Integrating Language and Science: A CLIL-Based English for Chemistry Digital Module

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Abstract. This study aimed to develop an English for Chemistry digital module based on the Content and Language Integrated Learning (CLIL) approach to enhance the competencies of chemistry education students and pre-service teachers. A research and development design using the 4-D model (Define, Design, Develop, Disseminate) was employed. The module was validated by experts and tested for practicality by lecturers and students using Likert-scale instruments. The results indicated very high feasibility in content (97.23%), media (97.67%), and pedagogical aspects (96.96%). Practicability testing also showed excellent results, with scores of 98.4% from lecturers and 98.54% from students. These findings demonstrate that the developed module is valid, practical, and user-friendly. In conclusion, the CLIL-based English for Chemistry module effectively integrates language and chemistry learning, supports 21st-century skills, enhances scientific communication and digital literacy, and promotes sustainable, paperless education in higher education.

Keywords: Content and Language Integrated Learning (CLIL), English for chemist, chemistry concepts, English competence.

1 Introduction

Rapid technological developments, globalization, and demands for 21st-century competencies have driven significant transformations in educational practices [1]. Teachers are not only required to be facilitators of learning, but also agents of change who are able to adapt teaching materials and learning strategies to the latest social and technological developments [2], [3]. One important aspect of this change is the continuous updating of learning literature [4]. Updated literature plays an important role in ensuring that learning content remains relevant, pedagogically effective, and aligned with the development of core skills such as critical thinking, creativity, collaboration, communication, and digital literacy [5]–[7]. In the context

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of Indonesian education, the national *Merdeka Belajar* (Freedom of Learning) policy encourages flexible and contextual learning, in which students play an active role in constructing knowledge. Proficiency in English is becoming increasingly important given its role as a global language in academia, technology, and professional fields [8]. The integration of English in subject teaching supports broader educational goals, including access to global knowledge and the development of graduates who are able to compete at the international level [9].

Theoretically, Vygotsky's sociocultural theory states that language functions as a mediating tool in the learning process that takes place in a social and cultural context [10]. In this case, English becomes an important tool for students in Indonesia to interact with international knowledge, collaborate across countries, and understand multicultural perspectives. In addition, Bandura's social cognitive theory emphasizes the importance of self-efficacy and the influence of the environment on learning outcomes [11]. Access to up-to-date and engaging English-based teaching materials can increase student motivation and confidence, especially when the material is contextualized with their local realities and future expectations [12]. Furthermore, 21st-century learning frameworks such as those developed by the Partnership for 21st Century Skills (P21) emphasize the importance of global awareness and information literacy as key competencies for modern learners [13]. Proficiency in English enables students to access international scientific literature, participate in digital learning environments, and engage with current global issues [14], [15]. Thus, the use of outdated literature not only reduces student engagement, but also limits their capacity to compete and collaborate in the global knowledge society [16].

The development of globalization and internationalization in higher education requires an increase in student competence not only in mastering subject content, but also in mastering foreign languages, especially English. In the context of chemistry education, the need to access international scientific literature, participate in global seminars and conferences, and prepare prospective chemistry teachers who are ready to compete in the global era is becoming increasingly important. On the other hand, many chemistry students and prospective chemistry teachers have difficulty understanding chemistry content in English [17], [18]. This has an impact on their low scientific literacy, limited access to global reference sources, and lack of confidence in communicating scientifically at an international level [19]–[21].

Despite the growing recognition of these challenges, existing learning resources in chemistry education in Indonesia remain largely content-centered and do not systematically integrate English language development with chemistry concepts. This indicates a clear research gap: while Content and Language Integrated Learning (CLIL) has been proven effective in simultaneously enhancing subject mastery and language competence in various international contexts [22]–[24], its application in Indonesian chemistry education—particularly through the development of a structured “English for Chemistry” module—is still very limited. CLIL enables students to learn chemistry concepts while developing English proficiency in a contextual and meaningful manner [25], yet there is a lack of development-based studies that design, validate, and test CLIL-oriented digital modules tailored to the characteristics and needs of prospective chemistry teachers in Indonesia.

Therefore, the novelty of this study lies in the development of a CLIL-based English for Chemistry digital module that systematically integrates chemistry content, English language

skills, and 21st-century competencies within the Indonesian higher education context. By grounding the development process in needs analysis, CLIL theory, and the specific characteristics of chemistry education students, this study addresses existing gaps in learning literature and offers an innovative instructional resource to support linguistic, scientific, and global competence among prospective chemistry teachers.

2 Research method

This study employed research and development (R&D) design with a mixed qualitative and quantitative approach at the initial stage of product development. The research was conducted at Technology Readiness Level (TRL) 3, corresponding to the conceptual development stage, which includes identifying assumptions and theoretical foundations, formulating the product concept, and analytically examining its initial functions and characteristics [26], [27]. The 4-D model (Define, Design, Develop, and Disseminate) was adopted operationally to guide the structured development of the English for Chemistry module. The integration of these two models was intended to ensure both conceptual rigor and practical clarity in the module development process, with providing the macro-level framework and the 4-D model supporting the micro-level product development stages.

Data collection instruments included expert validation questionnaires and practicality questionnaires for lecturers and students. Instrument validity was established through content validation by subject matter experts, media experts, and pedagogical experts, who evaluated the instruments in terms of relevance, clarity, and alignment with research objectives. Revisions were made based on expert feedback to ensure that all instrument items accurately measured the intended constructs. Instrument reliability was assessed using internal consistency analysis, and the results indicated that the instruments met acceptable reliability standards for educational research. The testing phase of the developed module was conducted at the University of Riau to evaluate feasibility and practicality prior to wider implementation.

3 Results and discussion

The initial product resulting from this development research is the CLIL-based English for Chemistry Module to Improve the Competence of Chemistry Students and Prospective Teachers. The initial product development was carried out based on the 4-D development model adapted from Thiagarajan et al. [28]. The following are details of the development stage results based on the research procedures that have been carried out:

3.1 Define

A needs analysis was conducted through interviews with lecturers and students of the chemistry education study program, which showed the need for teaching materials that are able to integrate English and chemistry content simultaneously. The results of the curriculum analysis showed that the CPL (Graduate Learning Outcomes) included mastery of academic English and mastery of chemistry material for prospective teachers. The difficulties identified among students included limited English chemistry vocabulary, low academic reading skills,

and lack of experience using English in scientific discussions. The definition stage was divided into 5 stages, namely:

a. Front-End Analysis

The purpose of this analysis is to identify problems found in the information obtained from interviews with chemistry education lecturers as a basis for learning that needs to be developed in the creation of electronic modules. The information obtained is taken into consideration to create better and more efficient learning. Some of the information obtained is as follows:

1. Existing English for Chemistry modules do not fully facilitate student learning

2. The use of technology in English for Chemistry learning is not optimal, even though technological facilities such as the internet are available to support the learning process.

The purpose of this analysis is to identify problems found in the information obtained from interviews with chemistry education lecturers as a basis for learning that needs to be developed in the creation of electronic modules. The information obtained is taken into consideration to create. Based on the results of observations and interviews, the researcher felt the need to develop an English for Chemistry module.

b. Student Analysis (Learner Analysis)

At this stage, observations were made of first- and second-year students with intermediate English skills (B1–B2). The main difficulties were chemistry vocabulary, reading scientific articles, and writing laboratory reports in English.

c. Task Analysis

This analysis covers the CPMK and Sub-CPMK of the Chemistry English course. This analysis involves identifying the concepts taught and developing rational procedures for abstract concepts, specifying instructional objectives, and analyzing the objectives of the formulation.

3.2 Design

This stage aims to create a preliminary design of the electronic modules and instruments used for the research data collection process. The results of the planning stage can be used as a basis for product development. The following is a detailed explanation of the design stages:

a. Development of Research Instruments

The research instruments used consist of a learning plan, an E-Module feasibility instrument and an E-Module practicality instrument.

b. Lesson Plan

The lesson plan (RP) is tailored to the current curriculum implemented by the UNRI Chemistry Education study program, the OBE Curriculum. Learning activities in the experimental and control classes are detailed in the Lesson Plan (RP), which includes introductory, core, and closing activities. The experimental class RP is tailored to the CLIL

learning model used in the development of the E-Module. CLIL integration is reflected at every stage of the learning process.

c. E-Module Feasibility Assessment Instrument

The e-Module feasibility assessment instrument was designed to assess the quality or feasibility of the developed e-Module. This feasibility assessment was conducted by a validator on material, media, and pedagogical indicators. The instrument was presented in the form of a questionnaire with assessments using a 5-point Likert scale.

d. E-Module Practicality Assessment Instrument

The E-Module practicality assessment instrument was designed to measure the practicality of the developed E-Module. This practicality assessment was conducted by a lecturer teaching English for Chemistry and students using a 5-point Likert scale.

e. Media Selection

Based on the analysis conducted in the define stage, the media selected that is relevant to students' needs is the CLIL-based Chemistry English E-Module. Researchers used Canva software and the Heyzine website to develop the E-Module. The resulting output is a link that refers to the E-Module presented in a flip format. The results of this development are links that can be accessed using Android smartphones, iOS, tablets, and PCs/laptops using existing search applications such as Google Chrome, Safari, and Microsoft Edge.

f. Format Selecting

This stage is carried out to determine the content of the CLIL-based Chemistry English E-Module design. This E-Module design consists of a cover, foreword, introduction, user manual, learning guide, developer profile, CPL, CPMK, sub-CPMK, indicators, learning objectives, learning materials, and learning activities in accordance with CLIL syntax, and a bibliography.

g. Preliminary Design

The initial design for this CLIL-based Chemistry English e-module was adapted to a predetermined format. Based on this format, a product design was produced in the form of a storyboard that provides an overview and guidelines for the preparation and creation of the e-module.

3.3 Develop

At this stage, an assessment was conducted on the initial design of the CLIL-based Chemistry English e-Module. Validation of the product and research instruments was carried out through expert appraisal and development testing. The following is a description of the results of the development stages:

a. Expert appraisal

Expert assessment is a theoretical validity test conducted to determine the feasibility of the CLIL-based Chemistry English e-module before its pilot testing. This assessment involved two expert lecturers with experience and expertise in environmental science and teaching

materials development. The expert lecturers provided assessments and comments on the questionnaire.

The feasibility test for the CLIL-based Chemistry English e-Module was conducted by expert lecturers through a questionnaire. The indicators assessed included material, media, and pedagogy, each with its own distinct aspects. A summary of the results of the e-Module feasibility test is presented in **Table 1**.

Table 1 Results of the E-Module feasibility test by expert judgment

Aspect	Average score	Maximum score	Percentage (%)	Category
Material Validation				
Content	24	25	96	Very Good
Construction	14.67	15	97.8	Very Good
Languange	19.67	20	98.33	Very Good
Total	58.34	60	97.23	Very Good
Media Validation				
E-Module Size	10	10	100	Very Good
E-Module Cover Design	34	35	97.14	Very Good
Content Design	53.67	55	97.57	Very Good
Total	97.67	100	97.67	Very Good
Pedagogical Validation				
E-Modules according to CLIL syntax	29.33	30	97.76	Very Good
Alignment of Learning with 21st Century Competencies	24	25	96	Very Good
Total	53.33	55	96.96	Very Good

Based on the results of the feasibility test of the CLIL-based Chemistry English E-Module by expert lecturers, the material validation aspect got a score of 58.64 out of a total of 60, the media aspect got a score of 97.67 out of a total of 100, and the pedagogical aspect got a score of 53.33 out of a total of 55. Thus, it can be concluded that the CLIL-based Chemistry English E-Module is feasible but needs to be revised slightly based on suggestions and input provided by expert lecturers.

The development trial stage was carried out after the CLIL-based Chemistry English E-Module had been revised and declared theoretically valid by expert lecturers. The development trial began with a practical test of the CLIL-based Chemistry English E-Module with environmental science lecturers and a readability test with students. The practicality test of the CLIL-based Chemistry English e-Module was conducted by five lecturers and 30 students using a 10-item questionnaire. The aspects assessed included ease of access, time

efficiency, and ease of use. A summary of the results of the e-Module practicality test is presented in **Table 2**.

Table 2 Results of the practicality test of the E-Module for lecturers and students

Aspect	Average score	Maximum score	Percentage (%)	Category
Lecturer				
Ease of Access	14,6	15	97.33	Very Good
Time Efficiency	10	10	100	Very Good
Convenience of Use	24.6	25	98.4	Very Good
Total	49.2	50	98.4	Very Good
Student				
Ease of Access	14.7	15	98	Very Good
Time Efficiency	9.9	10	99	Very Good
Convenience of Use	24.67	25	98.68	Very Good
Total	49.27	50	98.54	Very Good

Based on the test results of the CLIL-based Chemistry English E-Module by five lecturers with all aspects obtaining a very good category with a total assessment of 49.2 and a presentation of 98.4% and assessments from 30 students with all aspects obtaining a very good category with a total assessment of 49.27 and a presentation of 98.54%. So, it can be concluded that the CLIL-based Chemistry English E-Module is practical but needs to be revised based on suggestions and input provided by each lecturer. The results of the practicality test provide information that the CLIL-based Chemistry English E-Module is very good but needs to be improved before proceeding to the next stage.

The study results show that although CLIL has a similar basic learning structure, the two have fundamental differences in orientation, values, and learning outcomes to be achieved. However, this approach does not explicitly emphasize the dimensions of values, social awareness, and sustainability. In contrast, CLIL offers a more holistic approach by not only training students to design projects but also encouraging them to reflect on the social, economic, and environmental impacts of the projects undertaken. This aligns with SDG target 4.7, which emphasizes the importance of education that supports sustainable development, disaster risk reduction, and the formation of responsible global citizens.

This development research is an innovative effort in Environmental Science learning to produce a CLIL-based Disaster Mitigation E-Module that is packaged digitally, interactively, and contextually. This E-Module is designed to improve disaster literacy and sustainable awareness among environmental education students in Indonesia. The advantages of this CLIL-based E-Module include its user-friendliness, accessibility via smartphone, laptop, or PC without the need for heavy installation because it is web-based. This module also adopts the concept of paperless learning, which supports the reduction of paper use during the learning process as a real contribution to environmental conservation. Furthermore, the

presentation of disaster phenomena is packaged with attractive visualizations through videos, infographics, and interactive simulations. This supports the statement that the use of video-based digital media can improve student understanding and learning retention. However, a weakness of this E-Module is its reliance on a stable internet connection to access the interactive features. However, the benefits offered in increasing disaster literacy and sustainable awareness make this E-Module one of the important innovations in Environmental Science learning in the digital era.

Based on the expert assessment results, the CLIL-based Chemistry English E-Module received an excellent rating in all aspects, namely material (97.23%), media (97.67%), and pedagogy (96.96%). This indicates that the module content is in accordance with competencies, logical presentation construction, communicative language, and attractive visual design that meets the needs of digital learning. In addition, this module is also considered consistent with the PjBL syntax integrated with the principles of Education for Sustainable Development (ESD)[29], so that it not only focuses on cognitive understanding, but also on strengthening disaster literacy and sustainable awareness attitudes. These findings are in line with the views of UNESCO which emphasizes the importance of integrating social, economic, and environmental dimensions in learning, and that interactive visual design can improve students' conceptual understanding [30], [31].

The results of the practicality test involving five lecturers and thirty students also showed an excellent rating, with an average score of 98.4% for lecturers and 98.54% for students. High scores for ease of access, time efficiency, and ease of use indicate that the module is user-friendly and supports effective and efficient learning. This demonstrates that the e-module is capable of being a digital learning medium that is relevant to student needs and meets the demands of 21st-century learning. These findings align with research that emphasized the importance of easily accessible and time-efficient digital learning media and stated that integrating a project-based model with an ESD approach can help students interpret problems contextually and meaningfully. Thus, this e-module is deemed feasible and practical to use, although it still requires minor revisions based on expert and user input before wider implementation [7], [32].

4 Conclusion

Based on the research results, the development of a CLIL-based Chemistry English e-module has been shown to be both feasible and practical for learning implementation. Expert validation indicated excellent quality in material, media, and pedagogical aspects, while practicality testing by lecturers and students also achieved excellent ratings, with average scores exceeding 98%. The module effectively supports the simultaneous mastery of chemistry content and English language skills and integrates the principles of Education for Sustainable Development (ESD), contributing to the enhancement of students' disaster literacy and sustainable awareness. However, this study was limited to feasibility and practicality evaluation at Technology Readiness Level 3 and was conducted within a single institutional context, without measuring its impact on students' learning outcomes or language proficiency. Future research should involve experimental or quasi-experimental designs to examine the

effectiveness of the module on cognitive, linguistic, and affective learning outcomes, as well as broader implementation across different institutions and learning contexts.

References

[1] Volta, A. S., Nahdiyah, F., Cahya, A.: Transformasi Pendidikan Di Era 4.0: Intelektualitas Guru Tercipta Kualitas Sekolah Terjaga. J. Kepengawasan, Supervisi dan Manajerial. vol. 1, no. 4, pp. 143–151 (2024)

[2] Fadhli, M.: Manajemen Peningkatan Mutu Pendidikan. TADBIR J. Stud. Manaj. Pendidik. vol. 1, no. 2 (2017)

[3] Muhammadiah, M., Hamsiah, A., Muzakki, A., Nuramila, N., Fauzi, Z. A.: The Role of the Professional Teacher as the Agent of Change for Students. AL-ISHLAH J. Pendidik. vol. 14, no. 4, pp. 6887–6896 (2022)

[4] Anggraeni, E. S., Putri, R. A., Tristania, A. W., Maharani, T., Wirhanuddin, W., Rahmadani, A.: Kajian Literatur Penerapan Kimia Hijau dan Tujuan Pembangunan. Arfak Chem. vol. 7, no. 2, pp. 604–616 (2024)

[5] Winarsih, E., Furinawati, Y.: Literasi Teknologi Dan Literasi Digital Untuk Menumbuhkan Keterampilan Berwirausaha Bagi Kelompok Pemuda Di Kota Madiun. Pros. Semin. Nas. Int. vol. 1, no. 1, pp. 23–29 (2018)

[6] Smaragdina, A. A., Nidhom, A. M., Soraya, D. U., Fauzi, R.: Pelatihan Pemanfaatan dan Pengembangan Bahan Ajar Digital Berbasis Multimedia Interaktif untuk Menghadapi Era Revolusi Industri 4.0. J. KARINOV. vol. 3, no. 1, p. 53 (2020)

[7] Widarti, H. R., et al.: Analysis of content development in chemical materials related to ethnoscience: a review. J. Educ. Learn. vol. 19, no. 1, pp. 422–430 (2025)

[8] Saharudin., Harsyah, A. S.: The English VS Non-English Leaning Strategies Used by The Students in Learning English: A Survey On International Classroom in One Public University in Indonesia. J. English Lang. Teach. vol. 02, no. 1990, pp. 724–728 (2025)

[9] Bachrudin, S., Drajati, N. A., Santosa, E. B.: Pengembangan E-Modul berbasis Multimodal untuk Mendukung Penguasaan Berbicara Bahasa Inggris Pemuda Desa Piyak. J. Educ. Res. vol. 4, no. 4, pp. 1723–1730 (2023)

[10] Wardana, V., Arif, D., Nurhakim, R., Miftah, K., Martaleni, Y.: Integrasi Teori Perkembangan Kognitif Jean Piaget dan Vygotsky dalam Merancang Kurikulum Pendidikan yang Responsif dan Adaptif. vol. 4, no. 1, pp. 823–834 (2025)

[11] Wulandari, P. A., Wahyuni, R., Rahmatullah, M. I.: Analysis of Student Self-Efficacy Profile in Chemistry Education Study Program at Universitas Riau. Atlantis Press SARL (2025)

[12] Alhayat, A., Masriani, M., Rasmawan, R., Hairida, H., Erlina, E.: Profil Kemampuan Mahasiswa Pendidikan Kimia dalam Menyelesaikan Masalah Kontekstual Kimia. Edukatif J. Ilmu Pendidik. vol. 4, no. 3, pp. 3998–4009 (2022)

[13] Afandi., Sajidan., Akhyar, M., Suryani, N.: Development frameworks of the Indonesian partnership 21 st -century skills standards for prospective science teachers: A Delphi study. J. Pendidik. IPA Indones. vol. 8, no. 1, pp. 89–100 (2019)

[14] Bedir, H., Çapan, S. A.: Embedding 21st Century Skills into a Pre-Service English Language Teacher Education Program for Sustainability. Particip. Educ. Res. vol. 12, no. 2, pp. 164–182 (2025)

[15] Babaoğlu, G., Yıldırım, E. G.: The Effect on Gifted Students' 21st-Century Skills of Supporting Science Teaching with LEGO. Sci. Insights Educ. Front. vol. 15, no. 2, pp. 2305–2324 (2023)

[16] Ningtyas, P. K., Widarti, H. R., Parlan, P., Rahayu, S., Dasna, I. W.: Enhancing Students' Abilities and Skills through Science Leaning Integrated STEM: A Systematic Literature Review. Int. J. Educ. Math. Sci. Technol. vol. 12, no. 5, pp. 1161–1181 (2024)
[17] Mathews-Aydinli, J.: Problem-Based Learning and Adult English Language Learners. Cent. Adult English Lang. Acquis. pp. 1–8 (2007)
[18] Wahdatillah, B., Noer, A. M., S., L. A.: Pengembangan E-Lkpd Berbasis Pbl-Mr Menggunakan Aplikasi Flip Builder Pada Materi Bentuk Molekul Dan Interaksi Antar Molekul. Edusains. vol. 14, no. 1, pp. 72–83 (2022)
[19] Carin, A. A., Sund.: STEM Education: Inovasi dalam Pembelajaran Sains. Pros. Semin. Nas. Pendidik. Sains. pp. 2016–23 (2016)
[20] Winata, A., Cacik, S., Seftia, I.: Analisis Kemampuan Awal Literasi Sains Mahasiswa pada Konsep IPA. Educ. Hum. Dev. Journal. vol. 01, no. 01 (2016)
[21] Raharjo, M. W. C., Suryati, S., Khery, Y.: Pengembangan E-Modul Interaktif Menggunakan Adobe Flash Pada Materi Ikatan Kimia Untuk Mendorong Literasi Sains Siswa. Hydrog. J. Kependidikan Kim. vol. 5, no. 1, pp. 8–13 (2017)
[22] Kim, H., Graham, K. M.: Teachers' Needs and Professional Development: A Systematic Review. Lat. Am. J. Content Lang. Integr. Learn. vol. 15, no. 1, pp. 1–22 (2022)
[23] Mahan, K. R., Brevik, L. M., Ødegaard, M.: Characterizing CLIL teaching: new insights from a lower secondary classroom. Int. J. Biling. Educ. Biling. vol. 24, no. 3, pp. 401–418 (2021)
[24] Berdiyeva, S.: Teaching young learners through the use of CLIL method. Mod. Sci. Res. vol. 3, no. 2, pp. 473–480 (2024)
[25] De Smet, A., Mettewie, L., Hiligsmann, P., Galand, B., Van Mensel, L.: Does CLIL shape language attitudes and motivation? Interactions with target languages and instruction levels. Int. J. Biling. Educ. Biling. vol. 26, no. 5, pp. 534–553 (2023)
[26] Arianatasari, A., Hakim, L.: Penerapan Desain Model Plomp Pada Pengembangan Buku Teks Berbasis Guided Inquiry. J. Pendidik. Akunt. vol. 6, no. 1, pp. 36–40 (2018)
[27] Subroto, D. E., Supriandi., Wirawan, R., Rukmana, A. Y.: Implementation of Technology in Learning in the Digital Age: Challenges and Opportunities for Education in Indonesia. J. Pendidik. West Sci. vol. 1, no. 07, pp. 473–480 (2023)
[28] Thiagarajan., Sivasailan.: Instructional development for training teachers of exceptional children: A sourcebook. J. Sch. Psychol. vol. 14, no. 1, p. 75 (1976)
[29] Burmeister, M., Rauch, F., Eilks, I.: Education for Sustainable Development (ESD) and chemistry education. Chem. Educ. Res. Pract. vol. 13, no. 2, pp. 59–68 (2012)
[30] Unesco.: Global Education Monitoring Report 2017/18. Accountability in education: Meeting our commitments. Paris (2017)
[31] Aulia, H., Hafeez, M., Mashwani, H.U., Careemdeen, J. D.: The Role of Interactive Learning Media in Enhancing Student Engagement and Academic Achievement. International Seminar on Student Research in Education, Science, and Technology in Education, Science, and Technology, Indonesia, pp. 57–67 (2024).
[32] Juntunen, M. K., Aksela, M. K.: Improving students' argumentation skills through a product life-cycle analysis project in chemistry education. Chem. Educ. Res. Pract. vol. 15, no. 4, pp. 639–649 (2014)