

Evaluation instruments used in Problem-Based Learning

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Abstract

A focus group of 18 faculty members at Campus O of a higher educational institution and another focus group of 16 faculty members at Campus S of the same institution comprised the sample, representative of close to 100% of their respective populations. Independently, both groups were engaged in interactive Problem-Based Learning sessions. They subsequently completed two evaluation instruments. One evaluation instrument had five items (05ITEMS), and the other had ten items (10ITEMS). Each evaluation instrument had two forms; one used a five point Likert scale and the other a ten point Likert scale. Identical participant satisfaction ratings were recorded using 05ITEMS and 10ITEMS instruments at the 99%, 98% and 95% confidence intervals ($t = 0.59$, $\alpha = .01$, $df = 34$). Participants expressed satisfaction in a number of areas like clear delivery by workshop facilitator; capturing their interest; gaining knowledge; and obtaining useful handouts. Implications for improving teaching and learning in higher educational institutions through Problem-based Learning, engaging participants and saving time and cost are discussed.

Key words: Evaluation, teaching, problem-based learning, satisfaction, cost.

Introduction

Reducing institutional cost whilst achieving its mandate appears to be the goal of most organizations whether large, small or medium, wealthy or improvised. Given the present global recession, reducing institutional cost has taken centre stage in the everyday organization of activities. This paper uses real time analysis to show how evaluation may be done at reduced institutional cost. Campuses were labeled O and S for confidentiality.

Background

In order to meet the growing demands of an industrial based country, the then existing government conceived of the newly formed higher educational institution. The

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mission focuses on preparing citizens to meet the challenges of today's society by developing entrepreneurs, commercializing research and development and spawning companies for wealth generation and sustainable job creation towards the equitable enhancement of life for all. Accordingly, Problem-based Learning (PBL) was seen as one of the many avenues of accomplishing this goal. This researcher conducted several PBL faculty training workshops across the eight campuses of the university. The workshops were focused at faculty from different disciplines like engineering, performing arts, education, information and communication technology, maritime studies, environmental studies, agriculture, fashion and design, sports and manufacturing, among others. The workshops were meant to improve teaching and learning practices among faculty members and generally engage them in lifelong learning through professional development activities.

In order to provide the presenter with feedback about the effectiveness of the methods and materials used in the PBL workshop, a ten item instrument (10ITEMS) using a 10 point Likert scale was used. Judging from the reactions of the workshop attendees, it was felt that they wished to use minimum time and effort for workshop evaluations. As a result, a five item instrument (05ITEMS), using a 10 point Likert Scale was designed and simultaneously used to evaluate the same faculty workshop. In another faculty workshop, a five point Likert scale was used with both 05ITEMS and 10ITEMS.

Literature Review

Barrows and Tamblyn (1980:18) conceptually defined PBL as 'the learning that results from the process of working toward the understanding or resolution of a

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problem'. Usually, the problem is ill-structured and meant to be addressed in the learning process. The problem focuses on a number of learning outcomes, usually derived from the course outline or curriculum. The intention is that the problem would serve as a catalyst, focus, or even a stimulus for the application of problem solving or reasoning skills. The problem is meant to engage the learner in his quest for information or knowledge, comprehension, application and reflection.

Oftentimes conceived as a pedagogical method in which a real-life or authentic problem or situation is presented to students for investigation, analysis, solution, synthesis and evaluation, PBL presents numerous opportunities for the honing of skills normally overlooked by traditional teaching methods. Usually learners work in reasonably small sized groups with the teacher assuming a new role of coordinator, resource person, facilitator, coach, referee and fellow learning partner. Traditional roles like instructor, boss, tutor, director or disseminator of information are placed in the shadow and emphasis is placed on the learner and his immediate needs. Learning is student-centred rather than teacher-centred, yet both parties can simultaneously attain some reasonable measure of self satisfaction and self actualisation. When one considers that research is seldom conducted individually and more often conducted in teams, Gibbs (1995:3) believes that several abilities honed through PBL are applicable not only to the academic world but also to the commercial world.

In terms of restructuring traditional curriculum, Boud and Feletti (1997:15) see PBL as a way of approaching a curriculum: 'Problem based learning is an approach to structuring the curriculum which involves confronting students with problems from practice which provide a stimulus for learning.' With several course outlines structured

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in traditional styles, formal training in PBL appeared mandatory in order for the university to achieve its goals.

A number of researchers like Engel (1997); Gagné, Yekovich, & Yekovich (1993); Poikela & Poikela (1997) and Segers (1997) underscored the fact that today's society mandates that its graduates be able to solve complex problems. To achieve this objective traditional methods appeared incapable of accomplishing this purpose. However, because of the nature of PBL with its collaborative problem solving work requiring active communication in a collegial environment, learners are better able to acquire the skills needed to actively participate in real world situations. Barfield (2003:354) posited that '*interactive peer-based methods promote student creativity, critical thinking and experiential learning*'. As learners actively communicate in small sized groups they are forced to cultivate habits/skills for every-day use that would redound to their success in the market place long after they leave the institution.

Using three graduate levels, constructivist project-based courses, while asynchronously conducting a project-based learning activity, King and Puntambeker (2003) demonstrated that an online community of learners was established. This is understandable when one considers that group or team work is central to the PBL process. Further, learners have the opportunity to focus on personal interest and yet collectively accomplish a given task successfully. This means that PBL affords learners the satisfaction of excelling in their specialised areas of competence. In a scenario of this nature, individual learners need not feel over burdened but have a sense of shared responsibility thereby minimizing the stress attendant with information overload. Learners who need urgent attention are motivated and encouraged to move to higher

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levels and accomplish much more than they would normally have done. Since facilitators act like partners in the learning process they are also able to pursue their professional development simultaneously. They are able to improve their own competence and confidence in several instructional techniques and approaches that promote higher order thinking skills in their learners.

Additionally, learners construct their own meaning to information and are better able to internalize material for long term memory. Deeper learning results, as opposed to surface learning for its own sake, thereby creating a kind of learner who becomes interested in lifelong learning and personal continuous quality improvement. Barrett (2005) in their research on PBL, emphasizing its pragmatic and pedagogic advantages, draws attention to improved student outcomes.

Having understood the nature of the PBL workshops we proceed to relate the use of two evaluation instruments (**05ITEMS** and **10ITEMS**) using a five point and ten point Likert scale to obtain timely feedback from workshop participants. A Likert scale is a unidimensional scaling method that assumes that the concept to be measured is one-dimensional in nature (<http://www.socialresearchmethods.net/kb/scallik.php>). The psychometric scale allows respondents to evaluate responses or Likert items according to subjective or objective criteria with a view to measuring the level of agreement or disagreement.

The Likert scale used ranged from strongly agree (5) to strongly disagree (1) for the five point scale and strongly agree (10) to strongly disagree (1) for the ten point scale. A forced choice was not used to allow respondents to freely express their views even by using the middle option (neither agree nor disagree). The format of the five

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point Likert scale was a visual analog scale where respondents indicated by way of a number their preference according to the ordered scale as follows:

5. Strongly agree
4. Agree
3. Neither agree nor disagree
2. Disagree
1. Strongly disagree.

The summated scale (total = 25 on the 5 point and 100 on the 10 point), indicated the average respondent's perception.

One may not assume that respondents viewed all pairs of adjacent levels as equidistant. Hence, the eroding of the given statements indicated a symmetry about a middle category. Further, since a visual picture scale was provided with equal intervals or spacings, respondents may have assumed that interval coding was applicable.

This researcher has observed that Likert scales may be subject to distortion since respondents may express central tendency bias, that is they avoid using extreme response categories. Respondents may also display acquiescence bias by agreeing with statements presented. Additionally, respondents may manifest social desirability bias by attempting to portray themselves or their organization in a more favourable light than is truthful. To minimize some of these pitfalls, especially acquiescence bias, the instrument was specially designed with as balanced a keying as possible (approximate equal number of positive and negative statements) were present. Central tendency bias and social desirability presented more challenges to minimize. Using a simple transformation, Dawes (2008) found that data from a 5- level, 7- level or 10-point showed minimal differences in terms of mean, variance, skewness, and kurtosis.

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Learners are provided with the kind of scaffolding that allow them to better navigate their way through unknown territory that they would have otherwise been unwilling to venture. With such training, facing challenges at the work place appear less daunting. In particular, the paper focuses on answering the following research question:

Research Hypothesis

There is no significant difference between the results obtained from using **05ITEMS** as opposed to **10ITEMS**.

Participants

A focus group of 16 faculty members at Campus O and another focus group of 18 faculty members at Campus S comprised the sample, representative of close to 100% of their respective populations. Independently, both groups were engaged in interactive PBL sessions with the same workshop facilitator.

Method

The 16 faculty members at Campus O completed 05ITEMS and 10ITEMS evaluation instruments with both a five point and a ten point Likert scale at the end of their workshop session. The same procedure was followed for the 18 faculty members at Campus S. As mentioned earlier, the Likert scale used ranged from strongly agree (5) to strongly disagree (1) for the five point scale and strongly agree (10) to strongly disagree (1) for the ten point scale. Participants were presented with statements and asked to rate those statements using the given scale. They indicated how closely their feelings matched given statements on a rating scale. Statements were sourced from a large pool of data tailored to suit the needs of respondents, relating to areas of concern with respect to what makes a workshop good. In order to avoid misinterpretation, given

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the time allocated for workshop evaluation and the normal attitude of attendees, no reversal items (items reversed in meaning from the overall direction of the given scale) were used.

After the generation of the items a group of judges rated the items using the 1-5 or 1- 10 scale as previously described. The favourability of each item with respect to the given scale is what was determined. The rating of the judges was used to compute the intercorrelations between all pairs of items. Items were retained or discarded depending on their item-total correlations ($> .6$). A t test of the differences between the mean value for the item for the top and bottom quarter judges would indicate that higher t values suggest that there is a greater difference between the highest and lowest judges. Higher t-values mean higher discrimination, hence retention of items with high t-values. A final judgement call was used to determine the retention of items.

Data analysis presumed ordinal/interval data giving rise to modes/means and dispersions/standard deviations. The final score for a respondent was taken as the sum of the respondent's ratings for all the items ('summated scale').

Research Design

A post test only experimental design was used. Participants completed the 05ITEMS and 10ITEMS evaluation instruments after the PBL experience. In both instances a five point and ten point Likert scale was used.

Results

These are summarized in Tables 1 and 2 for the 16 faculty members at Campus O who completed 05ITEMS using both a five point and a ten point Likert scale.

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<Insert Table 1 here>.

Using 05ITEMS with a five point Likert scale, workshop attendee satisfaction rating was calculated at 80% (mean= 20/25, std. dev. = 2.47). This meant that the spread of scores about the mean was relatively small and indicated the usefulness of 05ITEMS with a five point Likert scale.

<Insert Table 2 here>.

Using 05ITEMS with a ten point Likert scale, workshop attendee satisfaction rating was also calculated at 80% (mean= 39/50, std. dev. = 4.87). This meant that the spread of scores about the mean was comparatively greater and underscores the superiority of 05ITEMS using a five point Likert scale.

Summarised in Tables 3 and 4 for the 18 faculty members at Campus S are the following results.

<Insert Table 3 here>.

With ten items and a five point Likert scale, workshop attendee satisfaction rating for the second workshop was calculated at 90% (mean = 44/50, std. dev. = 5.10). This meant that the spread of scores about the mean was greater than in the two previous cases.

<Insert Table 4 here>.

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Using a ten item instrument with a ten point Likert scale the identical workshop attendees recorded a satisfaction rating of the identical 90 % (mean= 86/100, std. dev. = 10.19). Clearly, the spread of scores about the mean was greater than in all the three previous cases.

The Student t-test was used to test whether there was a significant difference between the results obtained from each of the four scenarios above. Those t-tests results are summarized in Table 5.

<Insert Table 5 here>.

At the 99%, 98% and 95% confidence levels, the t value remained unchanged suggesting that there was no significance difference between the use of 05ITEMS using a five point Likert scale; 05ITEMS using a ten point Likert scale; 10ITEMS using a five point Likert scale and 10ITEMS using a ten point Likert scale.

Analysis of responses from semi-structured interviews showed that participants expressed satisfaction in a number of areas like clear delivery, capturing their interest, gaining knowledge and obtaining useful handouts. Some of the following written comments on the evaluation instruments included:

...everything was so simple and straightforward to understand ...

...I was never bored for a moment ...

...I much prefer the idea of completing a short instrument than a long one...less time and much less effort. Basically, they should get the identical results..I don't see why not...

... I learned a lot from all the activity ...

...what's the point in spending so much time on evaluation when you could get similar results in a shorter manner?...

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The foregoing listed comments speak to the workshop participants' preferred use of a shorter evaluation instrument that could be completed in minimal time.

Discussion and Conclusion

The value of PBL training in improving teaching and learning in higher educational institutions cannot be overemphasized. Participants hone numerous skills that may be traditionally omitted from a normal subject-centred curriculum. Evaluating workshop attendees' PBL experiences is considered important in determining the value of their experiences and determining useful ways for improving teaching and learning in the future. Maximising variance by having as many items as possible seems in order for a better understanding of how the PBL training is affecting participants. Clearly, we cannot assume that all respondents are identical in context and condition, and their needs are identically addressed by the experience and that the philosophy, teaching style and methods are equally appropriate for all learners. Additionally, we cannot assume that there is a single standard against which decisions are made by respondents.

Herein, lies the usefulness of this paper since it seeks to determine the best way of obtaining optimal results in the most cost effective and time efficient manner. Results indicated that It took respondents more than half the time to complete the evaluation forms with five items (05ITEMS) compared with ten items (10ITEMS). Surely, with a reduced number of items that measure the full construct identified by the theories underlying factor construction, then having five items is better than ten. The time/data trade-off is valuable judging from the comments made by respondents.

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From qualitative analysis one participant recorded expressing satisfaction with PBL experiences in a number of areas like clear delivery, capturing their interest, gaining knowledge and obtaining useful handouts. From quantitative analysis performed, the focus group of 16 members at the Campus O recorded an 80% satisfaction rating using 05ITEMS for both a five point and ten point Likert scale. Similarly, the focus group of 18 faculty members at Campus S recorded a 90% satisfaction rating using 10ITEMS for both a five point and ten point Likert scale. The t-test showed that there was no significant difference between the results obtained from using 05ITEMS and 10ITEMS. It must be pointed out that while a lack of significance is not the same as equivalence, the levels of significance considered tended to suggest that any differences present are insufficient to support the preferred use of 10ITEMS with a ten point Likert scale to 05ITEMS with a five point Likert scale.

Recognising that overall similar results were obtained from use of the five and ten point Likert scales for both 05ITEMS and 10ITEMS, this researcher realized that we could reduce institutional cost in paper, time, expertise and energy. Workshop participants can comfortably complete 05ITEMS in a shorter time while providing feedback. Time and money saved may be used for other useful endeavours to the benefit of the organization.

Perceptions expressed are assumed to accurately represent the true opinions of the respondents. It is also assumed that their perceived use of the information did not influence their responses in a noticeable manner. However, one may not necessarily assume that respondents viewed all pairs of adjacent levels in the Likert scale as being equidistant. The scale used indicates a symmetry about a middle category that could

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have influenced many respondents. Further, since a visual picture scale was provided with equal intervals or spacings respondents may have assumed that interval coding was applicable.

Since there were no previous benchmarks for this research in the Caribbean region consensus based assessment was used to create, refine and validate an objective standard. Clearly, the data has to be checked to ensure that it fits the axioms of the model. Building an affect measure on a true Likert scale has its own inherent difficulties. Nevertheless, the summation into an overall affect score may be cautiously interpreted as a generalized attitude towards the training despite being confounded by perceptual items rather than by attitude items. This may be addressed through the lens of writing.

With a restricted sample size, despite representing close to 100% of the population, limited generalisability can be expected. A small sample size is not recommended for item construction and testing. A minimum of about 35 for each level of variable referring to breadth of potential respondent is recommended.

The challenges of presenting this research as a methodological study of an instrument construction seem difficult to overcome. While the primary emphasis was evaluation, and not necessarily scale construction, the results obtained serve to provide useful information for practitioners. It is hoped that this research would serve as a catalyst for further work in improving teaching and learning in higher educational institutions the area.

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Table 1
Results from **05ITEMS** using a ten point Likert Scale

#	STATEMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVERAGE	STD.DEV
1	The Faculty and Graduate Student PBL Experiences Seminar prepared me mentally for learning more.	4	2	4	3	3	4	4	4	4	4	4	5	4	3	4	3	4	0.70
2	The PowerPoint slides helped me to focus on the important ideas.	5	3	3	3	4	4	5	4	3	5	2	3	5	4	4	4	4	0.91
3	The information contained in the presentations was delivered clearly.	4	4	4	4	5	4	5	4	3	4	4	3	5	4	3	4	4	0.63
4	The presentation was easy for me to follow.	5	4	5	4	5	4	5	4	3	4	4	4	5	4	4	4	4	0.58
5	The handouts helped me to understand more.	4	3	5	4	4	4	4	4	3	5	2	4	5	4	3	5	4	0.85
TOTAL		22	16	21	18	21	20	23	20	16	22	16	19	24	19	18	20	20	2.47

Note: Item scores are out of 5. Individual scores are out of 25.
5 POINT LIKERT SCALE : 1 = Strongly Disagree, 5 = Strongly Agree

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Table 2
Results from **05ITEMS** using a ten point Likert Scale

#	STATEMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVERAGE	STD.DEV
1	The Faculty and Graduate Student PBL Experiences Seminar prepared me mentally for learning more.	7	5	8	8	8	9	8	8	9	8	8	10	8	5	8	6	8	1.35
2	The PowerPoint slides helped me to focus on the important ideas.	8	6	7	6	8	9	9	8	6	10	4	8	9	6	9	7	8	1.59
3	The information contained in the presentations was delivered clearly.	6	8	8	8	10	9	10	8	7	8	6	8	8	9	9	8	8	1.15
4	The presentation was easy for me to follow.	8	8	8	7	9	9	10	8	7	8	8	7	8	9	9	8	8	0.83
5	The handouts helped me to understand more.	7	6	7	7	9	9	10	8	7	10	4	9	7	5	9	9	8	1.74
TOTAL		36	33	38	36	44	45	47	40	36	44	30	42	40	34	44	38	39	4.87

Note: Item scores are out of 10. Individual scores are out of 50.

10 POINT LIKERT SCALE : 1 = Strongly Disagree to 10 = Strongly Agree

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Table 3
Results from **10ITEMS** instrument using a ten point Likert Scale

#	STATEMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVERAGE	STD.DEV
1	The workshop prepared me mentally for learning more.	4	4	5	4	5	3	5	5	4	4	4	5	4	3	5	5	3	3	4	0.79
2	The activities stimulated discussion.	5	3	5	4	5	4	5	4	5	4	4	5	5	5	5	5	4	4	5	0.62
3	The PowerPoint slides helped me to focus on the important ideas.	4	4	5	3	5	4	5	5	5	5	4	4	4	5	5	4	4	4	4	0.61
4	The information contained in the presentations was delivered clearly.	5	4	5	3	5	4	5	5	4	4	4	4	4	4	5	4	3	4	4	0.65
5	The break-out groups allowed me to experience PBL.	5	4	5	3	5	5	5	5	4	4	3	5	4	4	5	5	4	4	4	0.70
6	The presenter(s) held my interest.	5	4	5	4	5	4	5	5	5	4	5	4	3	4	5	5	4	4	4	0.62
7	The presentations were easy for me to follow.	5	4	5	4	5	3	5	4	5	5	5	5	3	3	5	5	4	4	4	0.78
8	The facilitator(s) assisted me in experiencing PBL in practice.	5	4	5	3	5	4	5	5	5	4	4	5	3	4	5	5	4	4	4	0.70
9	The information summarized the main points.	5	4	5	4	5	5	5	5	5	5	4	5	3	5	5	5	5	4	5	0.59
10	I gained knowledge from this workshop.	5	4	5	4	5	5	5	4	4	5	3	5	3	3	5	5	4	4	4	0.77
TOTAL		48	39	50	36	50	41	50	47	46	44	40	47	36	40	50	48	39	39	44	5.10

Note: Item scores are out of 5. Individual scores are out of 50.

5 POINT LIKERT SCALE : 1 = Strongly Disagree, 5 = Strongly Agree

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Table 4

Results from **05ITEMS** using a ten point Likert Scale

#	STATEMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVERAGE	STD.DEV
1	The workshop prepared me mentally for learning more.	7	7	10	8	10	6	10	8	9	9	9	9	7	6	10	10	6	8	8	1.49
2	The activities stimulated discussion.	10	6	10	8	9	9	10	8	10	9	9	9	10	9	10	10	8	8	9	1.08
3	The PowerPoint slides helped me to focus on the important ideas.	7	6	10	6	10	7	10	8	9	10	9	8	7	9	10	8	8	8	8	1.37
4	The information contained in the presentations was delivered clearly.	9	7	10	6	10	7	10	8	9	9	9	8	8	8	10	8	6	9	8	1.29
5	The break-out groups allowed me to experience PBL.	10	7	10	6	9	9	10	8	9	9	8	9	9	8	10	10	8	10	9	1.15
6	The presenter(s) held my interest.	8	7	10	8	10	9	10	8	10	8	9	8	8	7	10	9	7	10	9	1.14
7	The presentations were easy for me to follow.	10	7	10	8	10	7	10	8	9	10	9	9	8	6	10	9	8	10	9	1.26
8	The facilitator(s) assisted me in experiencing PBL in practice.	10	7	10	6	10	7	10	8	9	8	8	9	7	7	10	10	8	8	8	1.34
9	The information summarized the main points.	10	7	10	8	10	9	10	8	9	10	8	9	7	9	10	10	9	6	9	1.25
10	I gained knowledge from this workshop.	10	7	10	8	10	9	10	8	9	10	8	9	8	6	10	10	8	9	9	1.20
TOTAL		91	68	100	72	98	79	100	80	92	92	86	87	79	75	100	94	76	86	86	10.19

Note: Item scores are out of 10. Individual scores are out of 100.

10 POINT LIKERT SCALE : 1 = Strongly Disagree, 10 = Strongly Agree

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Table 5
t tests for means results

	Confidence intervals								
	99%			95%			90%		
	Mean	SD	t	Mean	SD	t	Mean	SD	t
Focus Group 11 (n =16)	20.0	2.47	0.58	20.0	2.47	0.58	20.0	2.47	0.58
Focus Group 12 (n =16)	19.5	2.44		19.5	2.44		19.5	2.44	
Focus Group 21 (n =18)	44.0	5.10	0.59	44.0	5.10	0.59	44.0	5.10	0.59
Focus Group 22 (n =18)	43.0	5.09		43.0	5.09		43.0	5.09	

Note.: Focus Group 1:Two-tail confidence level = 43.11% (not significant), *df* = 30.
Focus Group 2:Two-tail confidence level = 44.01% (not significant), *df* = 34.