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A network analysis of blended learning: Perceived causal relations between use of learning resources, regulation strategies and course performance

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Abstract (max 150 words) currently 129

Blended learning is often associated with student-oriented learning in which students have more control over the learning path, which will stimulate self-regulated and deeper learning. Although the perceived value of blended learning is clear, less is known if and how blended learning contributes to better course performance. Current research often uses (multiple) linear regression to determine the effect of blended learning although in practise education is not a linear process. In the current paper we present a novel technique to establish the intertwined relationship between the use of (digital) learning resources, regulation strategies and course performance in a blended learning setting. Current research visualises indirect relationships between the use of (digital) learning resources and course performance. Moreover, it shows that centrality of nodes-determinant for course performance-differs considerably between courses.

Theoretical framework (max 600 words) currently 589

Within the slipstream of the popularity of MOOCs, blended learning can count on renewed interest in higher education. Currently, blended learning is seen as the solution to personalize education, even within mass education systems higher education faces nowadays. Blended learning describes learning activities that involve a systematic combination of offline (face-to-face) interactions and online technology-mediated interactions supported by learning technologies between students, teachers and course content (Bliuc, Goodyear, & Ellis, 2007). Blended learning could contribute to the autonomy of the students in which they have more control over the learning path, which will stimulate self-regulated and deeper learning (Lust, Elen, & Clarebout, 2013a). Although the perceived value of blended learning is clear, less is known if and how blended learning contributes to better course performance.

Research shows that students vary in the way they use these learning technologies to support learning. Research shows that a majority of the students do not use the learning technologies at all (Lust, Vandewaetere, Ceulemans, Elen, & Clarebout, 2011; Orton-Johnson, 2009) or apply it in such a way to substitute for the face-to-face activities (Bos, Groeneveld, Bruggen, & Brand-Gruwel, 2015). There is little insight into why students do or do not use certain learning technologies and what the consequences of these (un)conscious choices are in relation to course performance. It is hypothesized that motivation, self-regulation, goal orientation and self-efficacy play a major role in whether or not technologies are used (Lust et al., 2013a; Lust, Elen, & Clarebout, 2013b; Ellis et al, 2008). More research

is needed to determine the intertwined relation of motivational beliefs, self-regulation and the actual use of learning technologies in a blended learning setting and subsequently the impact the usage differences have on course performance.

One of the advantages of blended learning, from a researcher perspective, is that it takes place in an online environment, which easily generates data about these online activities. The measurement, collection, analysis and reporting using data from these online learning activities is often referred to as learning analytics (Siemens, 2012). Learning analytics measures variables such as total time online, number of online sessions or hits in the learning management systems (LMS) as a reflection of student effort, student engagement and participation (Zacharis, 2015). Learning data analysis from students in a blended learning setting provides the opportunity to monitor students' use of different learning technologies throughout the course which might provide insight into the relationship between blended learning and enhanced course performance. Current research often uses (multiple) linear regression to determine the impact learning technologies have on course performance. However, (multiple) linear regression has the assumption of a linear model in which all the independent variables have a significant and direct association with the dependent variable. However, in education these associations are often not linear and associations can also be mediating or moderating. When establishing intertwined relationships of motivational beliefs, self-regulation and the actual use of learning technologies in a blended learning setting a different methodological approach is needed. Current research uses novel technique: a network analysis of these different variables. Network analysis is often used to visualise social (media) networks, but can also be used to visualise the intertwined relationship of the different variables within a blended learning setting, including the use of the LMS, self-regulation of students and participation in offline activities. A network analysis presents the nodes as variables and the relationships between variables (e.g., correlations) as weighted edges in which important structures can be detected that are hard to extract by other means (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012).

Methods (max 400 words) currently 399

The participants were 333 university psychology students (243 female, 90 male, $M_{\text{age}} = 20.2$, $SD_{\text{age}} = 1.66$) attending an obligatory course on Biological Psychology. During the entire time frame of the course student attendance to the face-to-face lectures was registered on an individual level. These lectures were recorded and made available directly after the face-to-face lectures had taken place. The viewing of these lecture recordings was monitored on an individual level. During the course students were offered several formative assessments. Completion of these formative assessments was not mandatory although the amount of assessments a student completed and the score students obtained were stored in the database. Moreover the hits within Blackboard and minutes of use of Blackboard were also stored in the database. At the start of the course students were obliged to fill out the Inventory Learning Style (ILS) (Vermunt, 1992). Although originally designed to measure "Learning Styles" this self-report diagnostic instrument was used in this research to assess a student their regulation strategies and processing strategies.

Since we wanted to determine general principles between use of (digital) learning resources, regulation strategies and course performance, we conducted a follow up study at the Faculty of Law where 516 law students (218 male, 298 female, $M_{\text{age}} = 22.1$, $SD_{\text{age}} = 4.9$) participated in the research. During their course on Contract Law we gathered data that was similar to the psychology course: attendance to face-to-face lectures, attendance to case based lectures, minutes of watched recorded lectures for either the face-to-face or case based lecture, amount of formative quizzes completed, minutes spent in Blackboard and lecture sheet downloads. Also, at the start of the course students filled out the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & de Groot, 1990). For the purpose of the current research only the subscales processing strategies, regulation strategies and goal orientation were scored.

For these different variables undirected weighted networks were conducted for students who passed and for students who failed the course. In this network each variable is presented as a node and the correlations as edges. Green edges indicate a positive correlation and red lines a negative correlation. The thickness of the line reflects the strength of the correlation. Moreover, the centrality of the variables was determined to identify the most important vertices within a network. These centralities were calculated for both courses: students passing and failing the course and for all students.

Findings and conclusion (max 300 words) currently 290

The current study aimed to provide insight into the intertwined relation between use of learning resources, regulation strategies and course performance. A network analysis provides some insight in the variables and their relation with course performance. Figure 1 shows the correlation networks for both courses: students who passed the course and students who failed the course. As can be seen the different variables show less interdependence when students pass the course. Moreover, the variables measuring motivation and regulation, as determined by the ILS and MSLQ, show a limited correlation between the use of the learning resources. This trend is reflected in both courses.

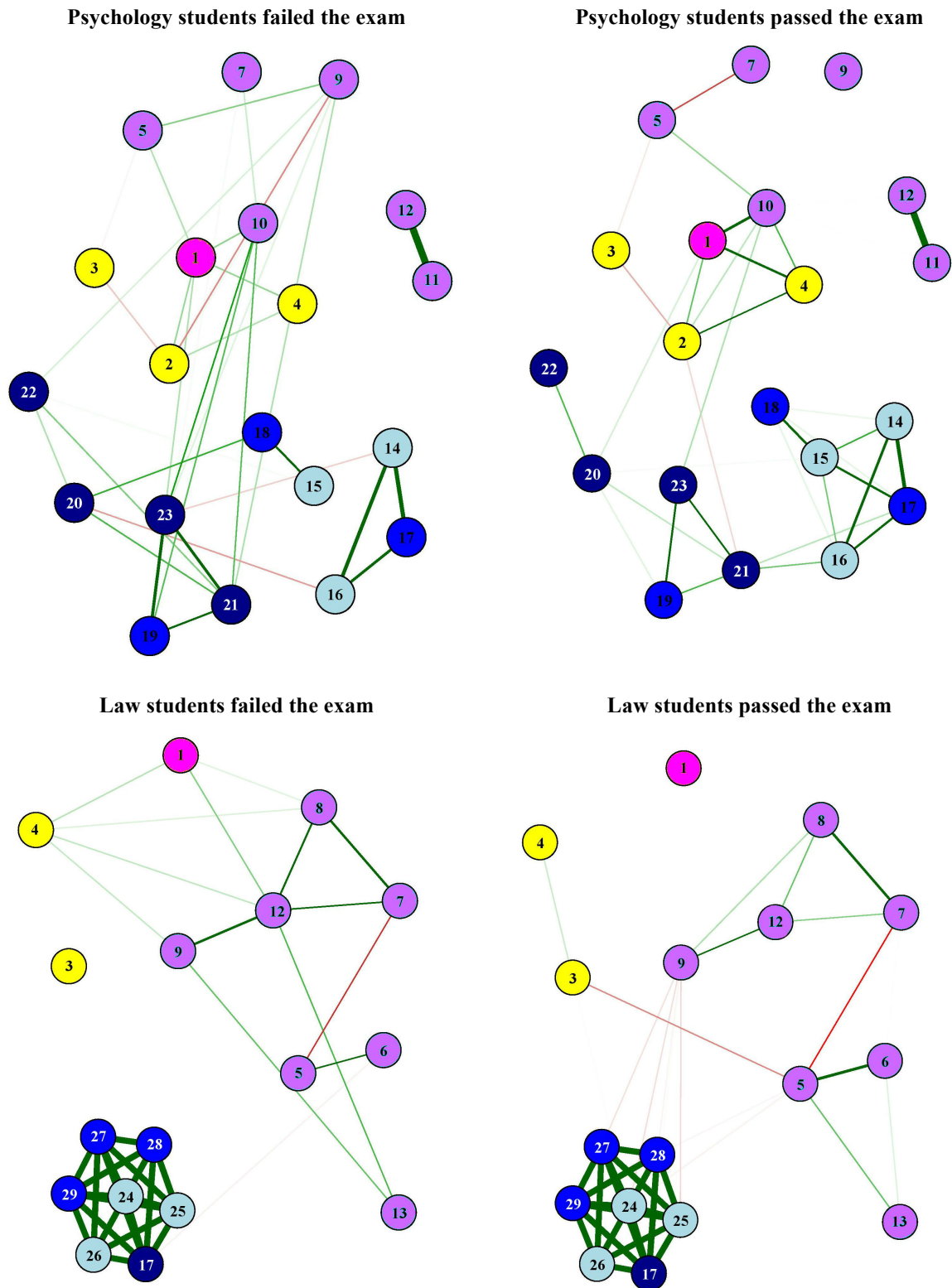
One of the advantages of the network approach is that indirect relations between variables are easier to detect. For example for psychology students who passed the course there is a positive correlation between score on the formative assessments and final grade of the course. In turn, attending face-to-face lectures positively influences score on the formative assessments, although attending face-to-face lectures has no direct impact on course performance.

The centrality of each node in the network is quantified by three indices: *betweenness*, *closeness* and *strength*. Figure 2 shows the centrality for the psychology network in which the score on formative assessments has the highest score on all three indices for all participants, indicating that this is the most central node in the network. In Figure 3, the centrality for the law network, shows that face-to-face lectures has the highest score on all three indices for all participants and is most central in the network.

During the conference we will discuss the results in more detail with a specific focus on the consequences for blended learning design and subsequently the use of learning analytics within a blended course.

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1. Final grade 2. GPA 3. Age 4. Grade First Course 5. Face-to-Face lectures 6. Case Based Lectures 7. Minutes of RL (F2F) 8. Minutes of RL (CB) 9. Amount of Formative Assessments 10. Score on Formative Assessments 11. Hits in Blackboard 12. Minutes in Blackboard 13. Lecture Sheets Downloads 14. Deep Processing Strategy 15. Stepwise Processing Strategy 16. Concrete Processing Strategy 17. Self Regulation 18. External Regulation 19. Lack of Regulation 20. Certificate Oriented 21. Test Oriented 22. Occupation Oriented 23. Ambivalent 24. Task Value 25. Intrinsic Goal Orientation 26. Extrinsic Goal Orientation 27. Self Efficacy 28. Critical Thinking 29. Peer Learning

Figure 1. Correlation networks of students who failed and passed the exam

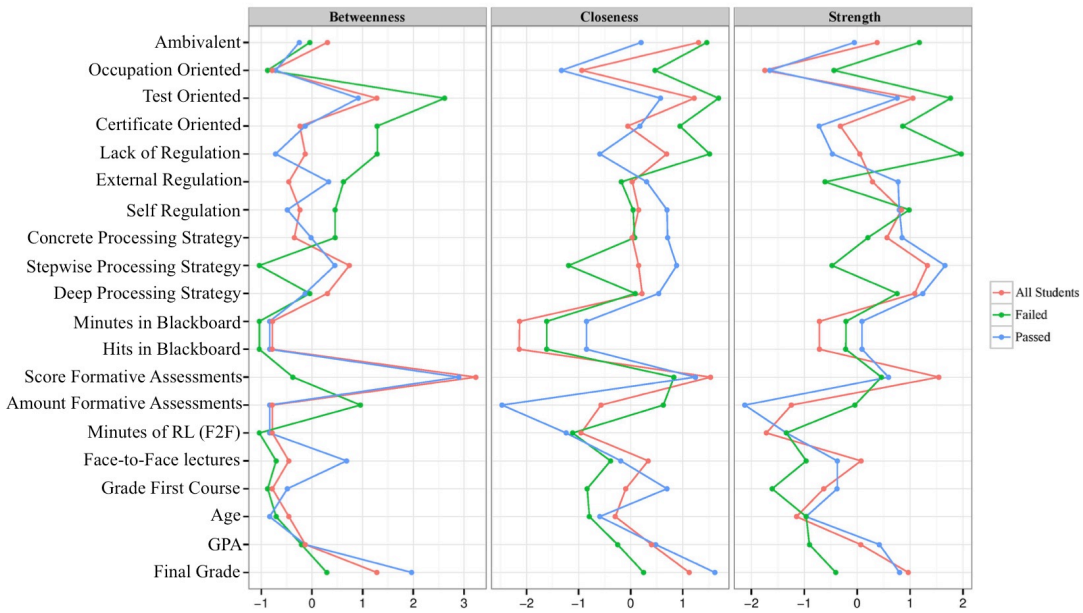


Figure 2. Centrality plot for psychology course for three networks depicting the betweenness, closeness, and strength of each node.

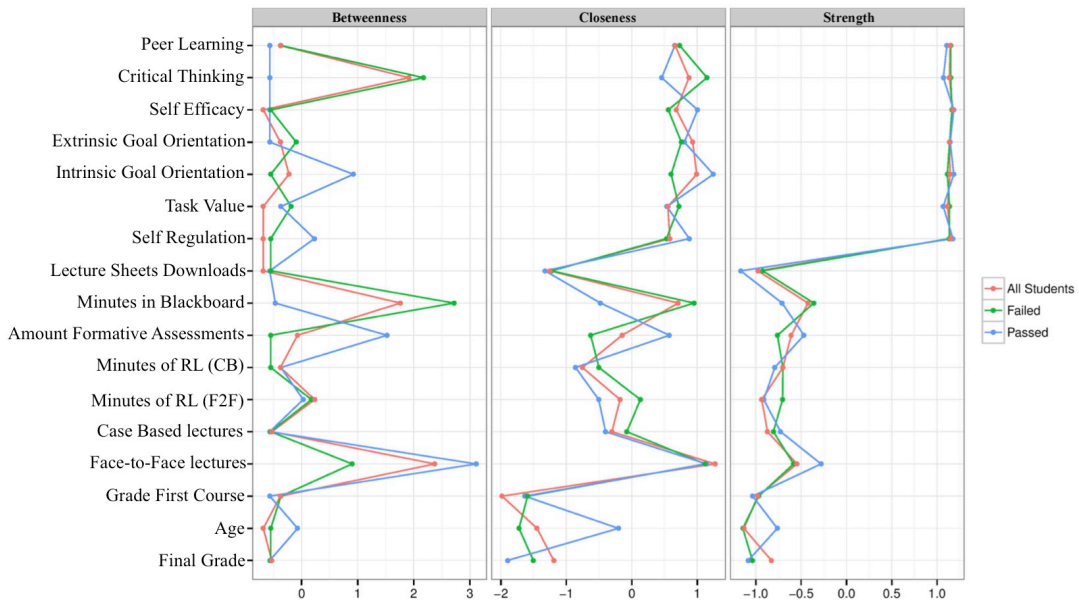


Figure 3. Centrality plot for law course for three networks depicting the betweenness, closeness, and strength of each node.