Chemistry *via* Carnival: An Activity Based Approach in Learning Chemistry
(Pembelajaran Kimia melalui Karnival: Pendekatan Pembelajaran Kimia Berasaskan Aktiviti)

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ABSTRACT

This paper reports the experience of activity based learning conducted in Chemistry Carnival 2011 in Sarawak. The active learning oriented activities include hands-on experiments, quiz, poster and mini lectures were used to educate the school students some basics chemistry relating to daily life. Approximately 300 students attended the activities. Observations and questionnaires were used as the instruments to describe and measure the learning experience whether various activities have contributed to effective learning. Among these, hands-on experiments were found to be the most effective approach; more than 86% of the participants agree that they have learnt well from this peer mentoring and collaborative learning strategy. Posters, mini lectures and quiz however were relatively less favoured as they suffered some inherited shortcomings for example lecture is lacking in interactivity, poster and quiz similarly fall short in proactive involvement of participants. Activity based learning is an effective approach however it needs to be carefully constructed to achieve the learning outcomes.

Keywords: Chemistry, Carnival, Student-centred learning, Effective learning, Activity-based learning

ABSTRAK

Kajian ini melaporkan pembelajaran berasaskan aktiviti berdasarkan kepada pengalaman Karnival Kimia Malaysia 2011 di Sarawak. Kaedah pembelajaran aktif yang berasaskan aktiviti seperti kuiz, poster, ceramah dan eksperimen telah digunakan untuk mengajar pelajar sekolah tentang kimia asas kehidupan harian. Lebih kurang 300 orang pelajar telah mengambil bahagian dalam aktiviti yang dianjurkan termasuklah eksperimen, poster, ceramah dan kuiz. Pemerhatian dan soal selidik telah digunakan untuk menilai pengalaman pembelajaran. Antara aktiviti yang diadakan, eksperimen merupakan kaedah yang dianggap paling efektif. Sebanyak 86% responden menyatakan bahawa pembelajaran telah berlaku dengan lebih berkesan melalui eksperimen di mana aktiviti ini melibatkan pemantauan dan pembelajaran bersama. Poster, ceramah serta kuiz adalah kurang efektif kerana kaedah-kaedah ini masing-masing mewarisi kelemahan, sebagai contoh ceramah melibatkan interaksi yang terhad bersama pendengar, Poster serta kuiz turut mengalami kesukaran ini. Pembelajaran berasaskan aktiviti didapati berkesan, tetapi ia perlu dirancang secara rapi untuk mencapai hasil pembelajaran yang diharapkan.

Kata kunci: Kimia, Karnival, Pembelajaran berpusat pelajar, Pembelajaran berkesan, Pembelajaran berasaskan aktiviti

INTRODUCTION

Students often perceived chemistry as one of the most difficult subjects. In a study, almost 100% of the respondents agree that the subject is heavily concept based and requires significant amount of time and commitment (Jedge (2007). For this reason, majority of students who take up chemistry are less motivated; they attend the course simply because it is a prerequisite. To improve the learning experience, numerous researches have been carried out to understand the obstacles in order to formulate effective teaching approaches (Jedge 2007; Ali 2012). In recent years, the student-centred learning approach has received considerable attention where the active learning strategies have been seen to work more effectively than the conventional approach resulting in increased retention of knowledge and higher scores in assessment (Dougherty, et al. (1995)]. In addition, students are found to demonstrate greater conceptual understanding where complex critical thinking skill is evidenced (Niaz et al. Town & Grant 1997). In this manner of learning, students play a greater role where they are objectively trained with better analytical and problem solving skills (Ali 2012; Baetenet et al. 2010).

There is a broad spectrum of student-centred learning strategies including collaborative learning, cooperative learning, team-based learning, problem-based learning, activity-based learning and etc. Among these, activity-based learning is one of the common instructional methods in supporting learning of science (Granger, et al. 2012; Johnson 2008). By definition, activity based learning implies learning by doing activities in and out-of-school, either individually or as a group. A key advantage of this approach is that students are exposed to academic knowledge and skill simultaneously where connection can be made to the content encouraging higher order thinking (Demirci, et al. 2010). An example of activity based learning, the Full Option Science System, has been developed to teach physical science, earth science, life science and scientific reasoning where the curriculum is hands-on and laboratory based (Encylopedia Britannica Co. 1992). Many countries have changed and revised their school curriculums to include activity based learning in teaching [Demirci et al. 2010). As a matter of fact, the approach has been very popular in numerous informal setting for example, KidZania an activity based theme park has allowed children to learn *via* role-play activities.

In conjunction to the International Year of Chemistry 2011, Malaysian Institute of Chemistry had organised Chemistry Carnival (Karnival Kimia Malaysia, K2M) in seven venues throughout Malaysia to illustrate the innovative and inventive nature of chemistry aiming to promote public awareness and chemistry education in schools and universities. In this event, various activities were carefully planned to emphasize active participation of students endeavour to teach some basics chemistry relating to daily life. In this paper, we attempt to report the experience of Chemistry Carnival and to evaluate the effectiveness of the activities held in nurturing learning. Note that this paper is prepared according to the experience of Chemistry Carnival organised in Sarawak, Malaysia on 15-16 October 2011.

Materials And Methods

The one-and-a-half day event had involved approximately 300 students (primary and secondary) from schools around Kuching, Sarawak, with activities include hands-on experiments, poster, talks and quiz. Twenty hands-on experiments were demonstrated by 17 postgraduate students and a group of selected school students. These experiments were simple home experiments such as silly putty, acid base properties of red cabbage and etc. Poster and talks were planned according to the sub-themes that have close relationship with our everyday life for example chemistry of water and chemistry of food and nutrition.

In this paper, observations and questionnaires were used to describe learning. The questionnaires were designed according to Kirkpatrick's four-level evaluation model that measures the reactions, learning, behaviour and results (Kirkpatrick 1996). We want to find out how participants feel about the carnival whether they have learnt from the activities held and whether they have been able to share their learning experience. A total of 154 students aged between 10 and 17 had responded to the questionnaires of which 100 were female and 54 were male. The responses were analysed using Microsoft Excel.

Results And Discussion

From the questionnaires, eighty five percents of the respondents agree that they have enjoyed the carnival where 73% have communicated their experience with friends and family members. It is believed that the knowledge can be better retained by sharing the learning experience; in addition, 63% of the respondents suggest they are no longer anxious of chemistry but rather enjoying the subject. It is essential to inculcate a positive perception among students on chemistry as increased appreciation towards the subject would enhance the effectiveness of learning. As reported by Kunter et al. (2007), it is important to develop and maintain learners' interest as it associates closely to the learning outcomes.

TABLE 1. Perception of Participants on Whether They Have Learnt from Each Activity

Activity	Percentage of participants				
	Totally disagree	Disagree	Neutral	Agree	Totally agree
Mini lectures	1.30	9.40	42.86	31.17	2.59
Posters	2.60	9.74	35.71	37.66	12.98
Quiz	2.60	8.40	24.68	37.66	25.32
Hands-on experiments	1.30	1.30	11.04	36.36	49.35

Table 1 summarises on how well participants agree that each activity has contributed to learning. A majority of the respondents (86%) perceive that they have learnt well from the hands-on experiments; quiz, poster and mini lectures have not been as effective with only 63%, 50% and 34% of the respondents agreeing that learning has occurred through these activities, respectively. According to Ravi & Sinha (1999), quiz is as an effective way to transfer learning in the shortest possible time in the atmosphere of excitement, fun and challenge. In fact, it has always been used as an instrument in a formal setting to gauge students' understanding on a specific topic and to indicate whether further facilitation is necessary [Kunter, Baumert & Koller (2007)]. In this occasion, the scopes of learning were rather broad; as a result, participants may have failed to focus jeopardising the learning expectation.

Lecture is a classic instructional method where the most obvious shortcoming is the lack of interactivity and the difficulty to capture continuous attention of learners (Wesselset al. 2007; Edwards et al 2001). Bloom has identified the problem of decreasing attention of learners associating it to low effort of learning Bloom 1953). Despite the shortcomings, lecture is still a very common approach in teaching. Over the past few decades, the shortcomings have been improved with various innovative methods such as audio/visual technology. In this event, participants were continuously prompted to make connection to their past experience and prior knowledge intending to foster a greater feeling of personal relevance so that new knowledge can be constructed on the foundation nonetheless the participants found this approach an unfavourable way of learning possibly because the number of audience was too large. Mayer et al. 2009) suggest questioning method in the lecture with large class however practically it is unlikely to engage every individual of a large group in a lecture hall setting.

The hands-on experiment involves combined peer mentoring and collaborative learning (Hansen, et al. 2008); the more capable students are expected to teach the less capable ones rendering them learning in a group. Figure 1 shows some experiments conducted at the carnival; we observed that students work together in a non-threatening setting exploring and building knowledge. In the experiment of silly putty, the instruction primarily involves making a bouncy polymer ball from PVA glue, starch and borax (Casassa et al. 1986; de Zea Bermudez et al. 1998) nonetheless the collaborative learning atmosphere has encouraged the students to explore beyond the objective, synthesizing new knowledge. The basic instruction of bouncy polymer balls was modified where the ratio of the ingredients were reformulated to result in elastic polymer; further effort was taken to optimize the material compositions yielding polymer with maximal elasticity (Figure 2). Clearly, the learning outcomes have expanded from barely cross-linking the polymer to changing the properties where students' creativity is fostered. This suggests that the peer learning approach has enriched the learning outcomes enhancing creativity corroborating the findings reported by Zou, et al. 2012). The interactions between students has allowed them to process ideas together moving into the higher hierarchical level of Bloom's learning taxonomy [Bloom (1956)] - being able to construct where ideas were adapted and evolved.

(a) (b) (c) (d)

FIGURE 1. Some hands-on experiments: (a) Silly putty; (b) Invisible ink; (c) Panadol soluble rocket; (d) Chromatography of food colouring

FIGURE 2. Stretchy putty – learning the property of a polymer

Poster is often used to convey some specific knowledge; this instructional method requires a great deal of self-motivation to learn. It was revealed in a study that audience with higher age group and higher education qualification would be more responsive to poster [Saha et al. 2005). For example in a clinic setting, poster has been reported as an effective way to educate patients (Daley 1997). In this case, we primarily dealt with young school students where facilitation is important so poster may not be as effective for disseminating the intended knowledge. To enhance the efficiency of learning, an activity sheet designed based on the materials of the poster is incorporated to motivate learning where reward is in addition offered to create a more inviting atmosphere. The attempts endeavour to transform the passive poster session into a self-directed learning session. We noticed that the students are intrinsically motivated to explore the posters.

Conclusions

This paper reveals the perception of participants on the activities held at the carnival whether learning has taken place. Obviously participants perceived that learning is more effective when there is a greater level of involvement; for example, the hands-on experiment of silly putty has educated learners on how to synthesize a polymer and at the same time they are introduced to the properties of the polymer. We also evaluated the limitations of the less favoured activity i.e., poster and mini lectures, supporting the observation based on the findings of the literature. Generally, more active participation with adequate facilitation is necessary to enhance effective learning.

The experience of the Carnival Chemistry demonstrates that active participation of learners is an important element to encourage learning. The hands-on experiments involving peer mentoring with collaborative learning is found to be the most effective. As a whole, activity based learning is a useful approach however it needs to be carefully constructed to achieve the anticipated learning outcomes.

References

Ali, T. 2012. A case study of the common difficulties experienced by high school students in chemistry classroom in Gilgit-Baltistan (Pakistan). *SAGE Open*: 1-13.

Baeten, M., Kyndt, E., Struyven, K. & Dochy, F. 2010. Using student-centered learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review* 5: 243-260.

Bloom, B.S. 1953. Thought processes in lectures and discussions. *Journal of General Education* 7: 160-169.

Bloom, B.S. 1956. *Taxonomy of educational objectives Handbook I: Cognitive domain*. New York: David McKay.

Casassa, E.Z., Sarquis, A.M. & Van Dyke, C.H. 1986. The gelation of polyvinyl alcohol with borax. *Journal of Chemical Education* 63(1): 57-60.

Daley, E. 1997. Effectiveness of poster for nutrition education in an Acquired Immunodeficiency Syndrome clinic. *Journal of the American Dietetic Association* 97(7): A28.

de Zea Bermudez, V., Passos de Almeida, P. & FériaSeita, J. 1998. How to learn and have fun with poly(vinyl alcohol) and white glue. *Journal of Chemical Education* 75: 1410-1418.

Demirci, A., Kesler, T. & Kaya, H. 2010. Activity-based learning in secondary school Geography lessons in Turkey: A study from teachers' perspective. *World Applied Science Journal* 11(1): 53-63.

Dougherty, R.C., Bower, C.W., Berger, T., Rees, W., Mellon, E.K. & Pulliam, E. 1995. Cooperative learning and enhanced communication: effects on student performance, retention, and attitudes in general chemistry. *Journal of Chemical Education* 72: 793-797.

Encylopedia Britannica Co. 1992. Full Option Science System. Chicago.

Edwards, H., Smith, B. & Webb, G. 2001. *Lecturing, Case Studies Experience And Practice*. London: Kogan Page Limited.

Granger, E.M., Bevis, T.H., Saka, Y., Southerland, S.A., Sampson,V. & Tate, R.L. 2012. The efficacy of student-centered instruction in supporting science learning. *Science* 338(6103): 105-108.

Hansen, E.W., Stein, E.M. & May, V.V. 2008. Work in progress: Building community among first year engineering students in *Proceedings of 38th ASEE/IEEE Frontiers in Education Conference*. 22-25 October, Saratoga Springs, New York, USA.

Jegede, S.A. 2007. Students' anxiety towards the learning of Chemistry in some Nigerian secondary schools. *Educational Research & Review* 2(7): 193-197.

Johnson, L. 2008. What's student-centered learning and why should we care. *Australian Biochemist* 39(3): 1-6.

Kirkpatrick, D., (1996) Revisiting Kirkpatrick's four-level-model. *Training and Development* 1: 54-57.

Kunter, M., Baumert, J. & Koller, O. 2007. Effective classroom management and the development of subject-related interest. *Learning and Instruction* 17(5): 494-509.

Mayer, R.E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B. & Chun, D. 2009. Clickers in the classroom: Fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology* 34: 51-57.

Niaz, M., Aguilera, D., Maza, A., & Liendo, G. 2002. Arguments, contradictions, resistances, and conceptual change in students' understanding of atomic structure. *Science Education* 86: 505–525.

Ravi, V. & Sinha, S. 1999. Effective learning through quiz as a training methodology. *Indian Journal of Training and Development* 29: 62-71.

Saha, A., Poddar, E. & Mankad, M. 2005. Effectiveness of different methods of health education: a comparative assessment in a scientific conference. *Public Health* 5 (88): 1-7.
Town, M.H. & Grant, E.R. 1997. "I believe I will go out of this class actually knowing something": cooperative learning activities in physical chemistry. *Journal of Research in Science Teaching* 34: 819–835.
Wessels, A., Fries, S., Horz, H., Scheele, N. & Efelsberg, W. 2007. Interactive lectures: effective teaching and learning in lectures using wireless networks. *Computers in Human Behavior* 23: 2524-2537.
Zou, T.X.P., Ko, E.I. & Mickleborough, N. 2012. Promoting multi-layered peer learning in a course on engineering grand challenges. *Procedia – Social and Behavioural Science* 56(8): 74-87.

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