

4. Discussion

There are a large number of factors that indicate a student's likely performance on a course delivered by blended learning in a flipped classroom environment. This study has attempted to identify and measure these to produce a model that can be used as a benchmark against which to monitor student engagement and identify students at risk as early as possible so that so that timely interventions can be made. This has long been the policy in courses delivered in a traditional classroom setting, where a continuous period of non-attendance prompts a request for a meeting and some corrective action, but similar schemes are not in common use when all material is delivered online.

When scheduled face-to-face sessions are held, attendance monitoring remains a valuable tool and the results presented here show that even with a blended delivery that does not require students to be physically present in order to receive the material, there remains a positive correlation between attendance and achievement. However, attendance is not the only, or the strongest, indicator of success. This study finds that the strongest indicator is consistency of effort – students who engage with the material on more occasions and with shorter gaps between engagements can be seen to achieve to a higher level than those for whom effort is more “bursty” in nature. This can be seen to have a greater positive effect than the overall time spent in engagement, and indeed the total engagement time is seen to have almost no relation to a student's overall performance. However, it should be recognised that the measures assessed in this study are not independent of each other. Student attendance at a scheduled session will by definition involve engagement with the material on that day and for the duration of the class. In addition, it is perfectly possible for students to engage with the Virtual Learning Environment only for the time it takes to download the material and work thereafter from a local copy, thus circumnavigating the activity tracking facility, but observation of student behaviour in labs suggests that very few (if any) adopt this approach.

There is no doubt that a study of students' work patterns can be used as an indication of their likely success on a course. Delivery using a Virtual Learning Environment that supports activity tracking can produce a wide range of statistics that enable detailed analysis to be carried out. However, the data may contain additional information that the linear regression analysis described here does not reveal. Future work will include the application of machine learning techniques. This will enable a deeper investigation into the relationship between students' work patterns and their overall performance. The ultimate aim is to construct a tool that enables real-time monitoring of student progress and automatic intervention for those for whom engagement is giving cause for concern.

References

- [1] Oakley BA, Sejnowski TJ. What we learned from creating one of the world's most popular MOOCs. *npj Sci. Learn.* 4 (7), 2019.
- [2] Dean A, Lima A. Student Experience of E-Learning Tools in HE: An Integrated Learning Framework. *European Journal of Social Science Education and Research*, 4(1), pp 39-51, 2017.
- [3] Wade R. Pedagogy, places and people. *Journal of Teacher Education for Sustainability*, 14(2), pp 147-167, 2012.
- [4] Fisher R, Perényi Á, Birdthistle N. The positive relationship between flipped and blended learning and student engagement, performance and satisfaction. *Active Learning in Higher Education*, 1(17), 2018.
- [5] Page J, Meehan-Andrews T, Weerakkody N, Hughes DL, Rathner JA. Student perceptions and learning outcomes of blended learning in a massive first-year core physiology for allied health subjects. *Advances in Physiology Education*, 41(1), pp 44–55, 2017.
- [6] Waha B, Davis K. University students' perspective on blended learning. *Journal of Higher Education Policy and Management*, 36(2), pp 172-182, 2014.
- [7] Purcell P. Engineering Student Attendance at Lectures: Effect on Examination Performance, in *Proceedings of the International Conference on Engineering Education ICEE 2007*; 3-7 September 2007; University of Coimbra, Portugal
- [8] Massingham P, Herrington T. Does Attendance Matter? An Examination of Student Attitudes, Participation, Performance and Attendance. *Journal of University Teaching and Learning Practice*, 3(2), 2006.
- [9] Lukkarinen A, Koivukangas P, Seppälä T. Relationship between Class Attendance and Student Performance. *Procedia – Social and Behavioural Sciences*, Vol. 228, pp 341-347, 2016.
- [10] Devadoss S, Foltz J. Evaluation of Factors Influencing Student Class Attendance and Performance, *American Journal of Agricultural Economics*, 78(3), pp 499-507, 1996.
- [11] Sloan D, Manns H, Mellor A, Jeffries M. Factors influencing student non-attendance at formal teaching sessions. *Studies in Higher Education*, 2019.
- [12] Ozdamli F, Asiksoy G. Flipped Classroom Approach. *World Journal on Educational Technology: Current Issues*, 8(2), pp 98-105, 2016.
- [13] Smallhorn M. The flipped classroom: A learning model to increase student engagement not academic achievement. *Student Success*, 8(2), pp 43-53, 2017.
- [14] Russell J-E, Andersland MS, Van Horne S, Gikonyo J, Sloan L. Large Lecture Transformation: Improving Student Engagement and Performance through In-class Practice in an Electrical Circuits Course. *Advances in Engineering Education*, 6(2), 2017.