Journal of Scientific Research & Reports
5(2): 161-170, 2015; Article no.JSRR.2015.083
ISSN: 2320-0227

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A Swot (Strengths, Weaknesses, Opportunities and Threats) Evaluation of University Student-Staff Partnerships in Co-creating Educational Resources, Peer Support and Research Within STEM (Science, Technology, Engineering & Mathematics) Subjects

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Authors' contributions

This work was carried out as a collaboration between all authors. Author AD led the design of the study, planned the data collection, led the workshop discussion on co-creation of research and led the writing of the manuscript. Author DM provided guidance on methods of qualitative analyses, supported coordination of the data collection and assisted in shaping the paper. Authors JH, AEK, AP led the workshop discussions on co-creation of education resources (JH) and peer support (AK and AP) and, provided subject-specific knowledge in these areas in the paper. Author NTG provided extensive support in coordinating the workshop, carried out much of the data analysis for the paper in collaboration with Author AD and produced the tables of data. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2015/14498
Editor(s):
(1) James P. Concannon, Associate Professor of Education, Westminster College, Fulton, Missouri, USA.
Reviewers:
(1) E. E. Achor, Dept. of Curriculum & Teaching, Benue state University, Makurdi, Nigeria.
(2) Anonymous, Korea National University of Education & Korea.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=748&id=22&aid=7199

Short Research Article

Received 1st October 2014
Accepted 19th November 2014
Published 15th December 2014

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ABSTRACT

The aim of this research was to compare perceived opportunities and challenges of co-creating educational resources, peer learning support and research within Science, Technology, Engineering & Mathematics (STEM) subjects. Two questions were addressed:
1) What types of STEM co-creation outputs are perceived possible within the categories of education resources, research and peer learning support?
2) What was the perceived Strengths Weaknesses, Opportunities and Threats (SWOT) analysis for co-creation of education resources, research and peer learning support?
Study Design: These questions were explored in a descriptive survey with 30 academic staff delegates from across STEM disciplines and UK universities who attended a Higher Education Academy workshop "Students as partners in co-creating STEM outputs."
Place and Duration of Study: The one day long workshop was hosted by Bournemouth University on Jan 16th 2014.
Methodology: For question 1 the delegates gave examples from their experience for each of the following categories for co-creation: i) educational resources ii) peer learning support iii) research. For question 2 they worked as a team to consider one of these categories and, using nominal group technique, identified and themed as many strengths, weaknesses, opportunities and threats as possible to partnerships with students.
Results: 29 different co-creation outputs were identified (7 for co-created educational resources, 10 for co-created research and 12 for co-created peer support). Delegates reported proportionally most strengths for co-created research and most challenges for co-created educational resources. Strengths centered on energizing student engagement through co-creating new products/understanding. Challenges highlighted the need to ensure more widespread student engagement to maintain momentum and data quality.
Conclusion: Findings suggest that two keys ways to enhance co-creation of STEM outputs are to better understand the range of factors that motivate different students and to better enable students and staff to perceive the specific benefits to them of engaging in co-creation.

Keywords: Co-production; engagement; SWOT analysis; higher education; pedagogy.

1. INTRODUCTION

Interest in engaging students effectively as partners in learning and teaching has proliferated in policy and practice internationally over the past few years [1]. The benefits for students have been identified as enhancing motivation and learning - leading to enhanced student retention [2,3,4,5], improving teaching and the classroom experience [4], improving facilities [3], enhancing course satisfaction [6,7] and developing meta-cognitive awareness and personal development [8]. Enhancing the success of HEIs in supporting co-creation of outputs requires the collection and sharing of information on perceived opportunities and challenges so as to build on best practice and to enable evaluation of the likely success of new partnerships. Co-creation involves pedagogical approaches centred on active-learning, and appreciation of the potential of active learning approaches for creating student engagement, employability skill gain and empowerment is widespread [9,10,11,12,13]. However, recent research on within-curricular active learning raises concerns that active-learning styles risk fostering surface rather than deep learning if students do not feel adequately supported to increment their engagement and if they feel lecturers are not authentically engaged in active learning process with them [14,15,16,17]. Co-creation partnerships need to be cognizant of this potential challenge so that their design mitigates against it. Similarly, there are challenges involved in embedding a culture of engagement [18] and in ensuring that academic staff feel confident that the quality of the output merits the time investment involved [19].

Arenas for co-creation of the learning environment can be broadly categorized as co-creation of: curriculum design and quality assurance; educational resources; peer learning support and research outputs. The co-creation of curriculum design and quality assurance processes enable students to shape strategy for enhancing the learning environment. This has a long track record and many identified overall benefits despite the challenges [20,21,22]. Exciting developments are also occurring in the other categories of co-creation, which all share the quality of producing resources and products that directly comprise the building blocks of the learning environment. For example, co-created educational resources can incorporate powerful active learning through students producing resources such as video podcasts [23,24] and wikis [25]. Co-created peer learning support also directly engages students in learning how to communicate what they know to their peers and can take the form of peer-to-peer formative feedback [26] and online student generated question repositories such as Peer Wise (www.peerwise.nz). The co-creation of new research knowledge through active, enquiry based learning incorporated into curricula is seen as key to authentically strengthening the research-teaching nexus [27,28]. Strengths and challenges are also emerging from study of the potential for students to work as research groups [29]. Finally, traditional individual final year research projects have the potential to contribute greatly to co-creation of new research knowledge if students are enabled to also be part of the dissemination process [30].

Co-creation of resources and products that directly comprise the building blocks of the learning environment are likely to be more closely rooted in subject discipline areas than co-created quality assurance processes shaped by standards and strategies of national and international cross-disciplinary agencies such as the QAA (UK) and TEQSA (Australia). This raises the question of whether there are differences in the opportunities and challenges associated with co-creating the diverse aspects of the learning environment between and within specific disciplines. Knowing what any differences are would help target efforts and inform best practice in effective co-creation. The aim of the research presented in this paper is to compare perceived opportunities and challenges of co-creating educational resources, peer learning support and research within STEM subjects. Reported here are the perceptions of 30 staff delegates from a range of UK HEIs participating in an HEA workshop on students as partners in co-creating STEM outputs.
The research addressed two specific questions:

1) What types of STEM co-creation outputs are perceived possible within the categories of education resources, research and peer learning support?
2) What was the perceived Strengths Weaknesses, Opportunities and Threats (SWOT) analysis for the co-creation of education resources, research and peer learning support?

2. METHODS

A total of 30 delegates from STEM disciplines ranging across geography, biology, human health and engineering, from 8 different UK universities, participated in this study. Data collection occurred during the afternoon of a full day Higher Education Academy (HEA) workshop "Students as partners in co-creating STEM outputs" which was hosted by Bournemouth University on Jan 16th 2014.

To address question 1, the delegates were first invited to suggest examples from their experience for each of the following categories of co-creation: i) educational resources ii) peer learning support iii) research. Delegates provided this information over a 45 minute lunch period in the workshop by adding their suggestions to a sheet of paper pinned to the wall for each category. Consequently, this was an open data collection method where all delegates were able to see all other responses.

To address question 2, the delegates were asked to join one of three teams sitting around a table, each considering one co-creation category. The suggestions generated for objective 1 were placed at the centre of the table and used as a reference point defining the scope of each category for the SWOT analysis. SWOT analysis was used because it is an intuitively simple thinking framework that has been widely applied across a range of disciplines. The analysis served as an immediate and accessible method for engagement of the delegates, irrespective of their discipline areas. Each team consisted of 6-7 delegates and was coordinated by one of the team members who was responsible for ensuring timings for the SWOT analysis. Each team explored the following SWOT questions for their categories:

1. What are the key pedagogic Strengths to partnerships with students?
2. What are the greatest pedagogic and practical Weaknesses of partnerships with students?
3. Opportunities: what factors maximize the benefits?
4. Threats: what elements can cause difficulties and how can these challenges be overcome?

The method used to generate results was based on Nominal Group Technique [31] and was led by each team coordinator. The coordinator first asked each team member to take five minutes to write down on post-it notes, without conferring, their answers to question 1. Delegates were asked to think of as many answers as possible and to use a separate post-it note for each answer. The coordinator then gathered the answers and repeated the process for questions 2, 3 and 4. Once all the answers were generated, the coordinator asked their team members to divide into 4 sub-teams, and gave each sub-team the set of answers for one of the four SWOT questions posed. The sub-teams were asked to theme answers into groups of responses that were similar for their S, W, O or T question. The teams then counted how many responses they had for each theme and divided this number by the total number of answers to generate the percentage frequency of each type of answer. This was presented as a pie chart for their S, W, O or T question. This process created a total of 12 pie charts i.e. a S, W, O and T pie chart for each of the three categories. These data were later converted into tabular form for presentation in this paper (see Table 3).

Whilst based on a large number of written responses (n=360), results were derived from a relatively small group of individual participants. This paper thereby offers a preliminary identification of key SWOT areas for co-production within STEM disciplines, with the aim of prompting practitioners from similar and more divergent disciplines to consider similarities and differences and to refine the themes identified as necessary. The results draw together thematically in one publication findings that have been identified in a number of widely scattered empirical surveys (see the references) and, as such, seem to be robust and representative.

3. RESULTS AND DISCUSSION

Results for objective 1 (Table 1.) indicate a diverse but distinctive range of responses within each category. All involve action based learning and many of the products co-created in one category can be used as the basis for fostering further co-creation in other categories. For example, co-created educational resources such as class data sets can form the basis of co-created research and Peer-Assisted Learning. The SWOT analysis of each category generated a total of 360 responses, grouped into 61 themes (Table 2). On average each participant gave 18 responses across the full SWOT analysis for their category, but there was considerable variation among categories. Despite team sizes being very similar, the "research" co-creation team generated almost 50% more responses than the other two teams for the SWOT questions and a greater proportion of their responses related to strengths compared with those for the other two categories (Table 2). The "education resource" co-creation team identified a similar proportion of strengths to weaknesses but identified a large percentage of threats. This finding will inevitably reflect the particular interests and experiences of the team members. However, it may also reflect the fact that educational resources lie at the very heart of the student-staff transaction and so have already been the focus of widespread scrutiny in terms of paradigm shifts from teaching to learner-centred approaches (e.g. [32,33,34]). Embedded within this scrutiny are concerns about staff ceding control and/or expertise to the 'customer' and co-creation of educational resources builds on this legacy so, arguably, requires a deeper, paradigm shift in attitudes to learning than does either co-created peer support or co-created research.

The main strengths identified with co-creating educational resources were the potential for creation of new resources and enhancing student engagement, while the main weaknesses identified were issues regarding quality control of output and achieving engagement from all students (Table 3). The main strengths identified for co-creating peer-learning centred on benefits to the students in terms of increasing their skill base and their broader personal development. These findings reflect previous studies, which demonstrate that peer-feedback may facilitate deeper understanding by requiring students to engage critically with course materials. Such activity leads students to reflect upon their own standard of work and results in enhanced understanding and higher attainment [35,36]. The weaknesses mirrored those identified for co-creating educational resources but were identified even more strongly and, together with concerns over quality of output and student engagement, comprised 75% of all weaknesses cited. The main strengths identified for co-created research were more diverse than those for the other two categories. The three most frequent ones (together making up approximately 70% of all cited) were enhancement of student skills/personal development, creating positive staff-student relationships and creating useful outputs. The first two of these echo the increasing evidence for the importance of “soft” social and communication skills for employability [37,38]. The creation of useful research outputs matches well with staff aspirations to also generate research outputs. This is facilitated by growing opportunities for undergraduates to be actively involved in disseminating their work via, for example, undergraduate conferences (e.g. the British Conference of Undergraduate Research (bcur.org), Washington Undergraduate Research Symposium (www.washington.edu/research/urp/about/index.html)) and scientific journals publishing high quality undergraduate research (e.g. Bio Science Horizons (biohorizonns.oxfordournals.org/) and Reinvention(www2.warwick.ac.uk/fac/cross_fac/iatl/reinvention/about/)), as well as many university-specific journals (see www.cur.org/resources/students/undergraduates/journals/ for examples from the USA). The weaknesses cited were also more diverse but over half related to either time constraints or to student engagement, echoing wider concerns across the sector [16,17].

Table 1. Types of co-creation identified within each co-creation category and considered by the teams conducting the SWOT analyses

Co-created educational resources	**Co-created peer learning**
1. Course work to make an on-line learning resource (in groups)	1. Give individual students partial information and then group them to share and problem solve. E.g. a reading group where each student reads different material and leads the discussion of that material by the group.
2. Creating class datasets for future use in lectures and assessments	
3. Creating e-portfolios for 2-way student/lecturer feedback	
4. Group wikis in partnership with international institutions	2. Peer Assisted Learning (PAL), Peer Assisted Study Sessions (PASS) & Peer-Led Team Learning (PLTLIS) (USA)
5. Student led creation of on-line learning lists	
6. Student presentations created for class loaded onto the internet for use for revision	3. Peer collaboration through Moodle/Learn/VLE/ Facebook groups/On-line forums
7. Students creating randomised calculations for the e-learning environment	4. Peer mentoring by (overseas) work placement students
Co-created research	5. Peer tutoring
1. Brain storming new ideas/topics with students	6. Peer-generated inductions
2. Dissertation project event where students apply for external projects after talks by practitioners	7. Peer-led IT support
3. Final year individual student research projects	8. Peer-led lectures
4. Integrating research as group projects in enquiry based learning in a third year module	9. Peer-led networks (within and across institutions)
5. Project based field days or project based residential field trip	10. Peer-led on-line discussions
6. Student-lecturer jointly authored papers with students as research participants	11. Peer-led presentations, interview practice, role reversal & feedback
7. Student-led fieldwork and reporting of results through report/presentation	12. Peer-led revision/essay review/study groups
8. Student-led research teams	
9. Undergraduate research conferences	
10. Undergraduate research journal	

Table 2. Comparison of quantity of responses for the SWOT analysis of each co-creation category

Co-creation category	Educational resources	Peer learning	Research
Number of participants per team	7	6	7
Total number of responses	107	95	158
Strengths	28	31	56
Weaknesses	30	20	50
Opportunities	17	22	29
Threats	32	22	23
Percentage of responses			
Strengths	26	33	35
Weaknesses	28	21	32
Opportunities	16	23	18
Threats	30	23	15

Table 3. Percentage frequency of occurrence of different strengths, weaknesses, opportunities and threats for each co-creation category

Co-created educational resources	Percentage (%)	Counts
Strengths		
Creates new learning resources	46	13
Enhances student engagement	25	7
Fosters staff-student feedback	18	5
Provides novel approaches to learning	11	3
Total		**28**
Weaknesses		
Some students may not engage	27	8
Limited quality of output	27	8
Time constraints	17	5
Need for student peer trust	17	5
Need for strong IT support	13	4
Total		**30**
Opportunities		
Increases recruitment by improving course & raising profile	35	6
Creates new cross-disciplinary and cross institutional networks	29	5
Creates new rewards	18	3
Enhances student engagement	18	3
Total		**17**
Threats		
Technological barriers	25	8
Time constraints	19	6
Institutional barriers	16	5
Funding constraints	16	5
Student expectations	13	4
Change in sector support/pedagogy fashions	6	2
Student understanding & limited quality of output	6	2
Total		**32**
Co-Created peer learning	**Percentage (%)**	**Counts**
Strengths		
Develops student knowledge, skills & critical thinking	42	13
Enhances personal development	26	8
Easy to implement	19	6
Enhances social integration & sharing experiences	13	4
Total		**31**
Weaknesses		

Co-created educational resources	**Percentage (%)**	**Counts**
Reduces quality – teaching the “wrong thing”	45	9
Some students may not engage	30	6
Threat to staff role	15	3
Student time pressures	10	2
Total		**20**
Opportunities		
Creates new cross-disciplinary and cross institutional networks	41	9
Enhances learning methods	27	6
Creates opportunity for training time for staff and students	14	3
Creates new projects/ideas	9	2
Creates new rewards	9	2
Total		**22**
Threats		
Institutional barriers (including lack of resources)	27	6
Dysfunctionality of created systems	23	5
Reduced staff-student contact time	23	5
Fatigue/overuse	14	3
Change in sector support/pedagogy fashions	14	3
Total		**22**
Co-created research	**Percentage (%)**	**Counts**
Strengths		
Develops student skills, critical thinking & personal development	29	16
Builds positive staff-student relationships	23	13
Creates outputs - research, learning resources and marketing	21	12
Enhances staff experience	13	7
Enhances student engagement	11	6
Creates societal benefits	04	2
Total		**56**
Weaknesses		
Time constraints	30	15
Some students may not engage	24	12
Limited quality of output	16	8
Funding constraints	12	6
Limited project scope	8	4
Lack of facilities & logistics	8	4
Unclear ownership of data	2	1
Total		**50**
Opportunities		
Creates new research	45	13
Creates new cross-disciplinary and cross institutional networks	24	7
Creates engagement and benefits for current students	17	5
Increases recruitment by improving course & raising profile	14	4
Total		**29**
Threats		
Creates unfinished projects	26	6
Institutional barriers	22	5
Time constraints	13	3
Limited quality of output	17	4
Funding constraints	22	5
Total		**23**

4. CONCLUSION

This study has identified a diverse range of potential co-creation STEM outputs, indicating broad support for the overall aspiration of increasing co-creation opportunities. The SWOT analysis part of the study found little evidence of widespread concern that active learning through co-creation fosters surface rather than deep learning. The main strengths identified across all types of co-creation examined were that they enhanced student engagement and personal development and created valuable new products. Consequently, overall the findings provide support for co-creation as a flexible, active learning tool. However, achieving engagement from all students formed at least a quarter of all weaknesses identified for all three types of co-creation. This was despite most of the strengths identified in each case being benefits to students. These findings suggest that two important ways to enhance co-creation of STEM outputs may be to better understand the range of factors that motivate students and to enable students to develop more specific understanding of benefits to them of engaging in co-creation. This would also be helpful in developing staff-student dialogues that authentically address the other significant issue identified in this study, ensuring data quality.

CONSENT

All authors declare that ‘written informed consent was obtained from all parties for publication of this case report and accompanying images.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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