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Perceptions of computer and pen-and-paper based learning environments for engaging in creative problem solving activities

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BACKGROUND

Previous research has established that engineering students are able to complete creative problem solving tasks effectively using either a computer or a pen-and-paper approach and that several factors including self-efficacy, open-mindedness and reflection have been linked to effective problem solving performance. As a result, computer based tools designed to teach creative problem solving skills, should enhance the development of these factors at least as well as a traditional pen-and-paper based approach. There is currently a lack of understanding as to whether using a computer has any beneficial or detrimental effect regarding facilitating enhancement of these factors during creative problem solving activities. Understanding whether students consider each platform to be effective and how this compares to their performance, may help engineering educators to best identify the means for both increasing the problem solving skills of students, and providing it though an environment which also aims to enhance factors which influence problem solving performance itself.

PURPOSE

It is important to comprehend whether students consider a computer platform to be as effective as a pen-and-paper approach for enhancing their creative problem solving skills, to understand whether the platform itself may have the unintended effect of discouraging students from such engaging in creative problem solving tasks.

DESIGN/METHOD

Students first engaged in a task that taught them how to apply a creative problem solving technique, using either a computer or pen-and-paper or web based approach. Feedback asking how the task had affected students' performance, confidence and reflection was gathered at the conclusion of the task using 7-point Likert scale questions, and student performance was established based on the number of independent ideas they had generated. Feedback data was compared to the performance of students during this task and a follow up task conducted eleven weeks later to see whether students rated one platform as superior, and whether their perceptions matched their immediate and long term performance.

RESULTS

Students' average performance and perception of the benefits of the first activity were slightly higher when the student had used pen-and-paper, as opposed to computer based approach, but all differences were statistically insignificant. Conversely, students who had used a computer approach in the first task were actually able to perform more effectively during the second task than students who had previously used a pen-and-paper approach, but the difference was statistically insignificant.

CONCLUSIONS

Outcomes of this study have shown students perceive completing a creative problem solving task using pen-and-paper is slightly more effective for enhancing factors important to the development of problem solving skills, suggesting using a computer may lead to less motivation to engage in such activities. However, long term performance indicated it was actually of more benefit to complete the task using a computer, meaning educators would need to overcome initial perceptions which may dissuade some students from utilising what turns out to be an effective resource and mode of delivery.

KEYWORDS

problem-solving, web-based tool, creativity.

Introduction

Several studies have consistently highlighted that there is a notable gap between the importance that engineering employers place on problem solving skills, and how well they consider that engineering graduates are effectively able to solve problems (Blom and Saeki, 2012; Male, Bush, and Chapman, 2010; Nair, Patil, and Mertova, 2009; Ramadi, Ramadi, and Nasr, 2015; Wickramasinghe and Perera, 2010). This raises the issue that despite engineering industry, graduates and university lecturers all ranking problem solving skills as fundamental for the profession (Wickramasinghe and Perera, 2010), and engineering students considering problem solving skills to be of vital importance (Steiner et al., 2011), there is still an apparent mismatch between the skills that graduates have in this area, and what industry expects. Finding new ways of increasing the problem solving skills of graduates to better meet the needs of industry is therefore a great challenge. One proposed method to enhance the problem solving and creativity skills of engineering students, while aiming to adhere to the time and curricula challenges faced by engineering educators, is to provide simple web based tools which can engage students in short activities designed to enhance creative problem solving (CPS) skills (Valentine, Belski, and Hamilton, 2015).

With the rapidly growing adoption of online based coursework and study materials into engineering curricula, it is imperative that the high standard of education which is expected from face-to-face instruction is replicated in the online environment. However, ensuring that online environments provide a suitable alternative to face-to-face instruction is not straightforward. In a review which compared the similarity of computer and paper based tasks, Noyes and Garland (2008) identified that there were numerous factors which can make computer based tasks different to paper based tasks. More recently, Lawton et al. (2012) have asserted that online and non-online based learning should not simply be regarded as equivalent, even when it uses the same study material. While this does not mean that one method of delivery is necessarily better or worse than the other, it highlights the concern that method of delivery may influence the learning process. Engaging students in CPS activities using a computer or pen-and-paper approach can lead to long term performance enhancement which may be deemed to be comparably similar by educators (Valentine, Belski, and Hamilton, 2016). However, this does not necessarily mean that students consider that the computer platform facilitates them to build upon their existing problem solving skills as effectively as a pen-and-paper approach.

Previous research which has compared engineering students' perceptions of traditional vs. online learning approaches have primarily focussed on comparing entire courses (Limniou and Smith, 2010; Martínez-Caro and Campuzano-Bolarín, 2011), while perceptions of using digital vs. non-digital resources has focussed on reading (Pinto, Pouliot, and Antonio Cordón-García, 2014; Waters, Roach, Emde, McEathron, and Russell, 2014) or information retrieval (Fidel and Green, 2004; Kerins, Madden, and Fulton, 2004). The experience of completing a short CPS activity is very different to what has been previously investigated, limiting what may be reliably inferred from the existing literature.

Students may perceive that for engaging in CPS learning activities, the learning environment provided by a computer is not as effective as a pen-and-paper approach. In this case, students may be less inclined to engage in such activities using a computer. Using the web may enable computer based versions of the activity to widely accessible, increasing the potential benefit of such activities. However, in the interest of encouraging students to engage in regular computer based learning activities designed to enhance their CPS skills, it is important to comprehend whether students consider a computer platform to be as effective as a pen-and-paper approach, to ensure that the platform itself does not discourage students from engaging in such tasks. In this case, the increased accessibility would be undermined by the reduced appeal of using what should be effective learning resources.

Computer software also has the potential to provoke or increase motivation to learn, because of its interactivity (Cavallucci and Oget, 2013). This raises the question of whether engineering educators may attempt to increase students' interest in improving their CPS skills, by providing computer based tools which can motivate them to engage in self-directed study.

There is a gap in the literature when it comes to understanding engineering students' perceptions of whether computer based tools can effectively build upon their problem solving skills, and how a computer approach compares to a traditional pen-and-paper approach. Understanding students' perceptions, misconceptions, and how these may additionally relate to their performance may assist engineering educators to better assess the suitability of adopting computer based tools with the intention of enhancing students' CPS skills. The research described herein aims to address this gap in the literature by empirically evaluating the results of an experiment consisting of two CPS activities.

Methodology

Research Questions and Metrics

In order to investigate students' perceptions of the effectiveness of the learning environment each platform (computer and pen-and-paper) and how these perceptions may relate to students' performance, the following research questions were proposed:

RQ1. How does the platform used to complete a CPS learning activity, influence students' perception of the activity's effectiveness at enhancing their problem solving skills?

RQ2. How does students' initial perception of the platform they use to complete a CPS learning activity, actually compare to the influence of the platform on long term CPS performance?

RQ3. How does students' performance in a CPS learning activity, influence their perception of the activity's effectiveness?

In order to establish answers to the research questions, suitable metrics were required. The choice of metrics was required to provide insight into whether each environment was suitable for building CPS skills. A major component of the CPS process is the search for new, original solutions that may be used to resolve a problem that is being faced (Treffinger, Isaksen, and Stead-Dorval, 2006). Findings by Osburn and Mumford (2006) indicate generating multiple solutions will lead to the generation of more original ideas. Additionally, when multiple solutions are generated, the solution with the highest rated originality is likely to be regarded as more original than if only one solution is generated (Reiter-Palmon and Arreola, 2015). As a result, the primary metric that was adopted to assess students' CPS performance was based upon the number of independent ideas that were generated during an activity.

The learning environment of a platform should not only be judged based upon students' immediate performance, but on whether it enables students to adequately build upon skills which are key to the type activity they are conducting. As a result, it was reasoned that the learning environments should be compared using metrics which are key to the development of problem solving skills. Numerous factors are reported to influence problem solving performance including confidence, creativity, reflection, having an open mind, being willing to take risks (Adams, Kaczmarczyk, Picton, and Demian, 2009), and motivation (Adams et al., 2009; Dalrymple, Sears, and Evangelou, 2011). Harlim (2012) asserts that three main factors should be utilised for specifically measuring engineering problem solving performance; self-efficacy, open-mindedness and reflection. In addition, it has been reported that motivation to face future problems, which is important to the successful development of problem solving skills, is considerably influenced by self-efficacy (Harlim and Belski, 2011). As a result, these three factors, in addition to performance, were considered as suitable metrics for establishing whether each platform helps a practitioner to build upon skills which are central to the development of problem solving capability.

Description of Activity 1 and Activity 2

For the purpose of this study, a series of two CPS tasks were designed. The tasks were conducted eleven weeks apart as part of a third year undergraduate course on engineering design. Completion of the non-assessed tasks was expected as part of tutorial classes, but participation in this study was voluntary. The purpose of the first activity (Activity 1) was twofold. First, it was designed to provide insight into students' perceptions of whether the learning environments (pen-and-paper and computer) had an equivalent influence on any apparent enhancement to their problem solving skills. Additionally, Activity 1 was used to understand if students' performance during the activity influenced their perception of how effective the task was for building upon their problem solving skills. This helps to identify two points. First, whether CPS activities should be targeted particularly towards certain students, based on those who may find it most beneficial. Second, it may highlight whether certain students consider the activity to be ineffective, which may emphasize if educators need to find a way to make it more appealing to these students. Activity 2 was used to analyse whether students' initial perceptions of each platform from Activity 1 actually corresponded to the performance outcomes during Activity 2, to understand whether students' impressions of each platform accurately reflected their effect on actual long term outcomes.

At the commencement of the Activity 1, participants were introduced to an idea generation technique to use during the activity. A pre-recorded video of 15 minutes duration was used to explain the technique, so that explanation would be consistent across the several tutorial groups which made up participants of the study. This video introduced students to the Su-Field Analysis technique in a manner that could be easily followed, by showing a step-by-step example of how to apply the technique to a simple problem (eliminating irritating flies). Su-Field Analysis was chosen as the technique for students to utilise during Activity 1 as it has repeatedly been shown to be effective for generating new solution ideas to a problem (Belski et al., 2015), and performance is similar when either a pen-and-paper or computer approach is used (Valentine et al., 2015).

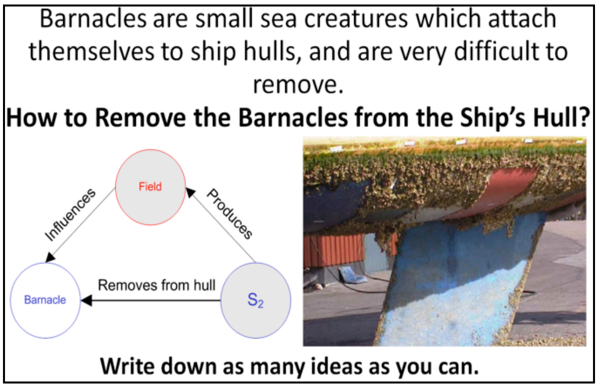

Figure 1: Problem presented during Activity 1

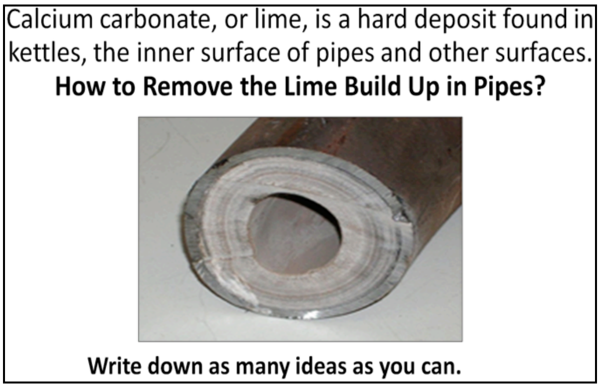

Figure 2: Problem presented during Activity 2

During Activity 1, students made use of either a pen-and-paper or equivalent web based template, which guided them through the application of Su-Field Analysis. Students who had brought their laptops to the tutorial classes were requested to use the web based template, while students who did not bring a laptop were asked to use a pen-and-paper template. In order to accommodate the concern that the groups were not randomly allocated, a short pre-activity questionnaire in the form of 7-point Likert Scale responses (1-Strongly Disagree, 7-Strongly Agree) was deployed to gauge whether student's problem solving skills, creativity skills and historical use of digital resources for studying were consistent between the groups.

If participants' responses to these questions were consistent between the groups, these could be eliminated as potential factors which may influence the result. Following this, participants were shown the problem presented in Figure 1, and provided with sixteen minutes to individually write their solutions on either the pen-and-paper or web based template they were using. Upon completion of the idea generation phase, students were requested to respond to a series of post-activity questions. These questions were in the form of 7-point Likert Scale responses (1-Strongly Disagree, 7-Strongly Agree) and asked students whether they considered that participating in the activity led to enhancement of the metrics of interest (see Table 2). Students were then able to voluntarily submit their responses to the tutor or online database for analysis as part of the research study.

Activity 2 took place in the same semester, eleven weeks after the conclusion of Activity 1. Participants were allocated into one of three groups which were dependant on whether they had previously (i) utilised a pen-and-paper template in Activity 1 (ii) utilised a web template in Activity 1, or (iii) not participated in Activity 1. Students who had not previously participated in Activity 1 were used as a control group, as they had no previous exposure to Su-Field Analysis, and thus its potential influence. Allocating the other students into groups based upon the platform they had previously used in Activity 1 meant any potential influence on long term performance due to the platform used in Activity 1 could be established. This performance could then be used to establish whether students' initial impressions of each platform from Activity 1 accurately reflected their performance in Activity 2.

During Activity 2, students were not provided with any specific idea generation technique as they has been in Activity 1. All participants of Activity 2 used the same pen-and-paper approach. Unlike the template used in Activity 1, the template used in Activity 2 only provided participants with a blank space to write ideas. The problem presented to students, shown in Figure 2, was different to that of Activity 1, but still of a technical nature. As in Activity 1, students were provided with sixteen minutes to individually develop solution ideas to the problem and write them down. Upon completion of the activity, students were again able to voluntarily return their templates to the tutor for inclusion in the research study.

Data Analysis

In order to establish the relative performance of each group during Activity 1 and Activity 2, three assessors individually evaluated the ideas that were generated by students. Evaluations were made through analysing the handwritten or database responses provided by each participant. Each assessor counted the distinct number of ideas generated by each student; results were then checked for inter-rater reliability using Cronbach's Alpha. The Cronbach's Alpha for the assessors' evaluations of the number of ideas generated by each student during Activity 1 and Activity 2 were both determined to be above 0.9, indicating the results were reliable. Further statistical analysis required the three individual sets of evaluations be amalgamated into one. As the evaluations were reliable, the average of the assessors' evaluations was adopted as the number of ideas a participant was deemed to have generated. For example, where the three assessors individually evaluated that a student generated 4, 6 and 5 ideas respectively, the average of 5.00 was adopted as the distinct number of ideas the student had generated.

Of the 45 pen-and-paper and 34 computer based participants who participated in Activity 1, 37 and 28 provided feedback on their perceptions of the tool, respectively. Student responses were split into two groups, dependant on the platform they had used in the activity, and the mean values of each feedback question were calculated for both groups.

In order to analyse the data for RQ2, student results were allocated into low, mid-range or high performing groups. Students were ranked in order of performance, dependant on the number of ideas they had generated during the activity. Students who had generated ideas, but not provided feedback at the conclusion of Activity 1 were excluded from this analysis. Students who had generated a number of ideas that ranked in the lowest 30% (4.33 ideas or less) were allocated to the low performance group. Students who had generated a number of ideas that ranked in the highest 30% (7.67 ideas or more) were allocated to the high performance group. All other students who had ranked between 30-70% (4.33 to 7.67 ideas) were allocated to the mid-range performance group. The mean values of each feedback question were then calculated across the three groups.

Results

The results of Activity 1 presented in Table 1 show that on average, using a pen-and-paper approach generated more ideas than students who used a computer based approach (6.75 vs. 6.20). Evaluation of the pre-activity questionnaire responses indicated student's problem solving skills, creativity skills and historical use of digital resources for studying were very similar and statistically insignificant between the groups, meaning these could be eliminated as potential factors which may influence the result. Distributions of the number of ideas generated by groups in each activity were found not to be normally distributed using the Shapiro-Wilk method, meaning that the non-parametric Mann-Whitney U Test was used to establish whether statistical significances had occurred. The difference between the number of ideas generated by groups in Activity 1 was established to be statistically insignificant. Likewise, the outcomes of Activity 2 found the difference between groups that had participated in Activity 1(3.45 vs. 3.98) was also statistically insignificant. In addition, students who used a pen-and-paper approach in Activity 1 generated a greater number of ideas on average than the control group (3.45 vs. 2.58), but the difference was statistically insignificant ($Z=-1.877$, $p=0.064$). Conversely, students who used a computer approach during Activity 1 generated more ideas than the control group (3.98 vs. 2.58), and the difference was statistically significant ($Z=-2.014$, $p=0.044$).

Table 1: The average number of distinct ideas proposed by students in Activity 1 and Activity 2

	Activity 1		Activity 2	
Group	**N**	**Mean (Std. Dev.)**	**N**	**Mean (Std. Dev.)**
Computer	45	6.20 (3.29)	21	3.98 (2.16)
Pen-and-paper	34	6.75 (3.98)	28	3.45 (1.17)
Control	N/A	N/A	8	2.58 (1.08)

Table 2 shows that feedback responses provided by students upon completion of Activity 1 were on average more positive when the participant had used a pen-and-paper based approach, although differences in the responses to each question were statistically insignificant.

Table 2: Comparison of feedback responses based upon platform used during Activity 1

Problem Solving Performance Factor	Question	CB (N=37) Mean (Std. Dev.)	PPB (N=28) Mean (Std. Dev.)
Performance	"This tool helped me to produce more solution ideas than I initially thought I may come up with."	5.24 (1.32)	5.61 (1.40)
Open-mindedness	"This tool helped me to consider a wider range of knowledge areas than I initially thought I may have used."	5.59 (1.32)	6.00 (1.16)
Self-efficacy	"This tool has increased my confidence in my ability to problem solve, even if only a little."	5.14 (1.11)	5.43 (1.48)
Reflection	"This tool has helped me to reflect on my problem solving abilities and how I may be able to further improve them."	5.38 (1.06)	5.54 (1.43)

CB = Computer Based, PPB = Pen-and-paper Based, all questions use Likert Scale of 1-strongly disagree to 7-strongly agree

The findings shown in Table 3 indicate that students rated the tool had a positive effective, regardless of their relative performance. However, the extent to which students positively rated the tool was somewhat influenced by their performance. When considering the “average student” response in each category, participants with the highest performance perceived that the tool was more effective than students whose performance ranked in the mid-range. Low performing students also considered that the tool was more effective on each metric than students whose performance ranked in the mid-range, although the difference was not as high as students who had high performance. Differences between both the low and mid-range performing groups, and mid-range and high performing groups were all statistically insignificant for each metric.

Table 3: Comparison of feedback responses based upon performance during Activity 1

Problem Solving Performance Factor	Number of Ideas Generated		
	Lowest 30% (N=20) Mean (Std. Dev.)	Mid-range (N=26) Mean (Std. Dev.)	Highest 30% (N=19) Mean (Std. Dev.)
Performance	5.35 (1.39)	5.15 (1.38)	5.79 (1.27)
Open-mindedness	5.85 (1.14)	5.54 (1.53)	6.00 (0.94)
Self-efficacy	5.25 (1.59)	5.15 (1.08)	5.42 (1.22)
Reflection	5.45 (1.40)	5.38 (1.27)	5.53 (1.02)

All questions use Likert Scale of 1-strongly disagree to 7-strongly agree

Discussion

Responses to each of the feedback questions shown in Table 2 were higher on average when the participant had used a pen-and-paper based approach during Activity 1. Although there were no significant differences on any of the feedback questions based upon the platform used to complete Activity 1, there is a clear overall trend showing students perceive a pen-and-paper approach as more effective for enhancing factors which influence their problem solving performance. Regarding RQ1, the results suggest that students perceive using either platform to engage in a CPS learning activity will positively influence factors which are key to the development of their problem solving skills. However, despite both platforms being regarded to positively influence these factors, it is apparent that students consider a pen-and-paper approach to be slightly more beneficial. Where CPS learning activities are made available to students, this may result in students having slightly less motivation, or a lesser number of students, engaging with such activities because they do not see them to be as beneficial, and therefore of as much use (Smart and Cappel, 2006). However, the web based platform was still positively received by students.

The outcomes of Activity 2 revealed unexpected results. Students who had used a computer approach during Activity 1 significantly outperformed the control group, but students who used a pen-and-paper approach in Activity 1, had not. Although the performance between the computer and pen-and-paper groups was significantly insignificant in both Activity 1 and 2, the performance of the groups became noticeably inverted. Whereas pen-and-paper was higher on average than computer in Activity 1 (6.75 to 6.20 ideas), this is reversed in Activity 2 (3.45 to 3.98 ideas). Regarding RQ2, these results show that students’ initial perceptions of each platform do not accurately reflect their actual influence on long term CPS performance. Educators may therefore seek to encourage use of computer based platforms, as the potential long term benefits may actually be greater.

Additionally, it was identified that students tended to rate the CPS learning activity as beneficial regardless of their performance during the task, though the extent to which it was beneficial may change. Considering the RQ3, while this suggests that some students may be more interested than others to engaging in similar CPS activities in the future, it shows students see benefit in completing CPS learning activities and that providing web based tools for this purpose may be a suitable method to increase their problem solving skills.

In this study, the computer based template was designed to be as similar to the pen-and-paper based template as possible, to allow a comparison of whether the platform itself has the potential to change perceptions about the usefulness of a CPS activity. However, as previously stated, the interactivity of computer software may provoke or increase motivation to learn (Cavallucci and Oget, 2013). If the software was designed to be more interactive, rather than a straight computer based implementation of an existing pen-and-paper template, the computer approach may have been more highly regarded by students. However, increasing interactivity needs to be done with caution. The computer tools should be designed such that they enable students to learn problem solving techniques and enhance their skills, but not to the stage where students become reliant on the tools to carry out the contained technique (Harlim and Belski, 2013). Ideally, students should be able to learn and internalise a problem solving technique by using the computer tool, so that they do not need to rely on the tool to carry out the technique in future.

There are limitations of this study which must be noted. Students were not randomly allocated into the computer and pen-and-paper groups during Activity 1. However, as discussed in the results section, evaluation of the pre-activity questionnaire responses indicated the problem solving skills and creativity skills of each group were similar. Also, the historical use of digital based resources for studying was similar, indicating these are factors which should not influence the results.

Conclusion

The findings of this study have established that engineering students on average consider a computer based approach to completing creative problem solving (CPS) learning activities less beneficial for enhancing their problem solving skills, than completing the activity using pen-and-paper. However, it has also been shown that students' initial performance and perceptions from completing the CPS learning activity, based upon the platform they utilised, were unreliable predictors of the true influence of each platform on future performance. While a computer based approach initially led to lower performance and student opinion of the benefits of completing the activity, a follow up CPS activity (conducted eleven weeks later) established that using a computer was actually more effective at enhancing long term performance, relative to a control group. It was also found that students considered the activity to be of benefit regardless of their relative performance, highlighting the potential for widespread student engagement in CPS activities. Future research may focus on the actual integration of computer based CPS learning activities tools into curricula and establishing whether regular engagement in such activities has measurable longitudinal benefits.

References

Adams, J. P., Kaczmarczyk, S., Picton, P., & Demian, P. (2009). Problem solving and creativity in engineering: Perceptions of novices and professionals. Paper presented at the World Congress on Engineering and Computer Science, San Francisco, USA.

Belski, I., Belski, A., Berdonosov, V., Busov, B., Bartlova, M., Malashevskaya, E., Kassi, T., Kutvonen, A., & Tervonen, N. (2015). Can simple ideation techniques influence idea generation: comparing results from Australia, Czech Republic, Finland and Russian Federation. Proceedings of the 26th Annual Conference *of the Australasian Association for Engineering Education – AAEE2015* (pp. 474-483). Geelong.

Blom, A., & Saeki, H. (2012). Employability and skill sets of newly graduated engineers in India. *IUP Journal of Soft Skills, 6*(4), 7.

Cavallucci, D., & Oget, D. (2013). On the Efficiency of Teaching TRIZ: Experiences in a French Engineering School. The International Journal of Engineering Education, 29, 304-317.

Dalrymple, O. O., Sears, D. A., & Evangelou, D. (2011). The Motivational and Transfer Potential of Disassemble/Analyze/Assemble Activities. Journal of Engineering Education, 100(4), 741.

Fidel, R., & Green, M. (2004). The many faces of accessibility: engineers' perception of information sources. Information Processing & Management, 40(3), 563-581.
Harlim, J. (2012). Identifying the factors that impact on the problem solving performance of engineers. (PhD Thesis), RMIT University.
Harlim, J., & Belski, I. (2011). Learning TRIZ: Impact on confidence when facing problems. *Proceedings of the Triz Future Conference* (pp. 113-122): Institute of Technology Tallaght.
Harlim, J., & Belski, I. (2013). Long-term innovative problem solving skills: Redefining problem solving. *International Journal of Engineering Education, 29*(2), 280-290.
Kerins, G., Madden, R., & Fulton, C. (2004). Information Seeking and Students Studying for Professional Careers: the Cases of EngINERering and Law Students in Ireland. *Information Research: An international journal, 10*(1).
Lawton, D., Vye, N., Bransford, J., Sanders, E., Richey, M., French, D., & Stephens, R. (2012). Online learning based on essential concepts and formative assessment. *Journal of Engineering Education, 101*(2), 244-287.
Limniou, M., & Smith, M. (2010). Teachers' and students' perspectives on teaching and learning through virtual learning environments. *European Journal of Engineering Education, 35*(6), 645-653.
Male, S., Bush, M., & Chapman, E. (2010). Perceptions of competency deficiencies in engineering graduates. *Australasian Journal of Engineering Education, 16*(1), 55.
Martínez-Caro, E., & Campuzano-Bolarín, F. (2011). Factors affecting students' satisfaction in engineering disciplines: traditional vs. blended approaches. *European Journal of Engineering Education, 36*(5), 473-483.
Nair, C. S., Patil, A., & Mertova, P. (2009). Re-engineering graduate skills–a case study. *European Journal of Engineering Education, 34*(2), 131-139.
Noyes, J., & Garland, K. (2008). Computer-vs. paper-based tasks: Are they equivalent? Ergonomics, 51(9), 1352-1375.
Osburn, H. K., & Mumford, M. D. (2006). Creativity and planning: Training interventions to develop creative problem-solving skills. Creativity Research Journal, 18(2), 173-190.
Pinto, M., Pouliot, C., & Antonio Cordón-García, J. (2014). E-book reading among Spanish university students. The Electronic Library, 32(4), 473-492.
Ramadi, E., Ramadi, S., & Nasr, K. (2015). Engineering graduates' skill sets in the MENA region: a gap analysis of industry expectations and satisfaction. *European Journal of Engineering Education*(ahead-of-print), 1-19.
Reiter-Palmon, R., & Arreola, N. J. (2015). Does Generating Multiple Ideas Lead to Increased Creativity? A Comparison of Generating One Idea vs. Many. Creativity Research Journal, 27(4), 369-374.
Smart, K., & Cappel, J. (2006). Students' perceptions of online learning: A comparative study. *Journal of Information Technology Education: Research, 5*(1), 201-219.
Steiner, T., Belski, I., Harlim, J., Baglin, J., Ferguson, R., & Molyneaux, T. (2011). *Do we succeed in developing problem-solving skills-The engineering students' perspective.* Paper presented at the Australasian Association for Engineering Education Fremantle, Western Australia.
Treffinger, D. J., Isaksen, S. G., & Stead-Dorval, K. B. (2006). *Creative problem solving: An introduction*: Prufrock Press Inc.
Valentine, A., Belski, I., & Hamilton, M. (2015). A comparison of web and paper based approaches for idea generation. *Proceedings of the 26th Annual Conference of the Australasian Association for Engineering Education – AAEE2015* (pp. 567-576). Geelong.
Valentine, A., Belski, I., & Hamilton, M. (2016). Engaging engineering students in creative problem solving tasks: How does it influence future performance?. *European Society for Engineering Education Annual Conference - SEFI2016*. Tampere, Finland.
Waters, J., Roach, J., Emde, J., McEathron, S. R., & Russell, K. (2014). A Comparison of E-book and Print Book Discovery, Preferences and Usage by Science and Engineering Faculty and Graduate Students at the University of Kansas.
Wickramasinghe, V., & Perera, L. (2010). Graduates', university lecturers' and employers' perceptions towards employability skills. *Education+ Training, 52*(3), 226-244