Winter June 13, 2018

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Student Success
ISSN: 2205-0795
Early Release
June 2018

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Abstract

While researchers agree that student participation is key to learning, it seems that the issue of interaction in online learning is not yet resolved. The current study investigated students' online interaction and online learner participation in an online enabling science subject and compared this with their final grades. The data were analysed through the lens of Anderson's (2003) interaction equivalence theorem. The findings from the current study provide support for the interaction equivalence theorem. Student-teacher interaction and student-content interaction were evident, but not student-student interaction. Significant relationships were found between student success and online learner participation, but not online interaction. Generalisations are limited by a small sample size and online interaction and participation was measured in terms of quantity rather than quality. Still, following the interaction equivalence theorem, it appears that students can have a satisfying and meaningful learning experience despite not having student-student interaction.

Please cite this article as:

Nieuwoudt, J. (2018). Exploring online interaction and online learner participation in an online science subject through the lens of the interaction equivalence theorem. *Student Success*. Advance online publication. doi: 10.5204/ssj.v10i1.424

This article has been peer reviewed and accepted for publication in *Student Success.* Please see the Editorial Policies under the 'About' section of the Journal website for further information.

Student Success: ***A journal exploring the experiences of students in tertiary education***

Introduction

Many colleges and universities offer degree programs and courses via distance education, making it possible for students to access higher education without physically attending classes (Butner, Smith, & Murray, 1999). Distance education has evolved through five generations as a result of the development of new technology (Taylor, 2001). The 'distance' in distance education is not as relevant anymore, as new technologies have the potential to remove distance by providing flexibility (Aoki, 2012). It is now possible for students to attend virtual classrooms and participate in discussion forums without leaving their homes. Because of the rapid development of technology, 'distance' education has been replaced by 'online' education. Online learning is becoming increasingly popular (Kahu, Stephens, Leach, & Zepke, 2013) and is vital in providing students from regional areas access to higher education (National Centre for Student Equity in Higher Education, 2017).

While online education allows more students to study at university, not all students succeed in their studies. Attrition rates are higher for online students compared to on-campus students (National Centre for Student Equity in Higher Education, 2017; Stone, 2017). Furthermore, the rate of attrition approaches 50% in enabling programs (Hodges et al., 2013; Pitman et al., 2016). It is thus essential to improve student success (Yorke, 2006) in order to decrease attrition rates in enabling programs. "It has become increasingly clear that 'success' means helping all students to become more engaged and more effective learners in higher education, thus improving their academic outcomes" (Thomas, 2012, p. 10). Student engagement is a key factor in student success in higher education (Nelson, Clark, Stoodley, & Creagh, 2014; Thomas, 2012). Student engagement is multifaceted (Krause & Coates, 2008) and is "a complex business" (Zepke, 2013, p. 11). Student engagement involves not only academic activities, but also non-academic activities that would contribute to high quality learning (Australian Council for Educational Research, 2008). Student engagement comprises of "motivated behaviour that can be indexed by the kinds of cognitive strategies students choose to use… and by their willingness to persist with difficult tasks by regulating their own learning behaviour" (Chapman, 2003, p. 1). A better understanding of students' learning behaviour in an online subject may lead to increased student success.

Research indicates that participation is central to learning (Wenger, 1998) and is related to interaction and a sense of community in online learning (Delahunty, Verenika, & Jones, 2014). Online interaction often occurs in synchronous chatrooms, asynchronous discussion forums, and via email and can be seen as engagement in a meaningful discussion, with online interaction being the equivalent of face-to-face tutorial discussions (Delahunty et al., 2014). Online learning communities are formed through online learner participation and are comprised of the teacher and students from diverse geographical locations and sociocultural backgrounds (Goertzen & Kristjánsson, 2007). It is thought that successful interaction depends on cooperation and a good relationship between students and the teacher (Goertzen & Kristjánsson, 2007). However, interaction can be forced when students' contributions in discussion forums are assessed. Hrastinski (2008) defined online learner participation as "a complex process comprising doing, communicating, thinking, feeling and belonging, which occurs both online and offline" (p. 1761). Online learner participation varies from merely accessing the online learning system to taking part in rewarding discussions (Hrastinski, 2008). The individuals in the learning community share the common goal of learning (Goertzen & Kristjánsson, 2007). It is thus not unexpected that there appears to be a positive relationship between being part of an online community and learning (Sadera, Robertson,

Song, & Midon, 2009). A sense of community can decrease feelings of isolation that is often experienced by online students. A sense of community can also increase retention rates (Liu, Magjuka, Bonk, & Lee, 2007; Owens, Hardcastle, & Richardson, 2009). It is generally accepted that students need to belong to an interactive community of learners to be academically successful in online learning (Garrison & Cleveland-Innes, 2005). Nonetheless, this may not be true for all students.

Anderson (2003) developed the interaction equivalency theorem to address the value of interaction in learning. Interaction comprises of student-student, student-teacher, and student-content interaction. If one of the forms of interaction is at a high level, then the other two forms of interaction can be at lower levels or even eliminated without having detrimental effects on learning (Anderson, 2003). Thus, a high level of engagement in one of the three forms of interaction will allow students to engage in deep and meaningful learning, whilst having a satisfying learning experience. The student is central to interaction. Student-student interaction is looking at how the student is interacting with other individual students or in small groups. Student-teacher interaction refers to interaction between the student and the teacher, with the interaction being synchronous or asynchronous. Student-content interaction is about interaction with the content. This includes using study guides, reading texts, watching videos, searching for information, and completing assessments (Bernard et al., 2009). The student should ideally be personally active and engaged instead of simply observing other active participants (Anderson, 2003).

The purpose of this research is to investigate the role online interaction and learner participation may play in student success in an online enabling science subject from a regional university. This research was guided by Anderson's interaction equivalency theorem. This research aimed to: (a) investigate the forms of interaction students were engaged in, (b) determine if students had a deep and meaningful learning experience, and (c) determine if students had a satisfying learning experience.

Method

Background

The *Preparing for Success at SCU Program* (PSP) is an enabling program at Southern Cross University that is 12 weeks in duration, and consists of four subjects. Southern Cross University is a regional university in northern New South Wales, Australia. The program is offered as three sessions a year, and can be studied online or on campus at the institution's campuses in Coffs Harbour, the Gold Coast, and Lismore. The three compulsory subjects equip students with communication, study, and numeracy skills. The fourth subject is an elective, and students can choose between an arts-based or science-based subject. Successful completion of the program provides a distinct pathway into tertiary study at Southern Cross University. The subject EDU10448 Studying Science introduces students to science, and key concepts in biology, physics, and chemistry.

For online students enrolled in the Studying Science subject, weekly online tutorials were held via the Blackboard Learn learning management system (LMS) in a virtual classroom where students and the teacher interacted online during live synchronous sessions. PowerPoint presentations were uploaded and the students and teacher communicated orally and exchanged messages through typing in the chat box, using emoticons, and writing on the shared whiteboard. The online tutorials were recorded and made available to students to watch at a convenient time if they were unable to attend the live online tutorial. The tutorial PowerPoint slides and additional learning resources were available in the Weekly Content folders. In Session 1

students had access to a study guide in a Portable Document Format (PDF). In Session 2 an interactive online study guide was introduced, but students also had access to the PDF. The interactive study guide consists of reading content, video clips, and interactive activities that are compatible with mobile devices. Students have to log onto to the LMS to access the interactive study guide. The interactive study guide supplements the tutorials. Weekly activities related to the tutorial content were posted on the discussion forum. Students were encouraged to participate on the discussion forum, but it was not mandatory nor graded. Students were also encouraged to ask questions related to the assessments on the discussion forum.

Participants

Student success, online interaction, and online learner participation of 128 students were examined. Students were enrolled in the online study mode of the Studying Science subject in an enabling program. Sixty-eight students were enrolled in Session 1, 2017, and 60 students were enrolled in Session 2, 2017. Ethics approval was obtained from the Human Research Ethics Committee of Southern Cross University (approval number ECN-16-039).

Procedure

The data was retrieved from usage information provided by the LMS. Online interaction and online learner participation were measured in terms of quantity. Emails were attained from the teacher and were measured in terms of quantity. Final grades were acquired from the LMS as an indicator for student success. Formal student feedback (anonymous) was acquired from the University's end-of-session feedback reports.

Data analysis

Descriptive statistics were used to explore the study population's characteristics. Spearman Rank Order Correlation (r_s) analyses were undertaken to examine the associations between final grade and student interaction on the LMS and via email. Mann-Whitney U tests were undertaken to examine differences between students from Session 1 and Session 2. Variables were not normally distributed, thus non-parametric tests were used. Effect size was calculated by z/square root of n. The level of significance was set at $p \leq .05$. Statistical analyses were performed using IBM SPSS, Statistics 24 (IBM SPSS; Chicago, Illinois).

Results

Forms of student interaction

Student online interaction and online participation are shown in Table 1. Students enrolled in Session 2 had higher (mean) levels of online interaction and participation in all measured areas, except Weekly Content views. Spearman Rank Order Correlational analyses found significant correlations between final grades and the number of views of Assessment details, the number of views of Weekly Content, as well as the number of emails received from students (see Table 2).

A Mann-Whitney U Test found a significant difference in the number of Study Guide views between students enrolled in Session 1 (Md = 5.00, n = 54) and students enrolled in Session 2 (Md = 12.00, n = 47), U = 727.000, p = .000, r = -0.368.

Table 1: ***Students' online interaction and online participation per teaching period***

	Session 1				**Session 2**			
	Students (*n*)	Total	Range	*M*	Students (*n*)	Total	Range	*M*
Discussion forum posts	20	79	1 – 22	3.95	24	111	1 – 24	4.63
Live Online Tutorial attendance	27	100	1 – 12	4	23	120	1 – 12	5
Assessment details views	60	4014	1 – 198	66.9	51	3739	4 – 197	73.31
Study Guide views	54	370	1 – 33	6.85	47	605	3 – 45	12.87
Weekly Content views	55	1927	1 – 180	35.04	49	1684	1 – 148	34.37
Number of emails received	39	162	0 – 26	2.38	40	219	0 – 25	3.65

Table 2: ***Spearman Rank Order correlation between final grades and student activity on the learning management system and the number of emails received from students***

		Hours on learning management system	Assessment details (views)	Weekly content (views)	Number of emails received
Session 1	Final grade	.762 (r_s)	.500 (r_s)	.576 (r_s)	.293 (r_s)
		.000 (*p*)	.000 (*p*)	.000 (*p*)	.030 (*p*)
		55 (*n*)	54 (*n*)	51 (*n*)	55 (*n*)
Session 2	Final grade	.612 (r_s)	.528 (r_s)		.417 (r_s)
		.000 (*p*)	.000 (*p*)		.003 (*p*)
		48 (*n*)	47 (*n*)		48 (*n*)

Quality of learning experience

The mean final score achieved was 52.96 (i.e. a Pass grade) out of a possible 100 (*SD* = 25.92) for Session 1. The mean final score achieved was 58.05 (i.e. a Pass grade) out of a possible 100 (*SD* = 27.41) for Session 2. Grades ranged from Fail to High Distinction, as presented in Table 3. Fail grades were awarded to students as a result of non-submission of one or more assessments, or an overall score of less than 50% for the subject. Absent Fail grades were awarded to students who did not submit any assessments.

Table 3: ***Sudents' final grade distribution***

Final Grade	Session 1 *(n)*	Session 2 *(n)*
Absent Fail	13	12
Fail (0-49%)	18	13
Pass (50-64%)	14	6
Credit (65-74%)	13	15
Distinction (75-84%)	10	7
High Distinction (85-100%)	0	7

Satisfaction with learning experience

In Session 1 the Studying Science subject received a score of 4.54 out of 5 for satisfaction with the subject and the teaching and delivery of the subject received a score of 4.38 out of 5. In Session 2 students rated their satisfaction with the subject at 4.58 out of 5 and the teaching and delivery of the subject was rated 4.47 out of 5. The formal student feedback response rate was 19% in Session 1 and 32% in Session 2.

Discussion

Student-student interaction

It is generally accepted that online learners need to belong to an interactive community of learners in order to be academically successful (Garrison & Cleveland-Innes, 2005). However, no significant relationship was found between the number of discussion forum posts made by students and their final grades. Previous research found a relationship between participation in an online discussion forum and academic success (Cheng, Pare, Collimore, & Joordens, 2011; Davies & Graff, 2005; Romero, López, Luna, & Ventura, 2013). However, greater online interaction is not necessarily associated with higher grades (Davies & Graff, 2005). For example, Cheng et al. (2011) found that there were students who achieved high grades without participating in the discussion forum while other students did poorly although they were actively participating in the discussion forum. Thus, simply increasing the frequency of online participation may not contribute to academic success (Davies & Graff, 2005). It cannot be assumed that online participation equates to student engagement (Garrison & Cleveland-Innes, 2005), as online participation can vary from simply accessing the online learning system to taking part in rewarding discussions (Hrastinski, 2008). Garrison and Cleveland-Innes (2005) alleged that interaction is not enough. Students should also explore and critique ideas for deep and meaningful learning. Most of the discussion forum posts in the current study were not discussions between students (i.e. student-student interaction) as it consisted of questions related to the assessments and directed towards the teacher. Thus, a simple exchange of information occurred. A previous study found that students who directed questions towards the teacher achieved higher grades (Weisskirch & Milburn, 2003).

In the current study the majority of students did not post anything in the discussion forum and it is thus not evident if students engaged in student-student interaction. Online students are often time-poor (Stone, 2017) and have to manage responsibilities such as employment and domestic duties as well as study (Burke, Bennett, Bunn, Stevenson, & Clegg, 2017; Delahunty et al., 2014). It is possible that students simply do not have enough time to participate in a voluntary unassessed discussion forum. Some students may be cognitively present while not actively participating in the discussion forum (Garrison & Cleveland-Innes, 2005). They may be participating online by reading messages and learning vicariously. It is thought that online participation is closely related to interaction and is important for building interpersonal connections between students, thus contributing to a sense of community (Delahunty et al., 2014). Students may not perceive online interaction as important as they may not feel the need to belong to an online community (Delahunty et al., 2014) nor value student-student interaction. Students may be focusing on assessments (Owens et al., 2009) instead of building an online community in the time that they have allocated for studying.

Student-teacher interaction

It appears to make no difference to student success whether students were attending the live online tutorial or watching the recording of the online tutorial. In the current study less than half of the enrolled students attended the live online tutorials, and those students attended on average four of the 12 tutorials in Session 1 and five of the 12 tutorials in Session 2. It is assumed that students watched the recordings of the online tutorials if they were unable to attend the live online tutorial. Unfortunately, the LMS does not capture information regarding 'watching of recordings'. Online tutorials have the ability to enhance the learning experience via student-teacher interaction (Little, Passmore, & Schullo, 2006; Ng, 2007). On the other hand, the lack of face-to-face contact in online tutorials may reduce students' sense of belonging (McBrien, Jones, & Cheng, 2009). The relationship between the teacher and students is key to building a sense of belonging to a learning community (Stone, 2017).

Researchers agree that student-teacher interaction is crucial in online learning (Marks, Sibley, & Arbaugh, 2005; Owens et al., 2009; Stone, 2017). Personalised interactions between teachers and students not only reduce feelings of isolation (McBrien et al., 2009), but are important in learning (Scott, 2008; Trowler, 2010). In the current study the teacher did receive (and replied to) 162 emails from 39 students in Session 1, and 219 emails from 40 students in Session 2. Thus, students did engage in student-teacher interaction. Furthermore, there was a significant relationship between final grades and the number of student emails received by the teacher.

Student-content interaction

Student-content interaction was evident as demonstrated in Table 2 by the number of times the Weekly Content, study guide, and assessment details were viewed. Student-content interaction depends on the extent to which it engages students (Anderson, 2003). Teachers are responsible for providing students with opportunities to attain the necessary academic skills (Taylor, 2013) as well as facilitating student engagement (Trowler, 2010) through active learning and innovative curricula (Scott, 2008). The interface for content delivery is also increasingly important, as many students are using mobile devices for studying (Stone, 2017).

An interactive online study guide was introduced in Session 2. There was a significant difference in the number of times the study guide was accessed between students enrolled in Session 1 and Session 2, with the study guide being accessed more in Session 2. In Session 1

students had access to a PDF study guide, not an interactive version. In Session 1 the Weekly Content folders were viewed more compared to Session 2. A significant relationship was found between final grades and the number of time the Weekly Content folders were accessed in Session 1.

There was a significant relationship between final grades and the number of times the folders containing assessment details were viewed in the current study. This was not surprising, as final grades are comprised of the assessment scores. Students had to view the assessment details in order to know how to complete assessments. There was a significant relationship between final grades and the number of hours on the LMS in the current study. This is in agreement with other researchers such as Wong (2013), Davies and Graff (2005) who also found that students who spent more time online had higher grades than students who spent less time online. However, Perera and Richardson (2010) found no relationship between academic success and the amount of time spent online. Wong (2013) proposed that there may be a correlation between the amount of time students spent online and the amount of time that they spent studying offline. This may include time working on assessments.

Limitations

It is acknowledged that the current study had several limitations. The small sample size from a science subject limits the generalisations that can be made from the results obtained. Future studies could collect data from a larger sample of students and other online subjects. In the current study online interaction and online learner participation were measured in terms of quantity rather than the quality of the interaction. It is also possible that students had student-student interaction in one or more of the other online subjects they were enrolled in the PSP, thus eliminating the need for student-student interaction in the Studying Science subject.

Student success is about improving students' academic outcome by increasing student engagement and becoming more effective learners in higher education (Thomas, 2012). Student success is thus a difficult concept to measure, as success can vary for individual students. In the current study student success was measured by final grades. However, it is not known if students felt that learning occurred regardless of the final grade awarded. It was challenging to determine if students had a satisfying educational experience. In the current study a satisfying learning experience was measured by formal student feedback collected at the end of the teaching period. The formal student feedback response rate was 19% in Session 1 and 32% in Session 2. Due to the low response rate, it is not known if all students had a satisfying learning experience.

Conclusion

Anderson (2003) stated that deep and meaningful learning can occur as long as students engage in student-teacher interaction, student-student interaction, or student-content interaction at a high level. If students engage in one of the three forms of interaction at a high level, then the other two forms of interaction are not necessary or can be engaged with at a lower level (Anderson, 2003). The current study provided support for Anderson's interaction equivalency theorem: students did engage in student-teacher interaction and student-content interaction while student-student interaction was not evident. It is difficult to tell if 'deep and meaningful learning' occurred, but in the current study it was assumed to be equivalent to student success as measured by the final grade. Furthermore, significant relationships were found between academic success and online learner participation, but not online interaction. Following Anderson's interaction equivalency theorem, it is possible

to provide students with a satisfying and meaningful learning experience by offering student-student interaction at a minimal or no level. This is in contrast with the generally accepted notion that online learners need to belong to an interactive community of learners in order to be academically successful.

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