doi: 10.13241/j.cnki.pmb.2017.33.036

·生物医学教学·

以问题为中心和以案例为基础的讨论式教学模式在重症医学科教学中的应用评价

于朝霞[1] 顾亚楠[1] 张向阳[2] 王 鑫[1] 王 毅[1]

(1 新疆医科大学第一附属医院重症医学科 新疆 乌鲁木齐 830054;
2 新疆医科大学第一附属医院心脏中心 新疆 乌鲁木齐 830054)

摘要 目的:探讨以问题为中心的教学(PBL)和以案例为基础的教学(CBL)的讨论式教学模式在重症医学科教学中的应用价值。**方法:**选取2015年至2016年在重症医学科轮转实习五年制与七年制学生70人,按随机数字表法分为实验组与对照组各35人。实验组采用PBL结合CBL的讨论式教学模式,对照组采用传统的教学讲座法,实习轮转结束后进行统一考试检查两组学生理论知识与技能操作,同时发放问卷调查进行教学效果评估。**结果:**考试中非病例分析题得分,实验组为(47.51± 4.75)分,对照组为(46.69± 4.54)分,差异无统计学意义(P=0.458);病例分析题与技能操作得分,实验组分别为(34.55± 3.01)分、(79.91± 4.04)分,均优于对照组的(26.47± 2.18)分、(65.98± 6.47)分,差异有统计学意义(P<0.05)。问卷调查显示,实验组学员在评价个人所接受教学模式可以激发学习兴趣、提高自学能力、团队合作能力、沟通和表达能力、检索查阅文献能力、技能操作水平和促进建立临床思维所占比例分别为85.71%、82.86%、88.57%、77.14%、85.71%、94.29%和85.71%,均高于对照组的42.86%、34.29%、28.57%、31.43%、51.43%、45.71%、54.29%,差异有统计学意义(P<0.05)。**结论:**PBL结合CBL讨论式教学法有助于提高重症医学科的教学质量,同时受到学生欢迎。

关键词:以问题为中心的教学;以案例为基础的教学;重症医学科;教学模式
中图分类号:G642 **文献标识码:**A **文章编号:**1673-6273(2017)33-6557-04

Application Value of Problem based and Case based Discussion Learning Mode in Department of Critical care Medicine Teaching

YU Zhao-xia[1], GU Ya-nan[1], ZHANG Xiang-yang[2], WANG Xin[1], WANG Yi[1]

*(1 Department of Intensive Care Unit, The First Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, 830054, China;
2 Heart Center, The First Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, 830054, China)*

ABSTRACT Objective: To explore the application value of discussion learning mode including problem based learning (PBL) and case based learning (CBL) in department of critical care medicine teaching. **Methods:** A total of 70 students of five year system and seven year system, who were practised in rotation in department of critical care medicine from 2015 to 2016, were selected and randomly divided into experimental group(n=35) and control group(n=35). The experimental group was given PBL combined with CBL discussion teaching mode,and the control group, traditional teaching method. After finishing rotation internship, the theoretical knowledge and skills of students of two groups were examined by a unified examination. Questionnaires were used to evaluate the teaching effect at the same time. **Results:** There was no significant difference in the scores of non-cases analysis subjects between the experimental group (47.51± 4.75) and the control group (46.69± 4.54)(P=0.458). The cases analyze and skill operation subjects scores of experimental group were (34.55± 3.01) and (79.91± 4.04), which were significantly higher than those (26.47± 2.18) and (65.98± 6.47) of the control group, and the differences were statistically significant (P<0.05). The questionnaire survey showed that the proportion of beneficial to stimulate interest in learning, improving self-learning ability, team cooperation ability, communication and expression ability, search and retrieval of literature ability, skill level and promoting the establishment of clinical thinking of the experimental group, in the evaluation of personal acceptance of teaching model, is higher than that of the control group,and the differences were statistically significant(P<0.05). **Conclusion:** PBL combined with CBL teaching method is helpful to improve the teaching quality of critical medicine, and is welcomed by students.

Key words: Problem based learning; Case based learning; Department of critical care medicine; Teaching mode
Chinese Library Classification (CLC): G642 Document code: A
Article ID: 1673-6273(2017)33-6557-04

作者简介:于朝霞(1975-),女,硕士,副主任医师,从事重症教学、心脏保护、脏器功能不全方面的研究,E-mail:fgihtfg@163.com
△ 通讯作者:张向阳(1957-),男,博士,主任医师,从事心脏保护、高血压、血脂调节方面的研究,E-mail:kucdty@163.com
(收稿日期:2017-03-16 接受日期:2017-04-12)

前言

重症医学科是一门抢救多病因、多系统、多学科的危重患者，并延续生命支持的新兴学科，要求医护人员具备理论扎实、操作熟练、思维活跃的素质[1]。随着医疗进步与教育模式不断革新，作为传统教学模式的讲座教学法（Lecture based learn，LBL）已经无法满足目前高校医疗教育对学生传授医学知识，建立临床思维以及培育医学人文素养的要求[2,3]。近年来我国医学教育模式革新尝试了以问题为中心的教学（problem-based learning，PBL）和以案例为基础的教学（case based learning，CBL）[4-6]。故我院重症医学教研室针对传统教学模式存在的弊端，引入 PBL 结合 CBL 的讨论式教学模式，与传统教学模式进行比较，得出以下医改成果。

1 资料与方法

1.1 一般资料

选取 2015 年至 2016 年在我科进行临床轮转实习的共 70 名五年制与七年制临床医学学生作为受试对象，其中五年制学生 50 人、七年制学生 20 人。按随机数字表法将 70 名受试对象分为实验组（35 人）与对照组（35 人）。实验组接受 PBL 结合 CBL 的讨论教学模式，对照组则接受传统讲座教学法。两组受试对象在年龄、性别、五年制与七年制所占比例、入科前专业课成绩与技能考核成绩上的差异比较无统计学意义（P>0.05），说明两组受试对象具有良好的可比性。详见表 1。

表 1 两组学生基线资料比较

Table 1 Comparison of baseline data between the two groups

Groups	n	Age(years)	Gender		Five-year/seven-year students	Scores of professional courses before admission (points)	Score of skills before admission (score)
			Male	Female			
Experimental group	35	22.06± 0.73	17	18	26/9	77.36± 4.65	69.43± 5.63
Control group	35	22.00± 0.91	16	19	24/11	77.23± 4.58	70.23± 5.74
x^2/t		0.329	0.057		0.280	0.026	-0.589
P		0.743	0.811		0.597	0.979	0.558

1.2 教学方法

1.2.1 教学内容 两组接受的教学内容均参照本院重症医学科教学大纲及教学计划的要求制定，并使用《内科学》（人民卫生出版社，第 8 版，葛均波、徐永健主编）为教材，教学过程所用讲授材料（如授课课件和病例资料等）均经过重症医学科教研室集体审阅并修订通过，保持教学内容一致。两组对象教学过程中相同教学内容均由教研室同一老师授课。

1.2.2 对照组教学实施 对照组主要采用传统讲座教学法进行授课教学。教学模式为带教老师依据教学内容向对照组成员讲授背景知识、主要临床症状、疾病病因、发病机制、临床鉴别与治疗方法等。对照组成员被动接受带教老师知识灌输。

1.2.3 实验组教学实施 实验组主要采用 PBL 结合 CBL 讨论教学法进行授课教学[7-9]。具体方法如下：（1）在完成分组之后，详细向实验组成员讲解 PBL 结合 CBL 讨论教学法，使该组成员对新型模式的教学方法有一定初步了解，并贯彻于重症医学科教学过程中。（2）PBL 教学阶段，将成员随机分成 6~8 人的若干讨论组，具体程序为 " 下发案例→提出中心问题→自主查阅资料→小组讨论→再次提出问题→二次查阅资料→班级交流分析→总结与反馈 "。（3）CBL 教学阶段，教学程序为 " 病例介绍→收集体征与检查指标→讲授启发→讨论总结 "。教学过程中，带教老师依据教学安排选取合适病例，组织成员进行讨论与分析，并在此过程中起适时点拨与引导作用，最后总结归纳。

1.3 评估方法

1.3.1 成绩测试 在课程结束时，依据重症医学科教学考试大纲对两组成员的理论知识与技能操作进行统一考试。理论考试与技能操作考试题目由考试题库随机抽取，卷面均以百分制计分。理论考试题型为非病例分析题：客观选择题（40 分）、简答论述题（20 分），以及病例分析题（40 分），考试结束后由教研室老师按统一标准进行流水式阅卷；技能操作考试由 5 名教研室老师现场评分，取平均值。

1.3.2 问卷调查 理论考试结束时同时下发问卷调查，用问卷形式调查学生对教学模式的评价。问卷涉及到接受的教学模式是否有利于激发学习兴趣、提高自学能力、团队合作能力、沟通和表达能力、检索查阅文献能力、技能操作水平和促进建立临床思维等 7 个方面。发放问卷 70 份且全部回收，回收率为 100%。

1.4 统计学方法

利用 SPSS19.0 统计学软件对数据进行分析处理，计量资料用均数± 标准差（$\bar{x}$± s）表示，两组样本组间比较采用 t 检验；计数资料用百分率表示，两样本率的比较采用 x^2 检验，P<0.05 为差异有统计学意义。

2 结果

2.1 两组成员理论与技能操作考试成绩比较

两组成员在重症医学科完成教学安排的授课学习后均进行了理论与技能操作考试，在非病例分析题部分，两组成员所得成绩差异无统计学意义（P>0.05），而在病例分析题与技能操作上，实验组成员所得成绩均高于对照组，差异具有统计学意义（P<0.05）。详见表 2。

2.2 两组学员调查问卷情况比较

两组成员在进行理论考试结束后都接受问卷调查，分析调查结果显示，实验组学员在评价个人所接受教学模式有利于激发学习兴趣、提高自学能力、团队合作能力、沟通和表达能力、

检索查阅文献能力、技能操作水平和促进建立临床思维所占比例均高于对照组，且差异具有统计学意义（P<0.05）。详见表3。

表2 两组成员理论与技能操作考试情况（分，$\bar{x}\pm s$）

Table 2 Test results of theory and skills of the two groups (scores, $\bar{x}\pm s$)

Groups	n	Non case analysis subjects	Case analysis subjects	Skill operation subjects
Experimental group	35	47.51± 4.75	34.55± 3.01	79.91± 4.04
Control group	35	46.69± 4.54	26.47± 2.18	65.98± 6.47
t		0.746	12.857	10.810
P		0.458	0.000	0.000

表3 两组成员问卷调查结果统计表

Table 3 Questionnaire survey results of the two groups

Survey contents	Experimental group		Control group		x^2	P
	Number	Percentage	Number	Percentage		
Stimulate interest in learning	30	85.71	15	42.86	14.000	0.000
Improve the self-learning ability	29	82.86	12	34.29	17.014	0.000
Improve team cooperation ability	31	88.57	10	28.57	25.963	0.000
Improve communication and expression ability	27	77.14	11	31.43	14.737	0.000
Improve the ability of searching and consulting documents	30	85.71	18	51.43	9.545	0.002
Improve operation ability	33	94.29	16	45.71	19.660	0.000
Promote the establishment of clinical thinking	30	85.71	19	54.29	8.231	0.004

3 讨论

重症医学科是一门集急诊、内科、外科、妇产科等多学科交叉的新兴二级学科，主要救治病情危重、病因复杂、病情多变的危重症患者，要求从事该专业的医护人员具有理论基础扎实、临床技能熟练、心理素质强大等素质。作为一门新兴学科，需要国内医疗教育系统培育出大量符合条件的高素质人才，促进学科发展，但是目前传统的教学模式却存在以下弊端[10]：（1）学生自主探究能力不足。长期以来，传统教学模式以教师课前备课，学生长期处在一种被动的学习地位被灌输知识。此外医疗卫生专业知识内容往往枯燥而乏味，学生的学习兴趣和积极性低下，导致自主探究能力不足。（2）学生临床思维存在缺陷。学生在传统教学模式教导下学习的每一种疾病相关知识往往相互独立，无法形成有效的知识网络。同时，课堂理论知识与临床实际情况存在差异，学生无法自主将理论知识运用至临床，造成临床思维分析能力不足。（3）学生团队协作意识薄弱。传统教育模式下，知识流动方向是教师指向学生，造成学生之间互动匮乏，面对问题往往等待教师讲解，而非通过相互探讨交流想法解决问题。重症医学科倡导的团队协作，注重沟通交流，恰巧是传统教学模式培养下的学生所不具备的[11]。因此，针对传统教育模式体现出的弊端，提高教学质量，是目前医疗改革必须思考的问题。

PBL教学法是1969年美国神经病学专家Barrows在加拿大的麦克马斯特大学创建的新型教学模式[12,13]，将传统教学模式中以教师讲授为主的特点转变为强调以学生的主动学习为主；它强调将学习与典型临床病例相结合，使学生通过对病例的理解，自主发现问题，再借助小组成员之间协作探究，自主地寻找问题的答案[14,15]。它令学生成为课堂的主导者，在轻松开放的课堂氛围中，充分阐述各自观点与主张，同时听取他人意见，扩展自我思维空间，进而学习隐含在问题背后的科学知识[16-18]。PBL教学法发挥学习过程中问题的导向作用，充分调动学生的主观能动性，促进学生形成自主学习与终生学习的行为习惯，同时可以运用所学知识解决现实问题，即所学有所用。美国哈佛大学医学院与法学院最先提出CBL教学法[19-21]，主旨是通过精选病例，使学生处于特定情境之中，运用已掌握的知识及检索文献资料，进行自主地判断与分析，最后由教师进行讲解概括，令学员从鲜明具体的实例中获取知识[22]。CBL教学法极大地激发学生学习兴趣与求知欲，从而有利于临床思维的养成[23-25]。国内外教育学者认可PBL与CBL教学方法在教育领域取得的成果，值得我国医学改革的借鉴[26-30]。本研究运用前瞻性实验方法得出结果显示，与采用传统教学模式的对照组相比，采用PBL结合CBL讨论式教学法的实验组成员，其学习学习兴趣与积极性更高；学习过程中，更注重分工协作与沟通表达，在查阅文献、提高操作水平与促进临床思维方面的差异具有统计学意义（P<0.05）。PBL结合CBL讨论式教学模式以学生为中心，使学生自主进行理论与实际相联系的学习，加强课堂知识的运用，加深了对所学知识的理解。统一考试结果也表明了实验组学生在病例分析、临床操作技能方面的成绩均高于对照组。

综上所述，PBL结合CBL讨论式教学法可以有效地克服传统教学法的弊端，明显改善重症医学科教学质量，并且得到学生认同与喜爱，值得进一步地推广应用。同时，应在实践探索过程中进一步完善方法，使之成为一种科学、高效的教学模式。

参 考 文 献（Reference）

[1] Kalil AC, Sun J. Bayesian methodology for the design and interpreta-

tion of clinical trials in critical care medicine: a primer for clinicians [J]. Crit Care Med, 2014, 42(10): 2267-2277

[2] 陈云,李燕.项目导向教学法在主动静脉治疗培训中的应用[J].护理学杂志, 2015, 30(11): 44-46
Chen Yun, Li Yan. Application of project-oriented teaching in active intravenous therapy training[J]. Journal of Nursing Science, 2015, 30 (11): 44-46

[3] Zhao B, Potter DD. Comparison of Lecture-Based Learning vs Discussion-Based Learning in Undergraduate Medical Students [J]. J Surg Educ, 2016,73(2): 250-257

[4] 王珣,杨晓达,郭敏杰,等.多种教学方法在短期留学生中医药学教学中的应用[J].中华医学教育杂志, 2014, 34(4): 515-516, 562
Wang Xun, Yang Xiao-da, Guo Min-jie, et al. The application of diverse teaching method in traditional Chinese medicine teaching for short-term international students[J]. Chinese Journal of Medical Education, 2014, 34(4): 515-516, 562

[5] 周飞虎,刘辉,康红军,等.CBS 结合 PBL 在重症监护病房血液净化治疗教学中的应用[J].山东医药, 2015, 55(16): 96-98
Zhou Fei-hu, Liu Hui, Kang Hong-jun,et al. Application of case-based study combined with problem-based learning in teaching of therapy of blood purification in ICU [J]. Shandong Medical Journal, 2015, 55 (16): 96-98

[6] 张红桥,郭慧芳,林冬梅,等.心肺复苏护理实习教学路径联合以案例为基础的学习法的效果[J].解放军护理杂志, 2015, 32(20): 70-73
Zhang Hong-qiao, Guo Hui-fang, Lin Dong-mei, et al. Effect of the Combined Cardiopulmonary Resuscitation Nursing Practice and Case-based Learn-ing Teaching Method [J]. Nursing Journal of Chinese People's Liberation Army, 2015, 32(20): 70-73

[7] Jin J, Bridges SM. Educational technologies in problem-based learning in health sciences education: a systematic review [J]. Med Internet Res, 2014, 16(12): e251

[8] Ohtsu F, Nagamatsu T, Nadai M, et al. The Synergistic Effect of Problem-based Learning Combined with the Jigsaw Method in a Pharmacotherapy Course[J]. Yakugaku Zasshi, 2016, 136(3): 389-396

[9] Nadershahi NA, Bender DJ, Beck L, et al. An overview of case-based and problem-based learning methodologies for dental education [J]. J Dent Educ, 2013, 77(10): 1300-1305

[10] 胡婕,刘辉,康红军,等.对重症医学科进修生的临床教学体会[J].现代生物医学进展, 2016, 16(2): 347-349, 346
Hu Jie, Liu Hui, Kang Hong-jun, et al. Experience of Clinical Education of Post Graduate Students in Department of Critical Care Medicine[J]. Progress in Modern Biomedicine, 2016, 16(2): 347-349, 346

[11] 刘宁,董丹江,唐健,等.重症医学科住院医师规范化培训模式与考核体系的探讨[J].中华医学教育探索杂志, 2015, 14(6): 623-626
Liu Ning, Dong Dan-jiang, Tang Jian, et al. Preliminary discussion of program and evaluation system for standardized training residents in the intensive care unit [J]. Chinese Journal of Medical Education Research, 2015, 14(6): 623-626

[12] Figueira AC, Rocha JB. A proposal for teaching undergraduate chemistry students carbohydrate biochemistry by problem-based learning activities[J]. Biochem Mol Biol Educ, 2014, 42(1): 81-87

[13] Asad M, Iqbal K, Sabir M. Effectiveness of problem based learning as a strategy to foster problemsolving and critical reasoning skills among medical students [J]. J Ayub Med Coll Abbottabad, 2015, 27 (3): 604-607

[14] Khobragade S, Abas AL, Khobragade YS. Comparative study on the measurement of learning outcomes after powerpoint presentation and problem based learning with discussion in family medicine amongst fifth year medical students [J]. J Family Med Prim Care, 2016, 5(2): 298-301

[15] Imai PH, Kresyman S, Asadoorian J. Factors Influencing Dental Educators As They Develop Problem-Based Learning Cases [J]. J Dent Educ, 2016, 80(6): 731-740

[16] Spiers JA, Williams B, Gibson B, et al. Graduate nurses' learning trajectories and experiences of problem based learning: a focused ethnography study[J]. Int J Nurs Stud, 2014, 51(11): 1462-1471

[17] 李康,朱长真,康维明,等.本科临床医学专业教育中不同教学方法的特点及合理应用 [J]. 中华医学教育探索杂志, 2015, 14(6): 589-592
Li Kang, Zhu Chang-zhen, Kang Wei-ming, et al. Characteristics and reasonable application of different teaching methods in professional education for undergraduates majored in clinical medicine[J]. Chinese Journal of Medical Education Research, 2015, 14(6): 589-592

[18] Choi E, Lindquist R, Song Y. Effects of problem-based learning vs. traditional lecture on Korean nursing students' critical thinking, problem-solving, and self-directed learning [J]. Nurse Educ Today, 2014, 34(1): 52-56

[19] Shigli K, Aswini YB, Fulari D, et al. Case-based learning: A study to ascertain the effectiveness in enhancing the knowledge among interns of an Indian dental institute[J]. J Indian Prosthodont Soc, 2017, 17(1): 29-34

[20] Kulak V, Newton G. A guide to using case-based learning in biochemistry education [J]. Biochem Mol Biol Educ, 2014, 42 (6): 457-473

[21] Shaw-Battista J, Young-Lin N, Bearman S, et al. Interprofessional Obstetric Ultrasound Education: Successful Development of Online LearningModules; Case-Based Seminars; and Skills Labs for Registered and Advanced Practice Nurses, Midwives, Physicians, and Trainees[J]. J Midwifery Womens Health, 2015, 60(6): 727-734

[22] Hashim R, Azam N, Shafi M, et al. Perceptions of undergraduate medical students regarding case based learning and tutorial format[J]. J Pak Med Assoc, 2015, 65(10): 1050-1055

[23] Qamar K, Rehman S, Khan MA. Effectiveness of Case-Based Learning During Small Groups Sessions at Army Medical College[J]. J Coll Physicians Surg Pak, 2016, 26(3): 232-233

[24] Raurell-Torredà M, Olivet-Pujol J, Romero-Collado À, et al. Case-based learning and simulation: useful tools to enhance nurses' education? Nonrandomized controlled trial [J]. J Nurs Scholarsh, 2015, 47(1): 34-42

[25] 闵卫利,赵阳,单昌友,等.PACS 影像系统与 PBL、CBL 教学在肿瘤临床教学中联合应用的价值 [J]. 中国医学教育技术, 2014, 28(6): 673-676

(下转第 6596 页)

[9] Vargas M E, Yamagishi Y, Tessier-Lavigne M, et al. Live Imaging of Calcium Dynamics during Axon Degeneration Reveals Two Functionally Distinct Phases of Calcium Influx [J]. The Journal of Neuroscience, 2015, 35(45): 15026-15038

[10] Huang S S Y, Noble S, Godoy R, et al. Delayed effects of methylmercury on the mitochondria of dopaminergic neurons and developmental toxicity in zebrafish larvae (Danio rerio)[J]. Aquatic Toxicology, 2016, 175: 73-80

[11] Akerboom J, Chen T W, Wardill T J, et al. Optimization of a GCaMP calcium indicator for neural activity imaging[J]. The Journal of neuroscience, 2012, 32(40): 13819-13840

[12] 陶核, 楼建林, 徐娟, 等. CdSe/ZnS 量子点对斑马鱼胚胎发育的影响[J].浙江预防医学, 2015, 27(2): 142-146
Tao He, Lou Jian-lin, Xu Juan, et al. The effects of CdSe/ZnS quantum dots on embryonic development of zebrafish[J]. Zhejiang Journal of Preventive Medicine, 2015, 27(2): 142-146

[13] Blackburn J S, Liu S, Raimondi A R, et al. High-throughput imaging of adult fluorescent zebrafish with an LED fluorescence macroscope [J]. Nature protocols, 2011, 6(2): 229-241

[14] Keller P J, Schmidt A D, Wittbrodt J, et al. Reconstruction of zebrafish early embryonic development by scanned light sheet microscopy[J]. science, 2008, 322(5904): 1065-1069

[15] Zhu L, Yuan Z, Simmons J T, et al. Zn (ii)-coordination modulated ligand photophysical processes-the development of fluorescent indicators for imaging biological Zn (ii) ions [J]. RSC advances, 2014, 4 (39): 20398-20440

[16] Hammers M D, Taormina M J, Cerda M M, et al. A Bright Fluorescent Probe for H2S Enables Analyte-Responsive, 3D Imaging in Live Zebrafish Using Light Sheet Fluorescence Microscopy [J]. Journal of the American Chemical Society, 2015, 137(32): 10216-10223

[17] Perez C C, Lauri A, Symvoulidis P, et al. Calcium neuroimaging in behaving zebrafish larvae using a turn-key light field camera[J]. Journal of Biomedical Optics, 2015, 20(9): 096009

[18] Prevedel R, Yoon Y G, Hoffmann M, et al. Simultaneous whole-animal 3D imaging of neuronal activity using light-field microscopy[J]. Nature methods, 2014, 11(7): 727-730

[19] Wolenski J S, Julich D. Fluorescence microscopy gets faster and clearer: roles of photochemistry and selective illumination [J]. The Yale journal of biology and medicine, 2014, 87(1): 21-32

[20] Zhang P, Jiang X, Nie X, et al. A two-photon fluorescent sensor revealing drug-induced liver injury via tracking γ-glutamyltranspeptidase (GGT) level in vivo[J]. Biomaterials, 2016, 80: 46-56

[21] Semmelhack J L, Donovan J C, Thiele T R, et al. A dedicated visual pathway for prey detection in larval zebrafish[J]. Elife, 2015, 3: 1-19

[22] Blackburn J S, Liu S, Raimondi A R, et al. High-throughput imaging of adult fluorescent zebrafish with an LED fluorescence macroscope [J]. Nature protocols, 2011, 6(2): 229-241

[23] 王佳佳, 屠云杰, 傅正伟, 等. 斑马鱼及其胚胎在毒理学中的实验研究与应用进展[J].生态毒理学报, 2007, 2(2): 123-135
Wang Jia-jia, Tu Yun-jie, Fu Zheng-wei, et al. Experimental Research and Application of Zebrafish and Embryos in Toxicology [J]. Asian Journal of Ecotoxicology, 2007, 2(2): 123-135

[24] 辛琦, 章强, 程金平. 纳米银和银离子对斑马鱼胚胎早期生长发育的影响及作用机制[J].生态毒理学报, 2015, 10(4): 55-64
Xin Qi, Zhang Qiang, Cheng Jin-ping. Effects of Silver Nanoparticles and Silver Ions on the Early Development of Zebrafish Embryos and Toxicity Mechanisms [J]. Asian Journal of Ecotoxicology, 2015, 10 (4): 55-64

[25] 殷健. 重金属对斑马鱼的毒性效应及作用机制研究[D].北京协和医学院, 2014
Yin Jian. Studies on Toxic Effect and Mechanism of Heavy Metals on Zebraflsh[D]. Peking Union Medical College, 2014

[26] 汪红军, 李嗣新, 周连凤, 等. 5 种重金属暴露对斑马鱼呼吸运动的影响[J].农业环境科学学报, 2010, 29(9): 1675-1680
Wang Hong-jun, Li Si-xin, Zhou Lian-feng, et al. The Effect of Exposure to Five Kinds of Heavy Metals on Respiratory Movement of Zebra Fish(Brachydanio rerio)[J]. Journal of Agro-Environment Science, 2010,29(9): 1675-1680

[27] Zhu X, Tian S, Cai Z. Toxicity assessment of iron oxide nanoparticles in zebrafish (Danio rerio) early life stages[J]. PLoS One, 2012, 7 (9): e46286

（上接第 6560 页）

Min Wei-li, Zhao Yang, Shan Chang-you, et al. Application of the PACS image system combined with PBL and CBL in oncological clinical teaching [J]. China Medical Education Technology, 2014, 28 (6): 673-676

[26] Elangovan S, Venugopalan SR, Srinivasan S, et al. Integration of Basic-Clinical Sciences, PBL, CBL, and IPE in U.S.Dental Schools' Curricula and a Proposed Integrated Curriculum Model for the Future [J]. J Dent Educ, 2016, 80(3): 281-290

[27] 刘建彰,曹晔,郭启燕,等.复合教学方法在口腔修复学临床实习中的初步应用[J].中华医学教育杂志, 2014, 34(5): 740-742, 763
Liu Jian-zhang, Cao Ye, Guo Qi-yan, et al. Preliminary application of an integrated teaching method combined with TBL, CBL and PBL in the internship education of prosthodontics [J]. Chinese Journal of Medical Education, 2014, 34(5): 740-742, 763

[28] Lei JH, Guo YJ, Chen Z, et al. Problem/case-based learning with competition introduced in severe infection education: an exploratory study[J]. Springerplus, 2016, 5(1): 1821

[29] 郭轶先, 苏力.CBL 和 PBL 教学方法在血液学专业见习中的运用效果分析[J].基础医学与临床, 2016, 36(8): 1176-1178
Guo Yi-xian, Su Li. Evaluation of CBL and PBL teaching methods in novitiate stage in hematology for medical undergraduate [J]. Basic & Clinical Medicine, 2016, 36(8): 1176-1178

[30] 吴南楠,马燕,王萌,等.CBL 与 PBL 相结合的教学模式在内分泌临床见习中的应用[J].中国病案, 2016, 17(7): 78-80
Wu Nan-nan, Ma Yan, Wang Meng, et al. Application of CBL combined with PBL Teaching Mode in the Clinic Trainee of Endocrinology Department[J]. Chinese Medical Record, 2016, 17(7): 78-80