

## Review Article

# Problem Based Learning (PBL) for Large Groups Medical Students e-Problem Solving Test: A Mutation Causing Retinoblastoma (Rb)

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## ABSTRACT

E-learning can be used to enhance and aid the implementation of problem-based learning (PBL). Through e-learning, learning can take place anywhere and anytime through the communication tools that it has. This feature provides a channel of communication among medical students and content experts in medicine that is not bounded by the class time and physical presence. Therefore, e-learning has been identified as a learning system that can greatly enhance the implementation of PBL among undergraduate-medical students. Concept-maps can be successfully used to teach conceptual thinking, thus increasing students' competence in critical thinking in the modern paradigm. The purpose of this paper is to put forth effective strategies for utilizing e-learning in PBL for medical and allied health science education with a model PBL on Retinoblastoma (Rb). Some effective strategies that have been identified are: (a) the use of online-learning tool to deliver structured assigned independent e-PBL problems to students, (b) content expert-facilitator-initiated communication for the PBL case scenario on the e-learning platform, (c) frequent availability of content expert on-medical education online for facilitation, and (d) the use of online resources such as relevant case scenarios, videos, research component such as review journal for reflection, construction of concept maps and assessment. These strategies will enable a more efficient and effective implementation of out-come based self-directed structured assigned independent learning e-PBLs related to difference modules of medicine, with relatively less number of content experts and in short time for large group of medical and allied health sciences students.

**KEY WORDS:** e-learning, e-problem based learning, Medical science education, Interactivity, Supplemental digital content, Research components, Concept mapping, Retinoblastoma.

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**Self-Directed Structured e-Problem Based Learning on Retinoblastoma (RB):** The exponential growth of knowledge is one reason that strategies, such as problem-based learning (PBL), are becoming popular, and technology support can be so valuable [1]. PBL is a method of instruction that uses patient prob

lems as a basis for developing students' problem solving skills and their knowledge of basic and clinical sciences. Students work together to understand a patient's medical problems. Usually, PBL occurs in small groups of six to eight students with a faculty tutor as a facilitator who offers appropriate feedback and

guidance. Medical science education and training varies considerably across the world. Various teaching methodologies have been utilized in medical science education, which is an active area of educational research. Problem based learning (PBL) with "Flying A Kite Approach" is an innovative approach and latest advance in the integrated medical curriculum to achieve the effective measurable outcomes for the large group of medical students in small groups with the on-line resources available (OLRA) [2,3]. Case studies are the basis of a well known medical education pedagogy called problem-based learning (PBL). Traditional case studies are paper based and contain brief medical facts about a patient's illness. It has been documented that, experts benefited more from visual information than did students [4].

A recent systematic review (2008) described the effectiveness of Internet based learning (IBL) in health professions education. A comprehensive synthesis of research investigating how to improve IBL is needed. This systematic review sought to provide such a synthesis [5]. Generally, blended learning environments are new educational media that can inspire great challenges and advantages for both teachers and students. They provide an opportunity to rethink our teaching and achieve learning goals that previously may have been beyond our reach [6]. Thus the way in which online activities are designed and delivered can add value and make a positive difference. Online, the PBL tutor plays a role different from the role of a tutor in a face-to-face PBL format [7], although the general issues and situations with which they must deal are essentially identical-to facilitate the process of active learning by students and foster the skills of critical thinking. But the WBL-PBL tutor has to fulfill additional conditions for successful online tutoring, which can be categorized as pedagogical, social, managerial, and technical [8]. The virtual case modality may have enhanced individual learning, since it allows an individual to control his or her own viewing and reviewing of images while reflecting on group discourse. The duration of undergraduate medical education is 5 years. A hybrid problem-based curriculum is the principal educational strategy in the first 2 years. This hybrid system

is similar to the description by [9] where the students are prepared by giving didactic lectures for fundamental concepts on which they elaborate in small group tutorials, facilitated by knowledgeable tutors who are able to provide adequate feedback on student's understanding and learning [9]. The students are grouped into a number of 10-12 students, with a lecturer appointed as facilitator. The facilitators are mainly lecturers from the basic medical sciences and paraclinical sciences department who have attended atleast a workshop on PBL and facilitation skills [10]. Problem-based learning (PBL), which focuses on spontaneity, collaboration, and flexible problem-solving skills, is such an approach that engages students in problem-solving scenarios. PBL programmes were more likely to plan and undertake research in their own time using resources that they had identified themselves rather than those identified by staff [11,12]. Concept maps are intended to represent meaningful relationship between concepts in the form of propositions [13]. High-yield cognitive concept mapping is an educational tool that encourages meaning and learning [14]. Fostering meaningful and self-directed learning among medical students is now recognized as a major goal of medical educators [15,16]. Concept mapping is an active, creative, visual and spatial learning activity in which concepts are organized according to their hierarchical relationships [17]. It has been documented that, innovative pedagogy such as concept mapping had improved primary medical care competencies in all aspects and the implications of the findings contribute to developing nursing education and improving nursing competencies in other contexts [18]. Concept mapping is an innovative classroom tool and technique that can deepen our curricula as students advance through an accounting program.

It is an enabling skill to enhance the development of students' thinking skills through more meaningful learning activities [19]. Whatever the clinical case may be, there was a pressing need to improve PBL facilitation by more rigorous training of facilitators. The "content experts" were tempted to teach, and "the non-content experts" sometimes felt out of

depth, in addition to need of more number of content experts. Neville (1999) reported that, Mc Master Education Committee's idea that the non-expert would be less inclined to emphasize detail and more inclined to see things from the view point of students and hence have the potential of becoming better facilitators [9]. It had been recognized that students view PBL from the point of view of passing examinations [20]. With e-learning becoming more and more popular [21], integrated PBLs covers the clinical relevance of the particular disease with different disciplines of medicine in relatively short time, which includes anatomy, pathophysiology, biochemistry-genetic basis of the disease, pathology, laboratory diagnosis, pharmacology, community medicine, behavioural issues at the must know level of large group phase-1 medical students with much emphasize on self-directed learning with the OLRA. Prioritise the learning issues to the most important which includes application of basic sciences in the practice of medicine, Clinical skills, Disease prevention and health promotion, Family and community issues in health care, professionalism, ethics, and personal development, self-directed life-long learning & information management, critical thinking and research [2]. PBL encourage the students to acquire up to date knowledge and clinical-communication skills right from the beginning of the medical curriculum and inculcate life-long learning. Some educators feel that case-based learning (CBL) is of more value, given the dense medical curriculum and need for efficient use of student and faculty time [22]. Video has such a strong influence on learners because text actually is an abstract representation of reality [23]. Video brings the abstraction to a level where students can begin to describe. Dual-coding theory might suggest that having a visual example of abstract representations should promote retention of the concepts and assist students in constructing a mental model, especially when visual cues have a critical role in the diagnostic process. Norman found that experts benefited more from visual information than did students [24].

Obvious lack of clinical experience or visual examples could explain this difference and should encourage educators to include more

visual examples of clinical concepts in their teaching [25]. Kenny and Beagan (2004) state that the use of video-based, PBL cases may be a natural complement to a commitment to thick narrative [26]. In combination, they have the potential to form a rich-narrative case for the robust exercise of PBL-based analysis, problem solving, and learning. Cases that use video rather than text provide information in a more realistic format and supply context to students [27]. This present article emphasizes the achievement of the measurable learning outcomes with the in relatively short time, with the structured assigned independent mode PBLs on a particular disorder which are not covered by any other mode of teaching-learning activities including didactic lectures and/or seminars and so on. At the beginning of the semester 1 of medical curriculum at least one hands-on workshop on PBL-process-facilitation is to be provided to the students by the content experts (PBL working group) of medical education unit. In this article provided with the case study on Retinoblastoma (Rb). Rb is a rare eye tumor of childhood that arises in the retina. Rb is caused by a deletion of chromosomes 13, 14, 15, 21, and 22 and is a frame-shift deletion mutation. It is the most common intraocular malignancy of infancy and childhood; with an incidence of 1/15,000-20,000 live births. The two most frequent symptoms revealing retinoblastoma are leukocoria and strabismus. Pleiotropy includes iris rubeosis, hypopyon, hyphema, buphthalmia, orbital cellulites and exophthalmia may also be observed. Sixty per cent of retinoblastomas are unilateral and most of these forms are not hereditary (median age at diagnosis two years). Retinoblastoma is bilateral in 40% of cases (median age at diagnosis one year).

All bilateral and multifocal unilateral forms are hereditary. Hereditary Rb constitutes a cancer predisposition syndrome: a subject constitutionally carrying an *RB1* gene mutation has a greater than 90% risk of developing retinoblastoma but is also at increased risk of developing other types of cancers. The PBL Process: Day-1: PBL-Induction: Step 1-Trigger 1: Release of the digital copy of figure 1 shows the phenotype of patients with retinoblastoma (Rb) and brain storming. Step-2: Trigger 2-display of karyotype

of a person affected by Rb and brain storming. Step-3: Trigger 3-display of pedigree chart-inheritance of Rb, discussion and division of labour. Day 1-Step 4: Research component on Retinoblastoma-Review Article: URL. Day 1- Step 5: Matching and fine tuning of the learning outcomes arrived by the team, facilitated by team leader. Day 2-Step 1: Presentations and summarization on Rb. Day 2-Step 2: Display of video clip on RB, U-Tube URL: <https://www.youtube.com/watch?v=FOmZKtupBYg> [28]. Day 2-Step 3: Construction of cognitive concept mapping and discussion, Day 2-Step 4: Spot test on matching questions.

**Terms to be Familiar With Before Start to Solve the Test:**

Retinoblastoma (RB), *RB1* gene on chromosome 13 (first tumor suppressor gene discovered), genetic disorder, Oncogenes, tumor suppressor genes, DNA-repair genes, epidemiology, mode of inheritance-X-linked, autosomal dominant (AD) transmission, penetrance, pedigree analysis, karyo-type of RB, frame shift-deletion-mutation, deletion of parts of chromosomes at 13, 14, 15, 21, and 22 [29]. Alfred Knudson's two-hit hypothesis [30], biochemical-molecular basis of retinoblastoma, sporadic (non-hereditary) RB, familial (hereditary) RB, consanguinity, risk factors of RB, signs and symptoms, pathophysiology, clinical presentation of RB, congenital anomalies-dysmorphism, differential diagnosis, molecular etiopathogenesis, bridge to pharmacology, management of RB, treatment options, preventive medicine, prenatal diagnosis, amniocentesis, genetic counselling, behavioural issues, ethics, referral to speciality clinics [31] Memorial Sloan-Kettering Cancer Center, URL: <http://edit.mskcc.org/pediatrics/childhood/retinoblastoma>, Memorial Sloan-Kettering Cancer Center, research component in RB, model review article on Retinoblastoma, Helen Dimaras., (2012) 32 URL: <http://www.sciencedirect.com/science/article/pii/S0140673611611379>, 32.

**PBL Process Keywords:** PBL, Learning Management System, learning outcomes, concept, hypothesis, provisional diagnosis, small group learning, integrated medical curriculum, measurable learning outcomes, on-line resour-

-ces, e-learning, self-directed learning, on-line reusable resources, questioning ability, clinical skills, higher order critical thinking, Bio-Gen Inno-vision, content experts, PBL-process, PBL-facilitation, group leader as facilitator-stimulating discussion, facilitators guide, audio-visual facility, medical dictionary, group dynamics, brain storming, team-work, peer value-review, division of labour, leadership quality and team player, group leader as a facilitator, communication skills, time-management, mono-acting as a simulated patient, parts of the PBLs: Step wise release of the parts of the PBL triggers-Step 1-5 and video clips, construction of high-yield cognitive concept mapping-innovative pedagogy, spot test-matching questions.

**Learning Outcomes:** Retinoblastoma, karyo-type of Retinoblastoma, Alfred Knudson's two-hit hypothesis, risk factors of Rb, amaurotic cat's eye, Flexner-Wintersteiner rosettes, histopathology of Rb, differential diagnosis of leukocoria, management and prevention of Rb, genetic counseling and ethical issues on Rb.

**Research Methodology:** This research article used a qualitative research design i.e. a case study method. Data had been collected from different teaching learning resources and PBL was constructed on Retinoblastoma based on "Flying A Kite Approach", in the e-learning system itself. Concept maps, research component in the form of review article on Retinoblastoma and questions relate to integration of e-learning in PBL had been postulated with less number of content experts in an electronic forum and students are required to summarise the learning outcomes, construct the concept map and respond to those questions at the end of the PBL.

**Next steps:** Although this pilot test is a limited one, more importantly, it sets the stage for further research. Our next step is to revise the current model and construct numerous e-PBLs with content experts of medical education on different modules of phase 1 integrated medical curriculum, perhaps through the incorporation of branched and interactive case material that would allow the learners to see the consequences of their decisions. We also plan

### The Self-Directed PBL Process Overall

The Self-Directed PBL Process Overall (Day-1 Induction; Day-2 Presentation)	
No	DAY 1: Induction of PBL on Retinoblastoma (Rb)
1	Day 1-Step 1-Trigger 1: Release of the Digital Copy of Picture 1 Shows the Presentation of Retinoblastoma Phenotype.
2	Day 1-Step 2-Trigger 2: Figure 2: Display of Digital Copy of Karyotype of Rb.
3	Day 1-Step 3-Trigger 3: Display of Pedigree Chart on RB. Figure 3: Genetic Features of Heritable Retinoblastoma.
4	Day 1-Step 4: Trigger 4: Research Component on Retinoblastoma- Review Article: URL: <a href="http://www.sciencedirect.com/science/article/pii/S0140673611611379">http://www.sciencedirect.com/science/article/pii/S0140673611611379</a> .
5	Day 1-Step 5: Matching and Fine Tuning of the Learning Outcomes Arrived by the Team, Facilitated by Group Leader (Chair Person of the PBL).
Day 2: Presentation on Retinoblastoma	
1	Day 2-Step 1: Presentations and summarization on Retinoblastoma.
2	Day 2-Step 2: Display of Video Clip on Retinoblastoma. URL: <a href="https://www.youtube.com/watch?v=F0nZKtupBYg">https://www.youtube.com/watch?v=F0nZKtupBYg</a> .
3	Day 2-Step 3: Construction of Cognitive Concept Mapping. Model Map on RB: URL: <a href="https://www.scribd.com/doc/263241934/Retinoblastoma-Cognitive-Concept-Map-Dr-Kumar-Ponnusamy-and-Dr-Jegathambigai-RN-Problem-Based-Learning-PBL-for-Large-Groups-Medical-Students">https://www.scribd.com/doc/263241934/Retinoblastoma-Cognitive-Concept-Map-Dr-Kumar-Ponnusamy-and-Dr-Jegathambigai-RN-Problem-Based-Learning-PBL-for-Large-Groups-Medical-Students</a> .
4	Day 2-Step 4: Spot Test on Matching Questions on Retinoblastoma.

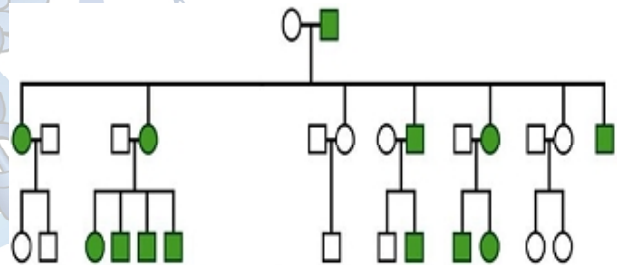
### The PBL Process: Day 1-Step 1-Trigger 1: Release of the Digital Copy of Figure 1 Shows the Presentations of Retinoblastoma Phenotype.



Reference: Helen Dimaras, Kahaki Kimani, Elizabeth A O Dimba, Peggy Gronsdahl, Abby White, Helen S L Chan, Brenda L Gallie. Retinoblastoma. Lancet 2012; 379: 1436-1446. Google Images.Com.

### Day 1-Step 3-Figure 4-Trigger 4: Genetic Features of Heritable Retinoblastoma-Model

#### Autosomal Dominance (AD) Pattern of Inheritance in Cancer Patients With a Family History of Retinoblastoma.



### Day 1- Step 1: Figure 2- Trigger 1: Display of Copy of Clinical Features.



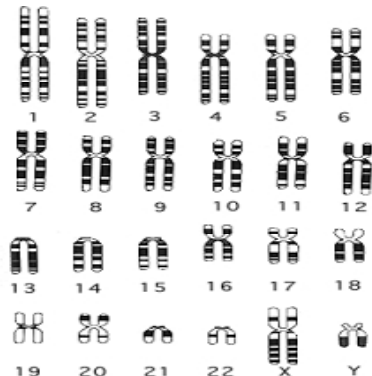
Leukocoria with tumor visible through the right pupil. Note the clear cornea and lack of orbital signs.

The left eye is enlarged. The cornea is opacified, the conjunctiva is injected, while tumor cells can be seen on the corneal endothelium (arrows).

Computed tomography demonstrates intratumoral calcifications consistent with retinoblastoma (black arrows). The left optic nerve is enlarged and retrobulbar opacities suggest extrascleral extension (white arrow).

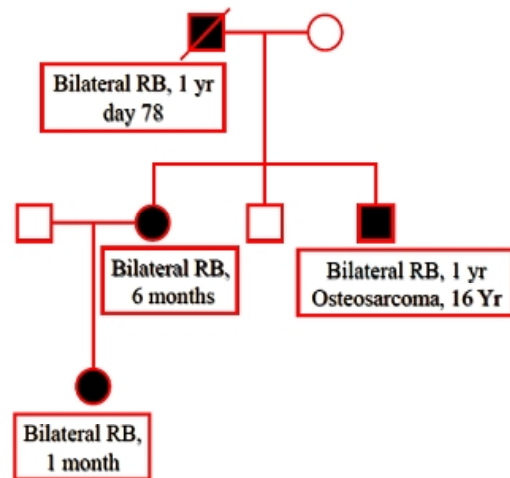
Source: Eye Cancer Network.com

### Day 1- Step 2: Figure 3-Trigger 2: Display of Digital Copy of Karyotype of Rb.



**Retinoblastoma Inheritance:** Rb is inherited as a dominant trait, but it is recessive at the cellular level. People with familial Retinoblastoma carry one mutated copy in all their cells. Cells that would get a second hit will develop Rb or later, other cancers.

### Day 1-Step 3-Figure 5-Trigger 5: Inheritance of Retinoblastoma.



**Day 1-Step 4 - Trigger 6: Release of Research Component on Retinoblastoma-Review Article: URL: [http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(11\)61137-9.pdf](http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(11)61137-9.pdf)**

**Day 1- Step 5: Matching and Correction of the Learning Outcomes Arrived by the Team, Facilitated by Group Leader (Chairman of the PBL Process).**

**Matching Questions on Retinoblastoma Inheritance:**

Matching Question on Retinoblastoma Inheritance			
No	Column A	Ans	Column B
1	Alfred Knudson's two-hit hypothesis	H	A. Associated with retinoblastoma containing deletion of chromosome 13.
2	Osteosarcoma	A	B. Variation in clinical features (type and severity) of a genetic disorder between affected individuals, even within the same family.
4	FISH	C	D. Tumor suppressor gene (TSG) loss.
5	Variable expressivity	B	E. RB1 mutation is present in all of the somatic cells.
6	Germinal retinoblastoma	E	F. Within a single individual or tissue, the occurrence of two or more cell lines with different genetic or chromosomal constitutions.
7	Hereditary pattern of familial retinoblastoma	J	G. The presence of an altered gene within the egg or sperm (germ cell), such that the altered gene can be passed to subsequent generations.
8	Mosaicism	F	H. Two separate loss of function mutations are required to inactivate both the homologous loci of the RB gene for malignant phenotype to be expressed.
9	The critical events has most likely resulted from an aberration involving chromosome 13 leads to a 5-month-old girl has bilateral retinoblastoma	D	I. A condition characterized by a whitish reflex within pupil. It is secondary to cataract, Coats' disease, retinoblastoma, retrolental fibroplasias, persistent hyperplastic primary vitreous, ect.
10	Germline mutation	G	J. Autosomal dominant (AD) inheritance.
11	Cytogenetic Location of Retinoblastoma	M	K. Multiple, often seemingly unrelated, physical effects caused by a single altered gene or pair of altered genes.
12	Pleiotropy	K	L. The proportion of individuals with a mutation causing a particular disorder who exhibit clinical symptoms of that disorder; most often refers to autosomal dominant conditions.
13	Penetrance	L	M. 13q14.2.
Ans: 1-H ; 2-A ; 3-I ; 4-C ; 5-B ; 6-E ; 7-J ; 8-F ; 9-D ; 10-G ; 11-M ; 12-K ; 13-M .			

to test future iterations with medical students within an established curriculum. Our aim is to learn more about how self directed structured integrated e-PBL case studies can recreate authentic situations that replicate the human experience in which medical professionals practice every day.

**CONCLUSION**

This exploratory study explains that, how the mode of e-PBL case presentation will be effective for critical thinking of groups using the e-PBL format. Students who learned in a virtual

modality with digital on-line resources, which includes the cognitive concept mapping, research component in the form of review article on a particular ailment, video, relevant case studies engaged in more critical thinking.

Norman and Schmidt (2000) suggested that the quality of the case in PBL relates to group functioning through which time spent on individual study relates to achievement 24. We have explored a few aspects of case quality, its mode of presentation. We believe our data support that the cognitive concept mapping and video will enhances critical thinking in either face-to-face or virtual PBL groups.

Previous e-learning medical education research data suggest that the concept maps and implementation of research component and video enhanced critical thinking in both face-to-face and virtual PBL groups.

**Abbreviations:**

- PBL-** Problem Based Learning,
- OLRA-** On-line resources available,
- RB1-** Retinoblastoma gene 1.

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