
- PBL overall had d = 0.15, and developing it requires a very substantial investment in time and resources.
- For acquisition of basic knowledge, PBL had a negative effect; but for consolidation, application and work at the level of principles and skills, it could increase to d = 0.75.
- PBL has not much use in primary schools, but that is not the case regarding professional courses at universities (which is where it is generally found).

Strobel & Barneveld (2009) used a qualitative meta-synthesis approach to compare and contrast the assumptions and findings of the meta-analytical research on the effectiveness of PBL. Their findings indicated that PBL was superior when it comes to long-term retention, skill development, and satisfaction of students and teachers, while traditional approaches were more effective for short-term retention as measured by standardized board exams (Strobel & Barneveld, 2009).

Problem-based learning seeks to foster active, collaborative and self-directed learning. It is increasingly utilized in health professional education; however, it is difficult to ascertain

effectiveness. Empirically, student satisfaction does not match academic achievement but the reasons for this are unclear (Spiers et al., 2014).

The use of video to improve teaching & learning and the need for a new study

In the abovementioned framework of "heated debate," we believe that there is a need to extend previous research by directing it on a new issue with two aspects; i.e., the study of positive influence of the use of video in teaching and learning, and registration of directions where the use of video improves the effectiveness of PBL. We believe that the findings would be beneficial to the education policy-makers in PBL and frameworks that use similar methods.

Materials and methods

Research questions

The research questions of this systematic literature review were:

1. What biographical references are relevant to the positive influence of the use of video in teaching & learning environments?
2. What are the directions in which, under the relevant bibliographical references, the use of video affects positively the effectiveness of the PBL?

Conceptual framework

Operational definition of the term "direction"

We define direction as the use of video compared to the non-use of video. The use of text on paper or verbal wording improves the effectiveness of the PBL instructional method; an observed (or measured) quantifiable increase of the main characteristic determines this situation in PBL framework. For example, in the review of Hung et al. (2008), they report two directions of positive impact on the effectiveness of the PBL instructional method when using video:

1. the video group examined the information more critically than the text group, and
2. the video group had more active group processing than their counterparts.

In the first case, the word "more" before the main characteristic "critically examine information" of the situation shows that this characteristic had a quantifiable increase when video was used. So, in this specific situation, its characteristic "critically examine information" expresses one "direction" of the requested set of directions. In the second case, the word "more" before the main characteristic "active group processing" of the situation, shows that this characteristic had a quantifiable increase when video was used. So, in this specific situation, its characteristic "active group processing" expresses another one "direction" of the requested set of directions.

Operational definition of the term "effectiveness"

According to Dictionary.com, the term "effectiveness" is defined as "adequate to accomplish a purpose; producing the intended or expected result: effective teaching methods." We clarify that, in adopting this definition of the term "effectiveness," we bound it closely within the limits of instructional method PBL. So our viewpoint is that the use of video affects not only the learning outcomes of PBL, it also generates improvement to or positively affects the effectiveness of the PBL, not strictly limiting them to only learning outcomes. In

other words, it affects every aspect of quality of learning similarly to the way that was shown by the establishers of PBL instructional method. Simply put, it is difficult to identify the other parameters except learning outcomes. Therefore, in the framework of the use of video in PBL, the purpose of this research is to bridge such significant concepts as "critical thinking," "multi-modality," "active learning," and "video-triggered PBL," with the directions where the use of video improves the effectiveness of PBL.

Designing search strategy: establishing the criteria used to select studies

Specifying criteria to decide which studies should be included in the review; i.e., count as data.

Inclusion criteria

The search terms and compounds of those terms were: "video" AND ("PBL" OR "problem based learning" OR "problem-based learning" OR "case-based learning" OR "project-based learning"), where the term "PBL" remains "inclusion criterion" either represents "problem-based learning" or "project-based learning." The resources used were online digital libraries (databases): ERIC, Scopus, Web of Science, as well as the web search engines Google Scholar and PubMed.

The time period covered by the systematic literature review was set as the period from 2003 until the date the research was conducted (initial search). The reason for this decision for determining the year 2003 as the starting point of the covered time period is because it relates to point when the MP4 file format version 2 (2003, ISO/IEC 14496-14:2003, MPEG-4 Part 14 (MP4 file format), Second edition) emerged. The quality and the advantages of this type of digital video established this format not only as a standard on Youtube and Vimeo, but also as a powerful tool for teaching and learning in classrooms and beyond; for example, in online educational websites and online learning courses. The reference types searched were journal articles and conference proceedings.

Exclusion criteria

The following were excluded: studies (or study sources) that were strictly literature reviews (i.e., containing the term review) as not primary studies and studies presented in a language other than English.

Running the search strategy to find promising sources

Carrying out the initial search

The automated search for primary studies, based on the search strategy mentioned above, was conducted from 26-29 of September 2016 and was limited to articles published between 2003 and (September) 2016. The initial search yielded 337 references.

Checking for apparently irrelevant references and discarding them

The 337 references resulted from the initial search were checked for the identification and removal of references that were apparently irrelevant. After the removal of six apparently irrelevant references, 331 references remained to be checked, and those references were checked by screening for relevance of both the titles and the abstracts.

Determination of research domains – Criteria for the included studies

To be included in this study, the articles had to make an explicit contribution to (at least one of) the following domains:

   a. the use of video improves (affects positively) the effectiveness of problem-based learning.
   b. the use of video improves (affects positively) the effectiveness of case-based learning.
   c. the use of video improves (affects positively) the effectiveness of project-based learning.

Checking using the title-abstract relevance screening

The abstracts of 331 references were screened, and 222 references were discarded for various reasons. The primary reasons for being discarded related to the fact that they did not make an explicit contribution to (at least one of) the three determined domains, and/or they were not sufficiently relevant to the two research questions. This resulted in 109 articles remaining for potential review. We had no full text access to eight articles for reasons beyond our control, so 101 articles remained for full-text screening.

Checking using full-text relevance screening

The full-text relevance screening of the remaining 101 articles was carried out using the same inclusion criteria. These articles were primary studies with empirical findings, i.e. empirical studies.

Appraisal of the quality and relevance of evidence

To ensure that the scientific evidence presented in the empirical studies (*N = 101*) suited the purpose of the review, these articles were judged on the following quality criteria (Gough, 2007):

I.   Consistency: Are research questions/purposes and data sources aligned? Are research questions and data analysis aligned? Are research questions answered by the data?
II.   Data collection: Are the instruments for data collection discussed? Are data collection procedures discussed?
III.   Data Analysis: Are procedures for data analysis discussed? Are instrument reliabilities reported?

Based on the above-mentioned criteria, each article was labelled as having "good quality" (scored "yes" on all criteria), "sufficient quality" (scored "no/insufficient" on one or two criteria) or "insufficient quality" (scored "no/insufficient" on more than two criteria). The results of this screening indicated that 49 articles were in the insufficient quality category and were therefore excluded from the final review. The remaining 52 articles were used in this review, and are shown in Table 1; the articles are in alphabetical order by the last name of first author identified in each article. Additionally, the data presented in Table 1 cover the first research question: What biographical references are relevant to the positive influence of the use of video in teaching and learning environments?

Focusing on problem-based learning and creation of a theoretical model of PBL

Focusing on studies of the problem-based learning domain (Table 1), it creates a subset of all the data: studies related only to PBL; 34 studies comprised this subset. To address the second research question, i.e., registration of the grouped directions in which, under the relevant bibliographical references, the use of video improves the effectiveness of PBL, is needed a way to connect the "main characteristic" of PBL that will have "improved effectiveness" using video in PBL (see definition of "direction"), with broader concepts of PBL, capable to group together under the same umbrella, several of the "main characteristics" of PBL.

Table 1. Overview of the Included Studies and their Contribution to Research Domains

Study No.	First Author	Year	Discipline Field of Study	Domain a (Problem-based Learning)	Domain b (Case-based Learning)	Domain c (Project-based Learning)
1	Antal	2013	Dental Education	X		
2	Azer	2007	Medical Teacher		X	
3	Azer	2012	Medical Education	X		
4	Azer	2015	Medical Education	X		
5	Balslev	2005	Medical Education		X	
6	Balslev	2009	Medical Education	X		
7	Basu	2012	Medical Education	X		
8	Bosse	2010	Medical Education	X		
9	Bridges	2015	Pedagogies	X		
10	Carbo	2012	Pathology			X
11	Chan	2010	Medical Education	X		
12	De Leng	2007	Medical Education		X	
13	DiLullo	2009	Anatomical Education		X	
14	Dittmer	2010	Environ. Education	X		
15	Docherty	2005	Medical Informatics	X		
16	Elazab	2015	Engineering & Technology	X		
17	Freitas	2016	Engineering Education	X		
18	Gelman	2006	Technology in Human Services	X		
19	Goeze	2014	Department of English		X	
20	Hakkarainen	2009	Communications & Technology	X		
21	Han	2013	Teacher Education		X	
22	Hmelo-Silver	2013	Physician Education	X		
23	Jeong	2010	Human Behavior	X		
24	Kabra	2015	Assessment & Learning	X		
25	Krammer	2015	Teacher Education		X	
26	Krebs	2013	Behavioral Sciences	X		
27	Krithivasan	2015	Computer Science			X

#	Author	Year	Field			
28	Kumar	2010	Science Education	X		
39	Lajoie	2015	Human Behavior	X		
30	Love	2014	Mathematical Education	X		
31	Lu	2015	Educational Technology	X		
32	Machado	2013	Mental Health	X		
33	Mason	2013	Engineering Education	X		
34	Matteucci	2011	Endoscopic Anatomy	X		
35	Menter	2012	Engineering Education			X
36	Miller	2012	English for Science			X
37	Monova	2010	Behavioral Sciences	X		
38	Monteiro	2012	Medical Education	X		
39	Papanna	2013	Medical Education	X		
40	Raikos	2014	Medical Education	X		
41	Roy	2012	Medical Education			X
42	Sarac	2009	Simulation and Education		X	
43	Schittek Janda	2004	Dental Education		X	
44	Schultz	2005	Industrial Engineering		X	
45	Siegel	2012	Educational Psychology	X		
46	Skoretz	2011	Education Competencies	X		
47	Smith	2015	Interdisciplinary Journal of PBL			X
48	Tatar	2010	Engineering Education			X
49	Ventura	2015	Computer Engineering	X		
50	Woodham	2015	Biomedical Education	X		
51	Zhang	2011	Teacher Education	X		
52	Zottmann	2012	Learning Environments		X	
Total				**34**	**11**	**7**

Aiming at the practical realization of the abovementioned rationale was created initially an artifact or a simple and practical model or the theoretical model. Therefore, the theoretical model, ought to address two concrete practical problems:

   a) Determine the broad or core concepts-characteristics of PBL that were contributed to in each included study.
   b) Group the identified directions of the research according to the correspondent broad or core concepts-characteristics of PBL.

The process of constructing the specific theoretical model of the PBL in this research of followed the steps below; these steps illuminate better the aim why PBL was created.

The theoretical model was founded based on the "Six Core Characteristics of Problem-based Learning" outlined by Gijbels et al. (2005), which Hattie (2008) indirectly suggested as being basic characteristics of making up and representing the PBL instructional method (see introduction). Also, these "Six Core Characteristics," for reliability purposes, were compared with the section "Characteristics of PBL" in Hung et al. (2008).

A pool of the key-terms of PBL was generated based on the article Gijbels et al. (2005) and on the section "Basic Domain Knowledge" in Hung et al. (2008). To create a pool that was as complete as possible other sources were also consulted other sources.

Each one of the "Six Core Characteristics of Problem-based Learning" was matched to the correspondent key-terms from the pool, controlling thoroughly the reliability of this correspondence and of the whole process of this mapping.

At the right of each one of the Six Core Characteristics of PBL a short expression was written that consisted of two words in square brackets. For example, in the first core characteristics the short expression "Student-Centered" is written. On a practical level, the short expressions of the two words, in square brackets, represent adequately and briefly the "Six Core Characteristics of Problem-based Learning."

The theoretical model of problem-based learning

The theoretical model, related to "Domain a" (Table 1) PBL which covers all the 34 corresponding studies in this research, acquired the form shown in Figure 1.
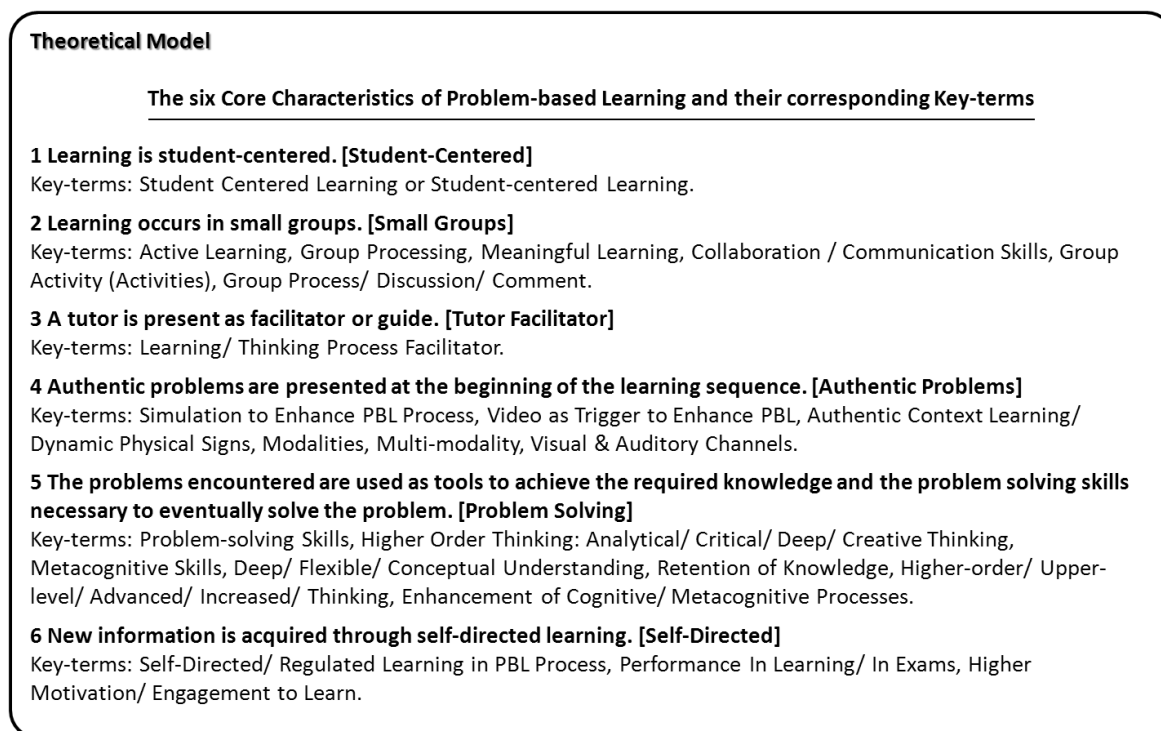
Theoretical Model

The six Core Characteristics of Problem-based Learning and their corresponding Key-terms

1 Learning is student-centered. [Student-Centered]
Key-terms: Student Centered Learning or Student-centered Learning.

2 Learning occurs in small groups. [Small Groups]
Key-terms: Active Learning, Group Processing, Meaningful Learning, Collaboration / Communication Skills, Group Activity (Activities), Group Process/ Discussion/ Comment.

3 A tutor is present as facilitator or guide. [Tutor Facilitator]
Key-terms: Learning/ Thinking Process Facilitator.

4 Authentic problems are presented at the beginning of the learning sequence. [Authentic Problems]
Key-terms: Simulation to Enhance PBL Process, Video as Trigger to Enhance PBL, Authentic Context Learning/ Dynamic Physical Signs, Modalities, Multi-modality, Visual & Auditory Channels.

5 The problems encountered are used as tools to achieve the required knowledge and the problem solving skills necessary to eventually solve the problem. [Problem Solving]
Key-terms: Problem-solving Skills, Higher Order Thinking: Analytical/ Critical/ Deep/ Creative Thinking, Metacognitive Skills, Deep/ Flexible/ Conceptual Understanding, Retention of Knowledge, Higher-order/ Upper-level/ Advanced/ Increased/ Thinking, Enhancement of Cognitive/ Metacognitive Processes.

6 New information is acquired through self-directed learning. [Self-Directed]
Key-terms: Self-Directed/ Regulated Learning in PBL Process, Performance In Learning/ In Exams, Higher Motivation/ Engagement to Learn.

Figure 1. Theoretical model: The six core characteristics of PBL and their corresponding key-terms

Studies related to PBL according to theoretical model

Based on the theoretical model and Table 1, all the 34 studies related to PBL, were ordered alphabetically showing their contribution to the Six Core PBL Characteristics, according to the corresponding key-terms. This process resulted in the creation of Table 2.

Table 2. Studies related to PBL and their contribution to 6 PBL Core Characteristics

Study No.	First Author	1. [Student-Centered]	2. [Small Groups]	3. [Tutor Facilitator]	4. [Authentic Problems]	5. [Problem Solving]	6. [Self-Directed]
1	Antal		X		X	X	X
2	Azer, 2012				X		X
3	Azer, 2015		X			X	
4	Balslev		X			X	
5	Basu Roy		X		X	X	
6	Bosse						X
7	Bridges		X		X		X
8	Chan		X		X	X	X
9	Dittmer		X			X	X
10	Docherty					X	X
11	Elazab	X	X			X	X
12	Freitas		X				X
13	Gelman	X	X		X		
14	Hakkarainen				X	X	X
15	Hmelo-Silver				X		X
16	Jeong		X	X		X	
17	Kabra					X	X
18	Krebs				X	X	X
19	Kumar		X		X		X
20	Lajoie		X		X	X	X
21	Love		X		X	X	X
22	Lu		X		X	X	
23	Machado		X	X	X		
24	Mason	X				X	X
25	Matteucci					X	X
26	Monova				X		X
27	Monteiro	X			X		
28	Papanna					X	X
29	Raikos						X
30	Siegel		X	X		X	
31	Skoretz					X	X
32	Ventura					X	X
33	Woodham				X	X	X
34	Zhang		X		X	X	X

Included PBL studies, theoretical model and the 2nd research question

The design of the second table of studies related to PBL and the determination of their contribution to six PBL core characteristics facilitates the process of answering to the second research question: What are the directions in which, under the relevant bibliographical references, the use of video affects positively the effectiveness of the PBL? Therefore, based on Table 2 and on the key-terms of each of the six PBL core characteristics, we started the process of identification and registration of the directions where the use of video improves the effectiveness of the PBL. Because of implementation of this process, we registered 16 directions for improvement of the effectiveness of the PBL using video. Subsequently, the 16 identified and registered directions for improvement of the effectiveness of the PBL using video were ordered alphabetically. But, instead of the simple presentation of a list of 16 ordered entries, using the theoretical model, it had become possible to present those registered directions, grouped per the six PBL core characteristics (see Research Findings). So, this feature constitutes the main advantage of the theoretical model.

Results and Findings

Results and findings per the first research question

Designed based on Table 1, Figure 2 shows "Included Studies by Research Domain" (in value) and "Included Studies by Research Domain" (in percentages). Based on Table 1, Figure 3 depicts "Included Studies by Year of Publication" (Trend/Regression Line Type: Polynomial) and "Number of Studies by Reference Type" (Value and Percentage).
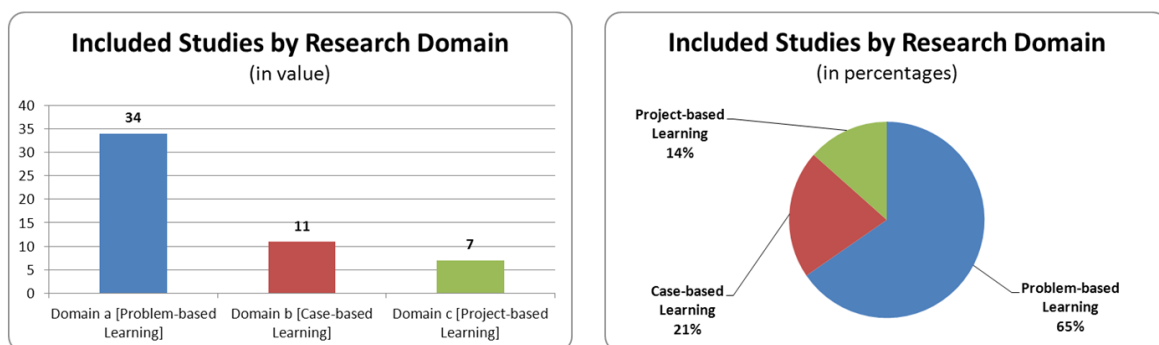

Figure 2. Research findings per research domain
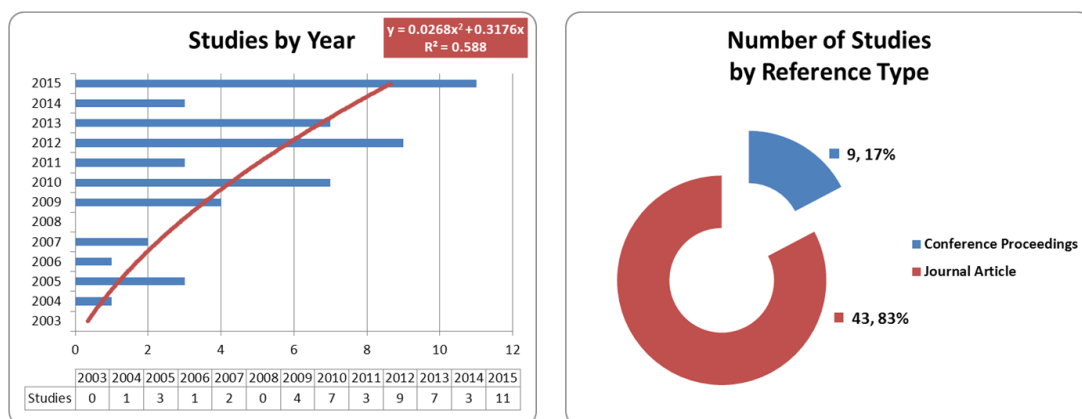

Figure 3. Studies included by year of publication (left) and by reference type (right)
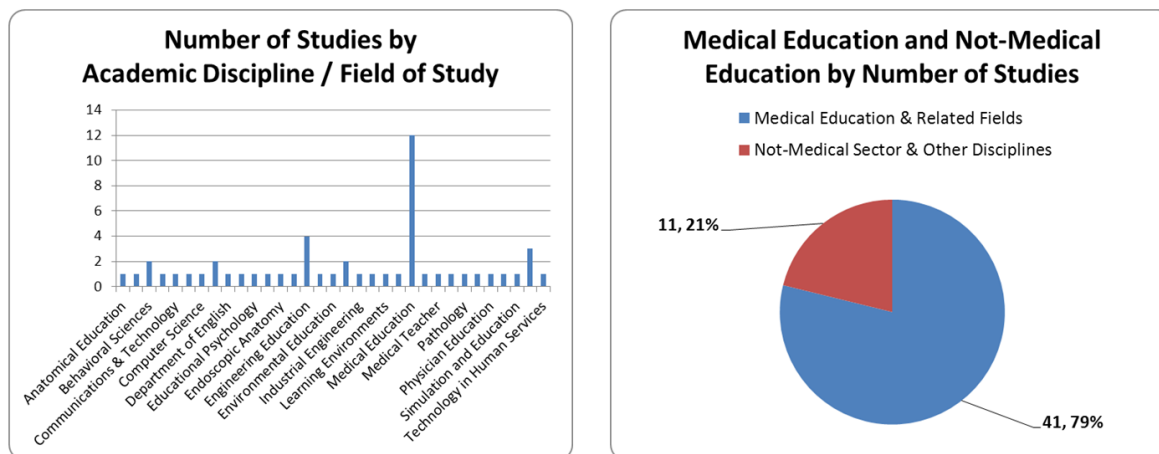
Figure 4. Number of studies by academic discipline / field of study (left) and medical education and not-medical education by number of studies (right)

Designed based on Table 1, Figure 4 shows "Number of Studies by Academic Discipline/Field of Study" and "Medical Education and Not-Medical Education by Number of Studies" (value and percentage).

Results and findings based on the second research question

As highlighted elsewhere in this review, one important practical problem that ought to address the theoretical model was to group the identified directions of the research based on the correspondent core concepts of PBL. During this research, we identified and registered 16 directions for improvement of the effectiveness of PBL using video.

Using the main advantage of theoretical model, in Figure 5, we present the identified and registered directions, in a manner sorted and grouped based on the six core characteristics of PBL. In other words, Figure 5 shows the dispersion of 16 registered directions where the use of video improves the effectiveness of PBL, grouped and sorted.

Following is the detailed report, of only two of the many available indicative excerpts, with reference for each direction.

I. Student-Centered

Not found: any direction where the use of video improves the effectiveness of PBL corresponding to this core characteristic of PBL.

II. Small Groups

(4): Direction of effective collaboration/communication skills.

- "Therefore, interaction involves several cognitive skills (e.g. hypotheses generation, enquiry plan construction, data analysis and justification of views) as well as non-cognitive skills (e.g. communication skills, handling conflict, time management and interpersonal skills)" (Azer, 2015, p. 3).
- "Learners' mutual regulatory activities during problem solving session can provide insights to understand how members engage in productive collaboration" (Lajoie, 2015, p. 20).
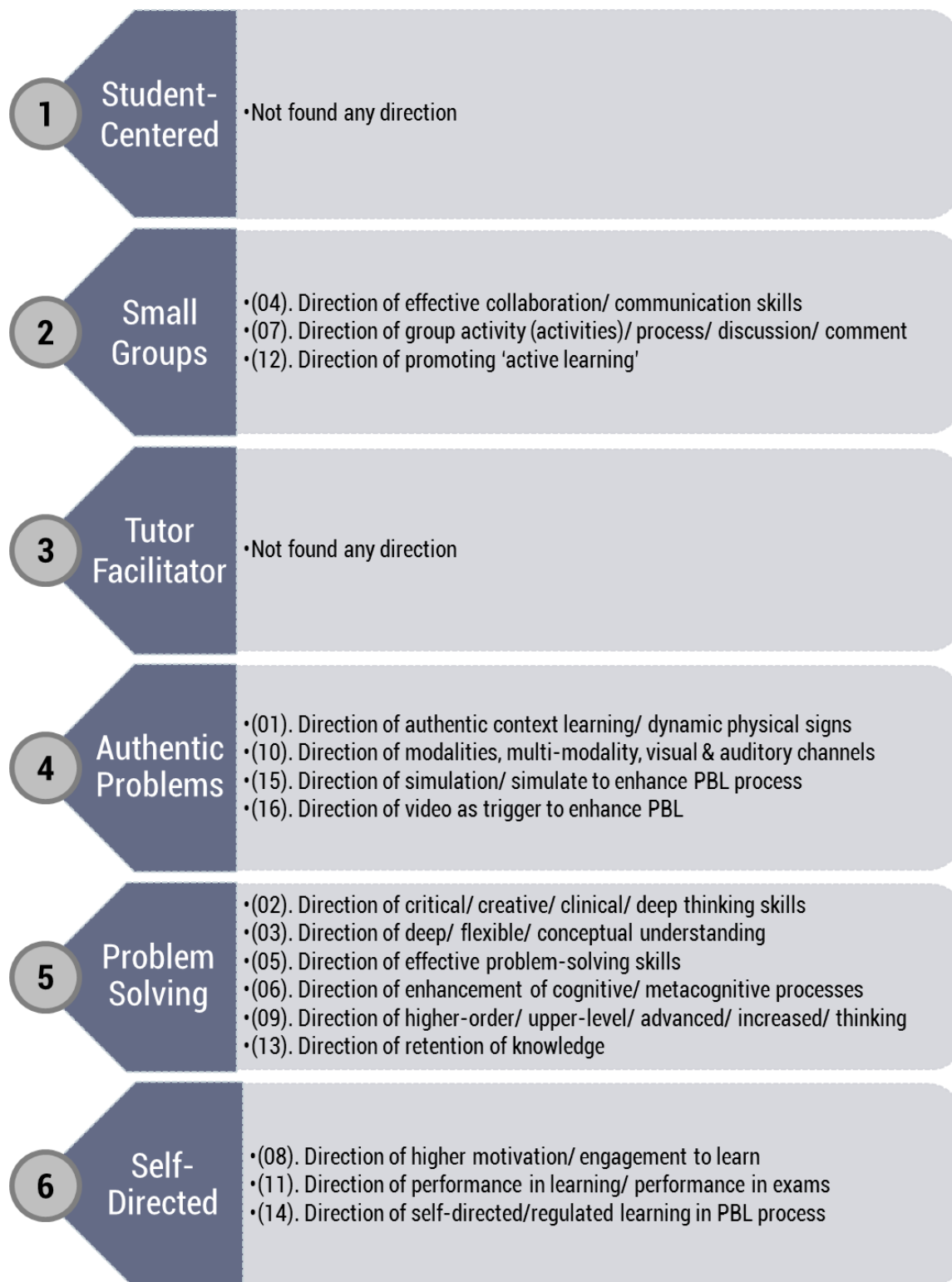
1 Student-Centered
- Not found any direction

2 Small Groups
- (04). Direction of effective collaboration/ communication skills
- (07). Direction of group activity (activities)/ process/ discussion/ comment
- (12). Direction of promoting 'active learning'

3 Tutor Facilitator
- Not found any direction

4 Authentic Problems
- (01). Direction of authentic context learning/ dynamic physical signs
- (10). Direction of modalities, multi-modality, visual & auditory channels
- (15). Direction of simulation/ simulate to enhance PBL process
- (16). Direction of video as trigger to enhance PBL

5 Problem Solving
- (02). Direction of critical/ creative/ clinical/ deep thinking skills
- (03). Direction of deep/ flexible/ conceptual understanding
- (05). Direction of effective problem-solving skills
- (06). Direction of enhancement of cognitive/ metacognitive processes
- (09). Direction of higher-order/ upper-level/ advanced/ increased/ thinking
- (13). Direction of retention of knowledge

6 Self-Directed
- (08). Direction of higher motivation/ engagement to learn
- (11). Direction of performance in learning/ performance in exams
- (14). Direction of self-directed/regulated learning in PBL process

Figure 5. The main advantage of theoretical model: presentation of identified and registered directions in a manner sorted and grouped according to the six core characteristics of PBL

(7): Direction of group activity/process/discussion/comment.

- "The results show that adding a PVC (patient video case) to a written vignette enhanced shared cognition through collaborative concept link formation among pediatric residents analysing a case in a small group" (Balslev, 2009, p. 4).
- "As such, historically, PBL is more closely aligned to small-group Socratic methods than to the lecture-based, post-industrial pedagogies of higher education in the more recent century" (Bridges, 2015, p. 7).

(12): Direction of promoting "active learning."

- "Many faculty members recognize the need for a more active learning environment and seek ways to incorporate that, to varying degrees, in their classes" (Love, 2014, p. 21).
- "Some of the advantages of problem-based learning include active learning, critical thinking, flexible reflections, and fruitful group cooperation" (Kumar, 2010, p. 19).

III. Tutor Facilitator

Not found: any direction where the use of video improves the effectiveness of PBL corresponding to this core characteristic of PBL.

IV. Authentic Problems

(1): Direction of authentic context/dynamic physical signs.

- "Few studies have examined the impact of the use of video in PBL . . . Those that have done focused on cases involving physical signs, where video has natural advantages" (Basu Roy, 2012, p. 5).
- "Similar questions confront the introduction of more authentic PBL—video-triggered PBL—into the curriculum" (Lu, 2015, p. 22).

(10): Direction of multi-modality, visual & auditory channels.

- "More specifically, the use of video was perceived as beneficial for providing details, visual information, and context where text was unable to do so" (Woodham, 2015, p. 33).
- "Storyboards provide groups with a visual representation and a structured map of their proposed video" (Skoretz, 2011, p. 31).

(15): Direction of simulation/simulate to enhance PBL process.

- "Games and simulations can serve as powerful tools because they encompass many aspects of human learning such as engagement, problem-solving, receiving corrective feedback, and repetition" (Krebs, 2013, p. 18).
- "By associating clinical simulation and a problem centered approach to whenever-wherever-availability, it will perfectly fit into what the authors believe will be the future of pre- and postgraduate lifetime education" (Monteiro, 2012, p. 27).

(16): Direction of video as trigger to enhance PBL.

- "They found PBL using video triggers more interesting and preferred it to PBL using paper cases" (Chan, 2010, p. 8).
- "The video case vignettes served as the context to trigger specific learning objectives in the PBL sessions" (Lajoie, 2015, p. 6).

V. Problem Solving

(2): Direction of critical/creative/clinical/deep/computational thinking.

- "Critical thinking is widely acknowledged to be an ideal characteristic of doctors, yet understanding of what it entails varies amongst medical school faculty members" (Basu Roy, 2012, p. 5).
- "One particular skill that has received considerable attention over the years in addressing the problems in computer science is computational thinking" (Ventura, 2015, p. 32).

(3): Direction of deep/flexible/conceptual understanding.

- "This visual representation of the inter-relationship amongst dialogue moves provides a deeper understanding of the impact of co-regulatory episode" (Lajoie, 2015, p. 20).
- "In our study, we found that students within a flipped classroom still performed as well as their peers in a traditional classroom on the final exam, representing conceptual understanding" (Love, 2014, p. 21).

(5): Direction of effective problem-solving skills.

- "Students also define and articulate problems by stating the goals and scope of the problem-solving process whose representations, unlike those of well-structured problems, are often ill defined and complicated by multiple possibilities" (Lu, 2015, p. 22).
- "Despite the numerous advantages of video triggers discussed above and the positive reaction of students and facilitators, video triggers cannot replace real patients in clinical situations in training students' problem-solving skills" (Chan, 2010, p. 8).

(6): Direction of enhancement of cognitive/ metacognitive processes.

- "It is possible that although our video cases foster generative cognitive processing through the use of multimedia, personalisation, the human voice and image, they may include too much extraneous information that competes for cognitive resources in working memory and thereby disrupts the process of organizing and integrating essential material" (Basu Roy, 2012, p. 5).
- "This background noise to decision-making has often been obscured by more cognitive dimensions of social life – such as representation and narrative" (Dittmer, 2010, p. 9).

(9): Direction of higher-order upper-level/advanced increased/thinking.

- "Teachers need to incorporate activities that will challenge students to use higher-level thinking skills and apply their prior knowledge to the problem at hand in the process of constructing new knowledge" (Jeong, 2010, p. 16).
- "It was found that the video groups showed increased critical thinking in all stages of critical thinking, except for the problem identification stage" (Chan, 2010, p. 8).

(13): Direction of retention of knowledge.

- "Problem-based learning (PBL) has been demonstrated to promote active learning, which appears to result in increased retention and to facilitate mental flexibility" (Basu Roy, 2012, p. 5).
- "Do inquiry-based activities increase students' ability to generate scientific questions, gain understanding, and increase retention of scientific concepts" (Zhang 2011, p. 34)?

VI. Self-Directed

(8): Direction of higher motivation engagement to learn.

- "The consequence is that the video trigger not only stimulates a more effective learning process but also the students' motivation to become a doctor" (Chan, 2010, p. 8).
- "Students are self-regulated to the degree that they are cognitively, motivationally, emotionally, and behaviorally active participants in their own learning process" (Lajoie, 2015, p. 20).

(11): Direction of performance in learning/performance in exams.

- "Content understanding was measured by the performance on course exams, and students in the flipped classroom environment had a more significant increase between the sequential exams compared to the students in the traditional lecture section, while performing similarly in the final exam" (Love, 2014, p. 21).
- "Learning was facilitated through network communications and reflection on video performances of self and others. Evaluations were positive, students demonstrating increased satisfaction with PBL, improved performance in exams, and increased self-efficacy in the performance of nursing activities" (Docherty, 2005, p. 10).

(14): Direction of self-directed/regulated learning in PBL process.

- "All in all, the PBL process supported especially the self-directed, active, collaborative, co-operational, conversational, multiple perspectives-oriented, constructive, contextual, and experiential characteristics of meaningful learning" (Hakkarainen, 2009, p. 14).
- "Attending to multiple perspectives can lead to shifts in one's knowledge that can lead to new forms of self-directed self-regulatory activities that are more informed" (Lajoie, 2015, p. 20).

Discussion

The results of this study do not contradict previous findings. On the contrary, the findings of this study not only agree, but in some way, they go beyond them: From two directions mentioned in the review of Hung et al. (2008), this study identified several additional directions that were explicitly showed. Furthermore, comparing this review to the above-mentioned review, the following results were revealed:

- The "increasing trend" on the left side of Figure 3 seems to confirm (partially) the much more general provision of the authors: "utilizing multimedia in constructing PBL environments is also gaining more attention as technology advances".
- The number of studies in Figure 4, which represents medical education compared to not-medical education, is much larger. Therefore, this result seems to confirm the following statements: a) since its first implementation several decades ago, PBL has become a prominent pedagogical method in medical schools and health-science-related programs throughout the world, and b) compared to PBL research conducted within the medical field, empirical studies conducted in nonmedical disciplines and K–12 settings are relatively scarce.

Also related to previous findings, analysing Figure 5 and the results, indicates that there are two cases that fall into the category "not found any direction" where the use of video improves the effectiveness of PBL corresponding to this core characteristic of PBL. These two cases are student-centered and tutor facilitator]. The first case is expected since choosing

PBL becomes, by definition, impossible when compared with the opposite situation of "teacher-centered." But the second case is not expected, and that is contrary to the first case. So, it is natural that the following question be asked: From 16 identified directions where the "use of video improves the effectiveness of PBL," why was at least one found related and attributed to the contribution and the role of the "Facilitator" in the process of learning in PBL framework? Contrasting this with the concept of "minimally guided instructional approaches" in the introduction, it seems that, even if not directly, there is (in this study) some qualitative confirmatory evidence of the "superiority of guided instruction" as described by Kirschner et al. (2006).

Finally, again related to previous findings, it is worth mentioning that, in 2016, the year we went through these studies, the comparable review by Rasi and Poikela (2016) was published. In their conclusion, those authors emphasized "the research evidence reviewed in this article clearly points out the advantages of video and video production in PBL settings" (Rasi & Poikela, 2016, p. 9). Also important is the explicit statement by Rasi and Poikela (2016) of the fact that "the uses of video need to be considered critically" (p. 9) and that the learning by video must be supported not only by tutors and facilitators, but "needs to be guided and supported by PBL tutors, facilitators, and teachers" (p. 9).

Conclusions

This systematic literature review explored and studied the positive influence of the use of video in teaching and learning environments and, focusing on PBL, the directions where the use of video improves the PBL effectiveness were identified and registered. Based on the research evidence reviewed, the corresponding findings were presented. The theoretical model created and utilized for the needs of this research resulted as a productive artifact. The positive results of its utilization were reflected mainly in relation with the ordered and grouped, according to the six core characteristic of PBL, of the 16 identified directions, where the use of video improves the effectiveness of PBL.

The purposeful use of video for improving the effectiveness of PBL and other similar approaches seems to gain more recognition and acceptance with the continuous improvements of the technology of its production and distribution. The findings and outcomes of this research will certainly contribute positively to the "heated debate" about the effectiveness of PBL and other similar approaches.

The education policy-makers in the sectors of "problem-based learning," "case-based learning," and "project-based learning" frameworks, will be better placed to make effective use of this study's findings related to the use of video for improvement of the effectiveness of these instructional methods.

There is still a great and unexplored potential for promoting the use of video, in PBL and other similar approaches, in sciences such as mathematics and physics.

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