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Using LectureTools to enhance student–instructor relations and student engagement in the large class

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Positive student–instructor relationships are important for student engagement, motivation, retention and achievement. Yet, as class sizes grow, these relationships can be increasingly difficult to develop. This study explores LectureTools – a web-based student response and learning platform that facilitates communication between instructors and students – as a possible solution to this issue by analysing survey data collected from students in a second-year communication class at a large Canadian university. This study builds on previous evidence that using LectureTools results in an increase in student engagement, attentiveness and level of learning, while expanding on this work to include the concept of student instructor relationships. Ultimately, the functionality of LectureTools was found to facilitate the development of student–instructor relationships in the large class while also enhancing student engagement.

Keywords: pedagogical design; undergraduate; mixed method; e-learning; technology

The prevalence of large class sizes in the current post-secondary landscape presents a challenge for educators. Of particular concern is the barrier that large classes present to the development of positive student–instructor relationships. These relationships have been found in numerous studies to contribute to student retention (evidence provided in Jaasma and Koper 1999) and improved student learning (evidence provided in Tinto 1993), among other positive outcomes. Given that profit-driven institutions are unlikely to eliminate large classes (Australian Universities Teaching Committee 2003), it is of great importance to understand how positive and supportive student–instructor relationships can be developed in this environment.

LectureTools – a web-based student response and learning platform that facilitates communication between instructors and students – may offer a solution to this challenge. By harnessing the power of the personal laptop, LectureTools has the potential to enhance the student–instructor relationship through increased communication with the professor. The purpose of this article is to confirm existing results about the potential of LectureTools to produce positive effects in the post-secondary class, while also extending these results to consider the impact this tool may have on student–instructor relationships.

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Student–instructor relationships

Positive student–instructor relationships have been a topic of interest for communication and pedagogical researchers alike. According to Frisby and Martin (2010), researchers have found that instructors are better able to promote student learning if they foster positive interpersonal relationships with students. Engaging in communicative behaviours designed to create these positive relationships generates affect, which in turn 'enhances cognitive learning' (Frisby and Martin 2010, p. 146). Indeed, positive student–instructor relations have been found to result in increased student retention (evidence presented in Jaasma and Koper 1999), improved student learning (evidence presented in Sher 2009; Tinto 1993), accelerated academic achievement (Battistich *et al*. 1997; Eccles 2004; Teven 2001) and increased feelings of confidence and self-directedness (Ames 1992; Midgley, Feldlaufer, and Eccles 1989; Pintrich, Roeser, and De Groot 1994; Ryan, Gheen, and Midgley 1998).

While some researchers explicitly talk about student–instructor relationships, others use the construct of 'rapport' to make sense of the numerous positive outcomes associated with affect-generating communicative behaviours in the class. In order to understand what is meant by 'positive student–instructor relationships', it is useful to briefly explore the related concept of rapport. *Rapport* is 'an overall feeling between two people encompassing a mutual, trusting and prosocial bond' (Frisby and Martin 2010, p. 147); the ability to generate rapport and the related feelings of trust and warmth has been found to be essential for excellent educators (Catt, Miller, and Schallenkamp 2007; Faranda and Clark 2004; Frisby and Martin 2010). The precise relationship between the interrelated concepts of student–instructor relationships and rapport is not always clear in the literature and seems to be understood differently by different authors. Suffice to say, our interest here is simply in exploring how the use of LectureTools in post-secondary classrooms may enhance positive student–instructor relationships (characterized by trust and rapport, as it is defined above).

Instructors can generate these positive relationships through interaction with students. Positive student–instructor relationships are developed through communicative behaviours, often initiated by the professor (Sher 2009). Examples of behaviours which contribute to the development of these relationships include using a rapid feedback cycle (Bergom *et al*. 2011), responding to questions (Sher 2009), providing personalized feedback (Sher 2009) and communicating with students outside of class (Dobransky and Frymier 2004). Professors can also facilitate the development of student–instructor relationships through the environment they create in their class. For example, building a 'collaborative and cooperative' learning environment is thought to contribute to student–instructor relationship building (Wurst, Smarkola, and Gaffney 2008, p. 1767), as it demonstrates that the professor cares about the input of students. Similarly, in his study on student–instructor relationships, Myers (2006) found that a professor's attempt to demonstrate an understanding of students' problems and needs contributes to positive closeness.

Difficulty of developing student–instructor relationships in the large class

Studies suggest that student–instructor relationships may be particularly difficult to develop in the large class, where lack of proximity and increased anonymity prevent the formation of meaningful connections (Myers 2006). Numerous factors – including

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a growing perception of the necessity of post-secondary education and, in turn, a growing demand for increased access to colleges and universities – have put immense pressure on post-secondary institutions in Canada and the United States (Clark *et al*. 2009). These factors have led to undergraduate enrolment increases in degree-granting institutions of almost 50% over the past decade in Ontario, Canada (Kerr 2011). In the U.S., enrolment increased by 37%, from 15.3 to 21.0 million between 2000 and 2010 (United States Department of Education 2012). One approach taken at both large research-intensive universities and small, primarily undergraduate schools is to increase class sizes. As Kerr (2011) points out in her report of research done by the Higher Education Quality Council of Ontario, about two thirds of Ontario universities reported that at least 30% of first year courses had more than 100 students in 2009.

This trend is unlikely to change. For profit-driven universities in particular, having a high student-to-instructor ratio is unavoidable (Australian Universities Teaching Committee 2003). Given the prominence of large classes in today's universities, understanding how these classes can be most effectively delivered is of significance to students, professors and administrators. This paper explores one way that student–instructor relationships can be facilitated in the context of the large, technologically advanced class.

Laptop use in the large class

Given the importance of student–instructor relationships and the barrier presented by large classes, it is important to explore whether technology can help facilitate the development of positive relationships. Laptops are increasingly being used by students in post-secondary classrooms for note-taking, presentation viewing and online reference (Cismaru and Cismaru 2011). Studies have demonstrated both negative and positive effects of laptop use in higher education. This discrepancy is perplexing, until one makes note of the variation in the nature of laptop use measured by these studies.

According to Kay and Lauricella (2011) in their study of different types of laptop use in university classrooms, laptops can be used in either an *unstructured* or a *structured* way, with drastically different results. Unstructured use of laptops occurs when students are permitted to use laptops in class, but the laptops are not incorporated into teaching practices in any meaningful way (Samson 2010). With unstructured use, students may be using their laptops to take notes or for online reference, but the professor isn't actively encouraging these – or any other – behaviours. In essence, the professor is lecturing as though the laptops do not exist, allowing students to use (or not use) laptops, as they wish. Unstructured use of laptops is associated with a decrease in attentiveness and engagement in class (Fried 2008; Kraushaar and Novak 2010; Wurst *et al*. 2008), diminished performance on examinations (Aguilar-Roca, Williams, and O'Dowd 2012; Fried 2008; Grace-Martin and Gay 2001; Sana, Weston, and Cepeda 2013), diminished classroom learning (Ravizza, Hambrick, and Fenn 2014) and increased distraction in class (Fried 2008; Zhu *et al*. 2011).

Structured use, on the other hand, refers to 'the use of technology in a deliberate and integrated manner [by professors] to affect learning goals' (Samson 2010, p. 2). Structured use of laptops may be an effective way to encourage student engagement and attentiveness in university classrooms, as well as facilitate student–instructor relationship development. Among other things, studies have found that structured

use of laptops in class can increase student engagement (Zhu *et al.* 2011), improve academic achievement (Kolar, Sabatini, and Fink 2002) and decrease off-task behaviour in class (Kay and Lauricella 2011).

Structured use of laptops can encompass myriad different tools, ranging from educational software, practical simulations, virtual assignments, videos, web pages and course-related tools such as LectureTools (Kay and Lauricella 2011, p. 34). LectureTools is a full suite of online tools, including auto-sync presentations, interactive polls and tests, and the ability for students to digitally ask questions, take notes on course material and flag concepts as confusing. LectureTools was developed by Dr. Perry Samson at the University of Michigan as part of a 2005 research project, and was later developed into a commercial product. The cloud-based suite of tools is licensed to higher learning institutions and, in turn, made available free for professors and students to use. The University of Ottawa, where this study was conducted, purchased a volume license for LectureTools in 2013 and provides training and support to professors who wish to use the tool.

Several studies have specifically compared classes with unstructured laptop use (control group) to classes using LectureTools (experimental group), in order to gauge the effectiveness of the service (see Bergom *et al.* 2011; Samson 2010). For example, both Bergom *et al.* (2011) and Zhu *et al.* (2011) found that LectureTools was significantly correlated with an increase in attentiveness, engagement and level of learning compared to the control group (p. 23). In a similar study, Samson (2010) found that students in the experimental group reported 'a dramatic increase in engagement with the use of technology' (p. 7) relative to the control group. These studies have led Samson (2010) to conclude that 'the benefits of LectureTools on student attentiveness and engagement (and self-reported learning) overcomes[sic] the potential risk from increased distraction' (p. 7).

LectureTools as a facilitator of student–instructor relationships

In addition to the positive impact on engagement, learning and satisfaction associated with structured laptop use, there is ample evidence that laptops 'can increase constructive discourse between students and between students and instructors' (Samson 2010, p. 2). LectureTools may specifically facilitate positive student–instructor relationships in several ways, as seen in Table 1 and elaborated upon thereafter.

In sum, LectureTools may facilitate student–instructor relationships in three main ways. First, through building a 'collaborative and cooperative' learning environment (Wurst *et al.* 2008, p. 1767), LectureTools contributes to relationship building. As discussed, this behaviour enhances the development of student–instructor relationships by giving students a degree of control over their own learning and the direction of course content (Wurst *et al.* 2008). In other words, the professor demonstrates concern for students by adapting the course content and direction to suit their needs. LectureTools is well situated to facilitate this behaviour. Through polling – both multiple choice and short answer – professors can gather ideas from students and incorporate them into the lecture. Professors may also poll students on the direction of course content, the preferred method of content delivery, or any other aspect of the course design or content.

Second, LectureTools may facilitate student–instructor relationships by enabling a rapid and personalized feedback cycle. Through instant polling and flagging slides as confusing, students can provide their opinion to the professor in such a way that

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Table 1. Behaviours which develop student–instructor relationships and associated LectureTools functions.

Behaviour which develops student–instructor relationships	LectureTools function
Building a 'collaborative and cooperative' learning environment (Wurst *et al*. 2008)	Instant polling, which enables the professor to incorporate student ideas into lectures, and adapt lectures to meet the real-time needs of students.
Using a rapid feedback cycle (Bergom *et al*. 2011)	Instant polling, flagging slides as confusing and the 'ask a question' feature all facilitate a rapid feedback cycle in the class.
Understanding students' problems and needs (Myers 2006)	Flagging slides as confusing and the 'ask a question' function enable the professor to know (almost instantaneously) when students are experiencing a problem. During downtime in a lecture, or after class, professors may review the data and follow up individually with students who flagged slides as confusing or asked questions.
Responding to questions one-on-one (Sher 2009)	The 'ask a question' function gives the student an 'instant line' to ask the professor a question during class.
Providing personalized feedback (Sher 2009)	The professor has access to students' names and can easily access their complete record of achievement on LectureTools.
Out of class communication (Dobransky and Frymier 2004; Sheer and Fung 2007)	The 'ask a question' function allows students to ask questions during class, which can then be followed up by the professor outside of class.

enables the professor to understand students' problems and needs. Professors can then respond verbally, by text, or by adapting their behaviour in the class, thus completing the feedback cycle. The 'ask a question' function is a particularly powerful way of developing the student–instructor relationship. Students can ask questions at any point in the lecture, and the professor is immediately notified. The professor (or teaching assistant) can respond immediately by text, or verbally in class. They may also choose to respond at a later time, such as after lecture. When students are logged into LectureTools, they are immediately notified when the professor responds to their question.

In addition, the professor has easy access to students' names and a complete record of their achievement on LectureTools. This includes data such as the previous questions that the student has asked, content that the student has flagged as confusing in the past and a record of his or her attendance. This easy access to data enables the professor to write a complete and personalized response to questions received.

For all of these reasons, LectureTools has potential for facilitating the development of positive student–instructor relationships in large post-secondary classrooms where it might otherwise be exceedingly difficult without the use of technology. To examine this possible impact, LectureTools was made mandatory in a second-year communication course at a large Canadian university for the duration of one semester. At the end of the semester, surveys were submitted to each student asking them to evaluate their experience using the tool, particularly as it related to

the interconnected concepts of student satisfaction, student engagement and student–instructor relationships.

Method

Sample

Undergraduate students at a public Canadian university completed a questionnaire during a regularly scheduled class period using LectureTools. A total of 92 surveys were submitted. The sample comprised students from a second-year organizational communication class (enrolment = 119). For privacy reasons, no demographic information such as participant age, gender, or program of study was collected. Prior to completing the questionnaire, students were informed about the purpose of the study. The data collection period ran for roughly 15 minutes of class time during the last regularly scheduled lecture of the 12-week semester. Students provided informed consent via LectureTools. In the event that a student did not respond to the informed consent question (or responded in the negative), that particular student's data were removed prior to analysis. In several cases, students responded to all the questionnaire questions but neglected to respond to the informed consent question. In part, this accounts for the discrepancy in class enrolment ($n = 119$) and the number of responses received ($n = 92$).

Instrumentation

To measure levels of student engagement and perception of the student–instructor relationship, students were required to respond to 10 statements using a five-point Likert-type scale (1 = *strongly disagree* and 5 = *strongly agree*). Statements targeting the topic of engagement in the large class asked participants to comment on their level of non-course related internet browsing and overall perception of feeling engaged as a result of LectureTools (e.g. 'As a result of using LectureTools, I felt more engaged and involved in the lecture'). Similarly, students were also asked about their perception of the student–instructor relationship, with questions such as 'By using LectureTools, I felt more inclined to ask the professor or TA a question', and 'When using LectureTools, I felt like I could develop a more personal relationship with the prof and/or TA'. Finally, students were asked to comment on the technical aspects of LectureTools by noting their level of frustration with the program as well as the use of all the tools offered. The goal here was to determine whether technical aspects such as the availability of tools or frustrations associated with the technology may have an impact on the relationship-building potential of LectureTools. A complete list of the exact survey questions appears in Appendix 1.

Following these Likert-type questions, students were presented with four open-ended questions. These questions allowed the students to make any additional comments about LectureTools in respect to the three categories – student engagement, student–instructor relationships and functions of the program.

Results and analysis

Frequency tables were generated in order to summarize the data received. A correlation analysis was conducted – the results have been presented in a correlation matrix table in

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Appendix 2. Summative scales were also created by combining the variables within the two main themes (engagement and relationship building). A thematic coding process was applied to the qualitative data using the three themes – student engagement, student–instructor relationships and functions of the program – as a guide.

Results

Frequencies

Over 70% of responses to questions related to student engagement indicated either agreement (41%) or strong agreement (31%) that LectureTools facilitated increased engagement in-class. Significantly, over 90% of respondents either agreed (43.5%) or strongly agreed (46.7%) with the statement 'As a result of using LectureTools, I felt more engaged and involved in the lecture'. Interestingly, approximately 57% of respondents said that using LectureTools caused them to browse the internet less often (compared to when they use their laptop in courses in an unstructured manner).

Approximately 60% of responses to questions related to student–instructor relationships indicated agreement that LectureTools facilitated the development of a positive student–instructor relationship. Significantly, 60% of respondents either agreed (43.5%) or strongly agreed (16.3%) with the statement 'When using LectureTools, I felt like I could develop a more personal relationship with the prof and/or TA', with 24% neither agreeing nor disagreeing. Finally, within the theme of LectureTools functionality, only 3% of respondents agreed or strongly agreed that LectureTools was frustrating to use.

The frequency of responses for each question appears in Figure 1.

Correlations

Three moderate, statistically significant relationships were found in the data, supporting the conclusion that student engagement and the development of student–instructor relationships are interconnected. First, there was a moderate, statistically significant correlation between responses to the question 'By using LectureTools,

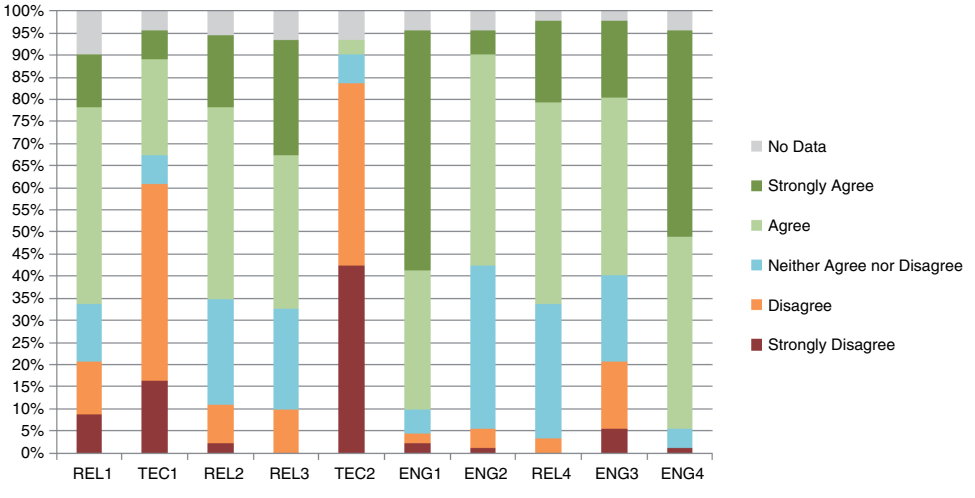

Figure 1. Frequency of responses.

I felt more inclined to ask the professor or TA a question', and responses to the question 'As a result of using LT, I felt more engaged and involved in the lecture'. Second, there was a moderate, statistically significant relationship between responses to the question 'By asking the professor or the TA questions via LectureTools, I felt that I was contributing more to class discussion' and responses to the question 'As a result of using LectureTools, I felt more engaged in lecture'. Both of these correlations suggest that students who used LectureTools to ask questions in class and interact one-on-one with the professor felt more engaged and involved in lecture.

Finally, there was a moderate, statistically significant relationship between responses to the question 'When using LectureTools, I felt like I could develop a more personal relationship with the prof and/or TA' and responses to the question 'As a result of using LectureTools, I felt more engaged and involved in the lecture'. This suggests that students who felt that LectureTools was successful at facilitating student–instructor relationships also felt that the tool increased their level of engagement in class.

Analysis

The purpose of this study was to explore the value of LectureTools in the large post-secondary class through the lens of student–instructor relationships. The theme of student engagement was also explored, as the literature suggested that the two constructs (student–instructor relationships and level of engagement) might have some bearing on one another. This is unsurprising given that the types of behaviours that enhance student–instructor relationships, such as responding to questions in class (Sher 2009) and building a collaborative learning environment (Wurst *et al*. 2008), would be expected to also have a positive bearing on student engagement.

The data supports the conclusion that using LectureTools has a positive overall impact on student engagement and student–instructor relationship building. First, the theme of engagement will be explored. Over 90% of respondents either agreed (43.5%) or strongly agreed (46.7%) with the statement 'As a result of using LectureTools, I felt more engaged and involved in the lecture'. In response to the survey's open-ended questions, students noted the value of the question feature of LectureTools – that is the ability to answer polls, respond to long answer questions and ask the professor questions in real time. One participant noted that 'when I knew there was a LectureTools question coming up, I paid more attention and thought about the answer'. Many students had similar responses, and mentioned that the most effective aspect of responding to long answer questions is that it increased their level of attention throughout the lecture. In other words, knowing they would have to respond to a question and demonstrate their understanding of the material required students to be more engaged and attentive.

Another participant commented on the effectiveness of multiple-choice polls in creating a more collaborative classroom environment, saying:

> Polls and participation activities allowed me to understand how much of the class that doesn't normally talk thinks. It would allow me to think of the concepts being taught in different ways, seeing how many others thought differently – trying to think of things from their point of view.

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In addition to multiple-choice polling, students also commented on the 'ask a question' feature, noting its positive effect on attentiveness and participation. Students found this feature useful because it allowed them to ask questions without 'interrupting the whole class' or 'having to possibly humiliate [themselves] in front of the class'.

These findings are consistent with the literature on LectureTools' impact on student engagement. As noted, both Bergom *et al*. (2011) and Zhu *et al*. (2011) found that LectureTools was significantly correlated with an increase in attentiveness and engagement, relative to a control group (p. 23). This study has uniquely explored the particular features – such as the 'ask a question' function and multiple-choice polling – which students say resulted in this increased engagement.

The next theme we explored – the focus of this study – was the effect of LectureTools on the formation of positive student–instructor relationships. Approximately 60% of responses to questions related to student–instructor relationships indicated agreement that LectureTools facilitated the development of a positive student–instructor relationship, with 42% agreeing and 18% strongly agreeing. One student mentioned that LectureTools 'created a sense of relationship with the TA and Prof' while another noted that it 'created a more hands-on ''relationship'' with the professor/TA'.

One of the most prevalent themes that emerged from the qualitative data was that LectureTools facilitated a perceived *one-on-one connection* between the professor and students who would normally be too shy to develop such a connection, particularly in the large class. One student noted 'it just made me more comfortable being able to speak to her and ask her questions', while another said, 'I'm usually shy in asking questions, but I was basically able to ask at least one every class'. This is consistent with Sher's (2009) finding that responding to questions one-on-one in the classroom improves student–instructor relationships.

Even students who didn't note 'shyness' as a particular issue reported feeling more connected with the professor (and teaching assistant) than they normally would in a large class. One participant noted that, 'Especially in a large lecture, it is sometimes difficult to communicate with the professor but LectureTools made the professor more accessible', while another said, 'I felt like I had a closer line of communication with the TA/prof'. This connectedness to the instructor seemed to extend beyond just simply being able to seek clarification. Students described the connection being formed between student and professor as 'personal' and 'close'. By having a direct, personal channel between the instructor and student through which communication is both synchronous and asynchronous, the instructor becomes more accessible. Through such accessibility, student–instructor relationship development, even in the large class, becomes feasible.

Two other interesting themes emerged from the qualitative data around student–instructor relationships. Several students noted that the opinion polling function (multiple choice and short answer questions asked in class) demonstrated that the professor 'cared' about the opinion of students. One student noted 'I felt I could easily interact with the professor ... by submitting my opinion', while another said, 'I think the occasional question allowed for better communication because it created feedback as a norm'. Finally, one student noted that LectureTools facilitated the development of closer relationships between students in the large class: 'it is really interesting to see how classmates and peers respond to questions as well. It puts a sort of positive relationship between us, creating a feeling of unity in the class'. It's possible that in-class polling contributed to what Wurst *et al*. (2008) call a

'collaborative and cooperative' learning environment (p. 1767), which has been found to contribute to positive student–instructor relationships.

Finally, this study explored whether increased frustration with using the tool resulted in diminished returns of student engagement and student–instructor relationships. No such negative correlations were found. It would appear that the frustrations associated with adopting and learning a new technology, while present, did not prevent students from reaping the positive rewards associated with LectureTools use. In fact, in their open-ended responses, several students noted both technical concerns (e.g., that the iPad app needed to be improved), while also noting the excellent benefits of LectureTools on their level of engagement and connection to the professor. This is a promising finding for any professor who is concerned that technology frustrations may diminish the positive impact of using digital tools in the large class.

While these findings were certainly promising, we did note some student concerns with the tool. Approximately eight students expressed either neutrality ('It didn't really add or subtract anything') or dissatisfaction with elements of the tool. Those who expressed frustration or dissatisfaction noted a wide variety of issues, with no two students mentioning the same concern. These concerns included: technical issues with the iPad app; the lack of certain functionality that the student deemed to be important (in this case, the ability to copy and paste text from a slide); and finally, the student's personal preference to record notes by hand.

Limitations

The results of this study are based on data collected from one undergraduate course. The student experience in this course may be affected by other variables (such as the course material, the professor, or room), which may have influenced students' overall positivity or negativity in responses. It would be of great interest and value to repeat the data collection with additional – and varied – groups of students.

Another limitation was created by the very polling technology this study evaluated. LectureTools permits multiple student responses to a single multiple-choice polling question. As a result, numerous students provided multiple responses to single questions (e.g., indicating both 'agree' and 'strongly agree' to a statement about student engagement). In these cases, responses to those questions had to be omitted from data analysis.

Conclusion

This study confirms the results of previous studies, such as Bergom *et al*. (2011), which found that LectureTools results in an increase in student engagement. Uniquely, however, this study found that LectureTools also facilitates the development of positive student–instructor relationships in the large post-secondary class. Students expressed overwhelming agreement that the tool increased their feelings of engagement with the lecture and facilitated a connection with the professor. This connection was described as 'close' and 'personal' suggesting a supportive relationship (Myers 2006); such supportive student–teacher relationships have been found to result in numerous positive benefits for student learning, satisfaction, motivation and retention. It must be noted that instructors need to learn, and indeed master, technology in the classroom so that time is not wasted in setting it up or managing it, so that it is used productively and not trivially and so that students remain interested in its use (Nielsen, Hansen,

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and Stav 2013). Nevertheless, large classes pose a barrier to the healthy development of positive student–instructor relationships. It is promising to find that technologies such as LectureTools have the potential to mitigate – perhaps even eliminate – the negative effects of large class size in this regard.

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Appendix 1. Instrument questions

Q #	Variable Code	Question
1	[a]REL1	Responding to short answer questions using LectureTools enabled the professor to get to know me better.
2	[b]TEC1	Other than submitting my reaction paper, I did not use any other LectureTools features (such as flagging slides as confusing or asking questions).
3	REL2	When using LectureTools I felt like I could develop a more personal relationship with the professor and/or TA.
4	REL3	By using LectureTools, I felt more inclined to ask the professor or TA a question.
5	TEC2	LectureTools was frustrating to use.
6	[c]ENG1	Responding to short answer questions using LectureTools encouraged me to remain attentive during the lecture.
7	ENG2	Flagging unclear material enabled the professor to respond to concepts that I might have not understood otherwise.
8	REL4	By asking the professor or TA questions through LectureTools, I felt that I was contributing more to class discussions.
9	ENG3	When using LectureTools I was less inclined to browse the internet (compared to laptop use in other classes that do not use LectureTools).
10	ENG4	As a result of using LectureTools I felt more engaged and involved in the lecture.

[a]Variables beginning in 'REL' relate directly to student–instructor relationships; [b]variables beginning in 'TEC' relate to functions of the LectureTools program; [c]variables beginning in 'ENG' relate to student engagement.

Appendix 2. Correlation matrix

		REL1	TEC1	REL2	REL3	TEC2	ENG1	ENG2	REL4	ENG3	ENG4
REL1	Pearson Correlation	1	−0.157	0.121	0.103	0.024	−0.040	−0.061	0.065	0.043	0.168
TEC1	Pearson Correlation	−0.157	1	−0.103	0.041	0.135	0.113	−0.034	−0.052	0.115	0.129
REL2	Pearson Correlation	0.121	−0.103	1	0.387[a]	−0.029	0.150	0.167	0.211[b]	0.215[b]	0.405[a]
REL3	Pearson Correlation	0.103	0.041	0.387[a]	1	0.103	0.313[a]	0.279[a]	0.535[a]	0.139	0.437[a]
TEC2	Pearson Correlation	0.024	0.135	−0.029	0.103	1	0.126	0.119	−0.063	−0.005	0.075
ENG1	Pearson Correlation	−0.040	0.113	0.150	0.313[a]	0.126	1		0.429[a]	0.482[a]	0.617[a]
ENG2	Pearson Correlation	−0.061	−0.034	0.167	0.279[a]	0.119	0.335[a]	1	0.419[a]	0.378[a]	0.309[a]
REL4	Pearson Correlation	0.065	−0.052	0.211[b]	0.535[a]	−0.063	0.429[a]	0.419[a]	1	0.270[a]	0.415[a]
ENG3	Pearson Correlation	0.043	0.115	0.215[b]	0.139	−0.005	0.482[a]	0.378[a]	0.270[a]	1	0.506[a]
ENG4	Pearson Correlation	0.168	0.129	0.405[a]	0.437[a]	0.075	0.617[a]	0.309[a]	0.415[a]	0.506[a]	1

[a]Correlation is significant at the 0.01 level (2-tailed); [b]correlation is significant at the 0.05 level (2-tailed).

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