PBL as a Framework for Implementing Video Games in the Classroom

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ABSTRACT

Video games and problem-based learning (PBL) are both significant trends in progressive approaches to education. The literature demonstrates a fit between the two approaches, indicating they may be mutually beneficial. With limited literature on implementing games in the classroom, and a growing body of researchers highlighting the importance of the teacher in mediating game use and maximizing the effectiveness of games for learning, guidance is needed on the role teachers can play in utilizing games in structured environments. PBL has a richer literature base on its effective use, and with its similarities to game-based learning, can inform the effective use of games. In order to assist educators in integrating video games into their curriculum, a video game implementation framework based on PBL principles was developed. The efficacy of utilizing video games for learning in formal and structured learning environments may be improved by integrating PBL guidelines as a framework.

Keywords: Educational Technology, Game-Based Learning, Problem-Based Learning, Teaching Methods, Video Games

INTRODUCTION

A growing body of advocates has called for the use of video games in order to engage learners and promote learning (Aldrich, 2005; Federation of American Scientists, 2006; Prensky, 2006; Quinn, 2005). However, sound empirical research on the outcomes of using games for learning are limited, particularly research on the use of games in classrooms, and results in the literature are mixed (Ke, 2009). Most of the available literature focuses on studies that examine the game as the tutor or instructor rather than as a tool for learning (Amory, 2010). Additionally, more and more researchers are highlighting the lack of research on implementation guidelines to support the effective use of games for learning, including the role instructors and teachers can play (Garris, Ahlers, & Driskell, 2002; Leemkuil, de Jong, de Hoog, & Christopher, 2003; O’Neil, Wainess, & Baker, 2005). Ke (2009) argues that more research is needed on how to effectively implement games.

Despite this call, little exists in the literature to guide teachers in how to actually implement games (Baek, 2011), particularly in a formal

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educational setting. Indeed, video games (hereafter, games) are sometimes promoted as a magical instructional solution where learners cannot help but learn, and the teacher may no longer be necessary. In reality, while further empirical research is necessary and results are mixed, there are studies demonstrating neutral or negative effects on learning from games (Gredler, 1996; Leemkuil et al., 2003; O’Neil et al., 2005), studies that reinforce the call for quality implementation guidelines. In practice, teachers can play a very large and important role in setting goals and promoting reflection by students playing games in formal educational settings (Watson, Mong, & Harris, 2011).

While the inherent challenges of implementing games within the sometimes unyielding confines of a classroom learning environment can offer strong impediments to the successful use of games for learning (Squire, 2003; Baek, 2008), the reality is that banishing games to after school programs and home use diminishes the scope of their potential impact and limits the availability of teachers to facilitate learning. It is therefore important to establish an implementation framework to guide the use of games in such structured environments as classrooms.

Problem-based learning (PBL) is a progressive approach to instruction focused on contextualized learning and the promotion of problem-solving skills that is a strong theoretical fit with games and offers a deeper research foundation on effective implementation. This article provides a practical framework for how teachers should implement games for learning in formal settings by integrating PBL implementation guidelines.

VIDEO GAMES IN THE CLASSROOM

Video games have been highlighted for their potential for promoting learning and their fit with learning theories such as situated cognition. Situated cognition theorizes that learning best occurs when learners complete authentic tasks in authentic environments (Brown, Collins, & Duguid, 1989). Game proponents have looked at how games provide rich environments as a context for performing authentic tasks and thereby gaining epistemological knowledge through the playing of a specific role (Gee, 2003; Shaffer, 2006). Furthermore, the interactive nature of games promotes engagement, and when used for learning, supports a learner-centered environment for learners (Prensky, 2002; Watson et al., 2011).

However, as previously discussed, it would be overly optimistic to assume that deep learning will occur with games unless the game is implemented using sound instructional practices. Egenfeldt-Nielsen (2008) posits that many educational games are now or need to be what he calls third generation educational games, based on social-cultural, situated learning where the game must effectively fit within existing curriculum and practice. He highlights the teacher as critical for facilitating learning and debriefing. A number of recent articles describe the use of games in classrooms and the role of the instructor in facilitating and promoting learning.

In her case study on implementing math education games in the classroom, Ke (2008) found that students often failed to reflect on what was happening in the games, and some students struggled without the support of their teacher. She stresses the importance of an instructor to facilitate games for learning and calls for additional research to discover how to promote engagement through games while also maximizing learning with the interplay of in-game and external instructional activities.

Amory (2010) conducted a study focusing on the use of a game as a tool for learning within a collaborative learning environment. A group of facilitators worked to guide learning amongst South African orphans playing a puzzle-oriented health education game. The study found that the game should facilitate the learning process as opposed to being the focus of the activity, and Amory argues that games should be part of a socially collaborative learning activity if they are to be implemented in classrooms.
Watson et al. (2011) observed a social studies teacher with years of experience using a game to teach about World War II and saw a teacher heavily involved in facilitating how the game was played while managing an engaging, learner-centered environment. The teacher noted how when he initially utilized the game, students did not reflect on their actions and took actions in the game that were not conducive to learning or succeeding in the game. His revised methods of using the game involved students working in groups, his promoting reflection by stopping gameplay and calling attention to events in the game, and grading students on how well they followed the objectives of the country they played during the game.

Echeverría et al. (2011) noted the importance of planning for implementation in their video game design and implementation framework that they utilized to design and develop an educational video game. The framework, however, focused primarily on game design and planning for implementation and did not stress the preparation of the teacher for effectively facilitating the game. Their later study highlighted this issue as they found initial feedback on the implementation of their educational video game indicated the need to more clearly define the role of the teacher and concluded that the teacher as a mediator of the game is highly important for effective learning (Villalta et al., 2011). They revised their framework for designing games for the classroom to include a flexible structure, allowing “the teacher, who is the game moderator and guides the flow of actions, to adjust the game to the actual participation of the students in the classroom” (p. 2044).

This need for a flexible structure to support teachers as they manage the use of a game in the classroom was also identified by Watson (2010) when interviewing teachers as part of the design activities of a game meant for use in social studies classrooms. The teachers interviewed expressed concern over how the structure of the school day and required curriculum created challenges to their effective use of games. Through these interviews, it was determined that not only was a flexible design needed for the game but that external pedagogical support materials should be designed alongside the game to support teachers implementing the game in different ways and in different contexts.

These studies illustrate continued recognition of the importance of external pedagogical supports to maximize the learning outcomes from games. As previously mentioned, numerous studies exist that demonstrate that games do not guarantee learning will occur, and this has led to calls for an examination of how games can best be supported. Despite these calls, little exists in the literature that addresses this issue. Futurelab generated a list of questions from a series of case studies on the use of games in the classroom in the United Kingdom that educators should ask when planning to implement games in the classroom (Sandford, Ulicsak, Facer, & Rudd, 2007), including identifying learning objectives, planning for reflection, and assessing learning gains. These questions are useful but limited in their guidance. It is our belief that problem-based learning is well suited as a framework for how to implement games in structured learning environments, such as classrooms. The following section will illustrate the strong fit between games and PBL, and how each can complement the other.

**PBL AND VIDEO GAMES**

Originating in medical education, PBL was identified as a means to move towards more learner-centered, multidisciplinary education that promotes lifelong learning and problem-solving skills (Boud & Feletti, 1997). Savery (2006) defines PBL as:

> “An instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem. Critical to the success of the approach is the selection of ill-structured problems (often interdisciplinary) and a tutor who guides the learning process and
Games and PBL share many attributes with their focus on goals/problems, their learner-centeredness, and advocates promoting them as instructional methods suitable to situated-cognition and constructivist approaches. Mann, Eidelson, Nissman, Robertson, and Jardines (2002) state that game-based learning can be seen as an example of PBL because games share many characteristics with PBL. Kiili (2007) proposes a problem-based gaming model as explanation for how learning occurs with games and for use in designing effective educational games; although, his study does not examine the role of the teacher as facilitator. Warren, Dondlinger, McLeod, and Bigenho (2012) highlight parallels between games and PBL by comparing game design elements and social constructivist design elements in the literature, noting that they overlap in educational games through pedagogical agents embedded in the game narrative. Each of these studies provide examples of PBL-based game designs. Mann, et al. (2002) described a medical education game with an in-game animated facilitator. Kiili (2007) utilized a business simulation game, and Warren, et al. (2012) developed an alternate reality game as part of a blended course where the instructor served as both teacher and game. While the first two of these games were implemented in classrooms, neither study examined the role of the instructor, while the third game was an alternate reality game as opposed to a video game and took place in a blended course. Walker and Shelton (2008) also highlight PBL as a model useful for designing educational video games but again constrain their discussion to in-game activity rather than also examining the classroom and surrounding learning activities. A number of other educational games have been described in the literature as being designed by utilizing PBL theory. Toprac (2011) describes The Alien Rescue Game, an astronomy education game, which while identified as a PBL game, resulted in some negative impacts on the traditional PBL process, including lessened student interaction and a focus on completing the game rather than discovering the best possible solution. Annetta, Cook, and Schultz (2007) describe how video games and PBL fit each other and then describe a biology game; however, they do not discuss its implications, only its mixed outcomes. Ultimately, it is clear that numerous researchers have noted the inherent fit between educational games and PBL; however, as Ke (2009) noted, research that examines how to implement games are scarce.

Games, as a popular form of technology, have a great potential to enhance PBL approaches because: (a) technologies were reported to be significantly beneficial in facilitating student learning in problem-based learning environments (Ellis & Carswell, 1998; Hallinger, 2005), and games share key characteristics of the reported technologies; (b) games, especially educational video games, and PBL activities share similar strategies of enhancing learning with their focus on problem-solving and intrinsic motivation (Dickey, 2006; Savery, 2009); and (c) video games are well-suited to overcoming implementation problems sometimes experienced with PBL (Hoffman & Ritchie, 1997).

Hoffman and Ritchie (1997) identify problems sometimes experienced with PBL, including: (1) current PBL courses relied primarily or exclusively on written or oral problem statements and learning resource material; (2) students initially felt discomfort with the increased degree of freedom that PBL brings; and (3) PBL caused time management problems including extra time in assessment, in designing and producing appropriate problem situations, and in engaging learners in complex problem situations. The ideal strategies Hoffman and Ritchie suggested to overcome these problems were to employ multimedia because of its capability to “increase the richness of the problem also increases the users’ ability to interpret and understand the problem through repeated exposures” (p. 103). They note that multimedia motivates learners by providing just-in-time information access and making the course speed controllable; and it improves efficiency by individualizing the elements of PBL.
Video games are representative of interactive multimedia and have the potential to overcome PBL challenges, making them a strong fit for PBL environments.

Likewise, reviews of the instructional game literature demonstrate that games are better suited to higher-order thinking skills than for declarative knowledge (Dempsey, Rasmussen, & Lucassen, 1996; Ke, 2009), matching the learning objectives of PBL. Problems in PBL are ill-structured problems, which possess unknown problem elements, multiple solutions, multiple criteria for evaluating solutions, and require personal decisions and opinions. In video games, problems are presented as part of the game’s story or context, and player tasks or actions compose the gameplay where “the player takes on the role of a virtual character moving through an elaborate world, solving problems” (Gee, 2007, p. 1). In other words, players solve problems in games; this is inherent to most gameplay. According to Shaffer (2006) video games provide opportunities for learners to “think by examining alternatives in play” (p. 25) and to “solve problems that are meaningful to them and in the world around them…” (p. 60). Dickey (2006) notes that the adventure genre of video games “can be characterized as a problem-solving environment” (p. 250). To a great extent, the problem-based tasks presented in video games are aligned with the ill-structured, problem-focused nature of PBL.

Video games and PBL share theoretical foundations and a natural synthesis in supporting each other’s strengths and weaknesses. With its inherent focus on the use of a tutor or facilitator to guide the problem-based learning process, PBL is a strong fit for providing implementation guidance for the use of games for learning. While facilitation of PBL environments requires skill and practice, significantly more research exists on how to effectively facilitate PBL than games. We therefore posit that PBL provides a strong framework to guide the implementation of games in classrooms.

FRAMEWORK FOR IMPLEMENTING VIDEO GAMES FOR LEARNING

The framework consists of five components pulled from PBL: problem, activation, exploration, reflection and facilitation to form the cycle of effectively implementing video games for learning (Figure 1).

Problem

We have previously discussed how video games are inherently goal and problem-based. Different video games provide different kinds of problems. Generally speaking, appropriate problems provided in video games are authentic/real-life problems that call for players to develop solutions (Gee, 2003; Shaffer, 2006). The problem could be creating a new life form to exist in a particular environment (Spore) or trying to get food, water, and medicine for your family in the genocidal environment of Sudan (Darfur is Dying). The key is that the teacher should be aware of the desired learning objectives and design a plan for how to best utilize the game along with other classroom activities to present these objectives rather than having the game specify and limit the targeted learning (Sanford et al., 2007; Watson et al., 2011). As Amory (2010) argues, it is important that learning occur with the game as a tool rather than solely from the game.

Activation

Activation of prior knowledge and related experience serves as the basis for learners to acquire new knowledge and skills. Recalling past relevant experience was reported to be more likely to activate an appropriate mental model that facilitates the acquisition of new knowledge and skills (Merrill, 2009).

The appropriate strategies for activating prior knowledge and experience include recalling, describing, sharing and demonstrating
past relevant knowledge and skills (Merrill, 2009). Whether these activities are in-game, facilitated by the teacher, or a combination of both approaches, it is important that learners be supported in connecting game experiences and contexts with prior knowledge and skills. Activation is essential to make the learning relevant to students’ existing knowledge structure, individual interests, and understanding of the surrounding world. Constructivism, a foundational theory for PBL that is also highlighted for its influence on how games can be used for learning, emphasizes individual interaction in a content area and the relationship of that interaction to the prior knowledge about the content (Jonassen, 1991), describing how learners construct new knowledge from existing knowledge. Activation is also important to facilitate cognitive structure change (Merrill, 2009) as learners reorganize their understanding as new knowledge is processed.

Teachers should generate specific examples of prior knowledge or skills that the students have previously gained that are relevant to the current learning objectives. By being familiar with possible outcomes and common strategies supported by the gameplay, teachers can plan ahead of time for opportunities for facilitating activation as well as closely observing student interaction and gameplay for dynamic opportunities for activation. The teacher in Watson et al.’s (2011) study called these opportunities “teachable moments” and discussed how he sought to help students connect what was happening in the game with prior knowledge and experiences they could easily understand.

**Exploration**

One shared aspect of games and PBL is the motivational process of exploration, which consists of learners assessing mastery of their content knowledge and skills, making plans for the acquisition of needed knowledge and generating potential solutions. In PBL, learners explore what they currently know and do not know and then make plans for pursuing activities like conducting research to acquire knowledge and skills needed for implementing potential solutions (Savery, 2009). In a very similar way, video games provide players with contexts to explore the environment, synthesizing resources and ultimately generating solutions (Shaffer, 2006).

The exploration process in video game includes (1) problem analysis, (2) identification
of needed knowledge and skills, (3) generating possible solutions, (4) experimenting or testing the knowledge and skills, and (5) determining the best solution. The exploration process to a great extent is an iterative inquiry process from hypotheses generating to making decisions. During the cycle, players are conducting inquiry through trial and error.

This exploration process is aligned with the basic process of PBL (Savery, 2009; Jonassen, 2000). Players cognitively reconstruct their knowledge by accessing prior knowledge, establishing a problem space, searching for new information and adjusting the information to both fit into and shape new mental models (Hmelo & Evensen, 2000). The exploration process in video games promotes engagement and motivation, while also mirroring the problem-solving process of PBL, allowing players to try solutions in an environment that is safe to fail in.

However, it is important for teachers to ensure that exploration with games is in accordance with meeting specified learning goals. Teachers should therefore plan to incorporate structured guidelines on gameplay that is oriented on meeting objectives. For example, Watson, et al. (2011) describe how the teacher they observed had implemented a grade associated with how well the student teams met their game objectives because the first time he utilized the game, the students had approached it from a play perspective and taken actions in direct contradiction to the game’s goals and their own success within the game. With Easter eggs (hidden content) and familiarity with the high level of forgiveness for failure that many games offer, students may be tempted to ignore game goals just to see how the game responds. This is fine in unstructured play experiences, but with the time constraints of the classroom, teachers must plan for how they will keep students on task while still having fun.

Toprac (2011) describes how the game he implemented demotivated students at times from engaging with the learning content and seeking the optimal solution. Instead, once the students realized that the game had levels, they focused primarily on just completing each level rather than strategizing what the best solution was. Student interaction was also negatively impacted by the game as students concentrated on the immediate feedback provided by the game while also sharing information gained from the feedback in order to pass levels rather than carefully considering the pros and cons of each choice.

As emphasized by Amory (2010) and Watson et al. (2011), structuring the classroom environment so that students collaborate as they seek to solve game problems is key to effective learning with games. It can encourage more thorough exploration as game strategies and choices can be discussed amongst students and deeper contemplation of the problem and identification of additional potential solutions can take place.

Reflection

Reflection is a key component to learning in both a PBL environment and an environment utilizing games for learning. A number of researchers have noted the critical nature of reflection or debriefing for effective game-based learning (Garris et al., 2002; Gee, 2003). Video games are highly interactive, and it can be easy for players to take action with little consideration. Watson et al. (2011) found that the teacher experienced with using games in his classroom quickly adopted a strategy of having small groups of students playing the game, and rotating which student controlled the computer in order to promote more reflection and collaboration amongst students. Just as PBL calls for small groups to work on problems together, there likewise is some benefit to having students play games in small groups to promote reflection and discussion before choosing to adopt a strategy or implement a solution.

As gameplay moves on, there are several points for players to reflect on: (a) data and information regarding the encountered problem at the problem analysis step; (b) knowledge acquired after conducting research at the step of identification of needed knowledge and skills;
(c) hypotheses to determine plausible solutions; (d) and the procedure for testing various solutions, reconsidering their hypotheses and constructing the best solution through the lens of their newly accessed information.

A concern of traditional PBL is that learner outcomes may not be very tangible (Margtson, 1999). In the game-based PBL environment, players make choices and the game generates results based on these decisions, often including scores. Screenshots or video captures can document specific outcomes of the experience, and in multiplayer environments, teachers and other players can see the outcomes of the choices and solutions of others.

A challenge to using video games for learning is that many games (particularly those designed for commercial and not educational purposes) do not build in reflection opportunities within the game. Therefore, it is very important that reflection be structured into the implementation process. Group discussion, storytelling, sharing and critique are appropriate strategies to support reflection. Dolmans and Schmits (2006) found that in a PBL environment, group discussion positively influenced students’ intrinsic interest in the subject matter under discussion (Dolmans & Schmidt, 2006). Collaboration is a key component of PBL, and this should be reflected in the use of games for learning. In PBL, it can be difficult for students to easily adapt to this new collaborative role (Brush & Saye, 2001). However, Ke (2008) found that when implementing a game in a classroom, students spoke naturally with each other when discussing gameplay, and Amory (2010) and Watson et al. (2011) also reported positive student in-class collaboration surrounding their game-based problem solving.

It is important for teachers to structure opportunities for reflection. This can include stopping game play to reflect in small groups or as a class, providing additional resources, facts, or insights and asking students to discuss them, or directing students to participate in journaling or other reflective activities to capture their in-game experiences outside of the game (Watson et al., 2010). Ketamo and Kiili (2010) note that conceptual changes with learners were facilitated by breaks from playing the game. Gameplay can be a very fast and fluid experience, and while this is conducive to engagement, often, structuring opportunities for reflection will be important to effectively promoting learning. Rieber (2005) argues “experience without reflection is detrimental to learning” (p. 554), and Garris et al. (2002) state that debriefing is critical to transforming the game experience into a learning experience. Kiili (2007) highlights the critical nature of reflection for learning with video games. Video games support problem solving by allowing players to become embodied in the game-play experience, moving through a fantastic, virtual world, encountering challenges, and reflecting and solving problems actively and critically (Gee, 2003).

Facilitation

Facilitation is a key component of PBL necessary to monitor the problem-solving process and various interactions. Koschmann, Glenn, and Conlee (2000) asserted that in PBL, instructors or facilitators should continually reinterpret and make relevant the experience within the confusion of the ongoing interaction. Educators should guide students to make connection within and between subjects and between what they were learning to what they had already known (Coles, 1999). Teachers should help promote student reflection and debrief the gameplay experience. Garris et al. (2002) describes debriefing: “a description of events that occurred in the game, analysis of why they occurred, and the discussion of mistakes and corrective actions” (p. 454). Teachers should also promote collaboration and interaction between students. Ke (2008) noted that while students in her study spoke easily about gameplay, this did not carry over to elaborating on their learning and scaffolding others’ learning. This again highlights the importance of the teacher in promoting reflection and elaboration.

As successful PBL implementation relies on skillful facilitation, PBL provides an ex-
cellent model for effectively facilitating the use of games for learning. Furthermore, as a learner-centered approach, PBL can be helpful in guiding teachers to establish a more active and engaging classroom environment. PBL facilitators, and therefore teachers implementing educational games, “should be more facilitory and less didactic, more guide like and less directly instructive….” (Koschmann et al., 2000, p. 53). The strategies for facilitation include asking questions and demonstrating steps most confusing to students. Hmelo-Silver (2004) asserted that teachers facilitated students’ learning by modeling and coaching primarily through the use of questioning strategies, which were helpful in facilitating learning and thinking. Questions should be:

- Open-ended, asking for more evidence or for clarification
- Focusing students’ attention/awareness and eliciting causal explanations
- Eliciting more information from students rather than informing students or directing what students ought to be learning
- Encouraging students to justify their thinking
- Designed to externalize students’ self-reflection (Gilkison, 2003; Hmelo-Silver, 2004).

Further facilitation techniques include:

- Elicitation: the tutor asks a question, in most cases generally to the group as a whole, but occasionally by directly questioning one student; an elicitation was an event that required a verbal response from the students.
- Re-elicitation: the tutor repeats the same elicitation, or rephrases it; a re-elicitation required a verbal response from the students, and indicates that the previous response given was inadequate in some way.
- Prompting: the tutor gathers more information or gets the students to expand on something they had not fully explained.
- Refocusing: the tutor uses re-focusing to bring the students back to the topic or the case scenario if they have wandered.
- Facilitating: the tutor guides the students in a certain direction, suggesting what to do next or attending to group dynamics.
- Evaluating: the tutor makes comments to evaluate the group process or individual students.
- Summarizing: the tutor summarizes a section of discussion; this usually signals the closing of one topic before the group moved on to the next.
- Giving feedback: the tutor confirms that she had heard or seen an appropriate response.
- Informing: the tutor passed on facts, information, opinions or ideas; giving information does not require a response from the students
- Directing learning: the tutor gives a direct message about what students should be learning (Gilkison, 2003).

CONCLUSION

This article argued that facilitator support is needed to maximize learning from video games. With a richer literature base on effective implementation, PBL offers a promising framework for games. We illustrated the similar approaches to learning through PBL and video games, and presented a framework, based on PBL, for how to best implement and facilitate the use of games for learning in the classroom. The process of using a game for introducing a problem, and then activating, exploring, reflecting, and facilitating around and within the game establishes a framework for effective learning to occur. Ultimately, although teachers will be primarily focused on facilitating the learning experience, they must be involved in planning for and supporting all aspects of the framework. It is important to recognize that the focus of this framework is on furthering the idea posited by Amory (2010) that learning is most effective with a game rather than from a game. This framework utilizes PBL to describe how to structure a learning environment that utilizes
a game as tool to further education but is less limited by game constraints and places great importance on the teacher to identify, facilitate, and promote the meeting of learning objectives.

Future research is needed that implements this framework and assesses its efficacy for supporting game-based learning in structured environments such as classrooms. Research is also needed on how to provide effective professional development for teachers on effectively implementing this framework. Educational game designers could also benefit from this framework in understanding the importance of designing not only games but also external pedagogical supports and teacher materials based on this framework in order to help teachers adopt and utilize the game (Echeverría et al., 2011).

While barriers exist to the implementation of both PBL and game-based learning, and the use of both methodologies have not yet become widely adopted in schools, today’s knowledge economy demands that students learn to be problem-solvers and collaborators. The use of games in the classroom is often a one-time event rather than a commitment to learner-centered approaches. Game-based learning and PBL both promote learner-centered learning environments and, as this article described, are complementary methodologies. Games can ease the transition for teachers to PBL and other learner-centered approaches by providing structure and taking on some of the responsibilities typically reserved for teachers in PBL environments that do not utilize technology. By following this framework, teachers will not only have guidance on how to effectively structure the use of games for learning in the classroom, but they will also be introduced to PBL, another learner-centered methodology well suited for meeting the needs of today’s learners.

REFERENCES


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